Autonomous Port of Dakar
Republic of Senegal

Master Plan Development Project of Multifunction Port of Ndayane Republic of Senegal

FINAL REPORT
Volume-Ⅱ

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JAPAN INTERNATIONAL COOPERATION AGENCY

NIPPON KOEI CO., LTD.

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3. Activity for Output 1 (Formulation of M/P)

3.1 Setting a Socio-economic Framework

3.1.1 Nominal GDP

(1) Senegal

The nominal GDP of Senegal's economies is estimated through 2050 using actual figures based on IMF's World Economic Outlook Database, April 2022 and estimated through 2027, and from 2028 onward using Nigeria's projected 2041-2050 growth rate of 4.5% based on PwC's Long-term Economic Outlook: 2050 World (May 2017).

Based on the above, the estimated nominal GDP of Senegal in 2047 is US$111 billion and in 2050 is US$126 billion.

Table 3.1 Estimation of Nominal GDP in Senegalese Countries

(Billions U.S. dollars)

Year	Nominal GDP	gdp growth(%)
2008	17	
2009	16	-4.3
2010	16	0.0
2011	18	10.4
2012	18	-0.8
2013	19	7.1
2014	20	4.7
2015	18	-10.2
2016	19	7.1
2017	21	10.3
2018	23	10.2
2019	23	1.2
2020	25	4.8
2021	28	12.7
2022	28	2.9
2023	32	12.9
2024	36	13.5
2025	40	8.8
2026	43	8.6
2027	46	6.6
2028	48	4.5
2029	50	4.5
2030	52	4.5
2031	55	4.5
2032	57	4.5
2033	60	4.5
2034	63	4.5
2035	65	4.5
2036	68	4.5
2037	71	4.5
2038	75	4.5
2039	78	4.5
2040	81	4.5
2041	85	4.5
2042	89	4.5
2043	93	4.5
2044	97	4.5
2045	101	4.5
2046	106	4.5
2047	111	4.5
2048	116	4.5
2049	121	4.5
2050	126	4.5

「World Economic Outlook Database, April 2022」IMF

2022-2027
Average annual growth rate
10.07 %/year

Nigeria's projected 2041-2050 growth rate of 4.5% based on PwC's "Long-term Economic Outlook: 2050 World (May 2017)"

2028-2034
Average annual growth rate
4.50 %/year

2035-2040
Average annual growth rate
4.50 %/year

2041-2050
Average annual growth rate
4.50 %/year

Source: JPT

- **Nigeria** is projected to be the fastest growing African economy in our model, growing at an average rate of 4.2% per annum. However, this is predominately driven by population growth, which is projected to increase by around 2.3% a year on average to 2050, the fastest growing total population of the 32 countries covered. In contrast to our previous 2015 edition, in which we projected Nigeria to be the fastest growing economy of the countries we modelled, Nigeria is now expected to be only the sixth fastest. This reflects the slowdown of the Nigerian economy over the last two years as a result of a fall in oil prices. Nigeria will average around 2% annual growth to 2020, with growth then picking up speed in the decades following to average almost 4.5% p.a. between 2041 and 2050. Along with South Africa, Nigeria is one of the few to see a marked acceleration of annual average growth over the next few decades, as opposed to a moderation. To support long-term sustainable growth, Nigeria needs to develop a broader-based economy, diversifying its exports to ensure its growth is not dampened by global price or demand shocks. Alongside this, Nigeria should develop its institutions and infrastructure, supporting long-term productivity growth (see Box 2 below for further discussion of these issues).

Table 3: Breakdown of the components of average real GDP growth (2016-2050)

Country	Average population growth p.a.	Average real growth per capita p.a.	Average GDP growth p.a. (in domestic currency)
Vietnam	0.5%	4.5%	5.0%
India	0.7%	4.1%	4.9%
Bangladesh	0.6%	4.1%	4.8%
Pakistan	1.4%	2.9%	4.4%
Philippines	1.1%	3.1%	4.3%
Nigeria	2.3%	1.9%	4.2%
Egypt	1.4%	2.6%	4.1%
South Africa	0.5%	3.2%	3.7%
Indonesia	0.6%	3.1%	3.7%
Malaysia	0.8%	2.7%	3.5%
Colombia	0.4%	2.9%	3.3%
Mexico	0.7%	2.5%	3.3%
China	-0.1%	3.1%	3.0%
Turkey	0.5%	2.4%	3.0%
Saudi Arabia	1.1%	1.9%	3.0%
Argentina	0.7%	2.2%	2.9%
Iran	0.4%	2.5%	2.9%
Brazil	0.4%	2.2%	2.6%
Thailand	-0.3%	2.9%	2.6%
Australia	0.9%	1.3%	2.3%
Poland	-0.4%	2.5%	2.1%
United Kingdom	0.4%	1.5%	1.9%
Russia	-0.3%	2.2%	1.9%
Canada	0.6%	1.2%	1.8%
United States	0.5%	1.3%	1.8%
South Korea	0.0%	1.8%	1.8%
Netherlands	0.1%	1.5%	1.6%
France	0.3%	1.3%	1.6%
Spain	-0.1%	1.5%	1.4%
Germany	-0.2%	1.5%	1.3%
Italy	-0.2%	1.2%	1.0%
Japan	-0.5%	1.4%	0.9%

Source: PwC analysis

Source: "The World in 2050"PwC

Figure 3.1 Prospects for Nigeria Growth Rates

(2) West Africa (16 Countries)

Nominal GDP for West Africa (the Economic Community of West African States and 16 countries in Mauritania) were the same as those for Senegal.

The estimated nominal GDP of West Africa (16 countries) in 2047 is US$3.398 trillion and in 2050 is US$3.878 trillion.

Table 3.2 Estimation of Nominal GDP in West Africa (16 Countries)

(Billions U.S. dollars)

Year	Nominal GDP	gdp growth(%)
2008	481	
2009	443	-7.9
2010	527	19.0
2011	594	12.6
2012	648	9.2
2013	724	11.7
2014	778	7.4
2015	684	-12.1
2016	609	-10.9
2017	597	-2.0
2018	669	12.0
2019	700	4.6
2020	691	-1.2
2021	734	6.2
2022	812	10.5
2023	908	11.9
2024	1,015	11.7
2025	1,132	11.5
2026	1,262	11.5
2027	1,409	11.7
2028	1,473	4.5
2029	1,539	4.5
2030	1,608	4.5
2031	1,680	4.5
2032	1,756	4.5
2033	1,835	4.5
2034	1,918	4.5
2035	2,004	4.5
2036	2,094	4.5
2037	2,188	4.5
2038	2,287	4.5
2039	2,390	4.5
2040	2,497	4.5
2041	2,610	4.5
2042	2,727	4.5
2043	2,850	4.5
2044	2,978	4.5
2045	3,112	4.5
2046	3,252	4.5
2047	3,398	4.5
2048	3,551	4.5
2049	3,711	4.5
2050	3,878	4.5

「World Economic Outlook Database, April 2022」IMF

2022-2027
Average annual growth rate
11.66 %/year

Nigeria's projected 2041-2050 growth rate of 4.5% based on PwC's "Long-term Economic Outlook: 2050 World (May 201

2028-2034
Average annual growth rate
4.50 %/year

2035-2040
Average annual growth rate
4.50 %/year

2041-2047
Average annual growth rate
4.50 %/year

Source: JPT

3.1.2 Population

(1) Senegal

Estimated populations of Senegal are based on actual figures from United Nations (UN) World Population Prospects 2024 and are up to 2050 (median estimates from 2024 onward).

Based on the above, the population of Senegal in 2047 is estimated to be 28.78 million and in 2050 is estimated to be 30.14 million.

Table 3.3 Population Estimates for Senegalese Countries

(1,000 people)

Year	Population	Growth rate(%)	
2008	11,907		「World Population Prospects 2024」UN
2009	12,191	2.4	
2010	12,484	2.4	
2011	12,787	2.4	
2012	13,131	2.7	
2013	13,490	2.7	
2014	13,932	3.3	
2015	14,373	3.2	
2016	14,814	3.1	
2017	15,255	3.0	
2018	15,695	2.9	
2019	16,134	2.8	
2020	16,572	2.7	
2021	17,007	2.6	
2022	17,435	2.5	
2023	17,867	2.5	
2024	18,288	2.4	median estimates from 2024 onward
2025	18,716	2.3	2024-2027 Average annual growth rate
2026	19,148	2.3	
2027	19,585	2.3	2.31 %/year
2028	20,029	2.3	
2029	20,480	2.2	
2030	20,934	2.2	
2031	21,393	2.2	
2032	21,855	2.2	2028-2034 Average annual growth rate
2033	22,317	2.1	
2034	22,780	2.1	2.17 %/year
2035	23,244	2.0	
2036	23,710	2.0	
2037	24,175	2.0	
2038	24,640	1.9	2035-2040 Average annual growth rate
2039	25,105	1.9	
2040	25,567	1.8	1.92 %/year
2041	26,028	1.8	
2042	26,487	1.8	
2043	26,946	1.7	
2044	27,404	1.7	
2045	27,862	1.7	2041-2050 Average annual growth rate
2046	28,317	1.6	
2047	28,775	1.6	1.64 %/year
2048	29,229	1.6	
2049	29,686	1.6	
2050	30,138	1.5	

Source: JPT

(2) West Africa (16countries)

Populations in West Africa (16 countries) are estimated by actual figures from United Nations (UN) World Population Prospects 2024 up to 2050 (median estimates from 2024 onward).

Based on the above, the population of West Africa (16 countries) in 2047 is estimated to be 698 million and in 2050 is estimated to be 730 million.

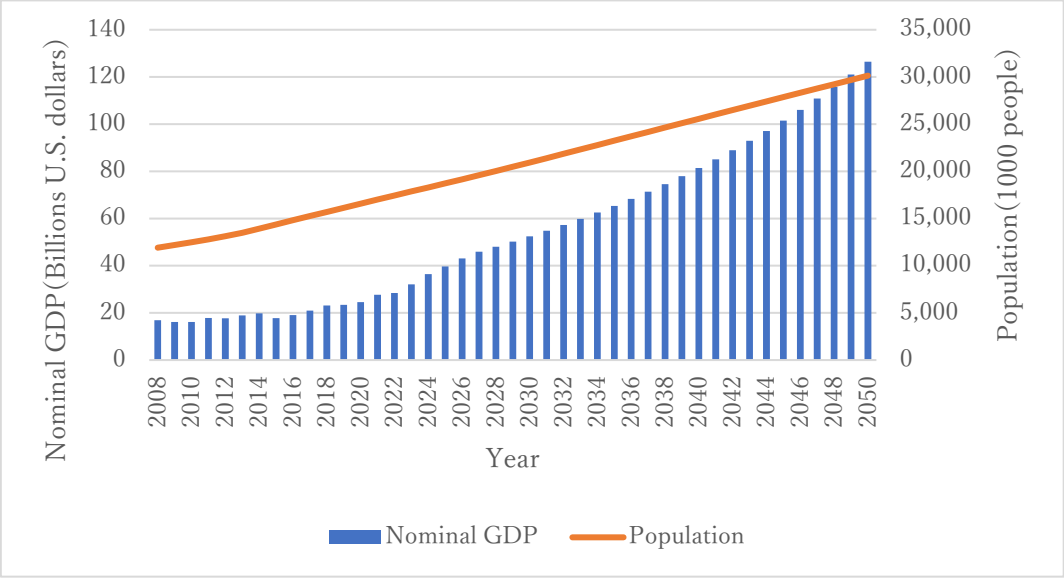
Table 3.4 Population Estimates for West Africa (16 Countries)

(1,000 people)

Year	Population	Growth rate(%)	
2008	298,947		「World Population Prospects 2024」UN
2009	307,407	2.8	
2010	316,061	2.8	
2011	324,976	2.8	
2012	334,243	2.9	
2013	343,464	2.8	
2014	352,903	2.7	
2015	362,641	2.8	
2016	372,360	2.7	
2017	382,333	2.7	
2018	392,213	2.6	
2019	401,883	2.5	
2020	411,478	2.4	
2021	421,164	2.4	
2022	430,921	2.3	
2023	440,953	2.3	
2024	451,136	2.3	median estimates from 2024 onward
2025	461,367	2.3	2022-2030 Average annual growth rate
2026	471,699	2.2	
2027	482,123	2.2	2.24 %/year
2028	492,638	2.2	
2029	503,209	2.1	
2030	513,867	2.1	
2031	524,577	2.1	
2032	535,376	2.1	2031-2035 Average annual growth rate
2033	546,249	2.0	
2034	557,173	2.0	2.07 %/year
2035	568,117	2.0	
2036	579,096	1.9	
2037	590,099	1.9	
2038	601,081	1.9	2036-2040 Average annual growth rate
2039	612,061	1.8	
2040	623,031	1.8	1.86 %/year
2041	633,965	1.8	
2042	644,852	1.7	
2043	655,700	1.7	
2044	666,489	1.6	
2045	677,224	1.6	2041-2047 Average annual growth rate
2046	687,871	1.6	
2047	698,450	1.5	1.57 %/year
2048	708,942	1.5	
2049	719,368	1.5	
2050	729,700	1.4	

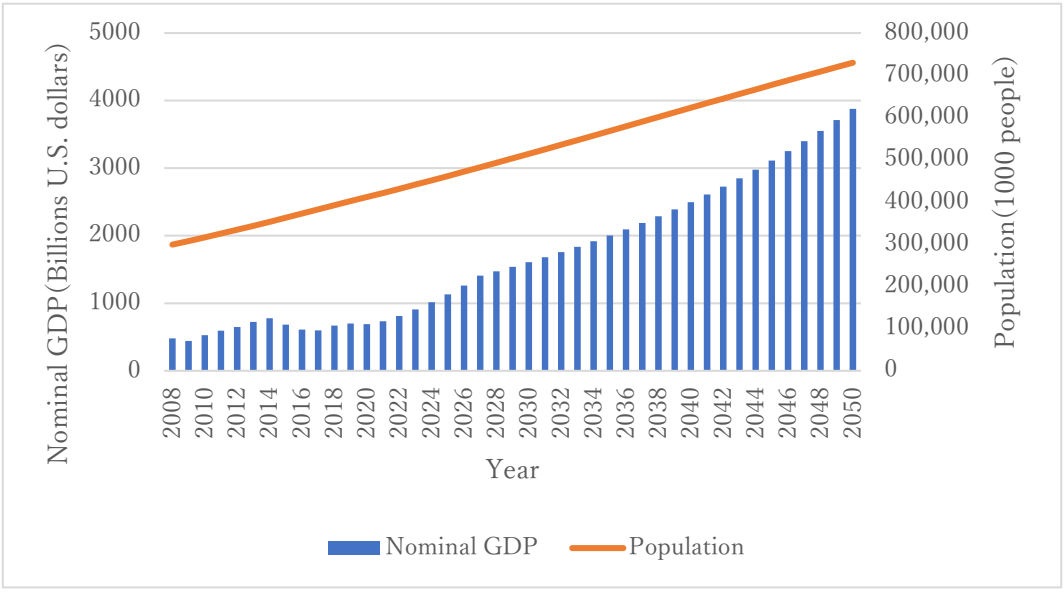
Source: JPT

The projected figures for nominal GDP and population are shown below.



Source: JPT

Figure 3.2 Projected figure of nominal GDP and population in Senegal



Source: JPT

Figure 3.3 Projected figure of nominal GDP and population in West Africa (16 Countries)

3.2 Contents of Environmental and Social Considerations

The environmental and social consideration of this Project will include comparison of alternatives and proposing the direction of M/P to maximize the development benefits while minimizing negative impacts of the Project from the view of Strategic Environmental Assessment (SEA). This will be based on the results of baseline survey of the Project affected area, analysis of legal and institutional arrangement, and stakeholder discussions. In addition to those consideration, the survey for gender

mainstreaming status will be also conducted to propose countermeasures and indicator to monitor gender related status of the project area. Survey targets are the women who are engaged in fishing related activities such as seafood processing at the port of Dakar and women's group around Ndayane new port area.

3.3 Basic Information of Strategic Environmental Assessment

The implementation of Strategic Environmental Assessment (SEA) in Senegal is regulated by laws and regulations related to environmental and social considerations. Therefore, the relevant laws and regulations and plan for implementing SEA are summarized below.

3.3.1 Regal Framework and Implementing Structure Relevant to Environmental and Social Consideration

In Senegal, relevant regal framework consists of constitution law, environmental law and its relevant orders. The provisions for Environmental Impact Assessment (EIA) are shown in the L49, L50, L51, L52, L53, and L54 of the Environmental Law. The specific procedures are detailed in the ministerial ordinances No.9468-9472 as presented in Table 3.5.

Table 3.5 Laws and Regulations Related to Environmental and Social Considerations

Reference Document	Contents
Constitution Law No. 2016-10, Apr.5	Provides the right for all Senegalese to live in health environment, and obligates environmental impact assessment for implementation of activities which may impact surrounding environment.
The Environmental Law No. 2001-01 (January 15, 2001)	The law specifies the system for environmental conservation, types of activities which are obliged to monitor impacts to ambient water bodies, air pollution, soil, noise etc., and penalty in case of non-compliance. Titre II, Chapter V stipulates items for environmental impact assessment, flow of impact assessment and public participation to the procedures.
Decree No. 2001-282(April 12, 2001) (Environmental law enforcement regulations)	It is an implementing regulation of the Environmental Law. It stipulates the methods of environmental impact assessment and the examination of the results of impact assessment. The Annexes define the project types subject to detailed or simplified environmental impac assessment.
Water Code Law No.1981-13	The law stipulates utilization of water bodies excluding marine area.
Ministry ordinances related to Environmental Considerations	
Ministry Ordinance No.9468, 28 Nov.200	On the public participation in the environmental impact study
Ministry Ordinance No.9469, 28 Nov.200	On the organization and operation of the technical committee
Ministry Ordinance No.9470, 28 Nov.200	On the conditions for issuing the accreditation for carrying out activities relating to environmental impact studies;
Ministry Ordinance No.9471, 28 Nov.200	On the content of the terms of reference for EIAs
Ministry Ordinance No.9472, 28 Nov.200	On the content of the EIA report

Source: JPT

The agencies and departments relevant to Environmental and Social Consideration of the Project are as listed in Table 3.6.

Table 3.6 Organizations Responsible for Environmental and Social Consideration of the Project

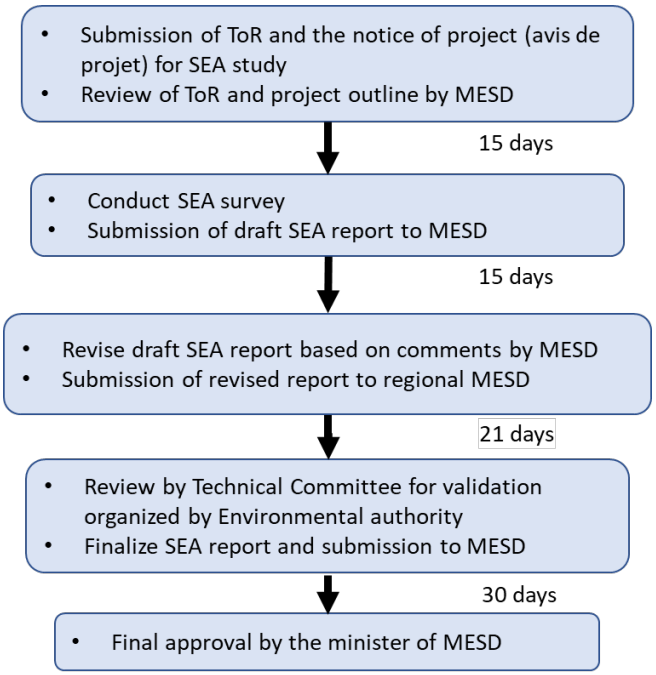
Organization/Department	Responsibilities and Functions
Ministry of Environment and Sustainable Development (Ministére de l'Environnment et du Development Durable: MESD)	The Ministry in charge of environmental protection and its role is defined by Ministerial Decree 2012-652, 4 July. It has jurisdiction over the formulation of national policies that contribute to the protection of the environment, conservation of ecosystems, environmental monitoring, and the preservation of water bodies. It is also responsible for minimizing the environmental impact of business activities that may lead to environmental pollution.
Direction of Environmentand Establishment Categories (Direction de l'Environnemnet et des Establissements Classees: DEEC), Environmental Impact Assessment Division (Division des Evaluation d'Impact sur l'Environnement)	Direction and department in MESD, in charge of appraisal of environmental impact assessment or strategic environmental assessment.
Technical Committee (TC)	A committee to be established the Project specifically in the process of environmental impact assessment to assist DEEC
Licensed environmental and social impact assessment firm by DEEC	Prepare a ToR for EIA/SEA study to be submitted to DEEC, conduct studies, prepare a report, and provide explanations to TC.
Dakar Port Authority (PAD)	As an implementing agency, PAD will be responsible of hiring above-mentioned licensed contractor and supervise the implementation of the study. It will also arrange for the technical committee's site visits and host public hearings as requested by DEEC.

Source: JPT

3.3.2 Procedures for Strategic Environmental Assessment of the Project

Since the objectives of the Project is to develop master plan for a port and surrounding port industrial area, a Strategic Environmental Assessment (SEA) shall be conducted to fulfill requirements for environmental impact assessment.

In conducting the SEA study, the project proponent shall contract an approved contractor to prepare a ToR for the environmental impact assessment study. This is attached to a letter of request for approval signed by the project proponent and submitted to MESD. After ToR is submitted, MESD conducts a survey of the proposed project site in parallel with the review by MESD, and any comments from MESD on the approval of ToR are reflected in the content of the survey. SEA survey usually takes about four months to complete. After the survey, the licensed contractor prepares a draft report, which is approved by the operator, finalized, and submitted to the MESD regional office. A technical committee will be established with the participation of the operator, contractor, and the survey team, etc., and will review the report. The report is then finalized and submitted to MESD, and final approval is obtained from the minister of MESD. As of September 2024, the SEA study report of the project is being prepared. The report will be submitted to MEDD, finalized based on the comments obtained by Technical Committee, and to obtain final authorization.



Source: JPT based on information obtained from local environmental consultants

Figure 3.4 SEA Approval Procedures in Senegal

3.3.3 Gap Analysis between Domestic Regulations and JICA Guidelines

Table 3.7 presents the gaps between JICA Environmental and Social Consideration Guidelines (hereinafter referred to as "JICA Guidelines") and Senegal's legal system for environmental and social considerations, and countermeasures to fill the gaps in implementing this Project and also the projects proposed by M/P.

Table 3.7 Gap Analysis between JICA Guidelines and Relevant Regulations

Item	Requirements from JICA Guidelines	Senegal Related Law	Gap and Implementation Policy for this Project
Basic matters	When implementing a project, at the planning stage, investigation and consideration for the impact of the project on the environment and society should be done as early as possible, and alternatives and mitigation measures should be avoided or minimized. The results must be reflected in the project plan. (Attachment 1)	Environmental Law L48 describes the necessity of evaluating the impact on the natural environment and living environment and avoiding or minimizing the impact in the implementation of policies, plans, and programs that are expected to affect all environments. (This item legitimizes SEA implementation) Environmental Law L51 It states that EIA includes impact assessment before, during, and after project implementation.	No major gap was observed. This project will proceed according to the JICA Guidelines and Senegal legal system.

Item	Requirements from JICA Guidelines	Senegal Related Law	Gap and Implementation Policy for this Project
Information disclosure	Projects must be well coordinated so that they can be agreed in a socially appropriate manner in the country or region where they are planned. In particular, for projects that are assumed to have a significant impact on the environment, information must be disclosed and fully discussed with local residents and other stakeholders from an early stage when considering alternatives to the project plan. The result is necessary to be reflected in the project contents. (Attachment1)	Environmental Law L52, L53, and L54 stipulate the information disclosure in the context of public consultation. However, disclosure of project related documents is not clearly defined.	Disclosure of project related documents is not clearly defined. In implementation stage, project related information should be disclosed to communities in suitable manners (such as community level discussion, information disclosure targeted to specific social group discussions such as women, fisheries etc.).
Public Consultation	Projects must be well coordinated so that they can be agreed in a socially appropriate manner in the country or region where they are planned. In particular, for projects that are assumed to have a significant impact on the environment, information must be disclosed and fully discussed with local residents and other stakeholders from an early stage when considering alternatives to the project plan. The result is necessary to be reflected in the project contents. (Attachment 1) Consultations with local residents and other stakeholders should be conducted as necessary throughout the project preparation and implementation period, but especially at the time of selection of environmental impact assessment items and drafting. (JICA Guidelines, Attachment 2. Environmental Assessment Report required for Category A)	Environmental Law L52, L53, and L54 stipulate that public hearing shall be conducted and the need for community participation in decision making during the implementation of environmental impact assessment.	No major gap was observed. Although the number of stakeholder consultations is not specified in detail, DPW EIA (2020) includes multiple rounds of public consultations, taking into account the scale and scope of impact of the project. Consultations under the project have been implemented several times at proper timings to fully collect PAPs' opinion and those are reflected to the plan.

Item	Requirements from JICA Guidelines	Senegal Related Law	Gap and Implementation Policy for this Project
Consideration of Alternatives	Several alternatives must be considered in order to avoid undesired impacts of the project, to minimize it and to select a better one for environmental and social considerations. When considering countermeasures, first consider avoidance of impacts, and if this is not possible, consider measures to minimize or mitigate impacts. Compensation measures shall be considered only if the effects are still unavoidable even if avoidance measures, minimization or mitigation measures are taken. (Attachment 1)	Article 9 of Ministerial Ordinance on Environmental Impact Assessment Report (No.9472) It states that various alternatives should be considered.	No gap was observed. This project has been proceeded according to the JICA Guidelines and Senegal legal system.
Monitoring	Project proponents etc. should make efforts to make the results of the monitoring process available to local project stakeholders. (JICA Guidelines, Appendix 1, Monitoring 3) When third parties point out, in concrete terms, that environmental and social considerations are not being fully undertaken, forums for discussion and examination of countermeasures are established based on sufficient information disclosure, including stakeholders' participation in relevant projects. Project proponents etc. should make efforts to reach an agreement on procedures to be adopted with a view to resolving problems. (JICA Guidelines, Appendix 1, Monitoring 4)	Article9 of Ministerial Ordinance on Environmental Impact Assessment Report (No.9472) It states that monitoring and environmental management plans should be considered.	No major gap was observed, though the disclosure of monitoring results to the concerned public is not well defined. This Project have been proceeded according to the JICA Guidelines and Senegal legal system, and monitoring result shall be disclosed.
Scope of impact to consider	The scope of impacts that should be investigated and considered for environmental and social considerations includes impacts on human health and safety and natural environment through the air, water, soil, waste, accidents, water use, climate change, ecosystems and biota (including cross-border or global environmental impacts. (Attachment1)	Environmental Law L39, The scope of environmental impact assessment is defined and covers the items in the left column.	No gap was observed. This Project have been proceeded according to the JICA Guidelines and Senegal legal system.

Item	Requirements from JICA Guidelines	Senegal Related Law	Gap and Implementation Policy for this Project
Ecosystem and Biota	Projects must not involve significant conversion or significant degradation of critical natural habitats and critical forests.	Environmental Law L3, The chapter provides for the consideration of biodiversity conservation and sustainable projects. It also provides for the development and implementation of ecosystem conservation plans for those projects may affect ecosystem and biota.	No gap was observed.
Indigenous Peoples	Any adverse impacts that a project may have on indigenous peoples are to be avoided when feasible by exploring all viable alternatives. When, after such an examination, avoidance is proved unfeasible, effective measures must be taken to minimize impacts and to compensate indigenous peoples for their losses.	There is no clear definition provided.	Although no clear provisions have been indicated by law, the survey results suggest that the affected population may include ethnic minorities. In case the impact of the Project is identified, a response in line with the JICA guidelines will be considered and proposed.

Source: JPT

3.3.4 Regal Framework and Implementing Structure Relevant to Land Acquisition and Resettlement

With regard to land acquisition in Senegal, the Law on the National Domain states that the government has the right to expropriate land, even private land, if it is for the public welfare. The procedure for expropriation of private land by the government is carried out by the Compensation Evaluation Committee organized by the prefectural governors who have jurisdiction over the land to be expropriated. Although the amount of compensation for expropriation is stipulated in the National Property Regulations, it is already far from the market price, so the amount is to be determined through negotiations between the Compensation Evaluation Committee and the landowner. In addition, Table 3.8 presents other major laws and regulations, and Table 3.9 presents relevant institutions.

Table 3.8 Laws and Regulations Related to Land Acquisition and Resettlement

Reference Document	Contents
"Law on the National Domain" No.64-46, Jun.17 1964	The Law stipulates the types and extent of state property and the authority of the state. Among them, the provision on state property states that the state can expropriate private land if it is for the public welfare.
Law No.76-66, Jul.2 1976	The law stipulates the classification of land ownership, including the types and extent of state-owned land, penalties, and the rights of landowners with respect to private land.
Law No.76-67, Jul.2 1976	The Law provides for the Land Acquisition for public facilities.
Law No.2011-07	The system for land registration and registry is arranged.
Law No. 1994-64, 22 Aug.	The law provides for the sale of state-owned land for industrial or commercial use.
Ministry ordinances related to Land Acquisition	
Ministry Ordinance No. 64-573. 1967	It provides for conditions of applying "Law on the National Domain."
Ministry Ordinance No. 77-563, 1977	Implementing regulations for the Law No.1976-67
Ministry Ordinance No. 81-557, 1981	Implementing regulations for the Law No.1976-66, describes the handling of private properties.

Reference Document	Contents
Ministry Ordinance No. 91-938, 1991	It revises chapter 38 of "Law on the National Domain" and stipulates compensation for informal habitants.

Source: JPT

Table 3.9 Institutions Relevant to Involuntary Resettlement and Land Acquisition

Organization/Department	Responsibilities and functions
Ministry of Economy and Finance (Ministre de l'Economi et des Finances)	When a presidential decree on land acquisition for a specific project is issued, the ministry will be responsible for implementing the land acquisition.
Ministry of Internal affairs (Ministre de l'Intérieur)	Responsible for the establishment and operation of the Compensation Evaluatio Committee.
Committee for Control and Operation of Land (Commission de Contrôle des Opérations Domaniales)	An organization that leads the procedures for land acquisition. It is established for each project and is composed of the prefectural governor, the district tax commissioner, the mayor of the target city, the head of the Ministry of Environment's regional environmental bureau, and the head of the regional office of the Ministry of Urban Planning.
Land Registration Office (Cadastre)	The office responsible for the practice of land registration.

Source: JPT

Table 3.10 summarizes the results of comparison of the legal framework for resettlement and land acquisition set forth by these and other guidelines such as the JICA Guidelines and the World Bank Safeguard Policies and other key issues. While there was no major gap observed, it was confirmed that there are no clear provisions on compensation for informal settlers, the timing of compensation payments, and the timing of livelihood restoration assistance and grievance redress mechanisms.

Table 3.10 Gap Analysis between JICA Guidelines and Relevant Senegalese Laws

No	JICA guidelines and World Bank Safeguard Policy	Senegalese Regulations	Result of analysis and Measures to fill the gap
1.	Involuntary resettlement and loss of means of livelihood are to be avoided when feasible by exploring all viable alternatives. (JICA GL)	Articles L48 and L49 of the "National Environmental Regulations" stipulate almost the same content as the left.	There are no major gaps.
2.	When population displacement is unavoidable, effective measures to minimize impact and to compensate for losses should be taken. (JICA GL)	The above provisions are made for the minimization of impact. Compensation for loss is stipulated in Law No. 76-67 (July 2, 1976) as monetary compensation.	There are no major gaps, however, there is no specific definition of "effective measures" for assistance programs. In formulating the SEA, effective measures such as livelihood recovery assistances are discussed and proposed.
3.	People who should be resettled involuntarily and people whose means of livelihood will be hindered or lost must be sufficiently compensated and supported, so that they can improve or at least restore their standard of living, income opportunities and production levels to pre-project levels. (JICA GL)	Law No. 76-67 (2 July 1976) governs the provision and content of compensation.	
4	Compensation must be based on the full replacement cost as much as possible. (JICA GL)	Article 14 of Law No. 76-67 (July 2, 1976) stipulates that compensation for affected residents and property shall be equivalent to the market value of the property for all affected persons.	There are no major gaps, but compensation based on the replacement cost is not clearly defined. In practice, the market value of the asset corresponds to the replacement cost, which has been clarified and incorporated in the plan.
5	Compensation and other kinds of assistance must be provided prior to displacement. (JICA GL)	Law No. 76-67 (July 2, 1976), Article 14 stipulates payment of compensation before physical relocation, and in practice, payment is usually made before relocation.	There are no major gaps.
6.	Compensation policy needs to be disclosed and applied consistently. Compensation standards should be informed to the affected people.	Article 5 of Law No. 76-67 (July 2, 1976) stipulates the disclosure of information to affected residents by means that are normally available.	Information disclosure is stipulated, but there is no specification of written explanation, application of consistent compensation standards. Those have been specified under this SEA and to be consistently applied for the projects implemented under the M/P.
7.	In principle, the content of individual compensation to be agreed should be explained in writing, and made available for confirmation at any time.		
8.	For projects that entail large-scale involuntary resettlement, Resettlement Action Plans must be prepared and made available to the public. (JICA GL) In addition, for projects involving land acquisition or involuntary resettlement of less than 200 persons, an Abbreviated Resettlement Action Plan (A-RAP) shall be prepared.	Although there are no specific provisions in Senegal's laws and regulations, in practice resettlement plans are formulated and published.	Although there is no clear provision for the formulation of a resettlement plan, it is prepared and made public in practice. In implementation of the projects under the M/P, formulation and disclosure of the Resettlement Action Plans in line with domestic laws, JICA guidelines, and the World Bank policy shall be made compulsory.

No	JICA guidelines and World Bank Safeguard Policy	Senegalese Regulations	Result of analysis and Measures to fill the gap
9.	In preparing a Resettlement Action Plan, consultations must be held with the affected people and their communities based on sufficient information made available to them in advance. (JICA GL)	Article 5 of Law No. 76-67 (July 2, 1976) stipulates the disclosure of information to affected residents by means that are normally available. In addition, the Environmental Law stipulates the implementation of consultations with residents.	There are no clear provisions regarding the details of consultations with residents (implementation language, etc.). In addition, considering the low literacy rate, etc., it is possible that information may not reach affected people. In the process of formulating this SEA, participation of affected people in an appropriate manner (explanation of residents in each area, discussion and explanation based on social attributes such as women's groups, fishermen, etc.) will be ensured.
10	When consultations are held, explanations must be given in a form, manner, and language that are understandable to the affected people. (JICA GL)	As noted above, it provides for information disclosure through the usual means, but does not detail the language used.	
11.	Appropriate participation of affected people must be promoted in planning, implementation, and monitoring of Resettlement Action Plans. (JICA GL)	Article 5 of Law No. 76-67 (July 2, 1976) encourages the participation of residents in formulating resettlement plans.	
12.	Mechanisms for handling grievances from affected people and communities should be in place. (JICA GL)	There is no clear provision in Senegal's current legislation regarding grievance mechanisms.	There is no grievance mechanism elaborated, therefore it may not be addressed appropriately. In this SEA, establishment of grievance mechanism will be proposed to establish the system to respond to complaints from PAPs.
13.	The Borrower shall, as part of the environmental and social assessment, conduct a census to identify the persons who will be affected by the project, to establish an inventory of land and assets to be affected, to determine who will be eligible for compensation and assistance, and to discourage ineligible persons, such as opportunistic settlers, from claiming benefits (ESS5 para20)	Article 20 of Law No. 76-67 (2 July 1976) stipulates that compensation must be determined on the basis of the results of a census study.	There are no major gaps.
14.	Beneficiaries of compensation and assistance are categorized as follows: (a) Persons who have formal legal rights to land or property; (b) Persons who do not have formal legal rights to land or property, but have claims to land or property recognized by domestic law; (c) Persons who have no legal right or claim to the land or assets they occupy or use (ESS5 para10) The Borrower shall provide the PAP with compensation at replacement cost and other assistance necessary to improve or restore living standards in accordance with the provisions of paragraphs 26 to 36 of the WB ESS. (ESS5 para 12)	Ministerial Decree No. 91-938, 1991 stipulates compensation for affected people, including informal people. On the other hand, Law No.76-67 does not stipulate compensation for irregular residents on state-owned land.	There are differences in the provisions of compensation and support for irregular residents depending on laws and regulations, and there is a possibility that compensation and support will not be provided appropriately. In case involuntary resettlement is required in implementing the projects under the M/P, a plan shall be formulated to ensure that informal residents are appropriately compensated.

No	JICA guidelines and World Bank Safeguard Policy	Senegalese Regulations	Result of analysis and Measures to fill the gap
15.	Where the livelihoods of the displaced persons are land-based or where the land is collectively owned, the borrowing country shall, unless it can prove to the Bank's satisfaction that equivalent alternative land is not available, shall comply with paragraph 35(a).to provide alternative site options. (ESS5 para14)	Ministerial Ordinance No. 64-573.1967 mentions the provision of alternative land, but Law No. 76-67 has no provision for the provision of alternative land. Monetary compensation is usually provided.	Although some laws and regulations stipulate the provision of alternative land, compensation in the form of money is generally provided. In case land acquisition of PAPs whose livelihood depends on land is required in implementing the projects under the M/P provision of equivalent alternative land shall be proposed and incorporated into land acquisition plan.
16.	Transitional support will be provided to all economically affected populations as needed, based on reasonable estimated time required to restore their income-earning capacity, production levels and living standards (ESS5 para36)	Article 14 of the National Property Regulations stipulates that damages caused by project implementation must be sufficiently compensated.	Property compensation is defined, but there is no clear provision for livelihood restoration assistance. In formulating the SEA, the study team will examine how to grasp the impact on livelihoods, propose reasonable estimates and appropriate support, and incorporate them into the plan.
17.	Particular attentions should be paid to gender aspects and the needs of the poor and the vulnerable. (ESS5 para26)	There is no provision for socially vulnerable groups in Senegalese legislation.	Since there is no applicable law, there is a possibility that socially vulnerable people will not be properly considered. When formulating the SEA, consider the socially vulnerable.
18.	To address issues identified in environmental and social impact assessments, the Borrower should develop plans that are commensurate with the risks and impacts associated with project implementation. (ESS5 para21)	Although there are no specific provisions in Senegal's laws and regulations, in practice it is dealt with in the process of environmental and social impact assessment.	There is no clear definition in laws and regulations that requires formulation of plans relevant to involuntary resettlement and land acquisition. In implementing the project under the M/P, formulation of those plans shall be obliged to ensure appropriate handling of identified risks and effect of the projects.

Source: JPT

3.3.5 Scoping of SEA

As mentioned above, the plan is still under consideration at the moment, alternative 1, which has a high environmental impact, was selected as the optimal plan with consideration to required capacity and functions of Ndayane Multifunction Port (refer 3.3 for detail of alternatives). Since the Project involves a large scale of development and will have a large impact on both the environment and society, it is necessary to consider the needs of residents and the impact on the environment through SEA procedures and reflect them in into M/P. Therefore, the following scoping was carried out with the aim of extracting items that should be considered through SEA.

Table 3.11 Proposed Scoping for Alternative 1

	Item	Rating		Reasons ** CP: Construction Phase, OP: Operation Phase*
		CP	OP	
Pollution Control				
1	Air Quality/Dust	✓	✓	CP: Air pollution is expected especially in the dry season due to the operation of construction machinery and construction vehicles, but the impact is estimated to be limited.
				OP: It is expected that the operation of large-scale port facilities will result in increase of both sea and land transportation and affect air quality.
2	Water quality	✓	✓	CP: Although discharge of contaminated water from construction activities will be temporary, it is assumed that the impact on the sea area will be large due to scale of the project. In addition, disposal of surplus soil from channel dredging may affect water quality.
				OP: Since the new facility will be a large-scale, the wastewater generated from the facility is expected to cause negative impact. So, it is necessary to check the sewage treatment facility and the quality of treated wastewater. In addition, it is necessary to confirm the impact of surplus soil dumping due to maintenance dredging.
3	Soil contamination	✓	✓	CP: Since this project involves large-scale construction and dredging, there are concerns about the impact of soil contamination from construction equipment and building materials at the construction site, as well as contamination from the dredged soil for channel.
				OP: There is concern about the impact on soil contamination due to the operation of new facilities and disposal of surplus soil from maintenance dredging.
4	Noise & vibration	✓	✓	CP: Noise and vibration are expected due to construction machinery and construction vehicles. Also, depending on the construction route, it is necessary to take appropriate consideration when carrying out construction near facilities that require silence (schools, hospitals, etc.).
				OP: Impacts of noise and vibration are expected due to equipment operation as new facilities are adjacent to villages and houses. It is necessary to take appropriate mitigation measures for facilities close to resident area.
5	Land subsidence	✓	✓	CP/OP: The impact on land subsidence is expected as there are no water sources other than groundwater. Intensity of the impact should be examined through SEA study.
6	Offensive Odors			CP/OP: No impact is expected, as the project does not envisage any facilities that will permanently generate offensive odors.
7	Bottom Sediment	✓	✓	CP/OP: Impact on bottom sediment is expected due to channel dredging during construction phase and maintenance dredging during operation phase.
8	Solid Waste	✓	✓	CP: It is expected that construction will generate dredging surplus soil, waste materials, and garbage from construction sites and workers' quarters. Also, there is a possibility that a large amount of construction earth and sand will be generated from large-scale excavation and dredging. Appropriate solid waste management methods such as recycling, and reuse should be considered.
				OP: A large amount of general waste from new facilities, sewage sludge generated through sewage treatment process, and discarded soil due to maintenance dredging are expected.
Natural (physical) environment				
9	Topography/ geography	✓		CP: It is expected that the impact on the topography will be significant as the project involves large-scale excavation work.
				OP: No impact is expected after construction is completed because the topography is stable.
10	Hydrography	✓	✓	CP: Since this project envisions the construction of large structures in the sea area and involves dredging of navigation channels, there is a high possibility that the sea conditions will be impacted during construction.

	Item	Rating		Reasons ** CP: Construction Phase, OP: Operation Phase*
		CP	OP	
				OP: The impact is expected to be similar to construction phase as maintenance dredging is planned. The impact will be evaluated based on operation plans.
11	Groundwater	✓	✓	CP/OP: The impact on groundwater is expected as there are no water sources other than groundwater. Intensity of the impact should be examined through SEA study.
12	Ecosystem/ Flora & Fauna/ Biodiversity	✓	✓	CP: A wide area along the coast, including part of the project area, is designated as an IBA named "La Petite Côte." Since the construction work will be accompanied by dredging and surplus soil treatment, there will be alterations that will have a large impact on both land and sea areas.
				OP: Impact is expected as the project plans to construct offshore structures, which will permanently modify the tidal current. In addition, maintenance dredging is also assumed, which may have a large impact on the sea area.
13	Protected area	✓	✓	CP/OP: No direct modification to the protected area is expected, but there are concerns about indirect impacts as the project area is located adjacent to the Popenguin protected area.
14	Coastal area	✓	✓	CP: there are concerns about the impact due to the large scale of construction though effluent from construction activities is temporary. In addition, the impact of channel dredging is also expected.
				OP: Some impact is expected, so it is necessary to estimate the quality and volume of wastewater from facilities, the quality of treated wastewater, and the impact of maintenance dredging to coastal area.
Social environment				
15	Land Acquisition/ resettlement	✓		CP: There is a high possibility that development projects under the M/P may cause large-scale involuntary resettlement and land acquisition.
				OP: No impact is expected as no additional land acquisition is expected for any project after operation phase.
16	Poor	✓	✓	CP: Since the project may affect the livelihoods of coastal fishermen, detailed information shall be obtained and confirmed through social surveys. On the other hand, there is possibility that the poor may have employment opportunities by construction works.
				OP: At one hand, the project may affect the livelihoods of the poor negatively, on the other hand, it is expected that the project may increase the job opportunities large amount of employment will be generated. Therefore, the positive and negative impacts shall be assessed and mitigation measures for negative impact shall be proposed through SEA study.
17	Ethnic minorities/indigenous peoples	✓	✓	CP/OP: From one source, the project implementation area is an area inhabited by ethnic minorities. However, there are perception that they are not considered as minority in reality. The actual situation will be examined through SEA study.
18	Local economy, including employment and means of livelihood	✓	✓	CP: Negative impacts on villages whose main means of livelihood are fishing and tourism are expected. Whereas, the positive impact on the local economy is expected due to increased commercial/employment opportunities generated by construction activities.
				OP: In the long term, it is expected that commercial/employment opportunities will increase along with the growth of the local economy in the project area. On the other hand, permanent impacts on fisheries, seafood processing, tourism, etc., and the termination of temporary employment opportunities for local workers may have negative impacts after the construction work is completed.
19	Land use and use of local resources	✓	✓	CP: The project involves large-scale land modification and is expected to have a large impact on land use. While it is assumed that there will be a need to use the land for construction yards and workers' lodgings, but the impact is expected to be temporary.
				OP: The project is expected to have a large impact on both land and coastal areas, as it will significantly modify land use patterns.
20	Water use and water rights	✓	✓	CP: Impacts on water use, such as obstruction of access to water sources due to construction activities are expected, but it remains insignificant and temporary.

	Item	Rating		Reasons ** CP: Construction Phase, OP: Operation Phase*
		CP	OP	
				OP: The impact of water intake by the project activities is expected. The impact will be evaluated based on operation plans.
21	Social infrastructur and social services	✓	✓	CP: Temporary impacts are expected since majority of project areas are close to residential areas, and construction yards and workers' lodgings, traffic congestion due to an increase in the number of construction vehicles are expected.
				OP: It is expected that social infrastructure services such as water supply, sewerage, and electricity will be developed in the surrounding villages.
22	Social institutions such as local decision-making institutions	✓	✓	CP/OP: The influx of construction workers and people from outside the area is expected to affect social institutions such as social capital and local decision-making institutions. Although the impact of construction will be temporary, new residents may contact local decision-making bodies.
23	Misdistribution of benefits and damages	✓	✓	CP/OP: Indirect and direct impacts will occur on the surrounding residents as the project will involve resettlement and land acquisition. In particular, there is concern about uneven distribution of damage and benefits, such as those who are subject to resettlement, fishermen, and those who receive commercial benefits from port facilities.
24	Local conflict of interest	✓	✓	CP/OP: The project may cause conflicts of interest in the area, such as (1) land acquisition targets and their surrounding residents, (2) existing fishermen and farmers and new workers who will flow in due to port development.
25	Religious facility	✓	✓	CP/OP: There is a possibility that impacts such as the relocation of religious facilities may occur due to land acquisition. Since there is a possibility of temporary and indirect impacts such as traffic restrictions due to construction work, it is necessary to confirm them through a survey.
26	Cultural and historical heritage	✓	✓	CP/OP: There are no international cultural heritage sites (tangible or intangible) such as World Heritage sites in and around the project site. Senegal's nationally designated cultural properties are not located within the project site, but two sites are located in the adjacent Popenguin district: the church and sanctuary of Popenguin, and the mansions of Popenguin and Cap de Nazé. In addition, there is a possibility that impacts such as the relocation of religious facilities may occur due to land acquisition.
27	Landscape	✓	✓	CP/OP: Neighborhood of project site is basically farmland or residential area. Since the coastal area, which is part of the area to be modified, is used as a scenic spot for the tourism. There are concerns about the impact of the landscape being significantly modified.
28	Gender	✓	✓	CP/OP: Although this project is not expected to have a significant gender-specific impact, the impact on women engaged in the fishing industry and so on will be assessed through the study.
29	Children's rights	✓		CP: There is a possibility that child labor in construction that may hinder schooling opportunities in case its child labor is practiced in project area. In addition, since there is a possibility that construction vehicles will block school routes in the vicinity of the project implementation area, those impacts will be confirmed through the study.
				OP: Since the employment opportunities created by the project will be for adults only during both construction and operation phases, no impact is expected.
30	Public health (infectious diseases	✓	✓	CP/OP: Impact on public health is expected due to the influx of construction workers for construction phase and port operation staff for operation phase. In addition, increased risks regarding sexually transmitted diseases (STDs/STIs), HIV/AIDS and COVID-19 are expected among workers and the local population.
31	Occupational healt and safety	✓	✓	CP: It is necessary to pay attention to occupational health and safety of construction workers.
				OP: It is necessary to continuously pay attention to occupational safety and health of workers engaged in port facility operations and activities in port industrial zone.
others				

	Item	Rating		Reasons ** CP: Construction Phase, OP: Operation Phase*
		CP	OP	
32	Accident	✓	✓	CP: An increase in the risk of accidents due to the operation of construction machinery and construction vehicles, dredging machineries and small fishing boats are expected.
				OP: An increase in the risk of accidents due to operation of large-scale vessels and small fishing boats in sea area, the operation of vehicles for the port facility and local residents is expected.
33	Climate change	✓		CP: Although the impact is temporary, greenhouse gases (GHGs) will be emitted from the operation of construction machinery and construction vehicles. In addition, there is concern that the rate of absorption of carbon dioxide will decrease if vegetations are cut down, and there is a possibility that the project will involve the clearing of part of coastal forests.
				OP: No impact is expected during operation phase.

Source: JPT

3.3.6 Alternatives, Including Environmental and Social Impacts, based on the Concept of Strategic Environmental Assessment

With regard to the Master Plan for Ndayane Port, there is a significant difference between the original development plan and those revised in 2021. Considering the current status, three alternatives are proposed as shown in Table 3.12 and Figure 3.5 through Figure 3.7.

Table 3.12 Alternatives for Master Plan (as of 2023 January)

Plan	Outline	Detailed contents
Alt-0—as it is (conserving current status)	No development of new port	This proposal is not realistic because DPW has already started to develop a container terminal in a part of the M/P study area ahead of the Project. The development of Ndayane Port is one of the pillars of the "Plan Sénégal Emergent" (PSE), and failure to develop Ndayane Port will force an economic policy shift of the country. Expansion of the Port of Dakar to accommodate the increased cargo handling volume will be difficult and will hinder economic development of Senegal.
Alt-1: Maximum development (see Figure 3.5)	Modified original development plan, that covers outside of the area approved for PAD to develop	Sufficient berth extension and land can be secured in addition to the container terminal May be effective in preventing the burying of shipping lanes from the south (depending on the results of ongoing study) Construction on southern part may contribute calming waves inside port area. Likely to require extension of breakwaters
Alt-2: Compromised development (see Figure 3.6)	Development at landside within the area approved for PAD, and also involve seaside development	Space for berth extensions and sites other than container terminals can be secured. Likely to require extension of breakwaters The return on construction cost is estimated to be lower than other proposals.
Alt-3: Minimal development (see Figure 3.7)	Development at landside within the area approved for PAD, without expansion to seaside	Only limited functions can be operated outside of container terminals, such as liquid bulk ports or Ro/Ro, as yards cannot be located directly behind berths.

Source: JPT

Source: JPT

Figure 3.5 Alternative 1, Maximum Development
(Red line area: Port Terminal Area, Blue hatched area: Dredged Basin)

Source: JPT

Figure 3.6 Alternative 2, Compromised Development
(Red line area: Port Terminal Area, Blue hatched area: Dredged Basin)

Source: JPT

Figure 3.7 Alternative 3, Minimal development
(Red line area: Port Terminal Area, Blue hatched area: Dredged Basin)

3.4 Official Strategic Environmental Assessment Procedure for the Project

3.4.1 Formal Procedures with the Ministry of Environment

The implementation of the Strategic Environmental Assessment in Senegal is regulated by the legislation related to environmental and social considerations. As mentioned above, the project proponent is required to hire an approved contractor for the implementation of SEA, prepare a project brief (Avis de Project) and a ToR for the environmental impact assessment study (TDR EES), and submit these documents to the MESD. The JICA survey team drafted these documents and submitted them to PAD at the end of June 2023, then PAD finalized and submitted to MESD on 25th July 2023. Comments by MESD on these documents were received on 28th February 2024 and the implementation of the environmental and social impact study was approved in the letter dated 29th February 2024. The impact assessment has been carried out based on the content of the M/P. The assessment report will be finalized after verification by the Technical Committee formulated by MEDD.

3.4.2 Activities Related to Environmental and Social Considerations

Table 3.13 presents the contents to be performed mainly by the subcontractor for SEA study that include baseline survey, stakeholder analysis and stakeholder meetings. JST agreed with PAD that SEA shall be conducted under following limitations that (1) the results of the field survey in the DPW EIA (2020) shall be utilized at the maximum extent as possible and (2) SEA shall cover the work necessary to obtain approval from Senegalese government. Based on the condition, SEA study has been carried out.

Table 3.13 Contents of Works to be Conducted by Subcontractor (provisional)

Items	Contents
Confirmation of domestic ESC regulations, organizational arrangements, and gap analysis	Annalise the gap between Senegalese Environmental and Social regulations (such as EIA, SEA procedures, land acquisition and involuntary resettlement, indigenous people, protection of cultural heritage etc.) and JICA guidelines, check the procedures required specifically for port sector if there are any.
Baseline survey	Literature review of baseline condition will be conducted on pollution control aspects: air, water, waste management, soil, and "bio-physical environment": flora and fauna, hydrology, geography, "social environment" land use, socio-economic condition, social infrastructure, gender, labor conditions, accidents, transboundary impacts) Field measurement of items, which will be necessary for impact assessment will be also conducted (air, noise and vibration, waste, aquatic ecosystem, transportation, land use, socio-economic condition, social infrastructure, status of land acquisition and involuntary resettlement conducted during previous phases of the port development) and ecosystem services
Support for stakeholder consultations	Support for implementation of consultations (3 consultations in total are proposed) for SEA development (initial consultation: scoping, 1st consultation: M/P and draft SEA, discussion of alternatives, 2nd consultation: draft SEA report, verification of positive and negative impacts of M/P implementation). Interviews and small group discussions with local representatives, residents, fishermen, and tourism industry representatives to promote participation of socially vulnerable groups and to effectively understand their opinions.

Source: JPT

3.4.3 Selection of sub-contractors for SEA work

In early 2022 before this project started, PAD had initiated the SEA procedures under Senegalese law for 600 ha of the hinterland of the M/P area with its own funds, and had hired a local environmental consulting firm. At the time this M/P study was initiated, the company had already conducted a part of site surveys, including procedures with the Senegalese Ministry of Environment and consultations with some of the stakeholders. Since the scope covered by this M/P study includes the SEA coverage (600 ha) initiated by the PAD mentioned above, it was strongly recommended from the perspective of efficiency and consistency of the re-commissioning work in the SEA study of this M/P, and it was deemed appropriate to continue the contract with the company.

3.4.4 Comparison of SEA Study Contents

Based on the above background, a SEA study has been conducted on the port industry area of approximately 1,200 ha where development have been authorized to PAD, including the port development of Alternative 1. Table 3.14 presents comparison between existing SEA TOR and changes.

In addition, as the project is a SEA, importance of stakeholder engagement is emphasized. Since public consultations had been already conducted in some of the project areas through preceding SEA, and some of stakeholder meetings for this SEA overlap with those of preceding SEA, careful considerations were made to avoid confusing the stakeholders.

Table 3.14 Outline of the SEA study and comparison with preceding SEA study

Category	Survey item	Remarks (Difference from previous SEA)
1. Survey implementation and scoping	Scoping and submitting the study ToR to MEDD Conduct a stakeholder analysis and consultation plan Conduct SEA survey (baseline survey, analysis and arrangement of survey results) Submit SEA Draft Report to MEDD Reflect comments by MEDD and finalize the survey report.	Target area is expanded from 600 ha in the preceding SEA to 1,200 ha in this SEA. Carefully explain the differences of the M/P to the stakeholders who participated in the previous SEA meeting before conducting the study.
2. Evaluation of Port Development M/P Based on SEA	Evaluate the M/P's development items, including without project option Evaluate the environmental and social aspects of the short-term development plan proposed in M/P	Preceding SEA has not been implemented up to the project evaluation stage.
3. Stakeholder meetings	Conduct stakeholder meeting Promote the participation of residents and NGOs in SEA formulation.	Stakeholder meeting was not included in the preceding SEA (public consultations were already conducted).
4. Reports	Inception report Baseline survey report SEA report Minutes of Stakeholder Meeting and Participation Promotion Report	Baseline survey plan and the results of the literature survey were submitted for the preceding SEA, since the contract was suspended before the baseline survey.

Source: JPT

3.4.5 Result of Environmental and Social Consideration Study

(1) Baseline Survey

As mentioned earlier, a detailed EIA report has been prepared by DPW EIA (2020) for a part of the study area, and some field surveys were conducted as a part of a separate SEA survey work. These existing materials were used as effectively as possible in this study. Based on a careful review of these existing documents and based on the comments made by the Advisory Committee, a baseline survey was conducted for this survey SEA survey. The results of the study are described in "2.6.3 Environmental and Social Situation in the Project's Sphere of Influence," and a summary, including impact assessment results, is presented in.

Table 3.15 Results of Environmental and Social Consideration Survey (including Assessment Results)

item	Summary of survey results
Pollution	
Air quality	As a baseline condition, it is confirmed that the air quality around the project-affected areas were generally good, except dust concentrations that tended to be high. As the planned project site is located away from principal residential areas, the impact of construction work is expected to be limited. However, the frequency of construction vehicles, operational traffics of the port and port industrial park will increase. In addition, dust will worthen especially during the dry season. Based on the result, appropriate mitigation measures for these should be considered.
Water quality	Surface water of the area indicated a relatively high salinity and is alkaline. Heavy metal concentrations in groundwater, except for arsenic, are within water quality standards or below the detection limit. The arsenic concentration exceeds the WHO drinking water quality standard but is within Senegal's environmental standard. Regarding seawater quality, BOD, COD and coliform bacteria counts far exceed Senegal's standards. The environmental management plan shall include provisions for appropriate treatment of wastewater, oils, grease, etc. that are expected to be discharged as a result of the operation of port facilities and port industrial parks that are expected to be implemented in accordance with this M/P, and for compliance with discharge standards. Furthermore, monitoring will be carried out keeping in mind that there are water

item	Summary of survey results
	quality items in the baseline that already exceed sewage discharge standards, and necessary measures will be considered.
Soil contamination	No soil contamination has been confirmed in the project target areas. During construction, oil protection sheets and oil traps will be installed in areas where oil and other substances are handled, and during operation, the risk of soil contamination will be minimized by thorough safety management and regular inspections of storage facilities where chemicals are handled.
Noise/Vibration	Noise conditions in the study area were generally below Senegalese environmental standards. Construction work that will have a significant noise impact will be piling work, but as all construction work will take place within the offshore, the impact on nearest settlements is expected to be minor. In addition, since the work will be carried out at sea, the effects of vibrations are not anticipated. Although most of the transportation of construction machinery and materials will be by sea, land transportation of some construction vehicles may temporarily have an impact on surrounding settlements in terms of traffic, noise, and vibrations, but this is expected to be limited. During operation phase, it is expected that the number of container trucks will increase, which could result in impacts such as traffic, noise, vibrations, and congestion around roads in residential areas. Local residents live in the coastal areas surrounding the proposed construction site, and necessary countermeasures and mitigation measures should be considered and implemented to minimize the impact of the project and maintain the status quo.
Land subsidence	The results of the natural conditions survey and the DPW EIA concluded that the ground strength is sufficient and there is no risk of subsidence. On the other hand, there are potential risks if groundwater uses increases for the implementation of the M/P. Therefore, as a preventive measure, it is recommended that water sources other than groundwater be developed.
Bottom Sediment	The condition of the baseline bottom sediment is good, and while the chromium concentration at the relocation site is slightly higher than the reference environmental standard, it is still significantly lower than the values at the port of Dakar and the nearby estuary. When considering landfilling with dredged soil during port construction, it is necessary to analyze the composition of the landfill material, check the contamination level, and then consider an appropriate disposal method.
Solid waste	During the construction phase, general solid waste will be generated from the worker accommodation and construction work, and once in operation, general waste will be generated from facility operation, and industrial waste from the ship dismantling facility is also expected. Hazardous waste and general solid waste generated during construction and after operation will be collected and disposed of by properly licensed contractors. Regarding waste handling, the project activities shall be operated in a way that minimizes waste generation by segregating wastes and recycling materials as much as possible. Any waste generated will be disposed of at approved disposal sites to minimize the impact.
Natural Environment	
Topography/Geology	There will be no changes to the land topography, but as there will be landfill works, a certain amount of reclaimed land will appear on the sea. As with bottom sediment, the contamination status of the landfill material shall be analyzed and appropriate landfill and disposal methods will be considered to minimize the impact.
Hydrology	As the project area is at the outlet of the storm water drainage, drainage channels that has capacity to handle the storm water volume upstream is required. Selection of appropriate sizes and routes and prioritize drainage construction shell be required to minimize impacts on existing hydrology.
Groundwater	This project plans to install seawater desalination plant as its main water source, and no impact on groundwater is anticipated. When using groundwater as a temporary water source, the amount of water pumped must be managed to minimize the impact.
Ecosystems/Flora and Fauna/Biodiversity Protected Areas	The proposed project site is located within an IBA, but no endangered species were directly identified as a result of site survey. On the other hand, according to information from residents, sea turtles classified as endangered (EN) on the IUCN Red List have been observed in the area. Taking these into account, construction and operation plans must be formulated taking into consideration the impact on these turtles. In addition, as

item	Summary of survey results
	species designated as protected under domestic law have been identified, similar consideration will be given to minimizing any negative impacts.
Coastal areas	In the project site and surrounding areas, there are residents whose livelihoods depend on the direct and indirect use of vegetations that includes mangroves, and the benefits of coastal ecosystem services provided such as traditional fishing practices. The impact of projects on these ecosystem services should be minimized from the planning stage, and if an impact on livelihoods is foreseen, negative impacts should be minimized by providing livelihood restoration programs and provision of alternative land.
Social Environment	
Land acquisition and involuntary resettlement	As a basic policy, the top priority will be given to formulating development plans that do not require resident relocation; however, in the event that involuntary resettlement is unavoidable, a resettlement action plan and compensation policy will be formulated in accordance with domestic law and JICA guidelines, and efforts, such as livelihood restoration programs will be made to minimize the negative impacts of resettlement. In addition, livelihood restoration programs will be considered and implemented based on opinions expressed by residents during stakeholder consultations.
Poverty	The development of the new port is expected to have negative impacts on small-scale fishing activities that include small businesses using marine resources and on the poor who depend on ecosystem services for their livelihoods. On the other hand, when the construction work is carried out and the facilities are put into service after completion, there is a possibility that poor people living in the vicinity will gain employment opportunities. Negative impacts will be minimized by prioritizing project affected people for employment of project related non-skilled labors, and implementing livelihood restoration programs suited to the characteristics of affected residents.
Ethnic minority and indigenous people	Stakeholder consultations have revealed that ethnic minorities are among the coastal residents who practice small-scale fishing, raising concerns that the negative impacts will be even greater. When considering measures to assist Project Affected People (PAPs) to restore their livelihoods, it is necessary to take into full consideration the negative impacts on ethnic minorities and to minimize these.

Local economy (Employment and livelihood)	During the construction period, a positive impact is expected on the local economy due to increased commercial and employment opportunities generated by construction activity. On the other hand, there is a risk of negative impacts after construction is completed as temporary employment opportunities for local workers will end. The business plan will include provisions for preferential employment of affected residents for non-skilled positions that will be created in operation phase, as well as provision of vocational training opportunities, in order to increase the benefits to PAPs.
Land use and utilization of local resources	The implementation of the project will involve large-scale land and sea alterations, throughout construction and operation phases, and is therefore expected to have impacts. Regarding the need for land use for construction yards and worker accommodation, as development is planned in stages within the proposed project site, no impact on the surrounding areas is anticipated. Regarding the impact of construction and facility operation on the fishing and tourism industries, repeated discussions should be held with PAPs as the development plans are finalized, and appropriate compensation and assistance shall be provided.
Water usage	The disruption of access to water sources and the impact on water use caused by construction activities will be taken into consideration when selecting construction transportation routes, and plans will be made to minimize such impacts as much as possible. If the impact cannot be avoided, it will be minimized by providing alternative water sources and taking other alternative measures. Once the facility is in operation, it is planned to secure a water source by seawater desalination plant, and it is anticipated that there will be no negative impacts on water use for surrounding residents.
Existing social infrastructure and service	The project site, which includes the DPW development area, will disrupt the roads connecting Dakar and Popenguine that run parallel to the coastline, including the Toubab Dialaw - Popenguine road, which will have the effect of disrupting normal traffic and pilgrimage routes. It is necessary to work in cooperation with relevant organizations such as AGEROUTE to ensure that pilgrimage routes and access for local residents are secured, and to work to minimize the impact.
Local decision-making institutions	There is no concern that the influx of people from outside the region will have an impact on decision-making or social organization, and it is anticipated that there will be limited or no negative impacts.
Uneven distribution of damage and benefits	Community-level stakeholder consultations have raised concerns that economic development will negatively impact local people's livelihoods. In parallel with the development of port facilities, necessary facilities (drainage facilities, roads, etc.) will be developed to minimize the impact on the livelihood activities of surrounding communities, and appropriate compensation and livelihood recovery support will be planned and implemented. In addition, continuous monitoring will be conducted, and if any negative impacts that have not been anticipated at present are identified, appropriate compensation shall be implemented for those as well.
Conflicts of interest within the region	Conflicts of interest may arise between port-related parties and fishermen at both the construction and operation phases. Mitigation measures are needed to minimize damage to fishermen.
Religious Sites	Although there are no important religious facilities within the project area, the project will divide and disrupt an important pilgrimage route. As described in "Existing social infrastructure and service", arrangements must be made to ensure alternative routes are available and mitigation measures must be implemented.
Landscape	As the current coastline, which is covered by beaches, will be altered to construct port facilities, it is expected that this will have an impact on the coastal landscape in particular. Appropriate mitigation measures should be considered and those will be implemented to minimize negative impacts.
Gender	Survey results confirm gender gaps in land ownership and use, and access to local ecosystem services. The compensation policy and livelihood recovery assistance for this project will incorporate gender considerations and be planned to ensure fair compensation.
Children's rights	Child labor is prohibited by law in Senegal, and this project will also comply with relevant laws. In addition, the driving routes of construction vehicles, container trucks, etc., as well as construction routes, will be determined taking into consideration the safety of the several schools in the project area, minimizing the impact on children's education.

Public Health (Infectious Diseases)	It is anticipated that public health will be affected by the influx of people from outside during construction and operation phases, such as those involved in construction, those involved in the port operation, and employees of companies entering the port industrial park. For these immigrants, public health awareness campaigns shall be conducted through their employers, and measures will be taken to minimize the negative impacts.
Occupational Health (including work safety)	There are concerns about occupational accidents caused by construction work, the operation of construction vehicles, construction workers, and the operation of the facility once it is in service. These impacts will be minimized by creating and disseminating emergency response manuals and conducting accident response training, etc. Additionally, because this is a port business and much of the work is done at sea, it is necessary to constantly be aware of safety equipment such as safety belts.
others	
Accident	During construction and operation, there is a risk of accidents due to the intersection of the boats of small-scale fishermen with the traffic routes of offshore construction, dredging work, and large vessels. It is necessary to implement mitigation measures such as sharing construction and navigation schedules and setting routes to minimize the risk of accidents.
Climate Change	Greenhouse gases (GHGs) will be emitted from the operation of construction machinery and the running of construction vehicles, but since this is an expansion of existing facilities and is not large-scale, the impact is expected to be minor. In addition, while the line is in service, the number of container ships and container trucks transporting cargo will increase, raising concerns about the impact on climate change, but this is expected to be limited.

Source: JPT

(2) Stakeholder Analysis

It is very important to engage with many stakeholders at national and local level for this SEA. The study team analyzed the importance of each stakeholder based on their distance from and relevance to the project area, as follows. Based on these importance levels, a stakeholder consultation plan has been developed as follows.

Table 3.16 Stakeholder Analysis

Category	Institutions
<Very important>	
Political and institutional	Prefecture of Mbour, Prefecture of Rufisque, Directorate for the Environment and Classified Establishments, Marine Fisheries Directorate, Directorate of Transport, Pollution and Nuisance Control Division, Environmental Assessment Division, Division of Classified Establishments, Dakar Autonomous Port, DREEC Thiès, DREEC Dakar
Local authorities	Municipality of Yène, Commune of Ndayane - Popenguine
Neighboring Communities	Village of Popenguine, Village of Touba-Dialaw, Village of Ndayane, Village of Yène, Village of Kholpa, Village of Dagga
Civil society	Local Council of Artisanal Fishing of Rufisque - Bargny, Local Council of Artisanal Fishing of Yène - Dialaw, Ndoungouman Association, Collective for the defense of the interests of Yène Dialaw
<Important>	
Political and institutional	Ministry of Environment Sustainable Development and Ecological Transition, Ministry of Fisheries and Maritime Economy, Ministry of Infrastructure, Land Transportation and Outreach, Directorate of Civil Protection, Community Marine Protected Areas Directorate
National service companies	POLLING, PROMOGED

Political and institutional	Plan Senegal Emergent (BOS-PSE) Follow-up Operational Office, Public Procurement Regulatory Authority (ARCOP), Sanitation Directorate, Directorate of Flood Prevention and Management, HASSMAR, ROUTE, National Maritime Affairs Agency, Climate Change Division, Coastal Management Division, Sustainable Development Division, Lighthouses and Beacons Subdivision, National Sanitation Office of Senegal, Departmental Service for the Promotion of Territorial Development of Mbour, Departmental Service for the Promotion of Territorial Development of Russia
Defense and Security Forces	National Navy, Brigade of the Fire Brigade of Mbour, Rufisque Fire Brigade, Popenguine-Ndayane Gendarmerie Brigade, Yene Gendarmerie Brigade - Toubab Dialaw
National Service Companies	Senelec Seat, Senelec Rufisque, Senelec Mbour, Senelec Popenguine, Sen Eau Siege, Sen Eau Rufisque, Sen Eau Mbour, Sonatel Seat, Sonatel Rufisque, Sonatel Mbour
Local authorities	Municipality of Diass
Neighboring Communities	Village of Tchicky, Village of Raffo, Village Chief of Touba-Dialaw, Village Chief of Thichy, Ndayane village chief
Local Private Sector	Trustee of hotel owners
Religious and customary authorities	Priest of Poponguine, Archbishop of Dakar
Civil society	Cicomap (Dakar-Popenguine pilgrimage walk), Area of Influence Community Radios, Local Television Yène - Toubab Dialaw, Association for the Protection of the Environment of the Area, Collective for the defense of the interests of Yène Dialaw, Tourism unions in the area, PEACH BRAKE, School of Sands
<Medium>	
Political and institutional	Ministry of the Interior, Ministry of Economy, Planning and Cooperation, Department of Finance and Budget, Ministry of Territorial Communities, Planning and Development, Ministry of Women, Children and the Family, Water Directorate, Forests Hunting and Soil Conservation, Directorate for Management and Exploitation of the Seabed, Directorate-General for Economic Planning and Policy, Hydrocarbons Directorate, Directorate of Energy, Hydraulic Direction, Management of Livestock, Directorate for Local And Regional Authorities, Directorate General of Customs, Senegalese Agency for Tourism Promotion, National Office for Vocational Training, Vocational and technical training fund, Regional Agency Development of Thiès, Dakar Regional Development Agency, Regional Inspection of the Waters and Forests of Thiès, Regional Inspection of Waters and Forests of Dakar, Service Régional de l'Urbanisme Thiès, Dakar Regional Urban Planning Service, Regional Labor and Social Security Inspectorate of Thiès, Dakar Regional Labor and Social Security Inspectorate, Regional Division of Rural Development of Thiès, Dakar Regional Division for Rural Development, Regional Directorate for Livestock and Animal Production of Thiès, Dakar Regional Directorate for Livestock and Animal Production, Departmental Health Service of Mbour, Departmental Service of Hygiene of Rufisque, Departmental Service for the Promotion of Territorial Development of Mbour, Departmental Service for the Promotion of Territorial Development of Russia Cheikh A. DIOP University,
Academic institutions	Cheikh A. DIOP University, Amadou M. Mbow University, Rufisque IEF, IEF de Mbour
Religious and customary authorities	Imam Ratib de Ndayane, Imam Ratib de Yène, Imam Ratib de Popenguine, Imam Ratib by Toubab Dialaw
Riparian Communities	Village Chief of Popenguine, Raffo village chief, Village Chief of Dagga, Village Chief of Yène, Village Chief of Kholpa
Local Private Sector	Private Clinic of Toubab Dialaw
Civil society	3D NGO
Infrastructure	Jules François Bocandé Training Center
Employers' Organizations	NOC/UPIC, CNES

Source: JPT

(3) Stakeholder Meetings

The SEA survey was initially scheduled to take place between June 2023 and January 2024; however, it

was delayed by approximately 3 months following the suggestions from PAD to initiate stakeholder meetings with a national level meeting, which could be organized together with the 2nd JCC meeting. As a result, the actual survey commenced in late September 2023, from the national level stakeholder meeting held on 25th September 2023, followed by community level meetings and individual interviews. During those meetings, three municipalities to be affected by the Project, namely, Diass, Popenguine-Ndayane and Yenne, were visited and the project details and this survey were explained to chiefs of those local bodies. In addition, the "*Prefet*" (the chief of departments) of the department of Mbour and his deputy, as well as some stakeholders at the level of the district of Sindia, were consulted. Stakeholder meetings in the Department of Rufisque have been finally conducted after November 2023 with assistance from PAD, which had been delayed due to transfer of the chief. Furthermore, a second central government-level stakeholder consultation was scheduled to be held in early 2024 at the same time as the consultation on the draft M/P approval after the implementation of the stakeholder consultation in the regions, but due to the presidential election in March 2024 and changes in the staffing of PAD and local governments, the consultation was held in July 2024.

As mentioned above, the interviews and discussions at three communes of Diass, Popenguine-Ndayane and Yenne were covered by the survey after visiting the mayors of the three communes. Specifically, in Diass, discussions with local authorities resulted in a preference for holding the community meetings. For example, after a meeting with members of the Diass City Council, village meetings were held in Raffo, Mbayard and Samkedji (the three villages considered to be the most affected by the port, notably by its Industrial Port Zone-ZIP) and in Tchiky.

In Yenne, the meetings took the form of focus group discussion (FGD) with the notables and village leaders, the Collective for the Defense of the Interests of Yenne-Dialaw and the herders, sometimes the form of individual interviews or with some representatives of specific groups such as young people, women, fishermen, etc. Implementation status of stakeholder meetings is summarized in the table below.

Table 3.17 Implementation Status of Stakeholder Meetings and Focus Group Discussions

No.	Date	Name of locality	Meeting place	Targets	Number of participants		
					Man	Women	Total
Mbour- Diass							
1	10-Oct-23	Diass	City hall	Municipal councilor	8	4	12
2	12-Oct-23	Tchicky	Public place	Community	21	1	22
3	12-Oct-23	Samkedji	Public place	Community	34	0	34
4	14-Oct-23	Mbayard	Public place	Community	50	6	56
5	14-Oct-23	Raffo	Public place	Community	28	0	28
6	14-Oct-23	Raffo	Public place	Women	0	43	43
Rufisque- Yenne							
7	23-Oct-23	Niayes Khaye	Public place	Actors in the livestock sector	28	6	34
8	26-Oct-23	Yenne	City hall	Village chiefs and their representative	9	0	9
Mbour- Popenguine-Ndayane							
9	31-Oct-23	Popenguine	City hall	Elders, village chiefs and authorities	17	0	17
10	31-Oct-23	Popenguine	City hall	Women's groups	0	4	4
11	10-Nov-23	Popenguine	City hall	Municipal Council	17	10	27
12	14-Nov-23	Ndayane	Mbar -Fishing wharf	Fishermen and fishmongers	12	0	12
13	14-Nov-23	Popenguine	City hall	Youth	16	0	16
				Total	**240**	**74**	**314**
				(%)	76.4%	23.6%	

Source: JPT

(4) Contents of Stakeholder Meetings

At the first central government level meeting, the opinion was expressed that the study should cover the area integrated with the hinterland PIZ. The details of the discussions in the Project impacted areas include, most relevant ones to ongoing DPW project, discrepancies in plan contents depending on the source of information and dissatisfaction with the compensation details including unfairness. In addition, the respondents raised their opinion about concentration of development activities in the same area (including not only new port development but also industrial zones), the fact that these development projects contribute to national economic development and not to the improvement of local residents' livelihood, and the fact that these projects are conspicuously disadvantageous to local residents.

In response to these current conditions, the local communities requested the Project to disclose information more clearly and constantly, to develop infrastructure that would improve local residents' living conditions in conjunction with port development, and to ensure access to Popenguine, an important and symbolic religious monument. In addition, the participants also requested the expansion of firefighting, security, and medical facilities that contribute to the health and safety of local community.

Moreover, the promotion of the employment for local residents in the new port, and the implementation of livelihood improvement projects for residents who are forced to change their means of livelihood were desired. Furthermore, as requests for the DPW project, improvements in the method of calculating compensation costs was suggested such as taking into account the impact on current productivity and incorporating the resident's grievances into calculation method. Detailed information will be attached as annex of the report.

During the second round of consultations at the central government level meeting, questions were raised regarding the relationship between the DPW EIA (2020) and this SEA study, the content of the Environmental Management Plan, the grievance system, and the treatment of ship dismantling workshops included in the draft M/P. The minutes of the meeting are attached at the end of this report.

3.5 Formation of Basic Policy on Port Development in Senegal

At the beginning of this project, PAD commented that the basic policy for port development in Senegal should basically follow PSE. JPT developed the following basic policy with reference to PSE. Then, Senegal Vision 2050 was announced in Senegal, and PAD commented that it should follow the Senegal Vision 2050. JPT confirmed that the proposed basic policy for port development is consistent with the Senegal Vision 2050.

- Establishment of an international maritime transport network and base to serve as a hub for West Africa
- Development of international hub ports to support a stable supply of resources, energy, and food
- Establishment of a domestic integrated transportation network that stably supports domestic logistics
- Formation of port space that leads to the creation of industries and the strengthening of logistics functions
- Securing port functions and maritime transportation functions that support the safety and security of the people
- Sharing of roles and cooperation among all international ports in Senegal
- Utilization of port space that contributes to the promotion of tourism such as cruises and the creation of festivity
- Promotion of utilization of port space that contributes to low-carbon society
- Port development and efficient operation through the utilization of the private sector
- Strengthen the organizational structure that supports the effective and efficient management and operation of ports and harbors

3.6 Demand Forecast (International/Domestic and Passenger/Cargo)

3.6.1 Macro Estimation

(1) Macro Estimation Method

Base year: 2021

Target year: 2047 and 2050

Estimated Cargo Classification: Three categories: Total Cargo Handled at Dakar Port, Number of Containers Handled, and Number of RORO Vehicles

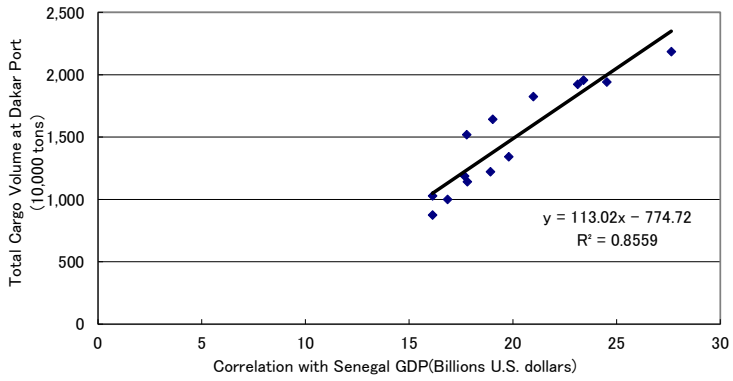
Macro Estimation Methods: 4 patterns of freight volume are estimated from correlations between the three categories of freight volume and the population of Senegal nominal GDP and West Africa (16 countries in the West African Economic Community and Mauritania), the population of Senegal, and the population of West Africa (16 countries). If no correlation was found (coefficient of determination is less than 0.7), it is estimated from the average annual growth rate of each indicator.

(2) Macro Estimates of Total Cargo Handled at Dakar Port

a) Correlations with the Senegal's Nominal GDP

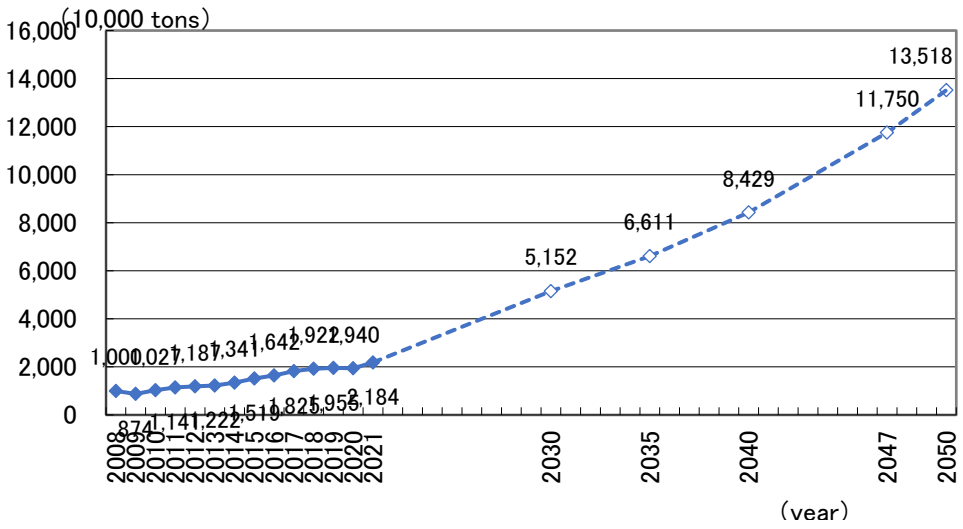
After observing the correlation between the nominal GDP of Senegal and the total freight volume handled at Dakar Port, the correlation was recognized as shown in the figure below. The estimated total cargo volume for the target year at Dakar Port is estimated by the correlation equation with the nominal GDP of Senegal (linear regression over the last 14 years (2008-2021), coefficient of determination = 0.8559).

Based on the above, the target annual total cargo volume of Dakar Port will be 51.52 million tons in 2030, 66.11million tons in 2035, 84.29million tons in 2040, 117.5million tons in 2047 and 135.1million tons in 2050.



Source: JPT

Figure 3.8 Nominal GDP in Senegal and Correlation with Total Freight Handled at Dakar Port



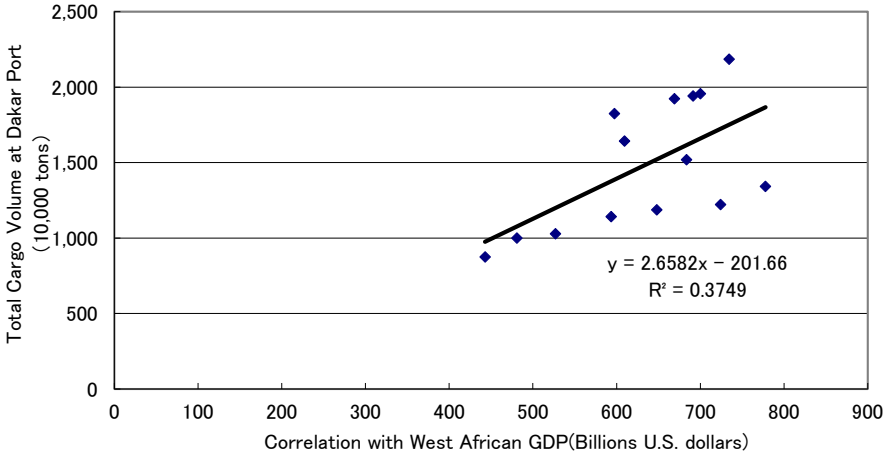
Source: JPT

Figure 3.9 Estimation of the Total Freight Handled at Dakar Port Based on the Future Outlook for Nominal GDP in Senegalese Countries

b) Correlations with Nominal GDP in West Africa (16 Countries)

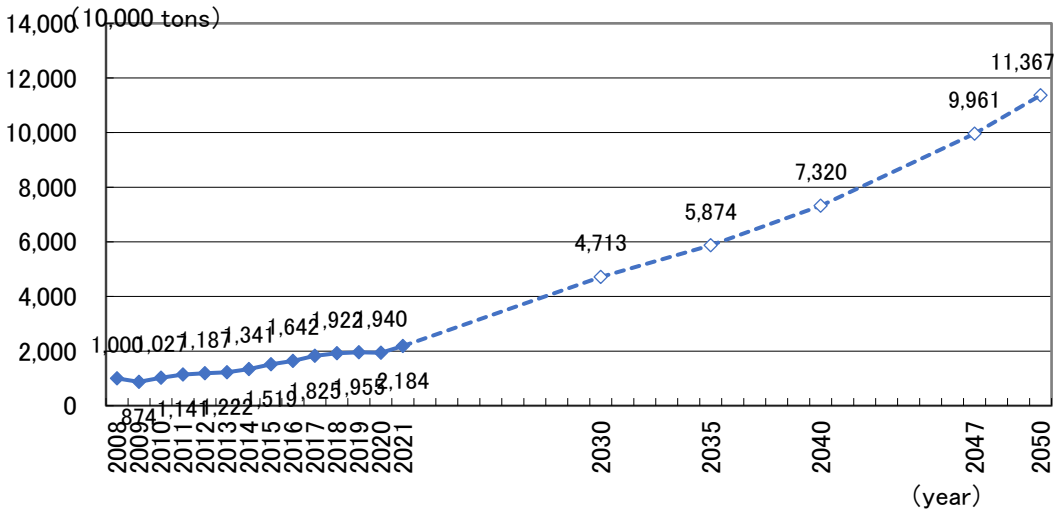
Observing the correlation between nominal GDP and the total freight volume handled at Dakar Port in West Africa (16countries), no correlation was observed as shown in the figure below. The estimated total cargo volume for the target year at Dakar Port is estimated from the annual mean growth rate of nominal GDP in West Africa (16 countries).

Based on the above, the target annual total cargo volume of Dakar Port will be 47.13 million tons in 2030, 58.74million tons in 2035, 73.20million tons in 2040, 99.61 million tons in 2047 and 11.37 million in 2050.



Source: JPT

Figure 3.10 Nominal GDP in West Africa (16 Countries) Correlated with the Total Freight Handled at Dakar Port



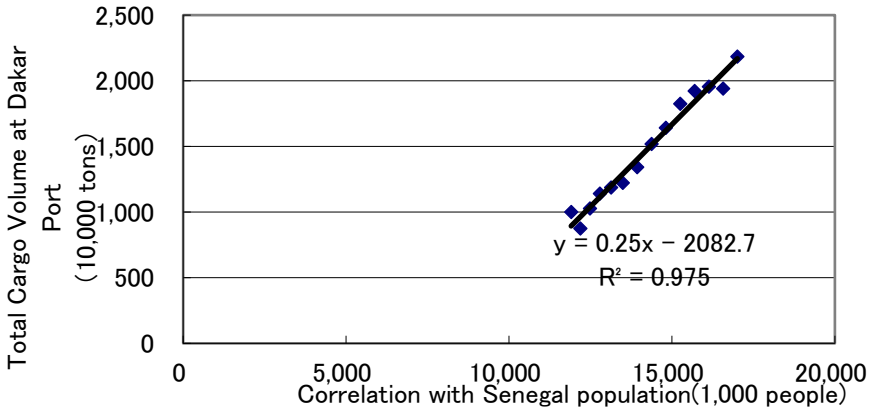
Source: JPT

Figure 3.11 Estimates of the Total Freight Handled at Dakar Port based on the Future Outlook for Nominal GDP in West Africa (16 Countries)

c) Correlation with Population of Senegal

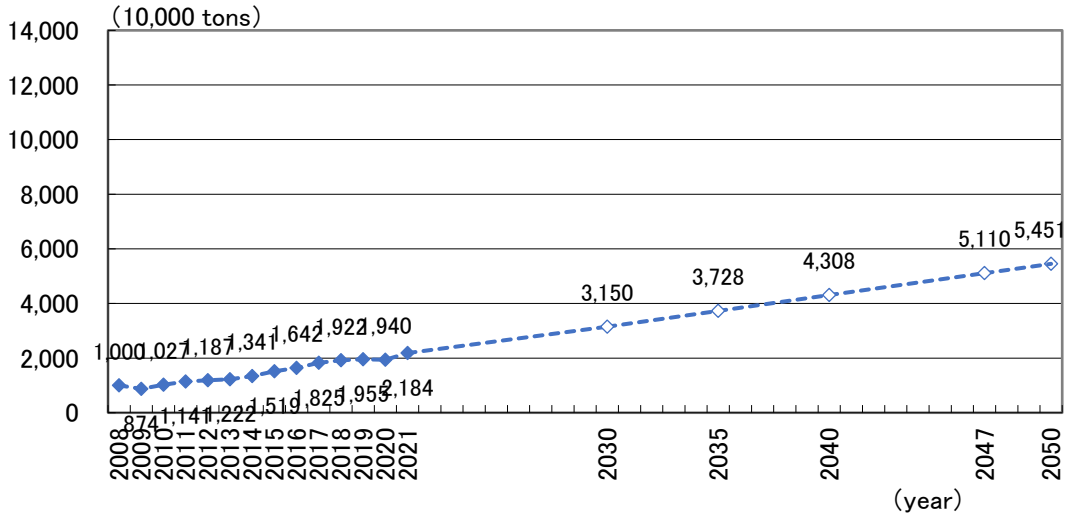
Observing the correlation between the Senegal's population and the total cargo volume handled at Dakar port, the correlation was recognized as shown in the figure below. The estimated total cargo volume handled at Dakar Port for the target year is estimated by the correlation equation with the Senegalese population (linear regression over the past 14 years (2008-2021), coefficient of determination = 0.975).

Based on the above, the target annual total cargo volume of Dakar Port will be 31.50 million tons in 2030, 37.28 million tons in 2035, 43.08 million tons in 2040, 51.10 million tons in 2047 and 54.51 million tons in 2050.



Source: JPT

Figure 3.12 Correlation between Senegalese Population and Total Cargo Handled at Dakar Port



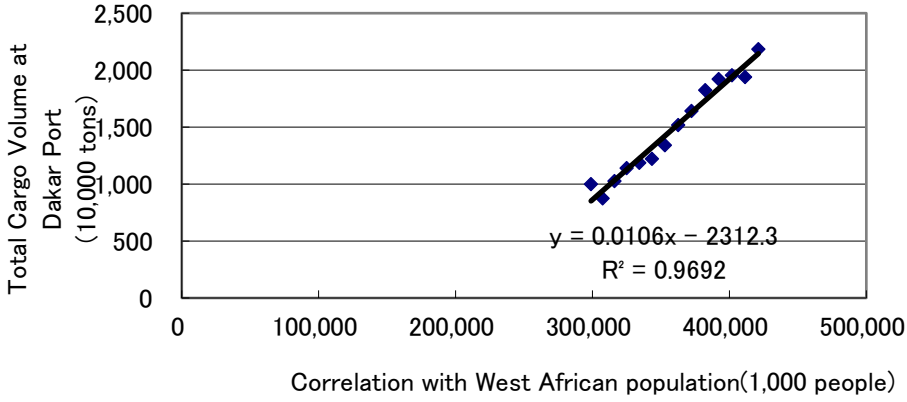
Source: JPT

Figure 3.13 Estimation Results of Total Cargo Handled at Dakar Port Based on Future Prospects for Senegalese Population

d) Correlation to Population in West Africa (16 countries)

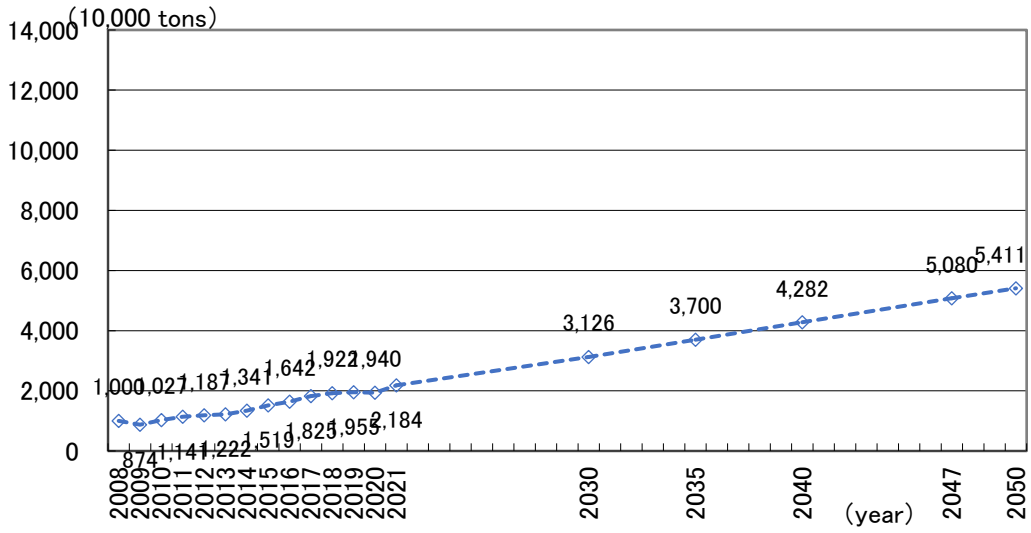
The correlation between the population of West Africa (16countries) and the total cargo volume handled at Dakar port was found as shown in the figure below. JPT estimates the total cargo volume handled at Dakar Port for the target year using the correlation equation with the population in West Africa (16 countries) (linear regression over the past 14years (2008-2021), coefficient of determination = 0.9692).

Based on the above, the target annual total cargo volume of Dakar Port will be 31.26 million tons in 2030, 37.00 million tons in 2035, 42.82 million tons in 2040, 50.80 million tons in 2047 and 54.11 million in 2050.



Source: JPT

Figure 3.14 Correlation between Population in West Africa (16Countries) and Total Cargo Handled at Dakar Port



Source: JPT

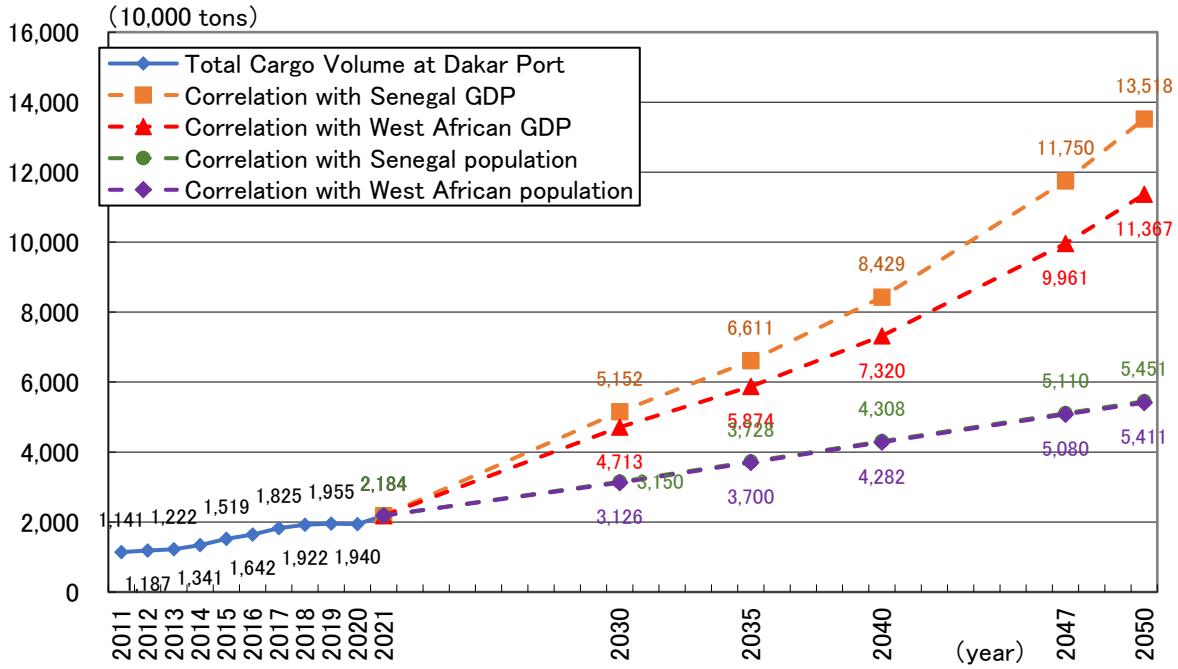
Figure 3.15 Estimation Results of Total Cargo Handled at Dakar Port Based on Future Projections of Population in West Africa (16 Countries)

e) Summary of Macro Estimation Results of Total Cargo Handled at Dakar Port

The below figure summarizes the macro estimation results of the total cargo volume handled at Dakar Port.

Macro estimation of gross freight volume of Dakar Port were 117.5 million tons in 2047 and 135.2 million tons in 2050 based on correlation with Senegal's nominal GDP as the largest and 50.80 million tons in 2047 and 54.11 million tons in 2050 based on correlation with West African (16 countries) populations as the smallest.

	2021	2030	2035	2040	2047	2050
Total Cargo Volume at Dakar Port	2,184					
Correlation with Senegal GDP	2,184	5,152	6,611	8,429	11,750	13,518
Correlation with West African GDP	2,184	4,713	5,874	7,320	9,961	11,367
Correlation with Senegal population	2,184	3,150	3,728	4,308	5,110	5,451
Correlation with West African population	2,184	3,126	3,700	4,282	5,080	5,411



Source: JPT

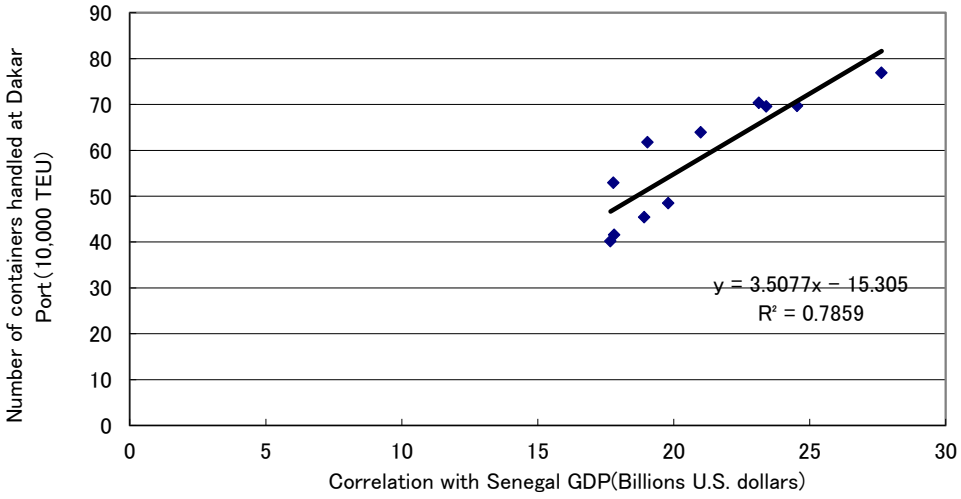
Figure 3.16 Summary of Macro Estimation Results of Total Cargo Handled at Dakar Port

(3) Macro Estimation of Number of Containers Handled

a) Correlations with the Senegal's Nominal GDP

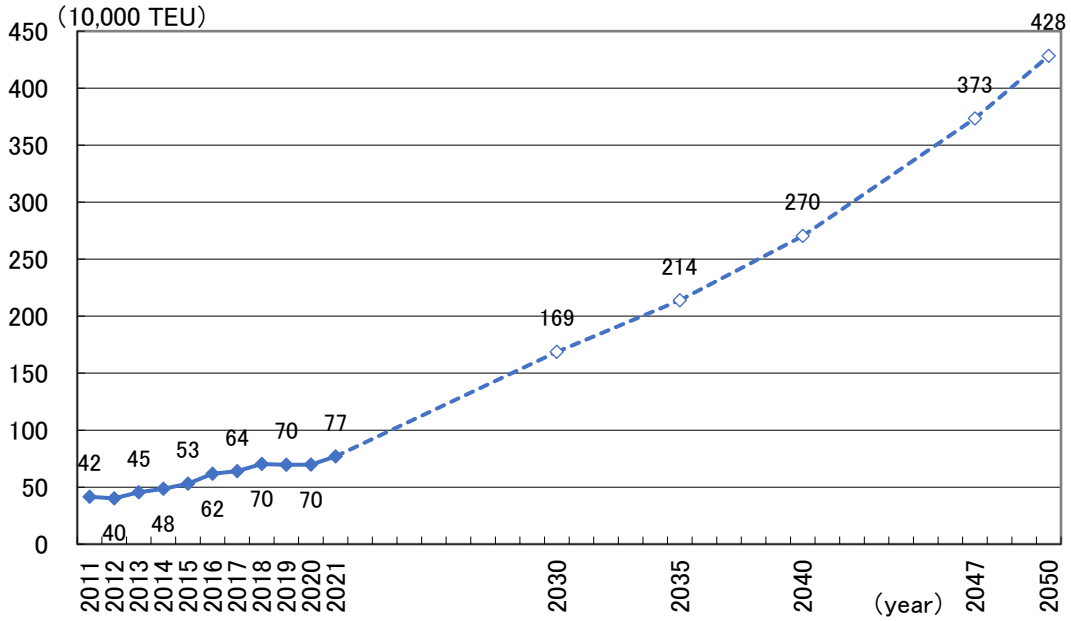
Observing the correlation between the nominal GDP of Senegal and the number of containers handled at Dakar port, the correlation was recognized as shown in the figure below. JPT estimates the number of containers handled at Dakar Port for the target year by using the correlation equation with the nominal GDP of Senegal (linear regression over the last 11 years (2011-2021), coefficient of determination = 0.7859).

Based on the above, the target annual number of containers at Dakar Port will be 1.69 million TEU in 2030, 2.14million TEU in 2035, 2.7 million TEU in 2040, 3.73 million TEU in 2047 and 4.28 million TEU in 2050.



Source: JPT

Figure 3.17 Correlation between the Nominal GDP of Senegalese Countries and the Number of Containers Handled at Dakar Port



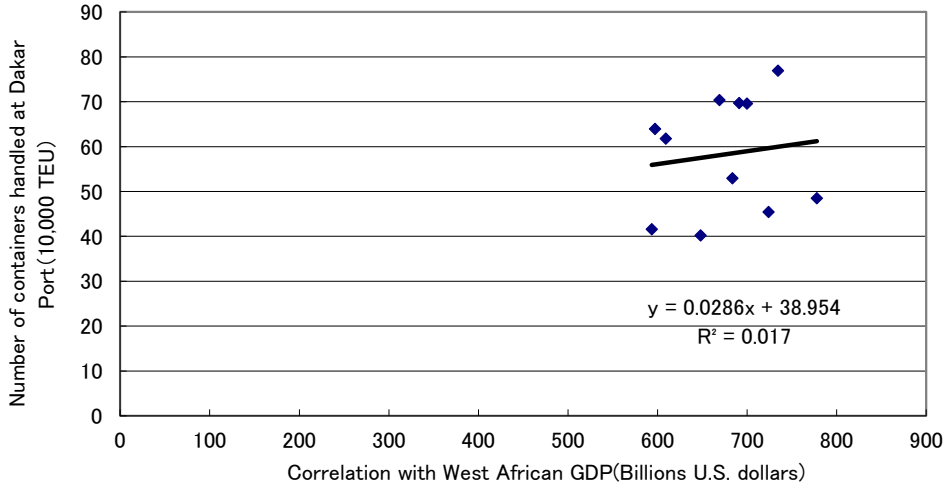
Source: JPT

Figure 3.18 Estimation of the Number of Dakar Port Containers Handled Based on the Future Outlook for Nominal GDP in Senegalese Countries

b) Correlations with Nominal GDP in West Africa (16 Countries)

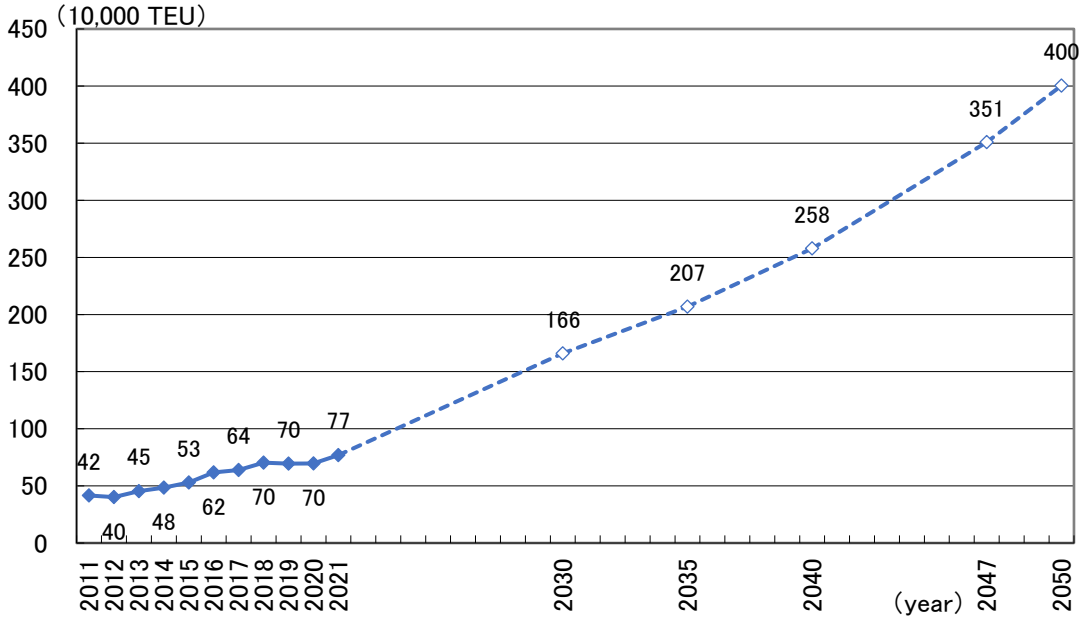
Observing the correlation between nominal GDP in West Africa (16 countries) and the number of containers handled at Dakar Port, the correlation was not recognized as shown in the figure below. The estimated number of containers handled at Dakar Port for the target year is estimated from the annual mean growth rate of nominal GDP in West Africa (16 countries).

Based on the above, the target annual number of containers handled at Dakar Port will be 1.66 million TEU in 2030, 2.07million TEU in 2035, 2.58million TEU in 2040, 3.51 million TEU in 2047 and 4.00 million TEU in 2050.



Source: JPT

Figure 3.19 Correlation between Nominal GDP in West Africa (16Countries) and Number of Containers Handled at Dakar Port



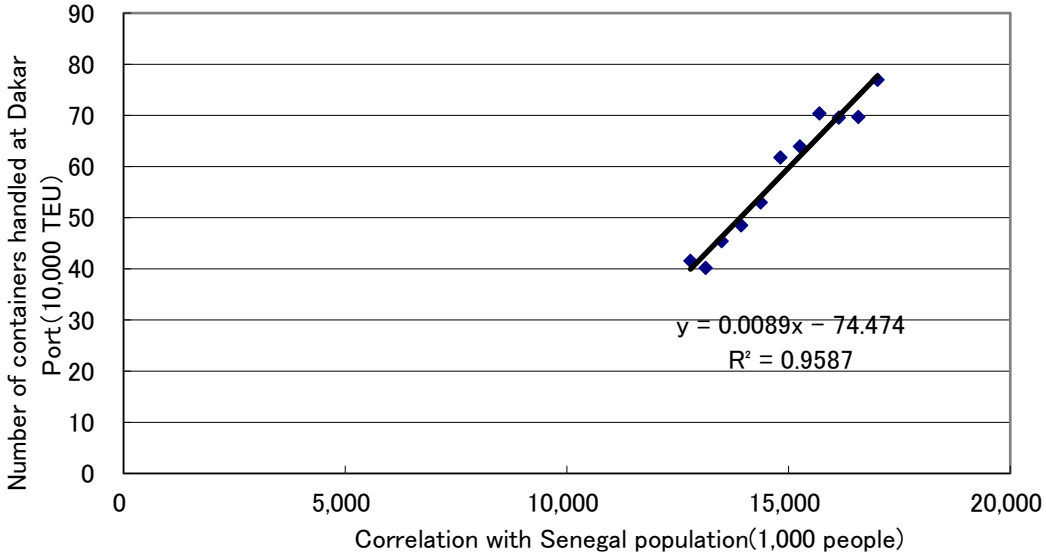
Source: JPT

Figure 3.20 Estimation of the Number of Containers Handled at Dakar Port Based on the Future Outlook for the Nominal GDP in West Africa

c) Correlation with the Population of Senegal

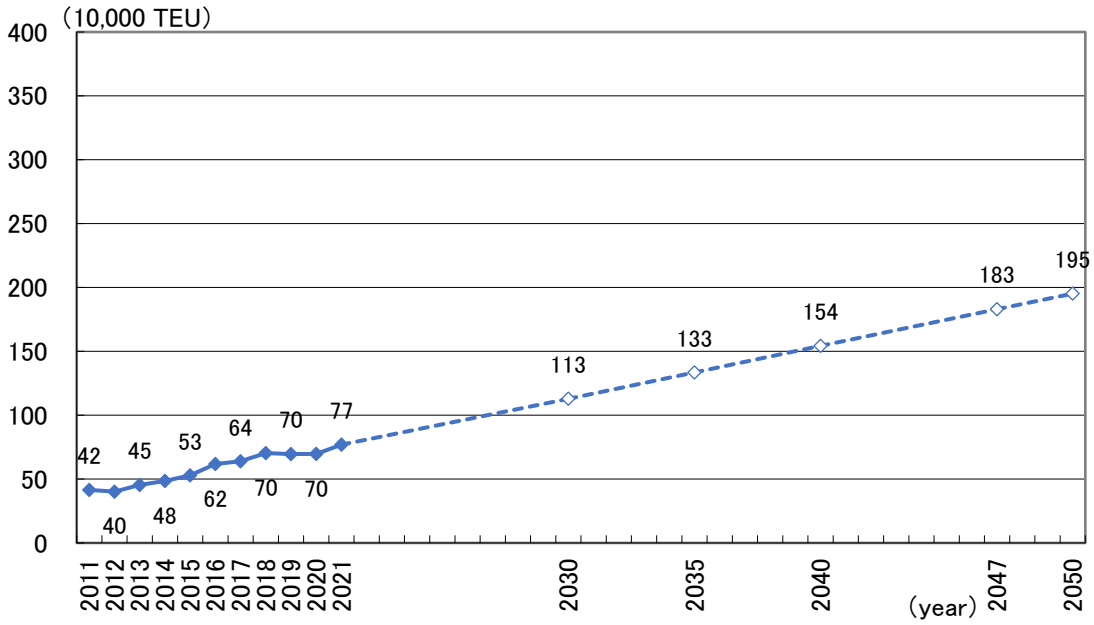
Observing the correlation between the Senegal's population and the number of containers handled at Dakar port, the correlation was recognized as shown in the figure below. The estimated number of containers handled at Dakar Port for the target year is estimated by the correlation equation with the Senegalese population (linear regression over the past 11years (2011-2021), coefficient of determination = 0.9587).

Based on the above, the target annual number of containers handled at Dakar Port will be 1.13 million TEU in 2030, 1.33 million TEU in 2035, 1.54 million TEU in 2040, 1.83 million TEU in 2047 and 1.95 million TEU in 2050.



Source: JPT

Figure 3.21 Correlation between Senegal's Population and the Number of Containers Handled at Dakar Port



Source: JPT

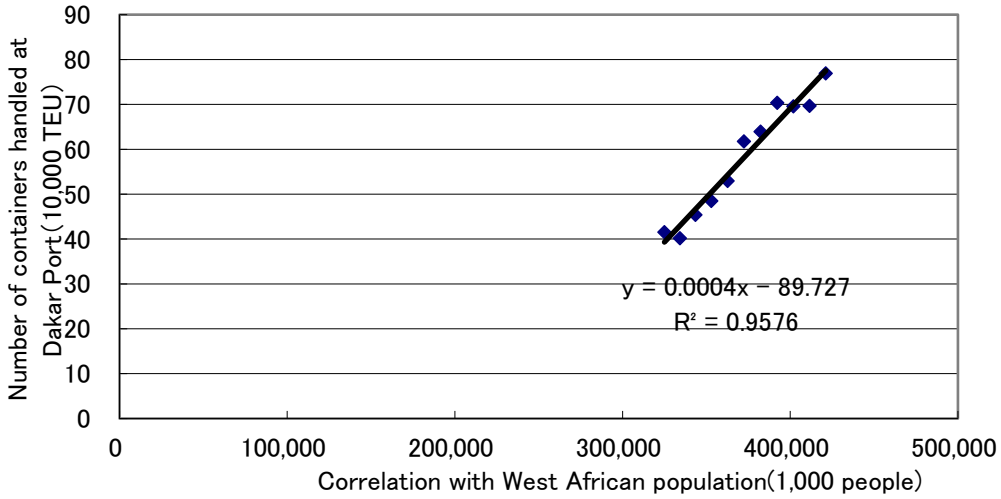
Figure 3.22 Estimation Results of Number of Containers Handled at Dakar Port Based on Future Prospects for Senegalese Population

d) Correlation to Population in West Africa (16 Countries)

The correlation between the population of West Africa (16 countries) and the number of containers handled at Dakar Port was found as shown in the figure below. The estimated number of containers

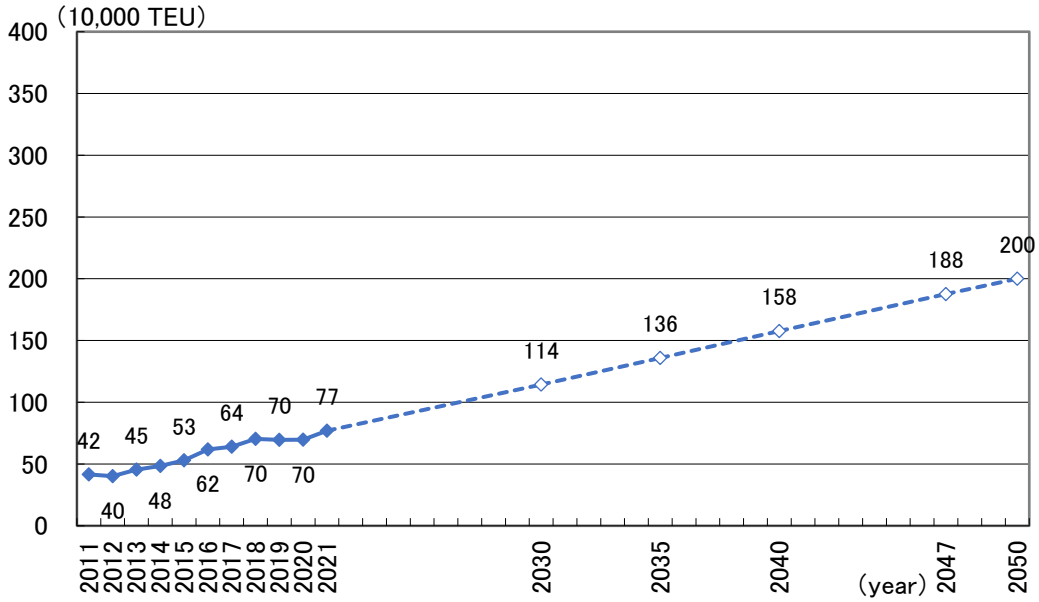
handled at Dakar Port for the target year is estimated by the correlation equation with the population in West Africa (16 countries) (linear regression over the past 11 years (2011-2021), coefficient of determination = 0.9576).

Based on the above, the target annual number of containers handled at Dakar port will be 1.14 million TEU in 2030, 1.36 million TEU in 2035, 1.58 million TEU in 2040, 1.88 million TEU in 2047 and 2.00 million TEU in 2050.



Source: JPT

Figure 3.23 Correlation between Population in West Africa (16Countries) and Number of Containers Handled at Dakar Port



Source: JPT

Figure 3.24 Estimation Results of Number of Containers Handled at Dakar Port Based on Future Prospects for Population in West Africa (16 Countries)

e) Summary of Macro Estimation Results for the Number of Containers Handled

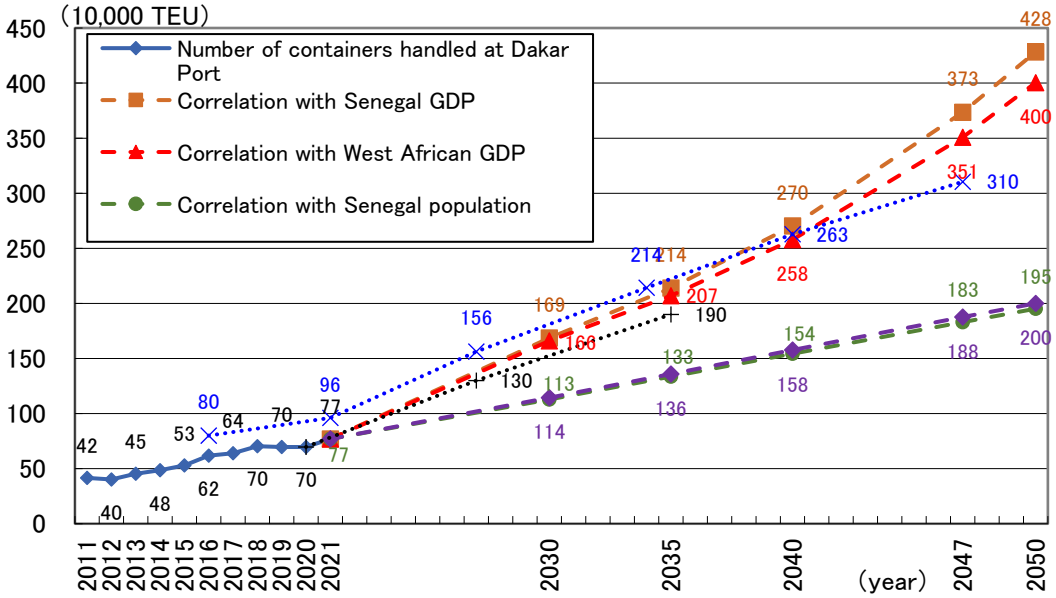
The figure below summarizes the macro estimation results of the number of containers handled at Dakar Port.

Macro estimation of containers handled at Dakar port shows the largest correlation with Senegal's nominal GDP, reaching 3.73 million TEU in 2047 and 4.28 million TEU in 2050, and the smallest correlation with Senegal populations reaching 1.83 million TEU in 2047 and 1.95 million TEU in 2050.

Compared with the estimates by the French Development Agency (AFD) and ALG_DPW estimates, it is close to the upper limit of the macro-level estimates, and therefore this macro-level estimate should be generally reasonable.

(10,000 TEU)

	2021	2030	2035	2040	2047	2050
Number of containers handled at Dakar Port	77					
Correlation with Senegal GDP	77	169	214	270	373	428
Correlation with West African GDP	77	166	207	258	351	400
Correlation with Senegal population	77	113	133	154	183	195
Correlation with West African population	77	114	136	158	188	200
[reference] AFD estimates	77	130	190			
[reference] ALG、DPW estimates	96	156	214	263	310	



Source: JPT

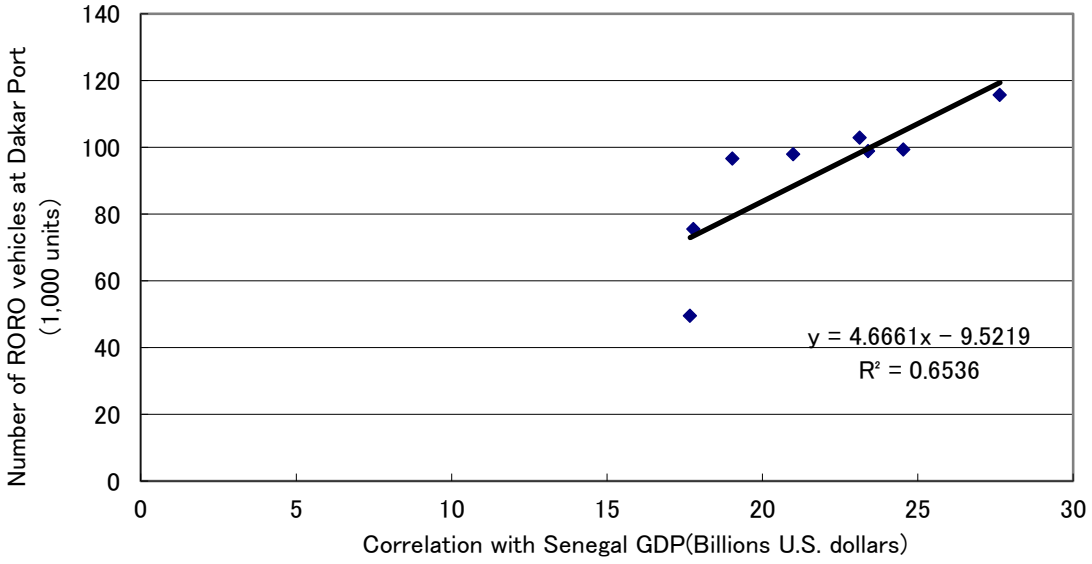
Figure 3.25 Summary of Macro Estimation Results for the Number of Containers Handled at Dakar Port

(4) Macroeconomic Estimates of RORO Vehicles

a) Correlations with the Senegalese Nominal GDP

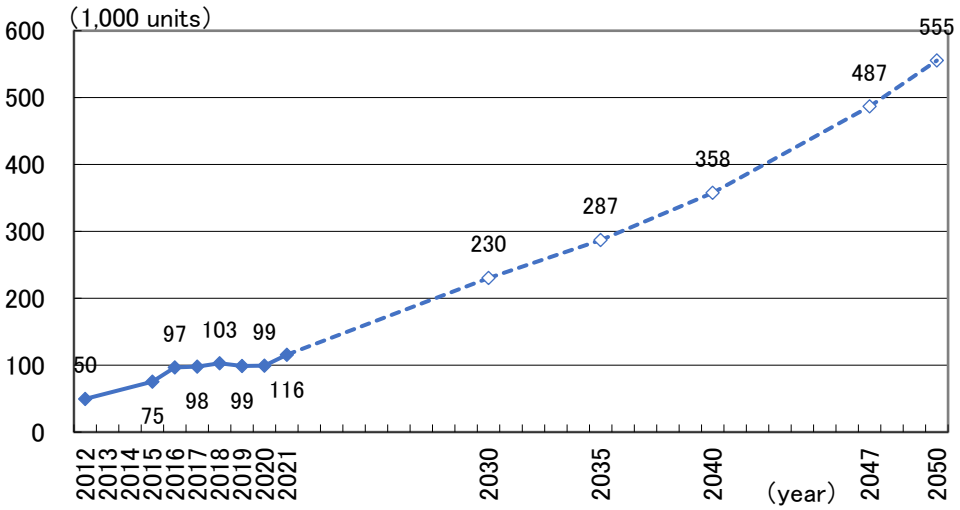
Looking at the correlation between the nominal GDP of Senegalese and the number of RORO vehicles at Dakar Port, there was no correlation as shown in the figure below. Based on the above, the estimation of RORO number of vehicles at Dakar Port for the target year is estimated from the average annual growth rate of nominal GDP in Senegalese.

Based on the above, the target annual RORO number of vehicles at Dakar Port will be 230,000 in 2030, 287,000 in 2035, 358,000 in 2040, 487,000 in 2047 and 555,000 in 2050.



Source: JPT

Figure 3.26 Correlation between the Nominal GDP of Senegalese and the Number of RORO Vehicles at the Port of Dakar



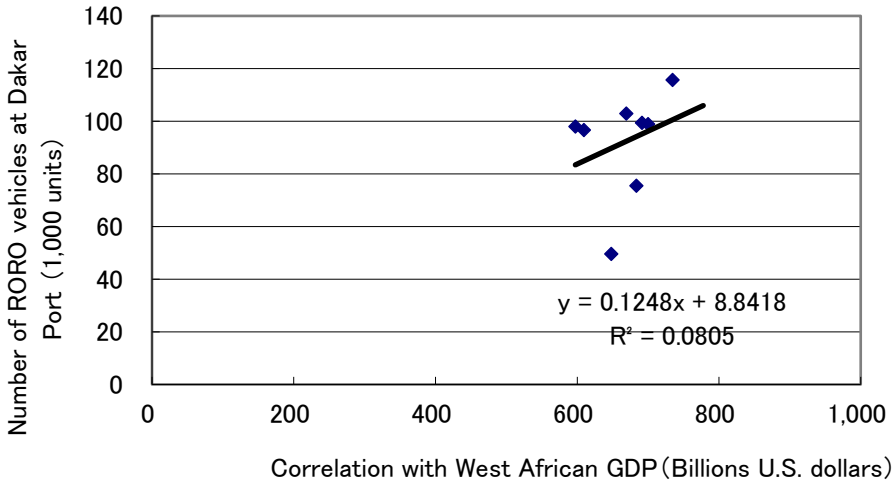
Source: JPT

Figure 3.27 Estimation of the Number of RORO Vehicles at Dakar Port Based on the Future Outlook for Nominal GDP in Senegalese Countries

b) Correlations with Nominal GDP in West Africa (16 countries)

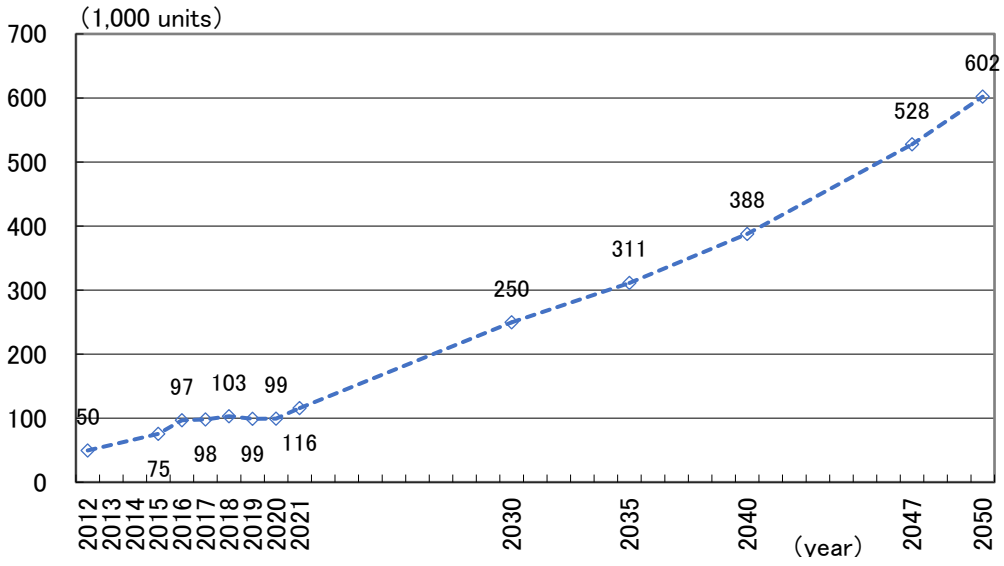
Looking at the correlation between nominal GDP in West Africa (16 countries) and the number of RORO vehicles at Dakar Port, there was no correlation as shown in the figure below. The estimation of RORO number of vehicles at Dakar Port for the target year is estimated from the annual mean growth rate of nominal GDP in West Africa (16countries).

Based on the above, the target annual RORO number of vehicles at Dakar Port will be250,000 in 2030, 311,000 in 2035, 388,000 in 2040, 528,000 in 2047 and 602,000 in 2050.



Source: JPT

Figure 3.28 Correlation between Nominal GDP in West Africa (16 Countries) and the Number of RORO Vehicles at Dakar Port



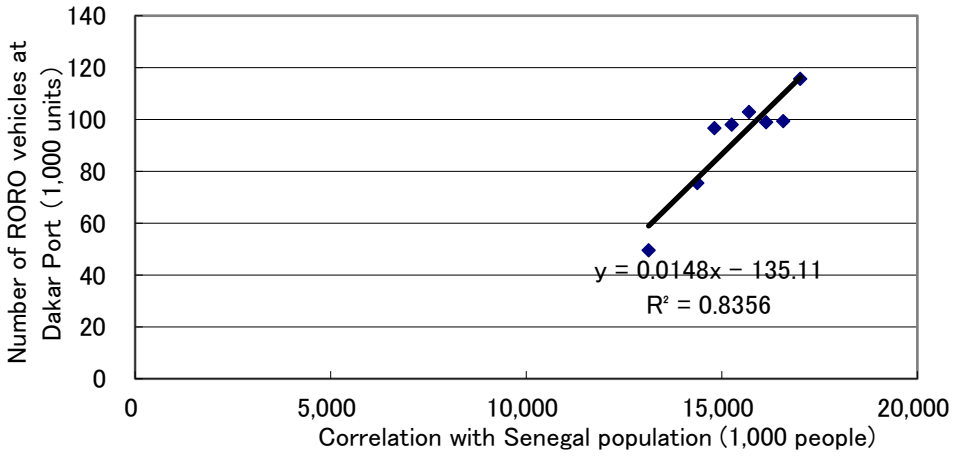
Source: JPT

Figure 3.29 Estimation of the Number of RORO Vehicles at Dakar Port Based on Future Prospects for Nominal GDP in West Africa

c) Correlation with the Population of Senegal

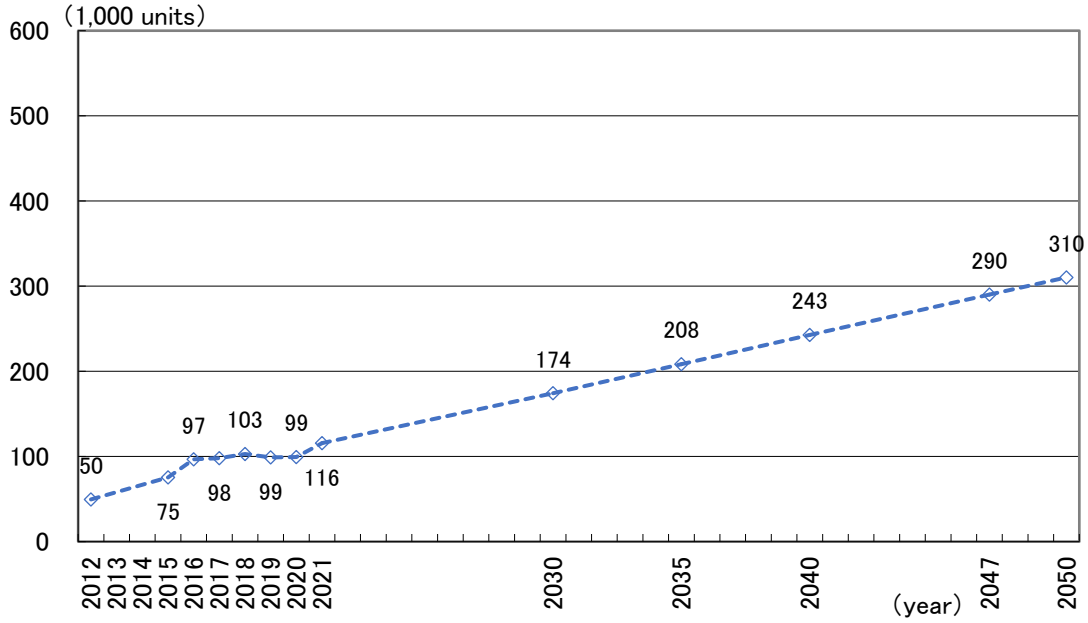
The correlation between the Senegal's population and the number of RORO vehicles at Dakar Port was found as shown in the figure below. The estimation of RORO number of vehicles at Dakar Port for the target year is estimated by the correlation equation with the population of Senegal (linear regression over the last 10 years (2012-2021), coefficient of determination = 0.8356).

Based on the above, the target annual RORO number of vehicles at Dakar Port will be 172,000 in 2030, 208,000 in 2035, 243,000 in 2040, 290,000 in 2047 and 310,000 in 2050.



Source: JPT

Figure 3.30 Correlation between Senegalese Population and the Number of RORO Vehicles at Dakar Port



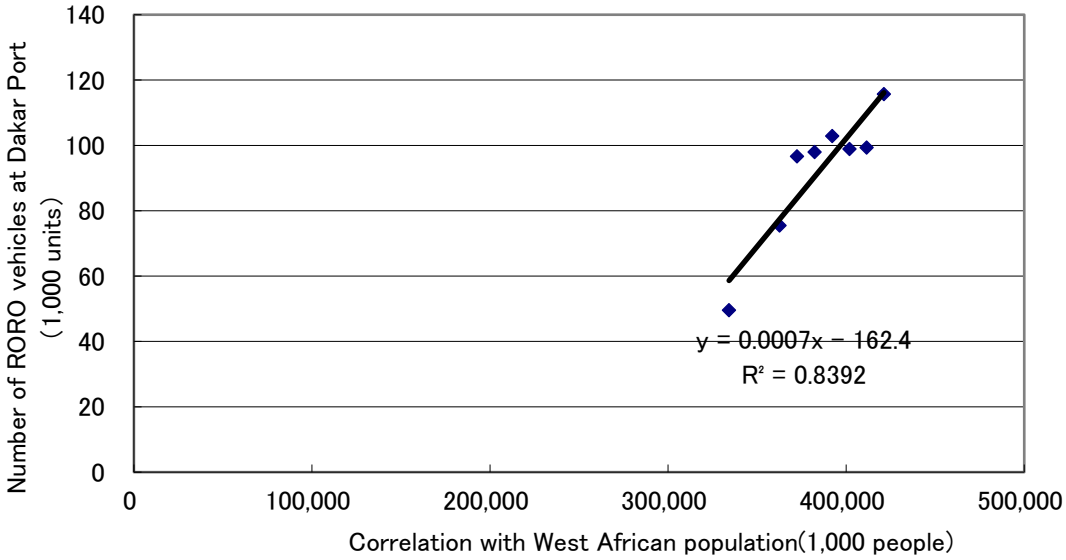
Source: JPT

Figure 3.31 Estimation of the Number of RORO Vehicles at Dakar Port Based on Future Prospects for the Senegalese Population

d) Correlation to Population in West Africa (16 Countries)

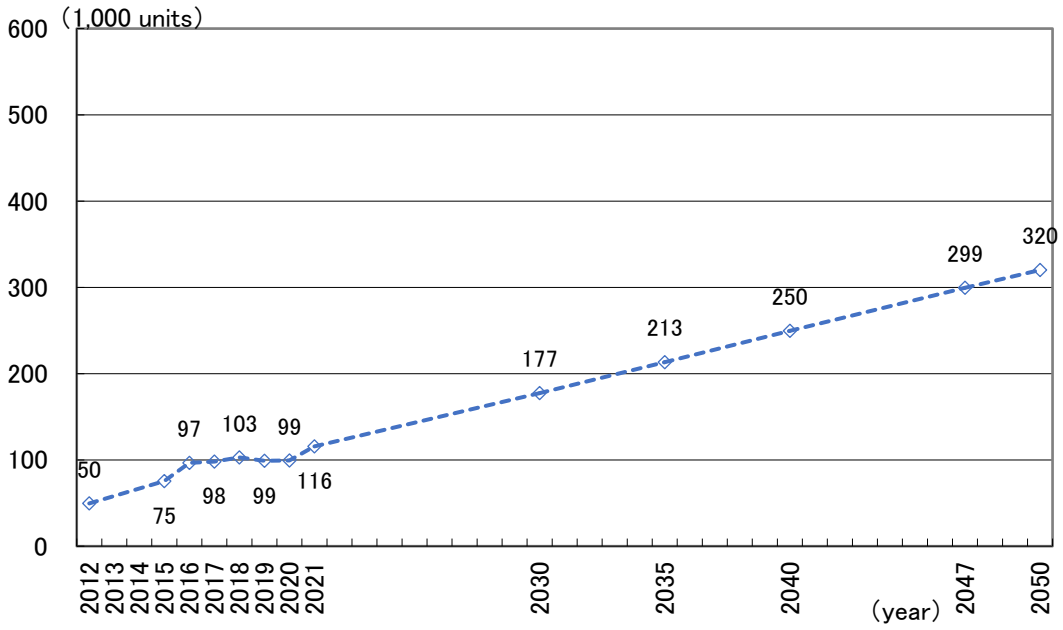
The correlation between the population of West Africa (16 Countries) and the number of RORO vehicles at Dakar Port was found as shown in the figure below. The estimation of RORO number of vehicles in Dakar Port for the target year is estimated by the correlation equation with the population in West Africa (16 countries) (linear regression over the last 10 years (2012-2021), coefficient of determination = 0.8392).

Based on the above, the target annual RORO number of vehicles at Dakar Port will be 177,000 in 2030, 213,000 in 2035, 250,000 in 2040, and 299,000 in 2047 and 320,000 in 2050.



Source: JPT

Figure 3.32 Correlation between the Population of West Africa (16 Countries) and the Number of RORO Vehicles at Dakar Port



Source: JPT

Figure 3.33 Estimates of the Number of RORO Vehicles at Dakar Port Based on Future Prospects for the Population of West Africa (16 Countries)

e) Summary of Macro-level Estimation of RORO Vehicles

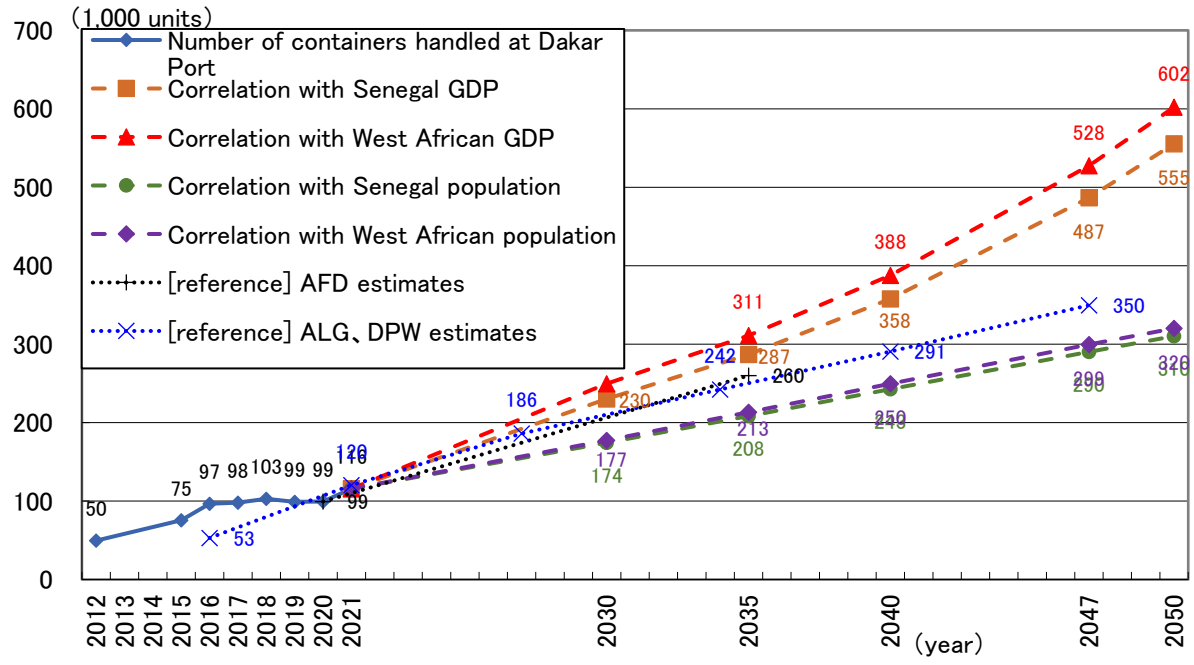
The following figure summarizes the macroeconomic estimation of the number of vehicles RORO at Dakar port.

Macro estimation of RORO vehicles at Dakar port will be 528,000 vehicles in 2047 and 602,000 vehicles in 2050, the largest in West Africa (16countries) GDP, and 196,000 vehicles in 2047 and 202,000 vehicles in 2050, the smallest in correlation with the Senegalese population.

Compared with estimates by the French Development Agency (AFD) and ALG_DPW estimates, these macro estimates are generally reasonable because they lie between the upper and lower bounds of the macro estimates.

(1,000 units)

	2021	2030	2035	2040	2047	2050
Number of containers handled at Dakar Port	116					
Correlation with Senegal GDP	116	230	287	358	487	555
Correlation with West African GDP	116	250	311	388	528	602
Correlation with Senegal population	116	174	208	243	290	310
Correlation with West African population	116	177	213	250	299	320
[reference] AFD estimates	116	172	260			
[reference] ALG、DPW estimates	120	186	242	291	350	



Source: JPT

Figure 3.34 Summary of Macro-level Estimates of the Number of RORO Vehicles at Dakar Port

3.6.2 Micro Estimates of Bulk Cargo

(1) Micro Estimation Method for Bulk Cargo

Base year: 2021

Target year: Estimated at three points in 2030 ,2035and 2047

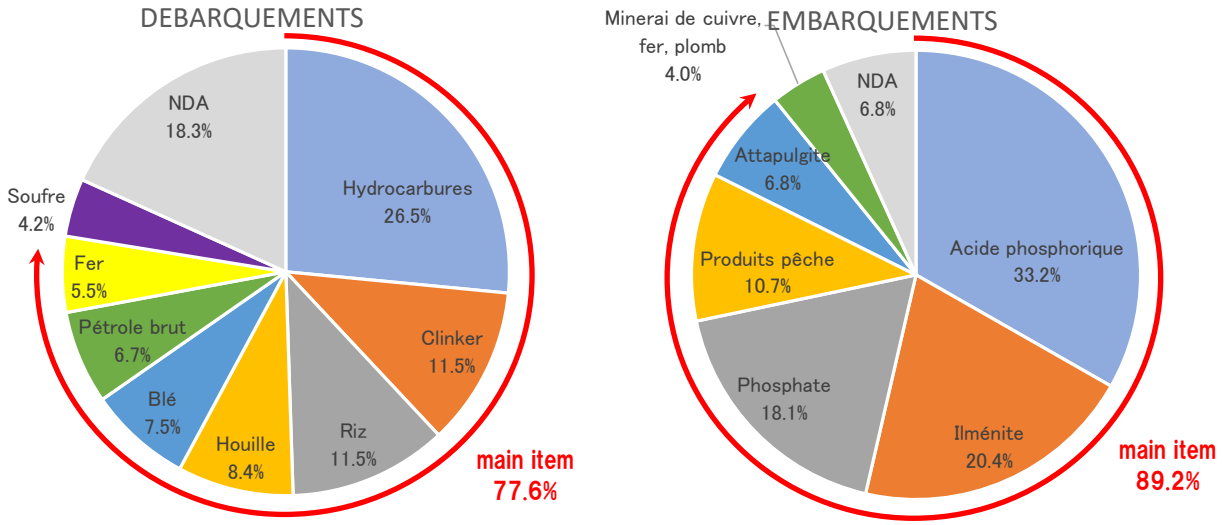
Statistical Data Used: Based on the transition data by item obtained from PAD and the item data of each container in 2017~2021, the bulk cargo volume by item in 2016 is estimated using the average containerization rate for 2017~2021.

Micro Estimation Method: In the bulk cargo volume by commodity in 2021, the main commodities account for more than 5% of the total volume by input and output, and are estimated based on the trend of commodities and socioeconomic conditions. Pattern analysis will be conducted for items other than major items based on trends in bulk cargo volume by item from 2012 to 2021.

Table 3.18 Pattern Analysis

Classification	Pattern of Changes in Cargo Volume			Main Products
	Increasing type	Decreasing type	Vibrating type	
In the estimates adopting policy	Grow in trend to target year	Adopt the latest value	Average over the past five years	Estimated based on trends in commodities and socioeconomic conditions

Source: JPT



Source: JPT

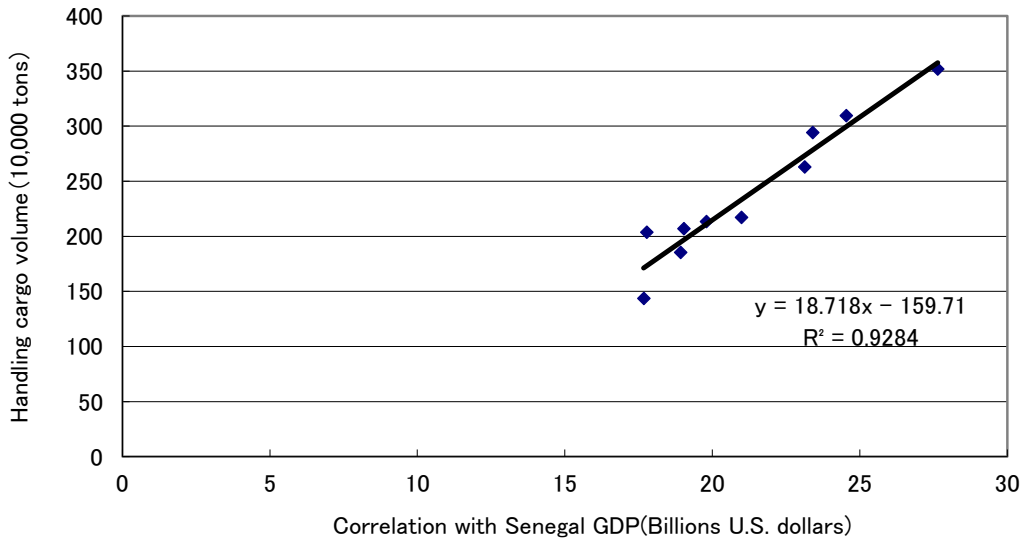
Figure 3.35 Major Products (5% or more of the total amount by entry and exit in 2021)

(2) Micro Estimates of Major Commodities

a) [DEB] Hydrocarbures

Imports of hydrocarbons (petroleum products) come from Société Africaine de Raffinage (SAR and from distributors such as Total, Touba, Puma. As of 2021, SAR operates a Dakar refinery with an annual capacity of 1.2 million tons, and its ongoing program will increase this capacity to 1.5 million tons. In 2025, this capacity could reach 3.5 million tons as long as modernization projects are on track. Currently, SAR accounts for about 40% of the domestic demand for hydrocarbons, and the remaining demand is part of the estimated Mali demand of approximately 1 million tons transported through the Senegal Corridor, supplied by imports from abroad. Hydrocarbons are a new source of energy for power generation and will probably also be used in the future as fuel for transportation.

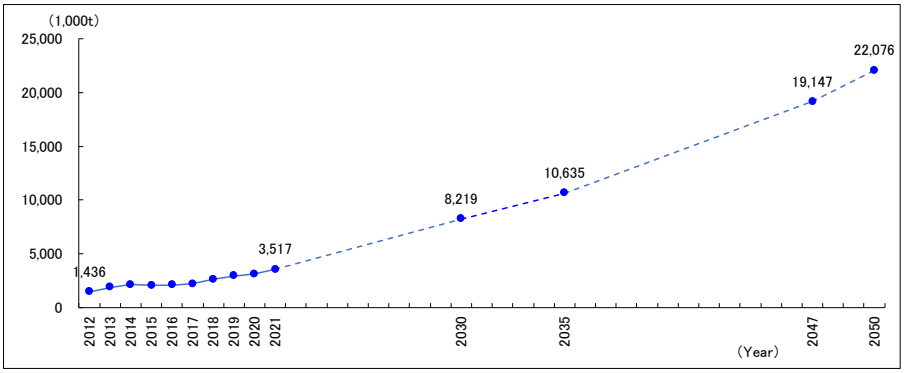
Therefore, future demand for hydrocarbons is determined by several factors, such as the conversion of power plants, the addition of capacity at SAR refineries, and the use of renewable energy in the energy mix of Senegal and Mari. Based on the above, it is estimated based on the correlations with the Senegalese GDP.



Source: JPT

Figure 3.36 Correlations between Senegalese Nominal GDP and Hydrocarbures

Items	Import or Export	Actual value(1,000t)										estimated value			
		2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2030	2035	2047	2050
Hydrocarbon	Import	1,436	1,853	2,134	2,036	2,070	2,172	2,628	2,942	3,095	3,517	8,219	10,635	19,147	22,076



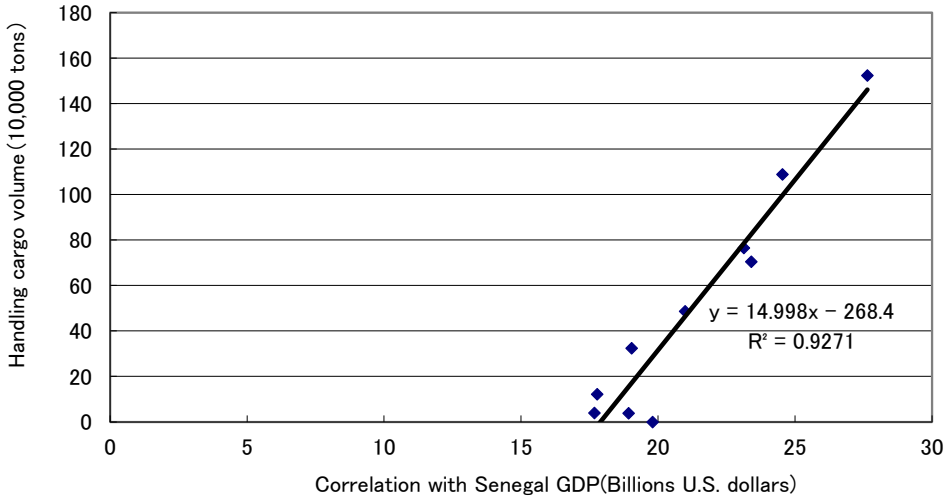
Source : JPT

Figure 3.37 Micro Estimates of【DEB】Hydrocarbures

b) [DEB] Clinker

Clinker, coal, and gypsum are the main inputs in cement production. In 2019, Senegal imported about 540,000 tons of clinker mainly from Turkey. The cement sector in Senegal is occupied by three major manufacturers: Dangote, Sococim, Ciments du Sahel (CDS). Senegal's total cement production capacity is approximately 8 million tons. Over the past few years, the growth of the cement market in Senegal has been very strong, and in the long term, growth levels are expected to be sustained, particularly with increasing populations and GDP. Demand for cement depends on several factors, including major construction and public works projects, urbanization, population growth and the rise of the middle class, all of which create a need for construction materials. The impact of various factors on cement demand is affected by several assumptions, which are generally reflected in GDP growing.

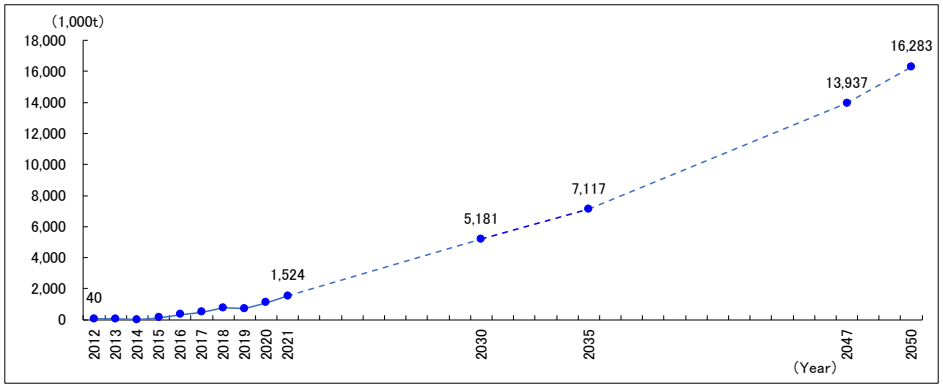
Based on the above, future clinker demand is estimated by correlations with the Senegalese GDP.



Source: JPT

Figure 3.38 Correlations between Senegalese Nominal GDP and Clinker

Items	Import or Export	Actual value (1,000t)										estimated value			
		2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2030	2035	2047	2050
Clinker	Import	40	38	0	121	324	487	765	704	1,089	1,524	5,181	7,117	13,937	16,283



Source: JPT

Figure 3.39 Micro estimates of【DEB】Clinker

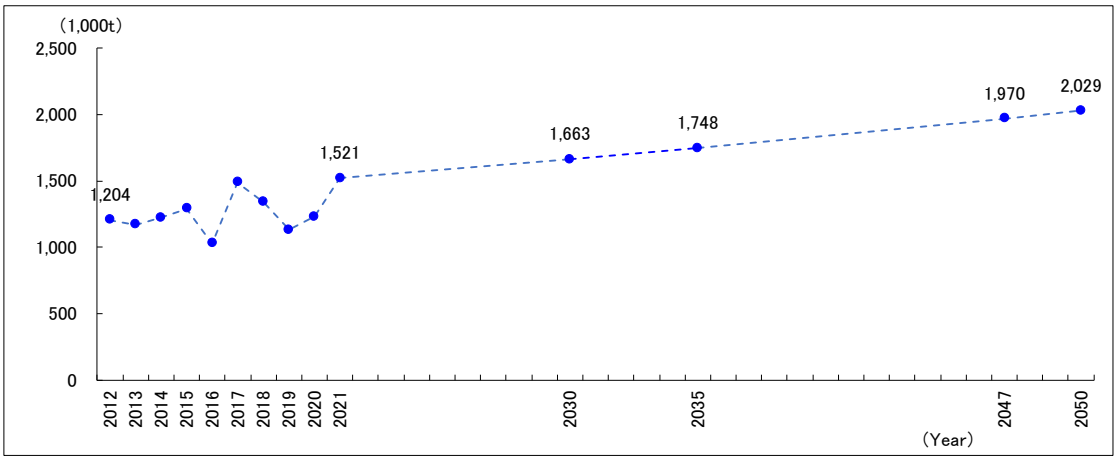
c) [DEB] Rice

The growth of rice imported to Senegal has slowed since the peak in 2017, partly due to the progress in the use of containers.

According to OECD/FAO, global demand for rice is expected to grow at a rate of 1% over the next several years. In Senegal, imports are expected to remain relatively stable due to the national program for rice self-sufficiency (PNAR), even if the annual growth rate of rice demand may exceed 1%, as populations are growing at a faster rate than in other parts of the world.

From the above, the future demand for rice is estimated from the annual increase of 1%, which is the growth rate of global rice demand predicted by FAO.

Items	Import or Export	Actual value (1,000t)										estimated value			
		2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2030	2035	2047	2050
Rice	Import	1,204	1,169	1,222	1,289	1,029	1,488	1,341	1,131	1,231	1,521	1,663	1,748	1,970	2,029



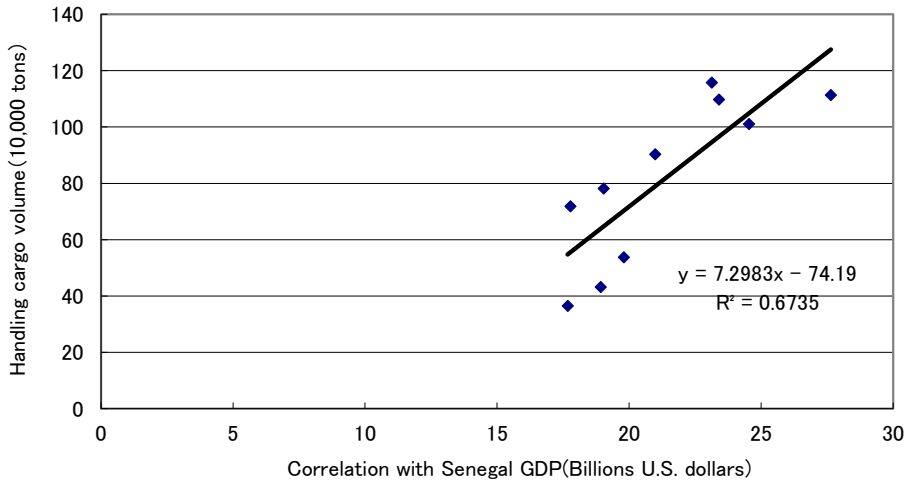
Source: JPT

Figure 3.40 Micro estimates of【DEB】Rice

d) [DEB] Coale

Like clinker, coal is the main input in cement production. In 2019, Senegal imported about 900,000 tons of coal from South Africa, Mozambique, and Russia.

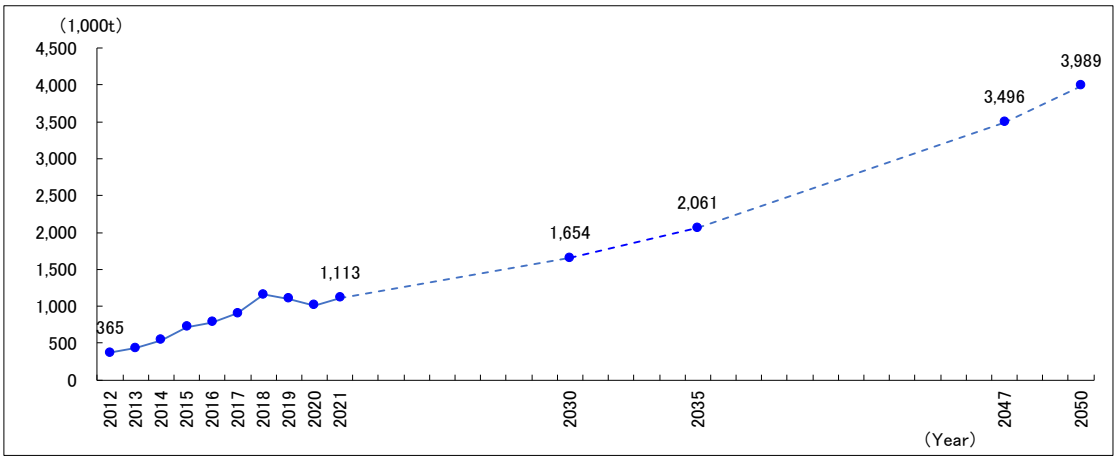
JPT confirmed the correlation of future demand for coal with the Senegalese GDP as in the case of clinker, but no correlation was found, so JPT estimates it from the annual mean growth rate of the Senegalese GDP.



Source: JPT

Figure 3.41 Correlations between Senegalese Nominal GDP and Houille

Items	Import or Export	Actual value (1,000t)										estimated value			
		2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2030	2035	2047	2050
Coal	Import	365	432	538	719	782	903	1,157	1,098	1,011	1,113	1,654	2,061	3,496	3,989



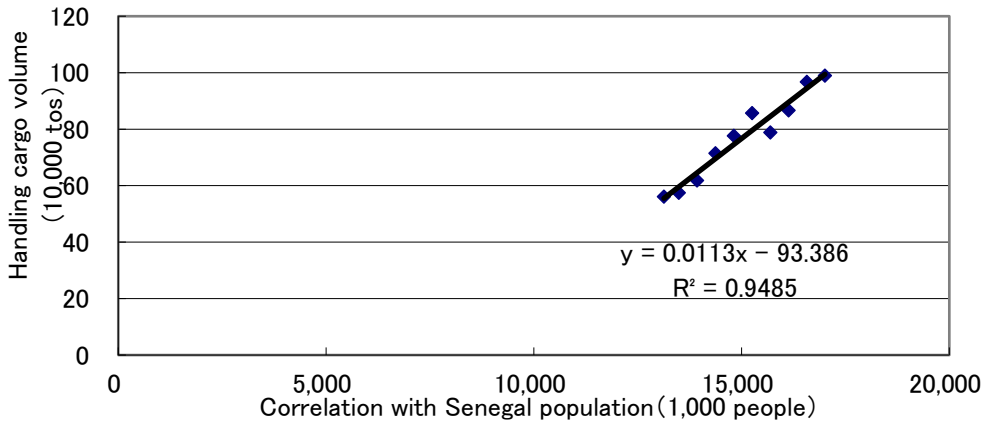
Source : JPT

Figure 3.42 Micro Estimates of【DEB】Houille

e) [DEB] Grain

For imported grains with very limited cultivation in Senegal (excluding corn), per capita consumption is unlikely to decline, so demand growth is expected to be more consistent with population growth. Wheat food availability in Senegal was 43kg/ in 2018 but 38.4kg/ at the import level. The difference between these two ratios is attributable to the previous year's annual inventory that did not need to be imported in 2018. Per capita wheat import rates have been relatively stable since 2016. Thus, population growth is a good indicator of growth in grain demand.

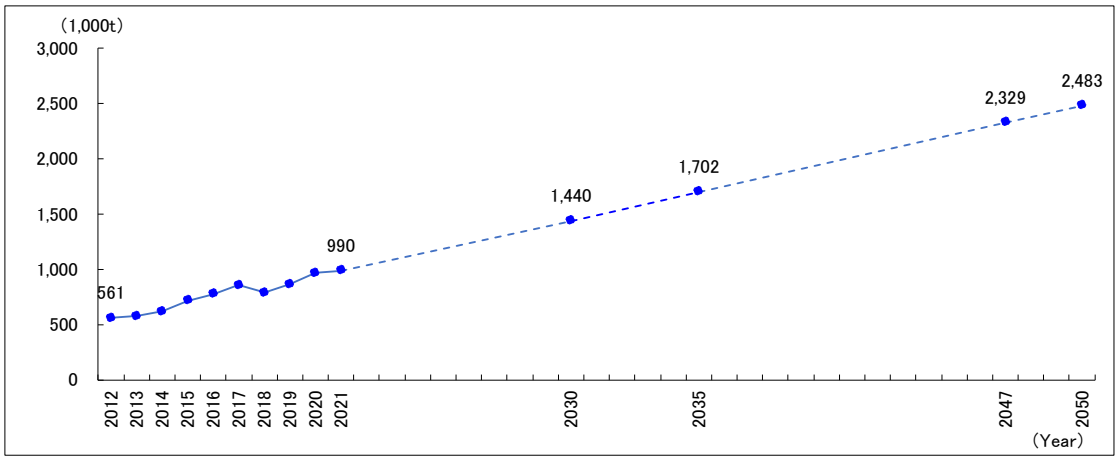
Based on the above, future wheat demand is estimated by correlation with the Senegalese population.



Source: JPT

Figure 3.43 Correlations between Senegalese Nominal GDP and Grain

Items	Import or Export	Actual value (1,000t)										estimated value			
		2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2030	2035	2047	2050
Wheat	Import	561	575	618	715	776	857	788	867	967	990	1,440	1,702	2,329	2,483



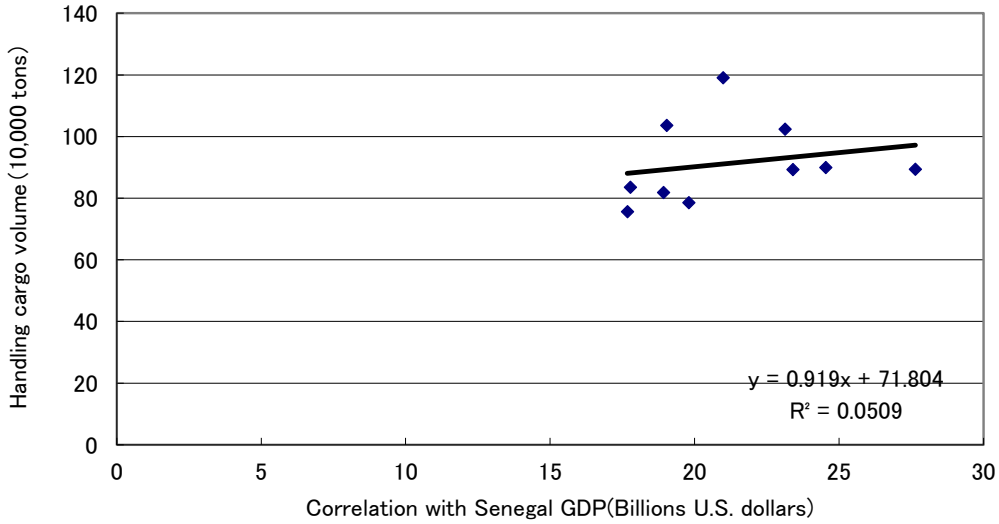
Source : JPT

Figure 3.44 【DEB】 Grain Micro Estimates

f) [DEB] Crude Oil

As with hydrocarbon imports, future demand for crude oil is determined by several factors, including the conversion of power plants and the use of renewable energy in the energy mix of Senegal and Mali.

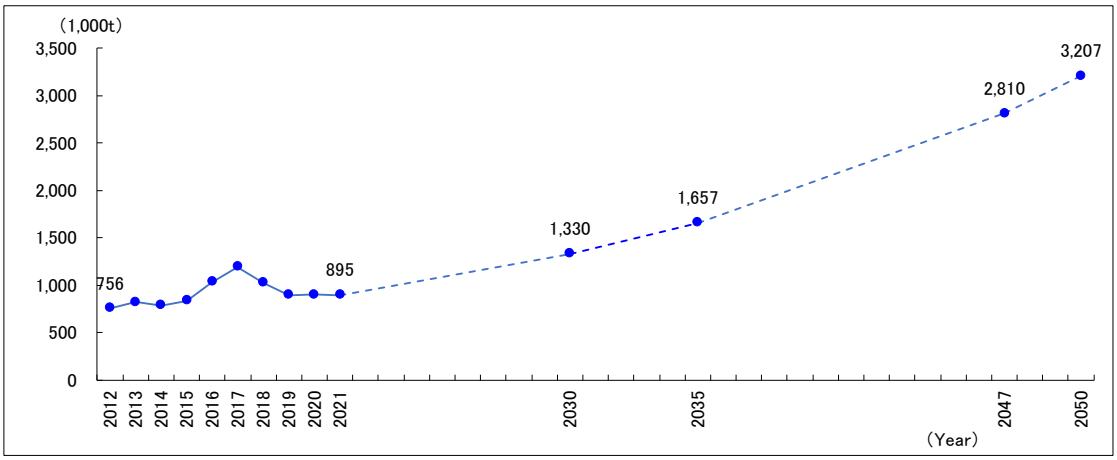
Future demand for crude oil was found to be correlated with the Senegalese GDP, but no correlation was found. Therefore, it is estimated from the annual mean growth rate of the Senegalese GDP.



Source: JPT

Figure 3.45 Correlations between Senegalese Nominal GDP and Crude Oil

Items	Import or Export	Actual value (1,000t)										estimated value			
		2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2030	2035	2047	2050
Crude oil	Import	756	819	786	836	1,036	1,191	1,024	894	900	895	1,330	1,657	2,810	3,207



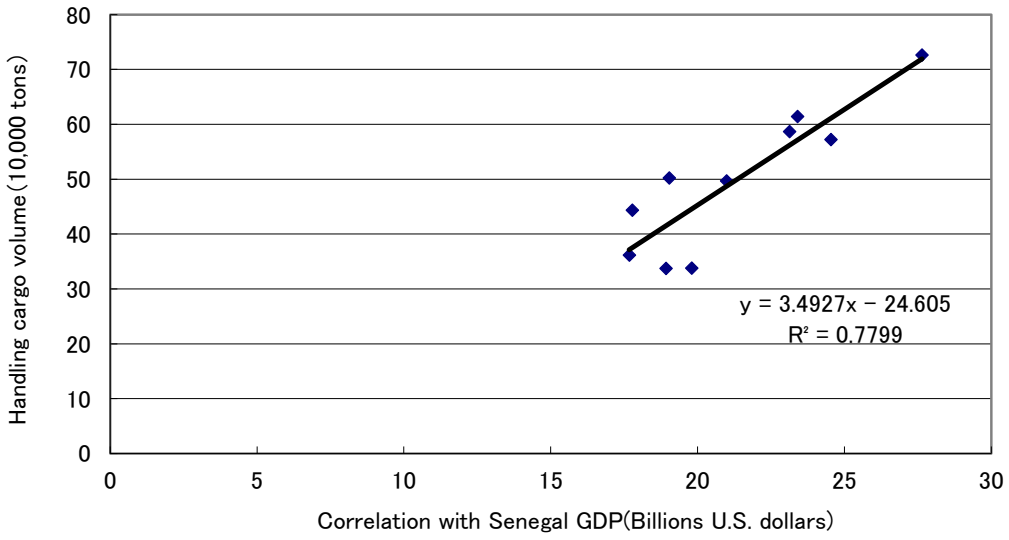
Source: JPT

Figure 3.46 【DEB】 Micro Estimates of Crude Oil

g) [DEB] Steel

Demand for steel, like cement, depends on several factors, including major construction and public works projects, urbanization, population growth, and the rise of the middle class, all of which create a need for construction materials, and generally these factors are reflected in GDP growing.

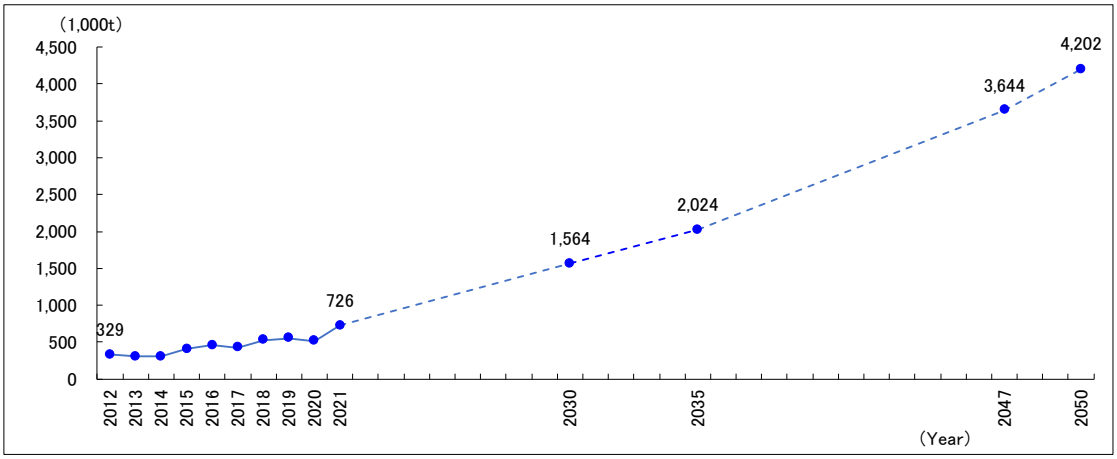
The future demand for steel is estimated by correlations with the Senegalese GDP.



Source: JPT

Figure 3.47 Correlations between Senegalese Nominal GDP and Steel

Items	Import or Export	Actual value (1,000t)										estimated value			
		2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2030	2035	2047	2050
Iron	Import	329	307	307	404	457	425	525	553	514	726	1,564	2,024	3,644	4,202



Source: JPT

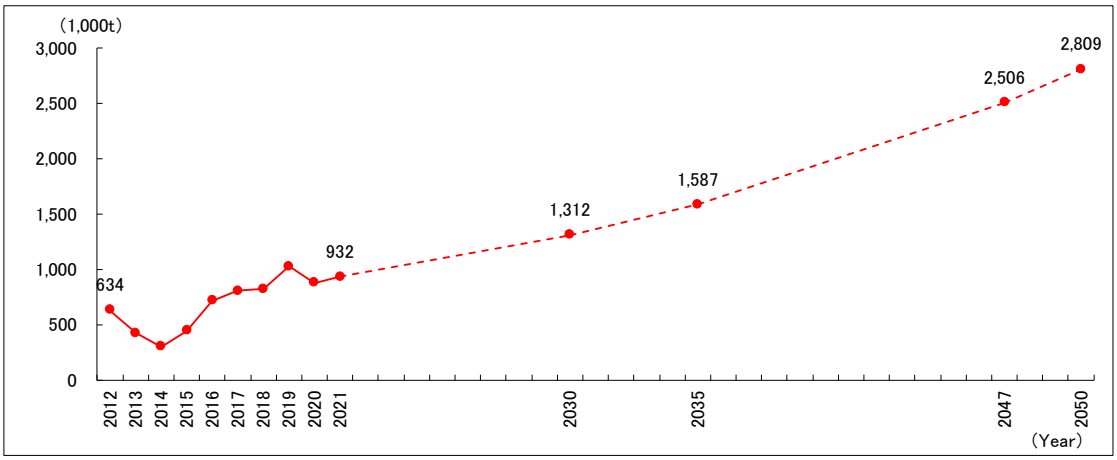
Figure 3.48 Micro estimates of【DEB】Steel

h) [EMB] Acide Phosphorique (Fertilizers)

Senegal produces and exports phosphate-based fertilizers. Exports have increased significantly from 450,000tons in 2015 to 1million tons since 2019. The global demand for phosphoric acid is expected to increase from 42million tons in 2020 to 43.6million tons in 2022, an increase of about 1.8% per year. However, Senegal's sulfuric acid is produced primarily at Darou facilities in ICS and exported primarily to India. The annual growth rate through 2022, as projected by FAO in South Asia, increased by 3.88%. Therefore, it is reasonable to assume that the export of phosphoric acid will increase at this rate in the future.

From the above, the future demand for phosphoric acid (fertilizer) is estimated from the future growth rate (3.88%) of South Asia, one of the export partners.

Items	Import or Export	Actual value (1,000t)										estimated value			
		2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2030	2035	2047	2050
Phosphoric aci	Export	634	425	302	446	715	805	824	1,025	876	932	1,312	1,587	2,506	2,809



Source : JPT

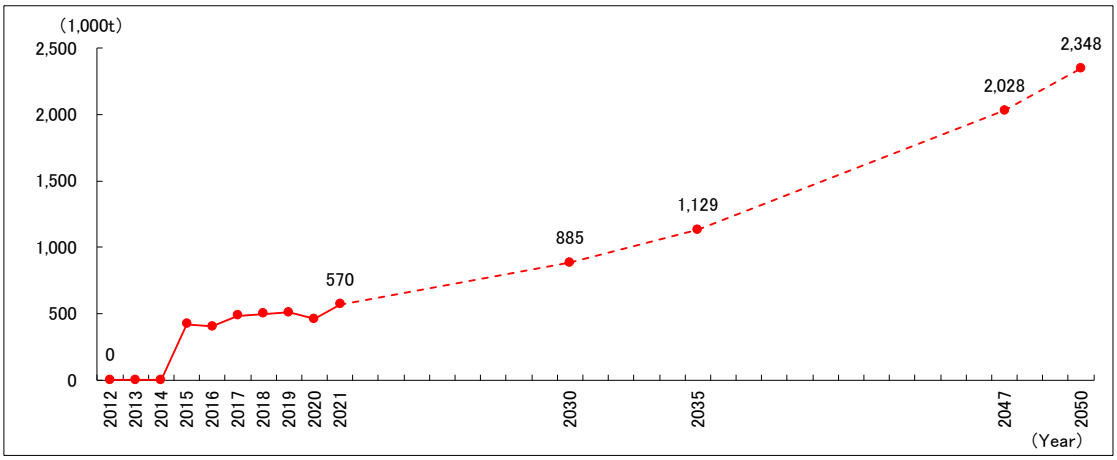
Figure 3.49 Micro estimates of【EMB】Acide Phosphorique

i) [EMB] Ilménite

Ilmenite is an ore used to produce high quality titanium and steel. However, it is mainly used in the production of titanium dioxide, a white pigment which is also used as an opacifier in paints. In Senegal, Ilmenite is produced by Grande Côte Opérations (GCO), which holds mineral sands leases on the Atlantic coast. GCO is planning to expand its output in Loumpoul. According to MarketWatch, the global demand for titanium dioxide is expected to grow by 13% annually between now and 2027. On the other hand, other analysts are forecasting 5%, 6% or 7.9% growth rates. In any case, the outlook for the demand for ilmenite is very good, and Senegal's exports are expected to continue to grow due not only to the demand for white pigments, especially for various industries, but also to the demand for high-quality steel used in the automotive industry.

From the above, the future demand for ilmenite is estimated from the global demand growth rate of titanium dioxide (5% of the lowest value).

Items	Import or Export	Actual value (1,000t)										estimated value			
		2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2030	2035	2047	2050
Ilmenite	Export	0	0	0	420	402	482	498	508	460	570	885	1,129	2,028	2,348



Source: JPT

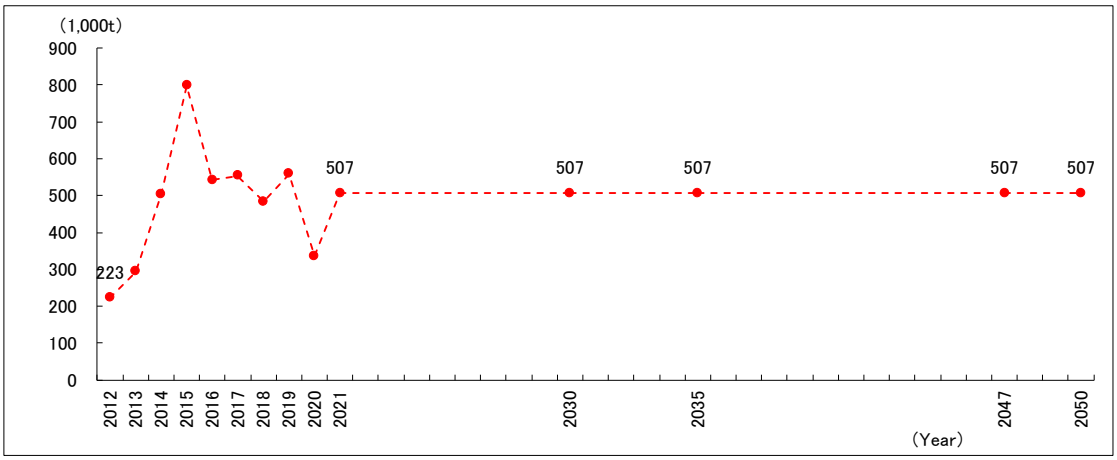
Figure 3.50 【EMB】 Micro estimates of Ilmenite

j) [EMB] Phosphate

Overseas exports of phosphate concentrate from Senegal are 0.5 million tons, peaking at 0.8million tons in 2015. Phosphate minerals are mainly used in the production of phosphate fertilizers and are utilized directly by producers of fertilizers used to fertilize soil. According to CRU projections reported by Averina, the global demand for phosphate concentrates is expected to increase from 213million tons in 2020 to 219 million tons in 2022, but even if demand grows, this will not systematically lead to export growth. Senegal's markets for the export of its phosphate are the Mediterranean coast (including Lebanon) and Europe, and Senegal's advantages in the world's phosphate market are its proximity to Europe, one of the world's major importers, and its transportation costs are lower than those of North America and Asia. In addition to balancing demand and supply and transportation costs, port capacity could be a major issue, and high inventories and crowding at the Dakar port are forcing Senegalese producers to cut production.

Based on the above, JPT assumes that the future demand for phosphate will increase at the same rate as the global demand, and estimate that it will maintain its current market share in Senegal (2021 value).

Items	Import or Export	Actual value (1,000t)										estimated value			
		2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2030	2035	2047	2050
Phosphate	Export	223	293	504	798	543	554	484	559	336	507	507	507	507	507



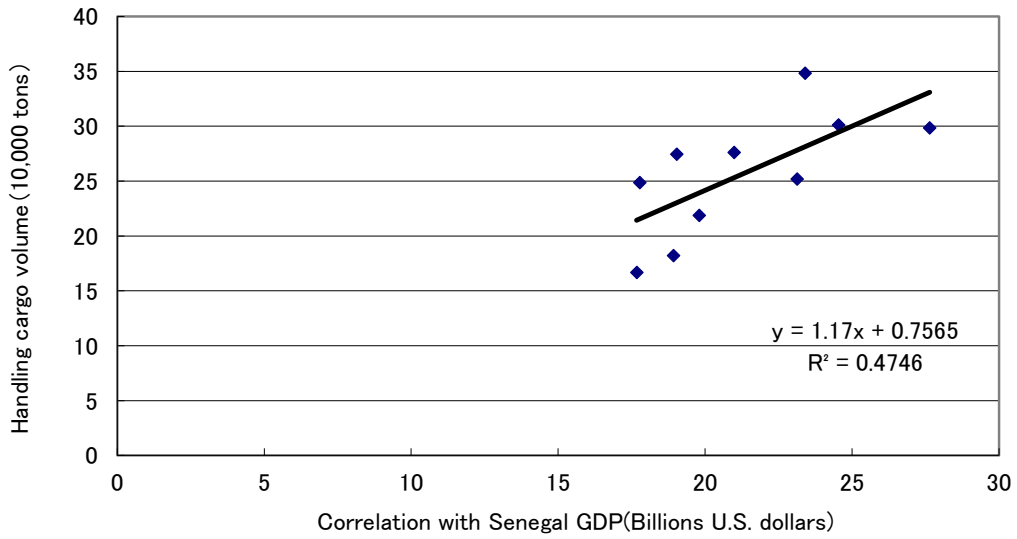
Source: JPT

Figure 3.51 Micro estimates of【EMB】Phosphate

k) [EMB] Fishing Products

Fishing products are trending upward despite increases and decreases.

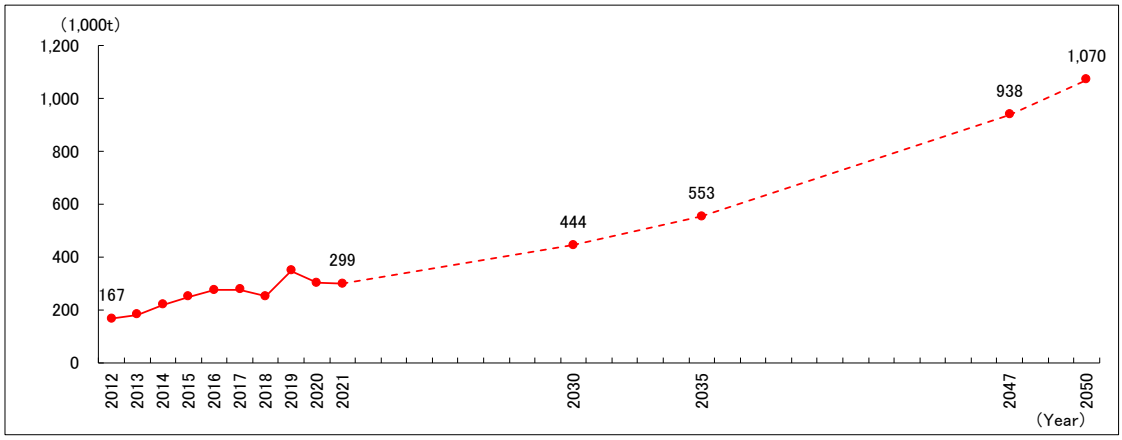
JPT confirmed the correlation between future demand for fishing goods and the Senegalese GDP, but no correlation was found, so JPT estimates the demand from the annual mean growth rate of the Senegalese GDP.



Source: JPT

Figure 3.52 Correlations between Senegalese Nominal GDP and Fishing Products

Items	Import or Export	Actual value (1,000t)										estimated value			
		2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2030	2035	2047	2050
Fishing products	Export	167	182	219	249	274	276	252	348	301	299	444	553	938	1,070



Source: JPT

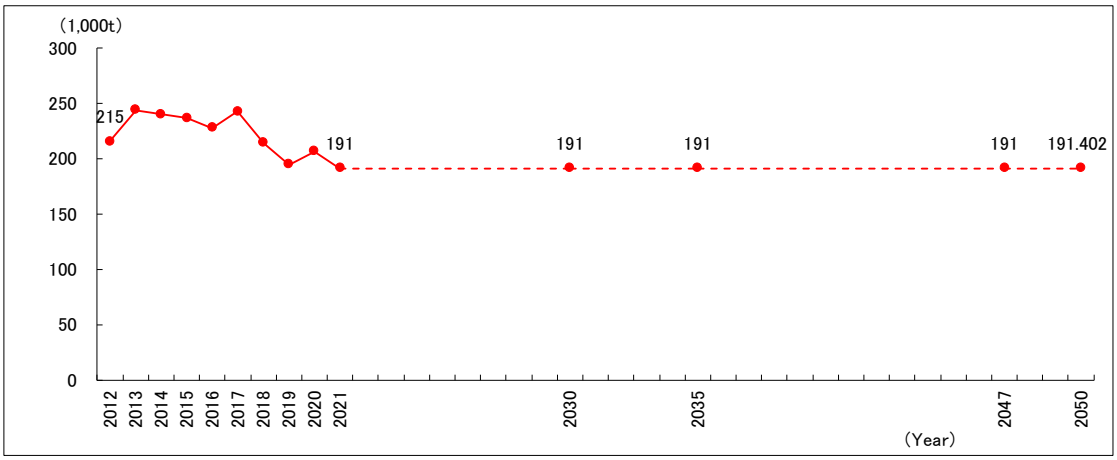
Figure 3.53 【EMB】Micro Estimates of Fish Products

l) [EMB] Attapulgite

Attapulgite is tricalcium phosphate which occurs naturally as clay. It is a mineral with excellent water absorption and oil absorption. Senegal is one of the world's major producers of attapulgite, and this attapulgite is made especially in Thies region and exported mainly to Europe. Attapulgite of Senegal is sold primarily as an absorbent animal litter and industrial absorbent by Tolsa. Since Senegal is estimated to have 100 million tons of reserves, the export potential of attapulgite is expected to continue over the long term. Exports in the past few years have been relatively stable at around 0.2 million tons, and there are no signs that demand for animal absorbents will decline or increase. Therefore, the current export level is expected to be maintained in the medium to long term.

Based on the above, we estimate that the demand for attapulgite in the future will be maintained at the current level (2021 value).

Items	Import or Export	Actual value (1,000t)										estimated value			
		2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2030	2035	2047	2050
Attapulgite	Export	215	244	240	237	228	242	214	195	207	191	191	191	191	191



Source : JPT

Figure 3.54 Micro estimates of【EMB】Attapulgite

(3) Pattern Analysis Other than Major Items

Exception of major commodities, estimates are made using pattern analysis based on trends in cargo volume.

The estimated results are shown in the table below. The target annual lifting cargo volume is 25.03 million tons in 2030, 31.57 million tons in 2035, 53.51 million tons in 2047 and 60.84 million tons in 2050. The target annual freight volume is 3.57 million tons in 2030, 4.20 million tons in 2035, and 6.40 million tons in 2047 and 7.15 million tons in 2050. The total cargo volume is 28.60 million tons in 2030, 35.77 million tons in 2035, 59.91 million tons in 2047 and 67.99 million tons in 2050.

Table 3.19 Micro Estimation Results of Lifting Cargo Volume by Item

(tons)

	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	Pattern of changes in cargo volume	2030	2035	2047	2050
Total	6,315,292	6,780,986	7,262,804	7,924,593	8,843,924	10,233,209	11,309,786	11,073,740	11,849,101	13,261,093		25,029,192	31,570,985	53,514,913	60,840,149
Hydrocarbon	1,436,441	1,853,101	2,133,728	2,035,646	2,069,722	2,171,950	2,627,958	2,942,190	3,094,594	3,516,884	Main Products	8,218,705	10,635,193	19,147,459	22,075,897
Clinker	39,808	37,703	0	121,444	323,798	486,563	765,326	704,220	1,088,864	1,524,093	Main Products	5,180,680	7,116,818	13,937,013	16,283,335
Rice	1,204,465	1,168,869	1,221,670	1,289,214	1,029,432	1,488,034	1,340,586	1,131,379	1,231,200	1,520,724	Main Products	1,663,193	1,748,033	1,969,727	2,029,412
Coal	365,425	432,385	537,554	718,904	781,751	903,111	1,157,467	1,097,968	1,011,186	1,113,062	Main Products	1,654,116	2,061,330	3,495,770	3,989,255
Wheat	561,114	574,862	618,135	714,774	776,425	856,990	788,246	866,676	967,237	989,572	Main Products	1,439,601	1,701,518	2,328,682	2,483,219
Crude oil	756,188	819,126	786,097	835,857	1,036,205	1,191,235	1,024,071	893,573	900,043	894,674	Main Products	1,329,571	1,656,887	2,809,884	3,206,544
Iron	328,891	307,163	307,218	403,781	456,971	425,135	525,243	553,058	514,390	725,905	Main Products	1,564,378	2,024,262	3,644,236	4,201,549
Sulfur	281,924	214,766	219,303	303,992	432,594	420,175	651,461	435,547	447,077	555,462	Vibrating type	501,944	501,944	501,944	501,944
Corn	156,283	140,093	187,915	246,260	220,115	269,999	377,567	346,960	314,811	407,358	Increasing type	653,060	796,143	1,139,542	1,225,392
Fishing products	228,066	163,220	188,136	184,580	230,175	284,611	301,813	352,603	362,157	335,045	Increasing type	556,264	664,865	925,508	990,669
Gaseous products	92,318	103,703	115,887	119,737	141,750	154,271	162,103	186,318	190,862	219,033	Increasing type	332,061	400,011	563,089	603,858
Gypsum	38,449	22,796	80,687	74,546	132,539	193,765	159,202	181,319	206,929	215,079	Increasing type	433,009	545,038	813,907	881,125
Construction materials	0	17,693	34,813	17,006	63,476	158,682	224,428	200,523	147,766	198,576	Increasing type	453,510	582,107	890,741	967,899
Sugar	130,054	204,839	96,445	175,948	154,629	178,179	150,307	151,304	206,331	114,448	Decreasing type	114,448	114,448	114,448	114,448
Onions	66,658	80,705	78,849	99,201	95,444	139,512	69,514	81,414	134,048	112,270	Vibrating type	107,352	107,352	107,352	107,352
Fruits	41,279	43,657	54,596	49,651	56,076	72,113	81,207	94,200	101,237	106,410	Increasing type	176,240	215,572	309,969	333,569
Edible oil	26,873	19,812	24,868	31,509	26,825	30,559	16,170	26,391	65,049	91,407	Vibrating type	45,915	45,915	45,915	45,915
Wood	60,269	54,872	61,657	56,185	63,410	75,133	71,505	99,284	78,611	84,411	Vibrating type	81,789	81,789	81,789	81,789
Soybeans	8,734	13,385	6,228	16,307	26,985	6,003	22,334	43,957	22,500	81,624	Vibrating type	35,284	35,284	35,284	35,284
Urea	143,405	151,896	195,248	88,584	194,913	160,133	117,573	205,727	237,081	61,532	Decreasing type	61,532	61,532	61,532	61,532
Bran	8,541	1,546	11,856	10,197	7,319	19,321	35,578	42,130	77,379	59,788	Increasing type	128,130	165,450	255,019	277,411
Asphalt	37,899	33,294	42,246	48,378	54,526	68,928	80,243	56,353	50,369	58,440	Vibrating type	62,866	62,866	62,866	62,866
Ammonium	120	0	0	0	690	1,110	0	0	10,790	57,440	Vibrating type	13,868	13,868	13,868	13,868
Potash	54,501	36,310	0	0	0	21,700	11,000	46,200	34,211	49,500	Vibrating type	32,522	32,522	32,522	32,522
Lubricating oil/Motor oil	18,063	21,385	23,081	25,340	33,415	29,682	31,932	32,022	34,340	41,883	Increasing type	59,045	70,130	96,735	103,386
Cement	4,030	5,679	3,653	4,573	5,373	6,918	18,739	32,921	85,688	31,077	Vibrating type	35,069	35,069	35,069	35,069
Fertilizers	128,986	169,172	131,807	152,042	267,957	188,850	257,273	136,218	104,071	28,801	Decreasing type	28,801	28,801	28,801	28,801
Ammonia	45	6,349	16,995	6,019	19,963	32,815	23,330	21,096	19,497	22,294	Vibrating type	23,806	23,806	23,806	23,806
Potatoes	16,687	12,614	18,320	17,374	18,170	18,006	2,554	9,716	22,288	14,865	Vibrating type	13,486	13,486	13,486	13,486
Flour	3,099	4,989	1,884	2,145	1,765	3,204	0	0	0	5,508	Vibrating type	1,743	1,743	1,743	1,743
Ammonium nitrate	23,575	19,798	16,888	15,990	21,314	39,657	60,132	80,926	42,665	5,398	Decreasing type	5,398	5,398	5,398	5,398
Packaging	0	0	0	0	0	8,336	1,424	1,749	364	3,134	Vibrating type	3,001	3,001	3,001	3,001
Tiles, Sanitaryware	0	0	0	0	0	29	7	7	11	3,023	Vibrating type	615	615	615	615
Oil cakes	25,362	13,140	18,301	26,884	22,419	54,343	51,394	9,750	34,162	2,894	Decreasing type	2,894	2,894	2,894	2,894
Chemical products	0	0	0	0	0	1,100	50	1,195	0	2,855	Vibrating type	1,040	1,040	1,040	1,040
Caustic soda	3,197	4,819	3,884	4,135	4,875	6,076	6,962	2,703	4,250	2,506	Decreasing type	2,506	2,506	2,506	2,506
Quicklime	3,374	3,138	2,454	3,071	3,412	8,017	6,016	0	0	1,605	Vibrating type	3,128	3,128	3,128	3,128
Petroleum coke	0	0	0	0	39,626	43,152	81,471	0	0	1,003	Decreasing type	1,003	1,003	1,003	1,003
Others	21,169	24,109	22,398	25,318	29,865	15,815	7,600	6,140	7,040	1,509	Vibrating type	7,621	7,621	7,621	7,621

Source: JPT

Table 3.20 Micro Estimation Results of Freight Volume by Item

(tons)

	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	Pattern of changes in cargo volume	2030	2035	2047	2050
Total	1,692,116	1,634,770	1,983,384	2,524,240	2,448,910	2,660,038	2,510,198	2,818,504	2,335,011	2,801,799		3,567,659	4,196,492	6,399,214	7,154,514
Phosphoric acid	633,779	424,689	301,748	445,881	715,198	805,118	823,543	1,024,613	875,814	931,509	Main Products	1,312,123	1,587,209	2,506,210	2,809,398
Ilmenite	0	0	0	420,438	402,043	482,457	498,423	508,272	460,004	570,472	Main Products	884,989	1,129,495	2,028,412	2,348,140
Phosphate	223,080	293,459	504,020	798,100	542,685	553,792	483,725	559,027	336,240	506,875	Main Products	506,875	506,875	506,875	506,875
Fishing products	166,674	182,092	218,705	248,715	274,418	276,159	251,817	348,291	301,210	298,592	Main Products	443,736	552,976	937,782	1,070,165
Attapulgite	215,441	244,138	240,148	236,550	228,002	242,484	214,154	194,850	206,775	191,402	Main Products	191,402	191,402	191,402	191402
Copper, iron and lead ore	84,737	66,141	37,490	565	1,145	0	0	0	52,677	112,686	Vibrating type	33,073	33,073	33,073	33,073
Solvent	24,215	47,174	40,772	51,166	37,950	49,962	58,055	37,455	12,120	46,287	Vibrating type	40,776	40,776	40,776	40,776
Salt	28,745	23,572	28,622	34,999	28,390	31,080	7,750	24,304	14,000	40,400	Vibrating type	23,507	23,507	23,507	23,507
Hydrocarbon	23,376	210,689	100,888	41,737	51,166	55,937	19,863	47,383	21,759	20,274	Vibrating type	33,043	33,043	33,043	33,043
Fertilizers	390	254	294	14,315	7,415	39,365	69,215	0	6,000	17,672	Vibrating type	26,451	26,451	26,451	26,451
Construction materials	0	2,266	1,069	880	14,073	19,296	16,440	11,993	9,961	12,196	Vibrating type	13,977	13,977	13,977	13,977
Iron	2,497	746	4,031	2,865	2,556	1,674	100	37	68	9,916	Vibrating type	2,359	2,359	2,359	2,359
Clinker	0	21,739	281,287	0	0	31,057	28,137	4,444	20,486	8,275	Vibrating type	18,480	18,480	18,480	18,480
Edible oil	4,897	5,882	12,896	19,454	9,219	11,166	18,424	10,979	1,861	3,066	Vibrating type	9,099	9,099	9,099	9,099
Rice	13,398	1,742	11,395	6,696	5,904	4,746	2,005	30,034	8,480	2,000	Decreasing type	2,000	2,000	2,000	2,000
Tiles, Sanitaryware	0	0	0	0	0	39	7	8	0	1,896	Vibrating type	390	390	390	390
Cement	252,770	96,917	123,625	147,107	52,304	1,261	1,980	883	1,330	1,256	Vibrating type	1,342	1,342	1,342	1,342
Cigarettes	0	0	0	0	0	0	0	0	0	557	Vibrating type	111	111	111	111
Wood	0	0	0	0	0	2,704	935	0	1,935	118	Vibrating type	1,138	1,138	1,138	1,138
Packaging	0	0	0	0	0	317	93	71	17	80	Vibrating type	116	116	116	116
Hardware	0	0	5	8	4	300	4	58	15	58	Vibrating type	87	87	87	87
Gaseous products	0	0	0	0	0	0	0	0	0	30	Vibrating type	6	6	6	6
Others	18,117	13,269	76,389	54,765	76,439	51,124	15,527	15,802	4,259	26,180	Vibrating type	22,578	22,578	22,578	22,578

Source: JPT

(4) Verification of Estimates based on Micro Estimations

The following tables and figures summarize the micro estimation results for bulk cargo.

The micro estimation results for bulk cargo will be 28.60 million tons in 2030, 35.77 million tons in 2035, 59.91 million tons in 2047 and 67.99 million tons in 2050.

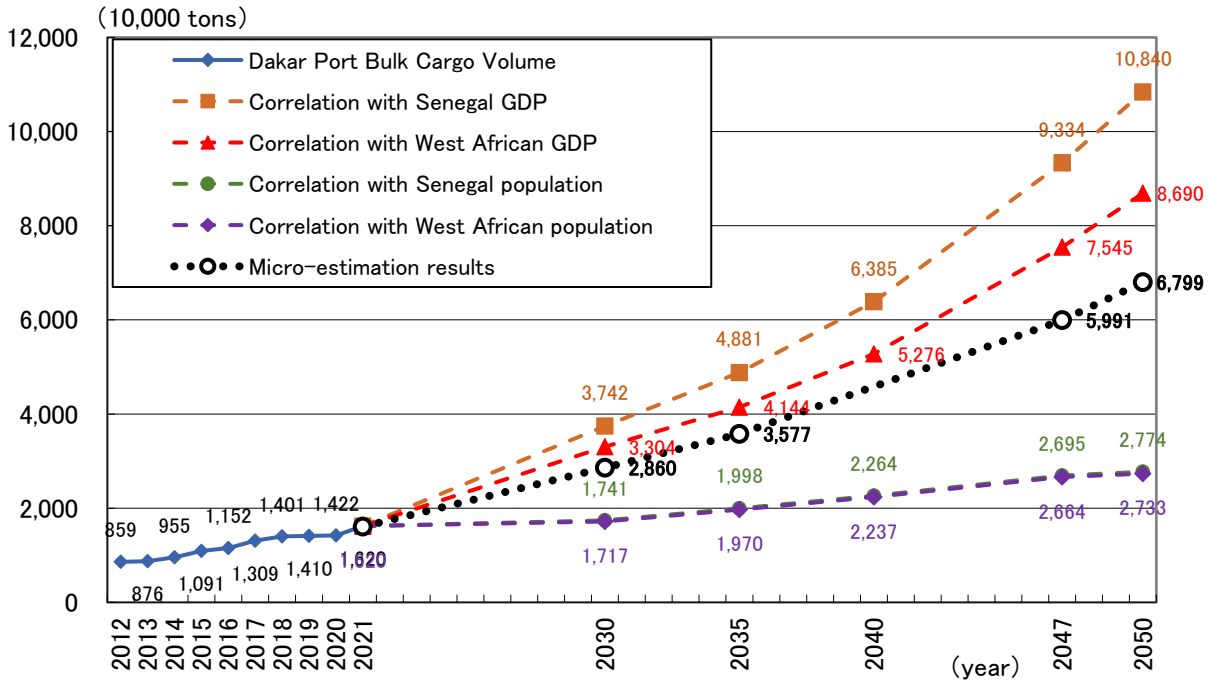
Compared with the macro estimates, this micro estimation results are generally reasonable since they lie between the upper and lower bounds of the macro estimates.

Table 3.21 Summary of micro estimation results of bulk cargo

(10,000 tons)

	2021	2030	2035	2040	2047	2050
Dakar Port Bulk Cargo Volume	1,620					
【Macro】Correlation with Senegal GDP	1,620	3,742	4,881	6,385	9,334	10,840
【Macro】Correlation with West African GDP	1,620	3,304	4,144	5,276	7,545	8,690
【Macro】Correlation with Senegal population	1,620	1,741	1,998	2,264	2,695	2,774
【Macro】Correlation with West African population	1,620	1,717	1,970	2,237	2,664	2,733
Micro-estimation results	1,620	2,860	3,577		5,991	6,799
DEBARQUEMENTS	1,335	2,503	3,157		5,351	6,084
EMBARQUEMENTS	285	357	420		640	715

Source: JPT



Source: JPT

Figure 3.55 Summary of Micro Estimation Results for Bulk Cargo

(5) Volume of Bulk Cargo Handled at Ndayane Port

From the micro estimation results of bulk cargo, in this report, the amount of bulk cargo handled at Ndayane Port is estimated by subtracting the amount of cargo to be transferred to Bargny-Sendou Port and the amount of cargo remaining at Dakar Port.

Based on the hearing with SMP, liquid bulk, agri-bulk, coal, and cement-related items will be transferred to Bargny-Sendou Port by 21.12 million tons in 2030, 26.85 million tons in 2035, 46.35 million tons in 2047 and 52.91 million tons in 2050.

Table 3.22 Micro Estimation Results of Bulk Cargo Items Handled at Bargny-Sendou Port

Impoort

(tons)

	2,030	2,035	2,047	2,050
Total	21,044,324	26,783,766	46,285,795	52,848,237
Hydrocarbon	8,218,705	10,635,193	19,147,459	22,075,897
Clinker	5,180,680	7,116,818	13,937,013	16,283,335
Rice	1,663,193	1,748,033	1,969,727	2,029,412
Coal	1,654,116	2,061,330	3,495,770	3,989,255
Wheat	1,439,601	1,701,518	2,328,682	2,483,219
Crude oil	1,329,571	1,656,887	2,809,884	3,206,544
Corn	653,060	796,143	1,139,542	1,225,392
Gypsum	433,009	545,038	813,907	881,125
Onions	107,352	107,352	107,352	107,352
Fruits	176,240	215,572	309,969	333,569
Edible oil	45,915	45,915	45,915	45,915
Soybeans	35,284	35,284	35,284	35,284
Lubricating oil/Motor oi	59,045	70,130	96,735	103,386
Cement	35,069	35,069	35,069	35,069
Potatoes	13,486	13,486	13,486	13,486

Export

(tons)

	2,030	2,035	2,047	2,050
Total	63,964	63,964	63,964	63,964
Hydrocarbon	33,043	33,043	33,043	33,043
Clinker	18,480	18,480	18,480	18,480
Edible oil	9,099	9,099	9,099	9,099
Rice	2,000	2,000	2,000	2,000
Cement	1,342	1,342	1,342	1,342

Source: JPT

As for the amount of bulk freight remaining at Dakar Port, the freight volume handled at Dakar Port is currently 16.2 million tons as in 2021. Since the port is currently crowded, it is assumed that 1,000 tons will be handled per 1 m of quays, which is the appropriate level of use, from the extension of the water depth-8.5 m at Dakar Port to the extension of the quays. This means that 7,210,000 tons will remain in Dakar Port in both 2030 ,2035, 2047 and 2050.

As shown in Table 3.23, the presumed quay extension of Dakar Port was calculated on the assumption that container cargo and RORO cargo will all be transferred to the port gradually, and the quays of container terminals and Wharf 2nd can also handle bulk cargo.

Table 3.23 Amount of Bulk Cargo Remaining at Dakar Port

Total length of bulk cargo handling quay	7,205 m
1,000t/m cargo handling volume	720.5 (10,000 tons)

Source: JPT

From the above, the estimation of the bulk cargo volume handled at Ndayane port will be 2.25 million tons in 2030, 2.88 million tons in 2035, 6.36 million tons in 2047 and 7.88 million tons in 2050.

Below is a case in which Ndayane port will be relocated the fastest, RORO cargo will move to Ndayane port in 2030, and DPW site (wharf 6 & 7) at Dakar port will not be used as a general cargo terminal. A case is shown in Chapter 3.18.6 in which RORO cargo will be moved to Ndayane port by 2035 and DPW site (wharf 6 & 7) at Dakar port will be used as a general cargo terminal.

Table 3.24 Bulk Cargo Volume Handled at Ndayane Port

('000 tons)

	2021	2030	2035	2047	2050
Micro-estimation results	16,063	28,597	35,767	59,914	67,995
Import	13,261	25,029	31,571	53,515	60,840
Export	2,802	3,568	4,196	6,399	7,155
Bargny Sendou Port		21,108	26,848	46,350	52,912
Import		21,044	26,784	46,286	52,848
Export		64	64	64	64
Dakar Port	16,063	5,242	6,044	7,205	7,205
Import	13,261	3,985	4,787	5,948	5,948
Export	2,802	1,257	1,257	1,257	1,257
Ndayane Port		2,247	2,876	6,359	7,877
Import				1,281	2,044
Export		2,247	2,876	5,079	5,834

Source: JPT

Table 3.25 Micro Estimation Results of Bulk Cargo Items Handled at Dakar Port and Ndayane Port

Import ('000 tons)	2030	2035	2047	2050
TOTAL	3,985	4,787	7,229	7,992
Sulfur	502	502	502	502
Asphalt	63	63	63	63
Quicklime	3	3	3	3
Petroleum coke	1	1	1	1
Iron	1,564	2,024	3,644	4,202
Fishing products	556	665	926	991
Gaseous products	332	400	563	604
Construction materials	454	582	891	968
Sugar	114	114	114	114
Wood	82	82	82	82
Urea	62	62	62	62
Bran	128	165	255	277
Ammonium	14	14	14	14
Potash	33	33	33	33
Fertilizers	29	29	29	29
Ammonia	24	24	24	24
Flour	2	2	2	2
Ammonium nitrate	5	5	5	5
Packaging	3	3	3	3
Tiles, Sanitaryware	1	1	1	1
Oil cakes	3	3	3	3
Chemical products	1	1	1	1
Caustic soda	3	3	3	3
Others	8	8	8	8

Export ('000 tons)	2030	2035	2047	2050
Total	3,504	4,133	6,335	7,091
Ilmenite	885	1,129	2,028	2,348
Phosphate	507	507	507	507
Attapulgite	191	191	191	191
Copper, iron and lead ore	33	33	33	33
Salt	24	24	24	24
Phosphoric acid	1,312	1,587	2,506	2,809
Fishing products	444	553	938	1,070
Solvent	41	41	41	41
Fertilizers	26	26	26	26
Construction materials	14	14	14	14
Iron	2	2	2	2
Tiles, Sanitaryware	0	0	0	0
Cigarettes	0	0	0	0
Wood	1	1	1	1
Packaging	0	0	0	0
Hardware	0	0	0	0
Gaseous products	0	0	0	0
Others	23	23	23	23

Dry Bulk
General Bulk

Source: JPT

Table 3.26 Micro Estimation Results of Bulk Cargo Items Handled at Ndayane Port

Import ('000 tons)	2030	2035	2047	2050
Total	0	0	1,281	2,044
Sulfur	0	0	89	128
Asphalt	0	0	11	16
Quicklime	0	0	1	1
Petroleum coke	0	0	0	0
Iron	0	0	646	1,074
Fishing products	0	0	164	253
Gaseous products	0	0	100	154
Construction materials	0	0	158	248
Sugar	0	0	20	29
Wood	0	0	14	21
Urea	0	0	11	16
Bran	0	0	45	71
Ammonium	0	0	2	4
Potash	0	0	6	8
Fertilizers	0	0	5	7
Ammonia	0	0	4	6
Flour	0	0	0	0
Ammonium nitrate	0	0	1	1
Packaging	0	0	1	1
Tiles, Sanitaryware	0	0	0	0
Oil cakes	0	0	1	1
Chemical products	0	0	0	0
Caustic soda	0	0	0	1
Others	0	0	1	2

Export ('000 tons)	2030	2035	2047	2050
Total	2,247	2,876	5,079	5,834
Ilmenite	568	786	1,626	1,932
Phosphate	325	353	406	417
Attapulgite	123	133	153	157
Copper, iron and lead	21	23	27	27
Salt	15	16	19	19
Phosphoric acid	841	1,105	2,009	2,311
Fishing products	285	385	752	880
Solvent	26	28	33	34
Fertilizers	17	18	21	22
Construction materials	9	10	11	11
Iron	2	2	2	2
Tiles, Sanitaryware	0	0	0	0
Cigarettes	0	0	0	0
Wood	1	1	1	1
Packaging	0	0	0	0
Hardware	0	0	0	0
Gaseous products	0	0	0	0
Others	14	16	18	19

Dry Bulk
General Bulk

Source: JPT

3.6.3 Estimation of the Number of Vessels Entering a Port

(1) Assumed Vessels in DPW M/P (2021)

The expected ship type of each ship type in DPW M/P (2021) is shown as follows. The expected years for each face are 2021~2027 for Phase 1, 2028~2034 for Phase 2, 2035~2040 for Phase 3, and 2041~2047 for Phase 4.

Table 3.27 General cargo design vessel

phase	Ship	classification	DWT	LOA (m)	B (m)	D (m)
1～4	max	Handymax	40,000	220	30	13
	average	Small Handysize	15,000	166	24	10

Source: MML

Table 3.28 RORO Assumption Ship

phase	Ship	classification	DWT	CEU Capacity	LOA(m)	B(m)	D(m)
1～2	max	Midsize Car Carrier	30,000	6,000	214	32.2	11
	average	Midsize Car Carrier	30,000	6,000	214	32.2	11
3～4	max	Large car carriers	40,000	8,000	265	32.2	12.4
	average	Midsize Car Carrier	30,000	6,000	214	32.2	11

Source: MML remarks：Car Equivalent Unit（CEU）

Table 3.29 Dry Agri-bulk Assumption Vessel

phase	Ship	classification	DWT	LOA (m)	B (m)	D (m)
1～2	max	Handymax	50,000	215	32.2	12.7
	average	Handysize	25,000	175	26.3	10.2
3	max	Panamax	70,000	236	32.2	14
	average	Handysize	25,000	175	26.3	10.2
4	max	Capesize	150,000	294	45	17
	average	Large handy size	30,000	186	27.9	10.9

Source: MML

Table 3.30 Container Assumption Ship

phase	Ship	classification	TEU	LOA (m)	B (m)	D (m)
1	max	PostPanamax	5,000	285	40	14
	average	Panamax	3,000	260	32.3	12.6
2	Max	SuperPostPanamax	14,000	366	51.2	15.5
	average	Panamax	4,000	280	32.3	13.5
3～4	max	ULCV	20,000	400	60	16
	average	PostPanamax	6,400	320	42.0	14.2

Source: MML

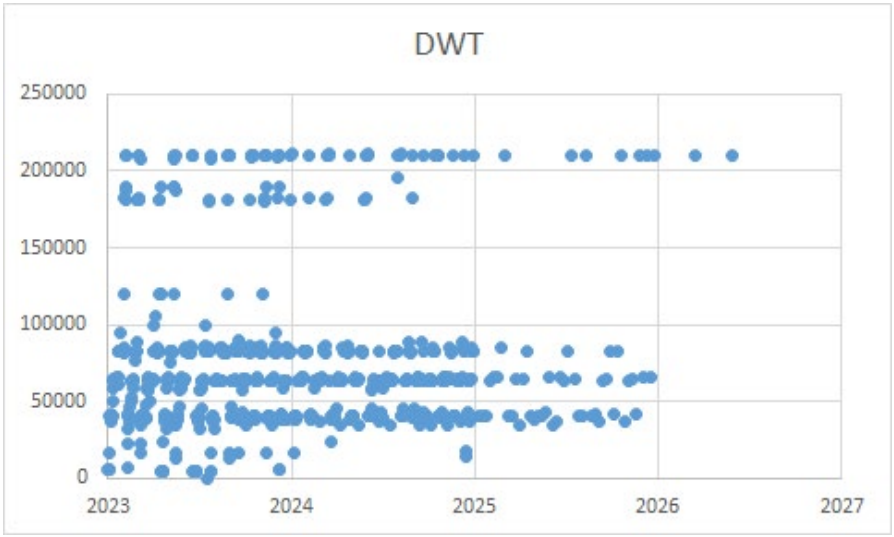
(2) Global Trend of Increasing Ship Size

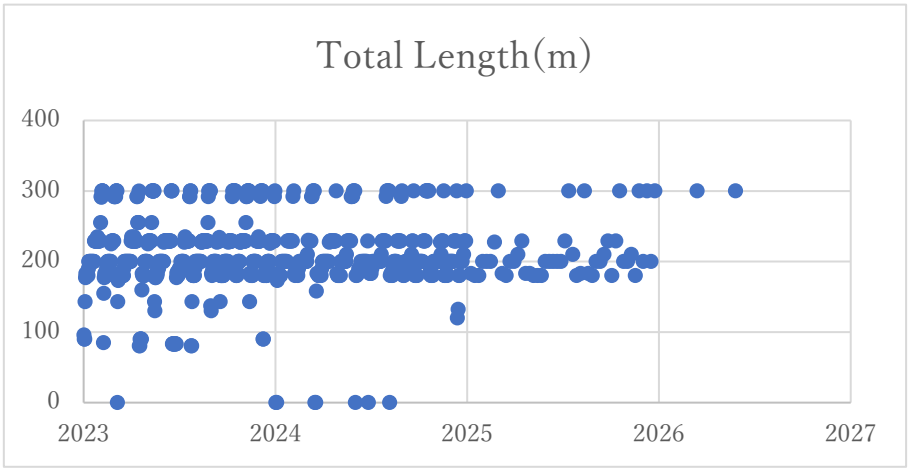
Based on the hull type data of bulk cargo ships and container ships scheduled to enter service in the future from IHSMarkit's Seaweb data, the ship types of container ships and bulk cargo ships to be built are as follows.

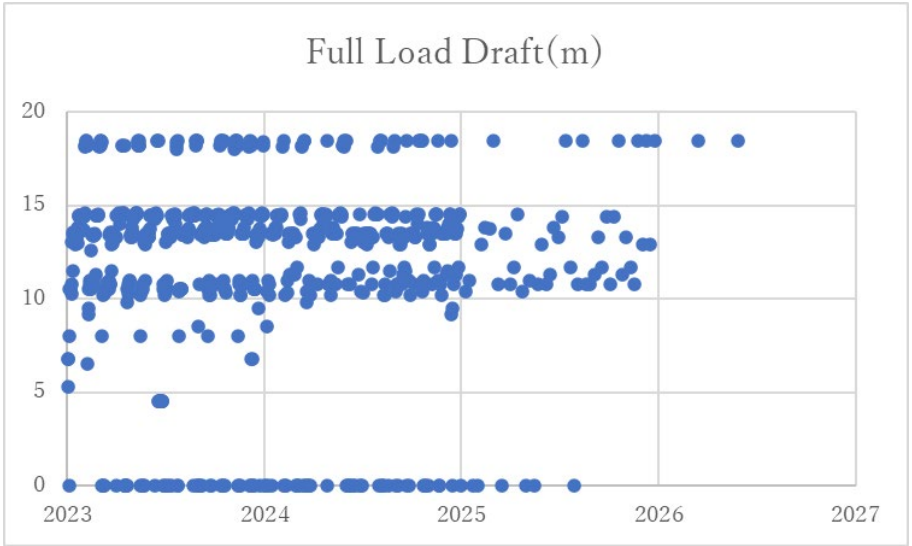
Among the bulk cargo ships scheduled to enter service in the future, there is no 150,000DWT class hull type, but 180,000~210,000DWT class hull type, with an overall length of 300m and a full draft of 19m. However, this data does not clarify the classification of the vessel type.

In terms of containerships, the 23,000~25,000TEU class and 13,000~16,000TEU class are expected to be the main ship types in the future. The maximum hull is 400 meters long and has a full draft of 18 meters.

Furthermore, according to the trend of increasing the size of ships organized by the Ministry of Land, Infrastructure, Transport and Tourism in Japan, the largest ship types are 200,000 DWT class for bulk cargo ships, 31,000 DWT class for car carriers (RORO ships), and 24,000 TEU class for container ships. Bulk cargo ships are intended for transporting grain, iron ore, coal, etc., so care must be taken when applying them to Ndayane Port.



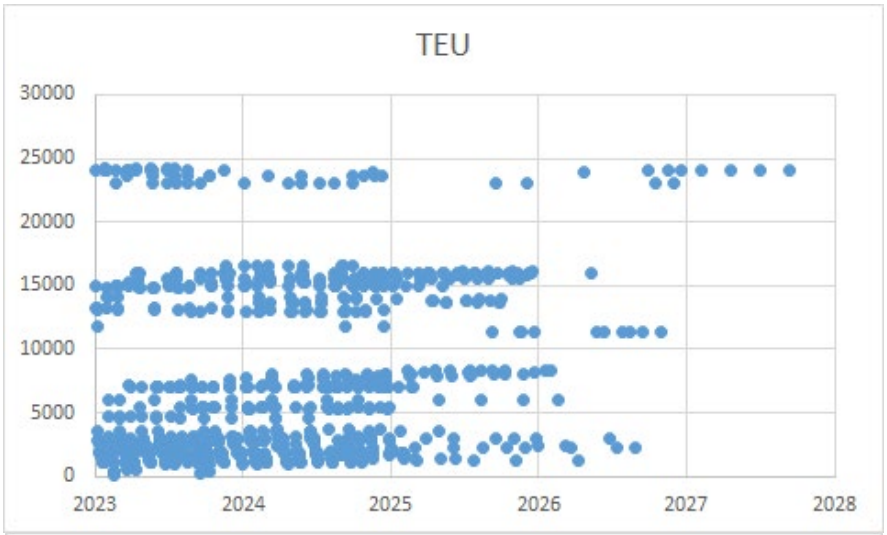


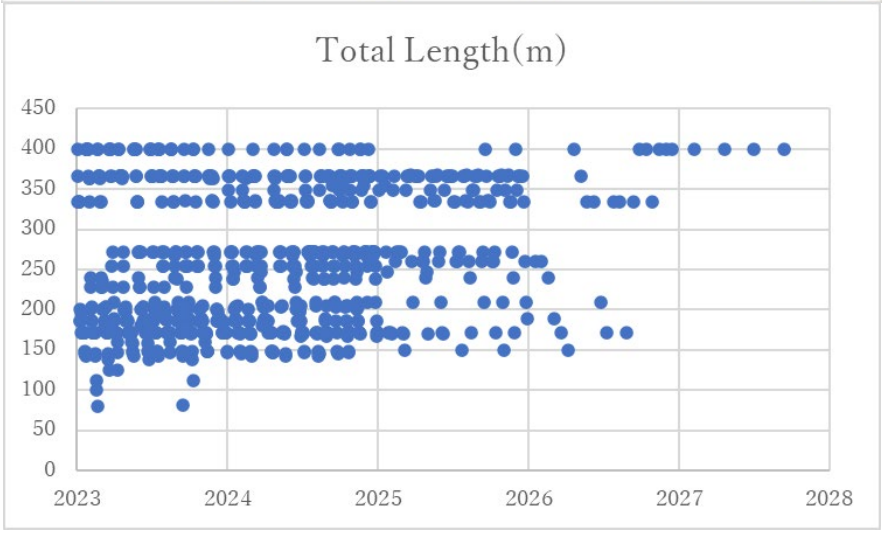


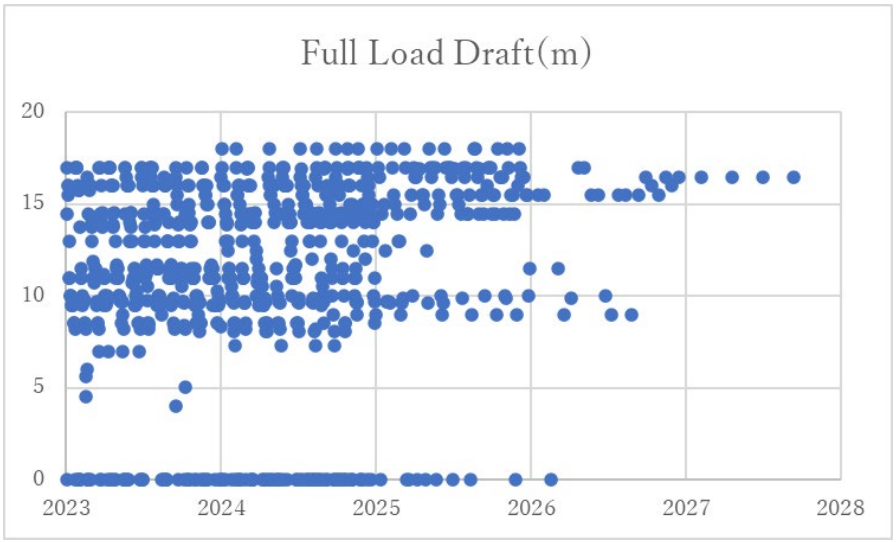
Source: Prepared from Seaweb (IHS Markit)

Figure 3.56 Hull Form (DWT, overall length and full load draft) of Bulk-cargo Ships Scheduled to Be Launched in the Future

※Note: The ships shown as 0 in the graph are those whose details are unknown.







Source: Prepared from Seaweb (IHS Markit)

Figure 3.57 Hull Form (TEU, overall length and full load draft) of Container Carriers Scheduled to Be Launched in the Future

※Note: The ships shown as 0 in the graph are those whose details are unknown

Designation (SHIP type: tons*1)	Target vessels (examples)			wharf depth (m)	Same-scale image (same scale in length)	grain	iron ore	coal
	Tonnage (DWT)	Length (m)	Full load Draft (m)					
Panamax (About 6~90,000 tons)	74,000 ton	225	12.0	14				
Neopanamax*2 (About 120,000 tons)	120,000 ton	250	14.4	16				
Cape Size (About 12~200,000 tons)	200,000 ton	300	18.1	20				
VLOC 〈Very Large Carrier〉 (About 200,000 tons)	330,000 ton	340	21.1	23				

＊1　The unit is Dead Weight Tonnage（DWT）。

＊2　A vessel that opened on June 26, 2016 and is compatible with the new Panama Canal.

Source：Japan Port and Harbor Association

Figure 3.58 Bulk ships are becoming larger

Required quay depth	Target vessels (examples)					Ship name	Same-scale image (same scale in length)	remarks
	Loading capacity (units)	Draft (m)	tonnage (DWT)	length (m)	width (m)			
5m	600	4.5	2,159	105	15.6	Daihatsu Maru		Example of a coastal car carrier (small)
10m	4,900	9.1	10,300	189.3	32.3	Violet Ace		Average ship type calling at Japan ports
12m	7,712	10.6	20,941	199.97	35.4	Hyperion Highway		Car carrier with the largest loading capacity of a Japanese shipping company(K-line)
	5,980	10.02	22,815	199.93	32.26	Aquarius Target		One of the largest tonnage car carriers of Japanese shipping companies (NYK)
	8,500	10.3	22,068	199.9	36.5	Hoegh Target		One of the world's largest car carriers （Hoegh Autoliners）
13m	7,879	11.3	31,143	230.84	32.26	Figaro		One of the world's largest tonnage car carriers （Wallenius Wilhelmsen）

＊1　The specifications of each vessel are according to the World Fleet Register (Clarksons Research) (as of June 2022) and the shipping company's website.

Source：Japan Port and Harbor Association

Figure 3.59 Car carriers (RORO carriers) are becoming larger

Ship name	Target vessels (examples)				Required quay depth when fully loaded (m)	Same-scale image (same scale in length)	remarks
	lading TEU	tonnage (DWT)	length (m)	Width (m)			
NAVIOS	4,360	52,360	259	32	14		Example of Panamax-class container ship [South American route]
SAN FELIPE	8,714	115,356	300	48	16		Example of a Neopanamax-class container ship (before the relaxation of the Panama Canal total width limit*) 【Africa Route】
MSC KANOKO	14,336	149,831	366	48	18		One of the largest container ships calling at Japan ports 【South America Route】
TRITON	14,424	155,000	369	51			The largest container ship that sailed through the Panama Canal among the Neopanamax-class container ships (after the relaxation of the Panama Canal upper limit*) 【European Routes】
MSC ISABELLA	23,656	224,999	400	61			The largest container ship to call at Japan ports in the past [North American West Coast and Europe Route]
EVER APEX	24,004	241,000	400	61.5			The world's largest container ship in business [European route]

＊The Panama Canal Authority relaxed the upper limit of the overall width from 49 meters to 51.25 meters in June 2018.

Source：Japan Port and Harbor Association

Figure 3.60 Containerships are becoming larger (as of August 2022)

Furthermore, the trend of increasing the size of bulk cargo ships with the addition of miners from the National Institute for Land and Infrastructure Management and others is shown in the figure below.

Ship type	tonnage (DWT)	length (m)	Full load draft(m)	coal	iron ore	grain	general
Mini	10, 000tons	125	7.7				
Handy	40, 000tons	190	11.8				
Handymax	60,000tons	203	12.6				
Panamax	74, 000tons	225	12.0				
New Panamax	120, 000tons	250	14.4				
Capesize	200, 000tons	300	18.1				
VLOC	330, 000tons	340	21.1				

Source: JPT

Core Size　Equivalent Size

Figure 3.61 Bulk ships are becoming larger

(3) Setting the Maximum Ship Type Entering the Port

The maximum types of ships expected to enter the port according to DPW M/P (2021) are 40,000 DWT class for general cargo ships, 150,000 DWT class for dry agribulation carriers, 40,000 DWT class for RORO ships (8,000 payloads), and 20,000 TEU class container ships.

On the other hand, according to IHSMarkit's Seaweb data, the largest hull types to be built in the future are 210,000 DWT class bulk freighters, 300 meters long and 19 meters full draft, and container ships of 24,000 TEU class, 400 meters long and 18 meters full draft.

Since the classification of bulk cargo ships is not clear, the maximum ship type will be set based on the trend of increasing the size of ships organized by the Ministry of Land, Infrastructure, Transport and Tourism in Japan.

[Maximum ship type proposed for this M/P]

Since agri-bulk cargo is expected to move to the port of Bargny-Sendou, setting 150,000 DWT is considered excessive.

Since bulk cargo handled at Ndayane Port will be consolidated cargo, packed general cargo, and bulk cargo such as mineral products, the 40,000 DWT class set in DPW M/P (2021) for general cargo, and the minor bulk trend in Fig. 3.60 for general cargo ships and dry bulk are assumed to be Handymax (40,000 DWT class, full draft 13 m) for both ships.

Table 3.31 Maximum hull type proposed in this M/P

		Assumed ship type DPW M/P(2021)	Ships to be built Seaweb(IHSMarkit)	Assumed vessels in Japan
General cargo ship	Ship type(DWT)	40,000		40,000
	LOA (m)	220		190
	B (m)	30		30
	D (m)	13		12
Dry Bulk ship	Ship type(DWT)	150,000	210,000	200,000
	LOA (m)	294	300	308
	B (m)	45		48
	D (m)	17	19	19.4
RORO Carrier (Car Carrier)	Ship type(DWT)	40,000		31,143
	Loading capacity(units)	8,000		7,879
	LOA (m)	265		230.84
	B (m)	32.2		32.26
	D (m)	12.4		11.3
container ship	Ship type(TEU)	20,000	24,000	24,004
	LOA (m)	400	400	400
	B (m)	60		61.5
	D (m)	16	18	

	Maximum hull type	Rationale for setting
Setting Ship Type(DWT)	40,000	Adopted the assumed hull type of DPW M/P (Handymax is assumed, equivalent to 40,000~60,000 DWT by Japanese standards)
LOA(m)	220	
D(m)	13.0	
Setting Ship Type(DWT)	40,000	Since Agribulk will be transferred to Barni Sendu Port, Ndayan Port will handle bulk cargo such as mineral bulk. Therefore, we assume a handymax.
LOA(m)	220	
D(m)	13.0	
Setting Ship Type(DWT)	40,000	Adopted the assumed hull type for the DPW M/P (in line with the trend of increasing the size organized by the Ministry of Land, Infrastructure, Transport and Tourism in Japan)
LOA(m)	265	
D(m)	12.4	
Setting Ship Type(TEU)	24,000	Based on the future trend of larger size, 24,000 DWT class is envisioned.
LOA(m)	400	
D(m)	18.0	

※General cargo ships handle consolidated cargo and packed cargo, and dry bulk carriers are dedicated vessels that transport mineral products, etc.

Source: JPT

(4) Estimation of the Number of Vessels Entering a Port

Based on the above, the assumed ship types in the existing plan are generally considered to be appropriate, and the number of ships entering the port is estimated from the average loading capacity of the assumed ship types in the existing plan. As for dry bulk carriers, Ndayane Port is expected to be dedicated to mineral products, and the average load capacity will be the same as that of general cargo ships.

The estimated results are shown in the table below. The number of general cargo ships will be 268 in

2047 and 345 in 2050. The number of dry bulk ships will be 155 in 2047 and 180 in 2050. The number of RORO ships will be 58 in 2047, and the number of container ships will be 485 in 2047.

Table 3.32 Estimated Results of the Number of Ships Entering a Port

Estimation of the number of general cargo ships entering a port

	2030	2035	2047	2050	Remarks
Maximum ship type of general cargo ship (DWT)	40,000	40,000	40,000	40,000	
Average load capacity of general cargo ship (DWT)	15,000	15,000	15,000	15,000	①: DPW M/P (2021)
Estimated volume of bulk cargo (general cargo) (tons)	1,195,302	1,564,481	4,027,420	5,178,959	②: Ndayane Port Bulk Cargo (General Cargo)
Number of general cargo ships entering a port (ship)	80	104	268	345	③=②/①

Estimation of the number of dry bulk ships entering a port

	2030	2035	2047	2050	Remarks
Maximum ship type of dry bulk ship (DWT)	40,000	40,000	40,000	40,000	
Average load capacity of dry bulk ship (DWT)	15,000	15,000	15,000	15,000	①: DPW M/P (2021)
Estimated volume of dry bulk ship (tons)	1,051,648	1,311,301	2,331,948	2,698,502	②: Ndayane Port Bulk Cargo (Dry Bulk)
Number of dry bulk ships entering a port (ship)	70	87	155	180	③=②/①

Estimation of the number of container ships entering a port

	2030	2035	2047	2050	Remarks
Maximum ship type of container ship (DWT)	14,000	24,000	24,000	24,000	
Average load capacity of container ship (TEU)	4,000	6,400	6,400	6,400	①: DPW M/P (2021)
Estimated volume of containers (TEU)	1,811,236	2,223,093	3,104,484		②: DPW estimates
Number of container ships entering a port (ship)	453	347	485		③=②/①

Estimation of the number of RORO ships entering a port

	2030	2035	2047	2050	Remarks
Maximum ship type of RORO ship (DWT)	30,000	30,000	30,000	30,000	
Average load capacity of RORO ship (units)	6,000	6,000	6,000	6,000	①: DPW M/P (2021)
Estimated volume of RORO vehicle (general cargo) (tons)	210,227	250,374	349,667		②: DPW estimates
Number of RORO ships entering a port (ship)	35	42	58		③=②/①

Source: JPT

3.7 Examination of the Possibility of Large Vessels Calling at the Port

As cargo volumes are expected to increase, in order to examine whether large ships will call at Senegal, JPT will first check the trend of larger new ships delivered to the market and the trend of ships calling at Dakar Port. In addition, Dakar Port may have a limited ship size that can enter the Port due to strict draft restrictions. Furthermore, in case it is difficult to increase the ship size, it is thought that the increase in the number of port calls will respond to the increase in cargo volume, so the possibility of large ships calling at the port based on the current operation of Dakar Port (berth occupancy rate, cargo handling rate) will be examined.

3.7.1 Trend Toward Larger New Ships

Currently, there are 878 container ships and 798 bulk ships under construction worldwide. As for container ships, 40-50% of the number of ships scheduled for delivery by 2024 will be the ships with length overall (LOA) of 140 m or more and less than 210 m. The large ships with LOA of 330 m or more also account for more than 30%. At present, the share of these ship sizes in new ships built by 2027 is expected to approach the same. As for bulk ships, LOA of 170 m or more and less than 210 m is expected to maintain around 60% of the planned number of ships scheduled for completion by 2025, and the speed of increase in size is expected to be slower than that of container ships. For new ships scheduled to be completed after 2023, Table 3.33 and Table 3.34 show the number of ships by LOA.

Table 3.33 Number and Completion Schedule of New Container Ships by LOA

Unit: Number of Ship

LOA	2023	2024	2025	2026	2027	Total
Less than 140 m	10	0	0	0	0	10
140 m or more and less than 210 m	202	143	21	6	0	372
220 m or more and less than 280 m	54	107	29	3	0	193
330 m or more	100	118	68	13	4	303
Total Number of Ships to be Completed	366	368	118	22	4	878

Source: IHS Markit Sea-web 2022/12/26

Table 3.34 Number and Completion Schedule of New Bulk Ships by LOA

Unit: Number of Ship

LOA	2023	2024	2025	2026	Total
Less than 170 m	36	10			
170 m or more and less than 210 m	221	179	36	0	436
220 m or more and less than 260 m	152	60	5	0	217
290 m or more	60	30	7	2	99
Total Number of Ships to be Completed	469	279	48	2	798

Source: IHS Markit Sea-web 2022/12/26

3.7.2 Trend of Larger Ships Calling at Dakar Port

Ships calling at Dakar Port are classified and recorded in 42 different types of ship. For example, there are nine types of cargo ships in general, two types of container ships, four types of RORO ships, and 10 types of bulk ships. Therefore, the target ship type was decided as a cargo ship (i.e., excluding passenger ship and fishing ship), and in principle, one type of cargo ship with a comparable number of port calls during the target period was extracted from each classification corresponding to cargo ships. For these ship types, the type with the highest number of port calls was determined as the standard type based on LOA, and the changes in the standard type and largest-size ship actually called at Dakar Port from 2011 to 2022 are summarized in Table 3.35.

Between 2011 and 2022, the standard types have changed significantly for containerships and reefer ships. The LOA of container ships has increased by 80 m for the standard type and 20 m for the largest-size ship. The LOA of reefer ships has increased by 40 m for standard type and 15 m for the largest-size ship. On the other hand, there was no particular change in the standard type for RORO/LOLO ships, and only moderate changes were observed for tankers, phosphate carriers and conventional ships.

According to Grimaldi, which was introduced in Chapter 2, Grimaldi's headquarters has plans to build new large ships, but in the short term, there are no plans to change the ship size for West Africa services, and rearrangement of the ships is expected, including services provided in other regions. As for Eolis,

they felt that the reefer ships currently used by the company is easy to obtain with a general type of about 200 m LOA, and responded that there are no plans to increase the size for the time being.

Table 3.35 Standard Type and Largest-Size Ship at Dakar Port (from 2011 to 2022)

Ship Type (Major Category)	Number of Ship Calling	2011		2022[Note 1]	
		Standard Ship LOA Full Draft (Ratio)[Note 2]	Largest-size ship LOA Full Draft	Standard Ship LOA Full Draft (Ratio)[Note 2]	Largest-size ship LOA Full Draft
Container ship (Container ship)	6,149	190 m or more to less than 200 m 9.8 m -11.5 m (17%)	274.6 m 14.4 m	270 m or more to less than 280 m 13.5 m – 14.5 m (15%)	294.1 m 14.5 m
RORO/LOLO ship (RORO ship)	4,418	210 m or more to less than 220 m 9.0 m – 10.8 m (45%)	228.7 m 12.0 m	210 m or more to less than 220 m 9.7 m – 9.8 m (44%)	214.0 m 11.0 m
Tanker (Tanker)	4,068	170 m or more to less than 180 m 9.8 m – 12.0 m (22%)	339.8 m 23.1 m	180 m or more to less than 190 m 10.2 m – 13.5 m (29%)	330.0 m 21.5 m
Reefer ship (Cargo ship in general)	1,996	140 m or more to less than 150 m 6.0 m – 9.8 m (46%)	173.3 m 10.0 m	180 m or more to less than 190 m 9.0 m – 9.7 m (39%)	188.6 m 9.7 m
Phosphate carrier (Bulk ship)	421	180 m or more to less than 190 m 9.9 m – 12.5 m (59%)	195.4 m 12.5 m	170 m or more to less than 180 m 9.9 m – 10.0 m (33%)	196.0 m 13.0 m
Conventional ship (Cargo ship in general)	300	Less than 100m 3.4 m – 6.0 m (83%)	158.1 m 10.2 m	110 m or more to less than 120 m 6.4 m (40%)	184.1 m 9.9 m

Note 1: This table includes the arrival of ships until December 19, 2022.

Note 2: The ratio of standard type in the total number of ships calling at port by ship type in the data period was taken.

Source: Based on journalEscaleDetail2022-12-20, created by JPT

3.7.3 Berth Occupation Rate at Dakar Port

The occupancy status of each berth at Dakar Port was reviewed by using the list of ships berthing at Dakar Port in 2021. It was confirmed that extreme congestion occurred at almost all wharves. Depending on the berth, the relatively vacant timing can be seen, but there are many situations where the ship berths within a few hours after another ship unberths, indicating that the ship to berth was waiting offshore. In addition, adjacent two and three berths are now often used as one berth, and the influence of the increase in the size of ships calling at the port can be seen. The berthing berth is almost determined by the ship type and cargo, but it can be seen that it is used flexibly according to the congestion situation. For example, it has been confirmed that general cargo ships, grain ships, and bulk ships share the same berths at 1st Wharf and 4th Wharf (non-concession), and it is considered that berths are usually rotated according to congestion. Meanwhile, berth No. 52 at 5th Wharf is a concession terminal of GCO (Grande Côte Opérations), which handles mineral sands, but grain ships and general cargo ships have berthed

and loading/unloading operation were done, and there is a possibility that the number of calling ships was so concentrated that it could not be handled at 1st Wharf and 4th Wharf. In addition, Penardiers ships, transporting edible oil and lubricant, usually use berth No. 83 at 8th Wharf with TVS (Bulk Terminal of Senegal), which handles bulk cargo such as attapulgite (calcium silicate) and phosphate, but when it is busy, it seems to be using berth No. 64 at 6th Wharf.

Table 3.36 shows the berth occupancy rate by wharf. The berth occupancy rate is the occupancy range of the berth = berth extension, and the vessel berthing time at each berth is divided by the target period (365 days).

Table 3.36 Berth Occupation Rate at Dakar Port (by Wharf)

Wharf	Major Cargo Handled	Number of Ship Calling (All)	Berth Occupancy Ratio (Average in Wharf)
1	General cargo, etc.	283	73%
2	RORO	270	37%
3	Cereal to Mali, etc.	42	29%
4	Cereal, etc.	225	72%
5	Mineral, etc.	57	65%
6	Container, etc.	1270	34%
8	Dry Bulk, etc.	151	51%
9	Liquid Bulk, etc.	151	55%

Source: Based on PAD Traffic Data 2021, created by JPT

For offshore waiting, PAD sets and manages target times. Table 3.37 shows the target times and actual times by terminal/ship type for 2021 and 2022. On an annual average for 2021, RORO, Bulk, 3rd Wharf, Grain, and General Cargo are operating almost as targeted, while Crude oil, Containers, and Minerals are operating below the target days. On the other hand, Liquid Bulk experienced nearly three times the target waiting time. The target has not been set target time for Crude oil, 3rd Wharf, edible oil, etc. for annual average for 2022. By assuming the target were as same as in 2021, Liquid bulk, Crude oil, 3rd Wharf, Minerals, and Grains were waiting offshore more than twice the target waiting time, indicating that the overall situation was congested.

Table 3.37 Offshore Waiting Time off Ships at Dakar Port (by Wharf / Ship Type)

Unit: Day

2021	Target days	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	Annual Average
RORO	1.25	2.63	1.24	2.11	2.96	0.00	0.73	1.58	0.76	1.43	1.43	1.43	1.32	1.47
Dry Bulk (TVS)	6.25	8.73	5.95	4.98	2.15	0.00	3.33	6.96	8.38	12.24	12.24	12.24	9.33	7.21
Liquid Bulk (Sea Invest)	1.25	2.40	1.26	2.69	1.08	0.00	3.93	3.46	2.83	6.90	6.90	6.90	4.87	3.60
Petroleum (Sea Line)	1.25	0.00	0.00	0.00	0.00	0.00	0.00	0.86	2.18	0.56	0.56	0.56	0.77	0.46
Container (DPW)	1.25	0.69	1.09	1.61	0.98	0.00	1.05	1.24	1.12	1.26	1.26	1.26	1.21	1.06
Wharf 3rd (Mali)	1.25	0.00	0.00	0.00	0.00	0.00	0.00	4.39	9.29	0.63	0.63	0.63	5.02	1.72
Mineral (GCO)	1.25	0.00	0.00	0.39	0.41	0.00	0.41	0.80	0.00	1.03	1.03	1.03	6.54	0.97
Edible Oil, etc. (Penardiers)	1.25	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Cereal	1.67	2.41	2.06	1.13	0.95	0.00	4.11	4.22	1.59	1.11	1.11	1.11	3.86	1.97
General Cargo	2.50	6.08	1.60	1.41	4.91	0.00	5.44	7.89	2.06	1.10	1.10	1.10	4.86	3.13

2022	Target days	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	Annual Average
RORO	1.25	1.32	0.71	2.11	2.96	2.60	1.47	0.58	1.17	0.71	3.32	0.71	-	1.61
Dry Bulk (TVS)	6.25	30.33	12.44	4.98	2.26	2.83	5.64	5.51	17.67	12.44	10.45	12.91	-	10.68
Liquid Bulk (Sea Invest)	1.25	3.09	9.35	2.69	2.14	1.36	2.95	0.58	1.68	9.35	3.99	5.23	-	3.86
Petroleum (Sea Line)	-	1.25	0.00	0.52	0.99	0.00	13.14	4.64	7.64	0.00	16.20	2.91	-	4.30
Container (DPW)	1.25	0.87	1.32	1.32	0.00	1.59	5.27	5.10	5.40	1.32	2.15	1.33	-	2.33
3rd Wharf (Mali)	-	1.03	1.18	0.00	0.41	0.00	3.67	1.65	20.23	1.18	2.15	24.38	-	5.08
Mineral (GCO)	1.25	3.07	2.60	2.30	0.00	0.78	1.78	1.61	0.39	2.60	9.27	9.74	-	3.10
Edible Oil, etc. (Penardiers)	-	0.00	0.00	0.00	0.00	0.00	2.02	1.61	0.00	0.00	0.00	0.00	-	0.33
Cereal	1.67	1.22	2.17	1.13	0.00	3.71	0.00	4.23	12.11	2.17	36.11	5.59	-	6.22
General Cargo	2.50	1.85	2.30	1.41	0.00	0.00	0.00	3.23	9.59	2.30	18.98	1.54	-	3.75

Note: The colored columns are those that have waited offshore more than twice the target number of days.

Note: The data for December 2022 are not available due to the timing of information obtained.

Source: Based on PAD ATTENTE RADE 2021 2022, created by JPT

3.7.4 Cargo Handling Rate at Dakar Port

Table 3.38 shows the cargo handling rates by wharf/ship type calculated based on the list of ships berthing at Dakar Port in 2021. The exceptionally high cargo handling rates of crude oil, containers, and minerals are thought to be due to the use of subsea pipelines and cargo handling equipment such as STS, conveyors, etc. Liquid cargo such as liquid bulk and edible oil is unloaded through pipelines installed at quays. Other cargo is mainly handled by the ship crane. For grain, it is the average of cargo handling

when the cargo is the bagged grain and the grain bulk. In the case of bagged grain, the cargo is unloaded by attaching a net to the ship crane and loading it onto a truck by human power. In the case of grain bulk, the cargo is unloaded by attaching the grab bucket to the ship crane, dropped to the shooter, connected to a conveyor and transported to the warehouse, or dropped into the shooter, bagged at the quay and loaded onto a truck by human power. At 3rd Wharf, bagged cargo unloading method is adopted.

Table 3.38 Cargo Handling Rates of Ships at Dakar Port (by Wharf / Ship Type)

Wharf / Ship Type	Number of Calling Ship (with cargo)	Total Cargo Volume (ton) (loading/unloading)	Cargo Handling Rate (ton/24 hours)	Average Cargo Volume (loading/unloading) (ton/ship)
RORO	238	1,051,566	2,231	4,418
Dry Bulk (TVS)	155	4,313,236	5,234	27,827
Liquid Bulk (Sea Invest)	185	3,076,406	3,131	16,667
Petroleum (Sea Line)	114	2,250,902	8,200	19,745
Container (DPW)	598	6,042,082	8,591	10,095
3rd Wharf (Mali)	35	225,836	1,289	6,452
Mineral (GCO)	21	544,700	12,511	25,938
Edible Oil, etc. (Penardier)	29	129,965	2,404	4,482
Cereal	87	1,517,726	2,247	18,640
General Cargo	274	2,557,021	1,554	9,332

Note: The distinction of wharf and ship type follows PAD's classification.

Cargo Handling Rate is calculated by dividing Total Cargo Volume (loading/unloading) by Number of Calling Ship (with cargo) and multiplied by 24 hours.

Source: Based on PAD Traffic Data 2021, created by JPT

For the cargo work of container ship, six quay gantry cranes are used. The cargo handling rate per quay gantry crane (crane productivity) is calculated by converting the cargo handling rate based on tons to TEU base. The total container handling volume in ton in 2021 is 6,042,082 tons and the total container handling volume in TEU in 2021 is 723,770 TEU (total of full container and empty container). Therefore, 1TEU is regarded as 8.42 tons. The cargo handling rate per 24 hours is 8,591 tons, which is equivalent to 1,020 TEU. By dividing this value by the number of quay gantry crane which is 6, and then divided by the working hours per day. In case the working hours per day is 24 hours, per hour productivity is 7 TEU, and it is 28 TEU in case the working hours per day is 6 hours. As a reference, the per hour productivity is 24.6 TEU in Lome (Togo) (Lome Container Terminal 2021), and 30 TEU in Tanger MED (Tanger MED 2020).

Since there are cases where different ship types are doing cargo handling operation at the same wharf at Dakar Port, the cargo handling rate for each wharf is also shown in Table below.

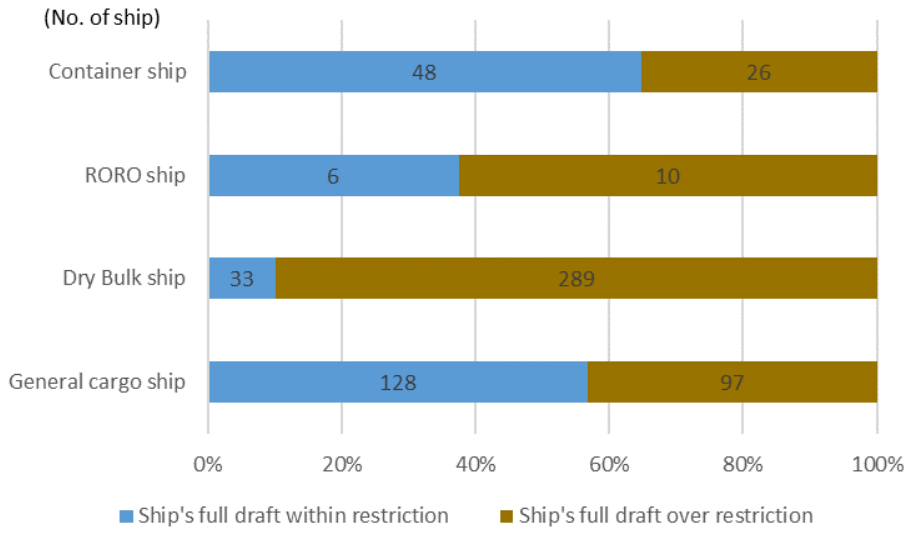
Table 3.39 Cargo Handling Rate of Ships at Dakar Port (by Wharf)

Wharf	Major Cargo Handled	Number of Calling Ship (with cargo)	Total Cargo Volume (ton) (loading/unloading)	Cargo Handling Rate (ton/24 hours)
1	General cargo	229	2,614,467	1,867
2	RORO	261	1,129,606	1,819
3	Cereal to Mali	37	230,836	1,243
4	Cereal	147	1,453,267	2,952
5	Mineral	51	1,440,741	7,010
6	Container	612	6,094,871	7,564
8	Dry Bulk	148	3,613,730	4,851
9	Liquid Bulk,	136	2,880,858	4,746

Source: Based on PAD Traffic Data 2021, created by JPT

Based on the daily arrival data of ships calling at Dakar Port, the relationship between the full draft of ships entering the port and the draft restriction of Dakar Port and the draft of ships at arrival was analyzed. Since the daily recorded arrival data does not include cargo volume information, the purpose of arrival at the port includes both loading and unloading. In addition, since the full draft is not included in the ship's specifications in the data, only ships whose full draft is found after checking with other data provided by PAD are targeted. Therefore, it is inconsistent with the statistics on the number of vessels calling at Dakar Port presented in this report.

Figure 3.62 shows containerships, RORO ships, bulk ships, and general cargo ships classified by specification (full draft). Based on the depth described in the berth information of PAD, a draft restriction considering a margin of 10% was assumed for each berth. Moreover, the ships were classified by its full draft (not the actual arrival draft) according to whether it was within the draft restriction at each berth. Full draft of many of the containerships enter the port were within the draft restriction. Therefore, many of the containerships were able to enter the port with full draft. The opposite is for RORO ships, with the number of ships entering ports, of which full draft in the specification exceed the draft restriction. Therefore, these RORO ships enter the port with less than its full draft (with vacant space). Bulk carriers overwhelmingly exceed the draft restriction, and general cargo ships are almost same.



Source: Based on PAD Dakar Port Arrival Information (2022), created by JPT

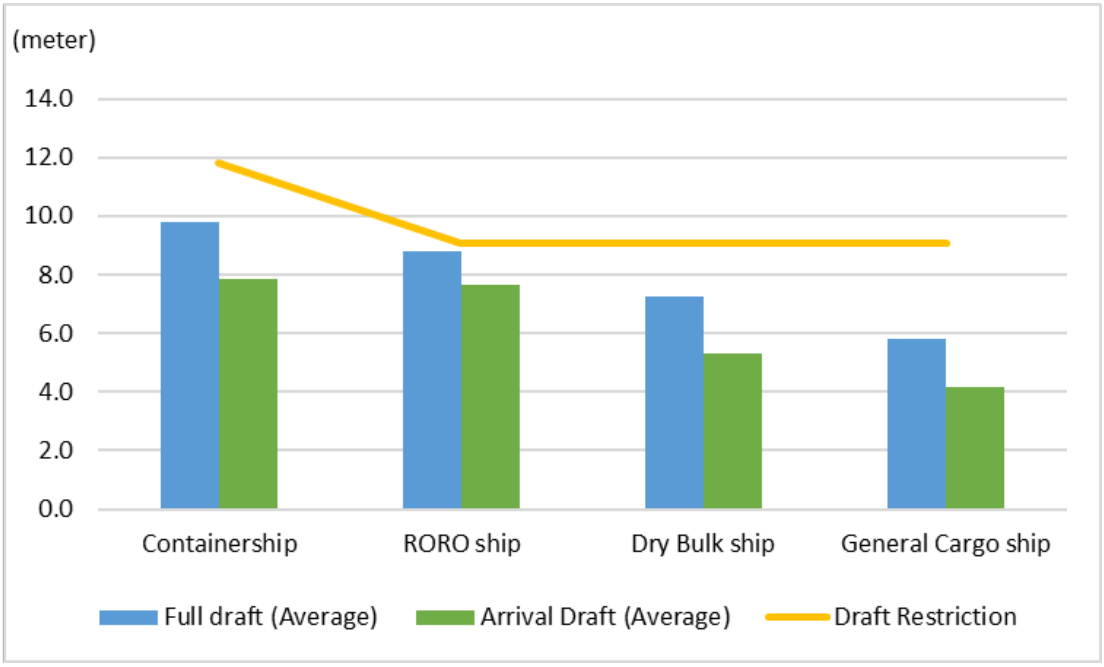
Figure 3.62 Classification by Full Draft of Ships Enter Dakar Port

The draft restrictions of each Wharf were compared with the full draft and arrival draft of ships entering the port. In the case of ships entering the port where the full draft is below the draft restriction of Dakar Port, overall, the draft at arrival is with a considerable margin for the full draft. On the other hand, in the case of ships entering the port whose full draft exceeds the draft restriction of Dakar Port. Since bulk ships and general cargo ships entered the port with a draft deep to the draft restriction of Dakar Port, it is possible that the appropriate size of ships for the cargo volume could not be procured, or that more cargo could have been transported if the port had a deeper draft restriction. The relationships between draft restrictions and the full draft of a ship entering the port and the draft at arrival are shown in Figure 3.63 and Figure 3.64.

Table 3.40 Relationships between Full Draft of Ships entered Dakar Port and Arrival Draft and Draft Restriction at Dakar Port

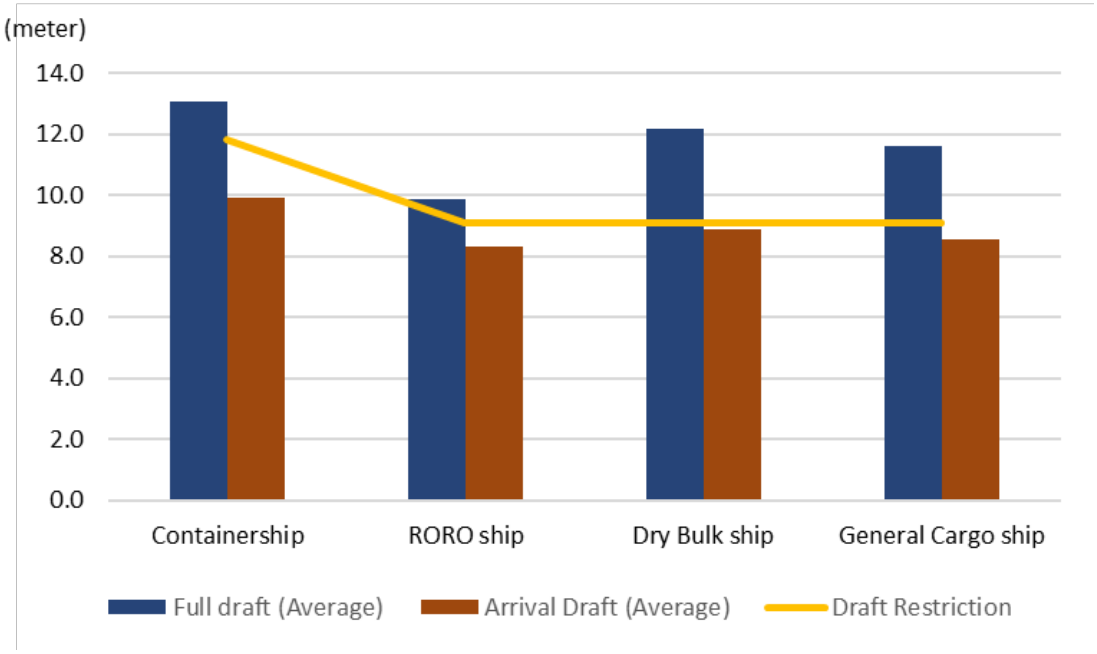
Ship Type	Wharf	Depth (m)	Draft restriction (m)	Ships enter port with its full draft same as or less than draft restriction			Ships enter port with its full draft over draft restriction		
				Full draft (average) (m)	Difference of full draft and arrival draft (m)	Difference of draft restriction and arrival draft (m)	Full draft (average) (m)	Difference of full draft and arrival draft (m)	Difference of draft restriction and arrival draft (m)
Containership	6	13.0	11.8	9.8	1.9	4.0	13.1	3.2	1.9
RORO ship	2	10.0	9.1	8.8	1.2	1.4	9.9	1.6	0.8
Bulk ship	8	10.0	9.1	7.2	1.9	3.8	12.2	3.3	0.2
General Cargo ship	1	10.0	9.1	5.8	1.7	4.9	11.6	3.1	0.5

Source: Based on PAD Dakar Port Arrival Information (2022), created by JPT



Source: Based on PAD Dakar Port Arrival Information (2022), created by JPT

Figure 3.63 Ships Entering the Port with Full Draft within Draft Restriction



Source: Based on PAD Dakar Port Arrival Information (2022), created by JPT

Figure 3.64 Ships Entering the Port with Full Draft Over Draft Restriction

3.8 Examination of Marine Transportation Network Scenarios including Neighboring Countries

As described in Chapter 2, the current international liner routes are mainly between Europe and Senegal and between South Africa and coastal countries in the south of West Africa. As long as the combination of production and consumption areas does not change, it is considered as an efficient network, but if

production in West Africa increases and volume of cargo to/from Senegal become competitive to other West African ports, the route between both Asia and Europe may change. For Asia, container ships currently turning around at ports in coastal countries south of West Africa may travel north to Senegal, and for Europe, there is a possibility that direct routes to and from northern Europe rather than through Morocco and Spain will increase. Since this is premised on an increase in the volume of cargo transported to and from Senegal, it is essential to strengthen the competitiveness of Senegalese ports in addition to improving and developing transit routes between Senegal and landlocked countries.

For bulk cargo, it is basically a combination of loading and unloading ports, but when similar cargo is handled at West African ports, it is possible that a competitive port will become a hub and feeder transportation to other ports if cargo volume increases. The future transportation network was examined by collecting information on the loading and unloading ports of major cargo, and comparing it with cargo handled at other ports in West Africa.

3.9 Confirmation of Appropriate Location of the New Port from a Technical Viewpoint

A ceremony was held by DPW and the local government in Ndayane in early 2022 prior to the start of this study in July 2022, and Ndayane has already been selected as the development site. Therefore, there is no realistic scope to propose a new location for the new port, but the process by which Ndayane was selected is reviewed below and discussed from a technical perspective.

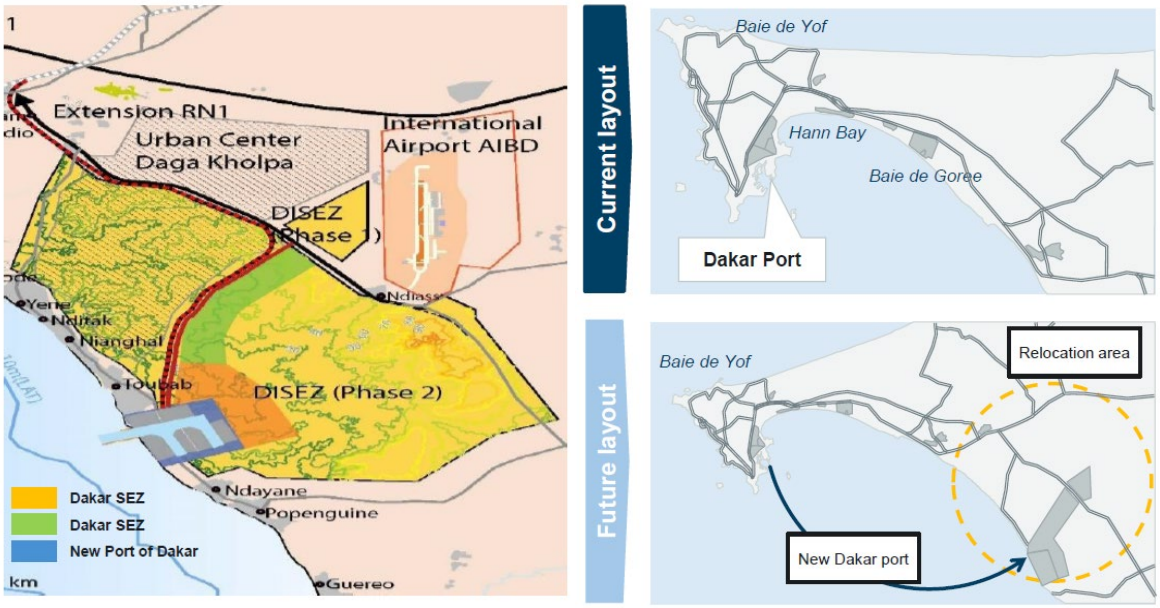
In October 2007, DPW was granted a concession by PAD to develop new port at Dakar, and its location was proposed in November 2016 (DPW M/P (2021)). It is found out that Ndayane has the following advantage as the new port location;

- Synergies are expected due to the proximity to the Diass SEZ (phases 1 and 2) near Dakar Airport.
- Good accessibility is expected with motorways and a railway to be built in the future.
- Mineral and cotton production is also taking place in the vicinity, and the port will be useful for the transport of these products.

They are reasonable for selecting Ndayane as the site for the new port. In addition, the following factors could also be reasons for selecting Ndayane.

- The coastal areas around the port are densely populated with houses and are prone to resettlement problems, whereas Ndayane is located at the mouth of a river from the hinterland, so this problem is less likely to occur.

Therefore, the location of Ndayane is considered appropriate from a technical point of view, although environmental and other aspects are required to be considered in the future.



Source: DPW

Figure 3.65 Surrounding condition of Ndayane

3.9.1 Appropriateness from a Urban Planning Perspective

In order to ascertain appropriateness from an urban planning perspective, the urban plan for the Ndayane area is reviewed below.

- Dakar Metropolitan Area Development Master Plan, developed by JICA in 2016, classifies land use in Ndayane are as agricultural land or greening promotion and management land (Figure 2.16).
- A conceptual plan for the Daga Kholpa area within the same master plan overlaps with DPW's planned SEZ site, which is classified as a low-density residential area (Fig. 2.17).
- Master Plan for the Diass area, developed by DGUA in 2017, classifies the land use in Ndayane are mainly in Zone à restructurer (land restructuring area). Meanwhile, the area along the river is classified as Zone non aedificandi (construction control area) (Figure 2.18).

As mentioned above, the existing urban plan does not include industrial development around Ndayane. However, it is expected that the President will issue a decree permitting the construction of the Ndayane port and PIZ, and since decree takes precedence over the master plan in Senegal, there should be no particular obstacles to the construction of them. On the other hand, it is essential to ensure consistency with the existing plan when formulating land use in PIZ in order to achieve the overall optimization of the Dakar metropolitan area.

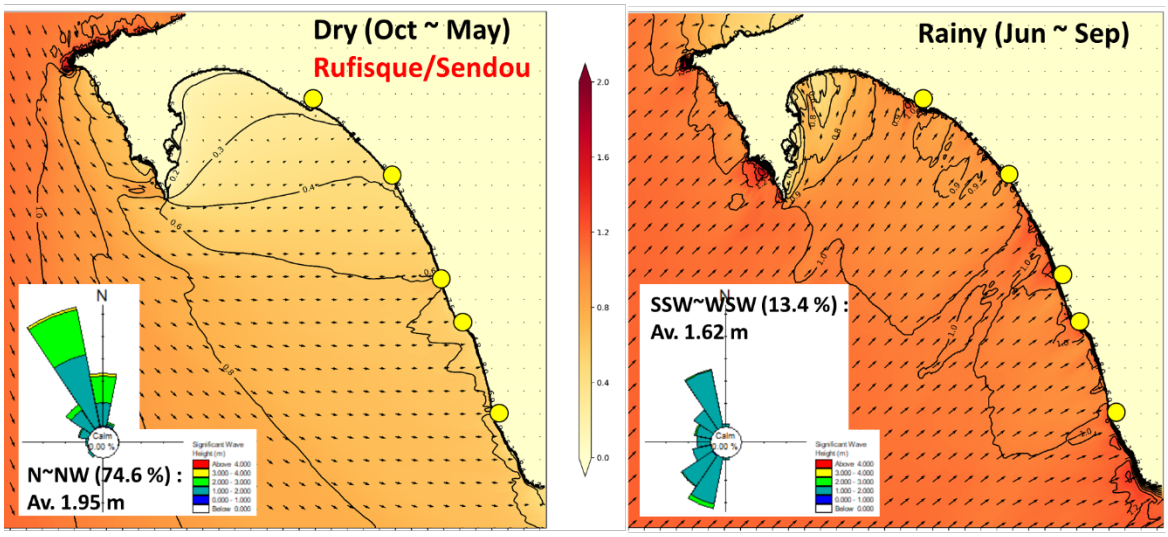
3.9.2 Evaluation of Appropriate Location of the New Port from Viewpoints of Waves and Shoreline Changes

To evaluate the suitability of the location in terms of waves and shoreline change, waves were estimated and compared at the five sites shown in Figure 3.66. Details of the wave estimation method are described

in Section 3.15 Calmness Analysis for Waves. Figure 3.67 shows the distribution of wave heights in each season, and Table 3.41 shows the wave ratios by offshore wave direction (the rate of attenuation of wave heights at each location when offshore waves are set to 1.0) and wave direction after wave transformation.

Source: Prepared by JPT based on Copernicus Sentinel data in Jan 2023 processed by Sentinel Hu,

Figure 3.66 Wave Estimation Point



Source: JPT

Figure 3.67 Estimation of Wave Distribution by Seasons

In the area north of Ndayane, the effect of wave reduction is enhanced by the shielding effect of the peninsula on waves coming from the north, which account for more than 70% of the total waves. The area south of Ndayane is considered to be out of the shielding zone of the peninsula because the reduction rate against the waves does not change significantly. Therefore, it would be preferable to place

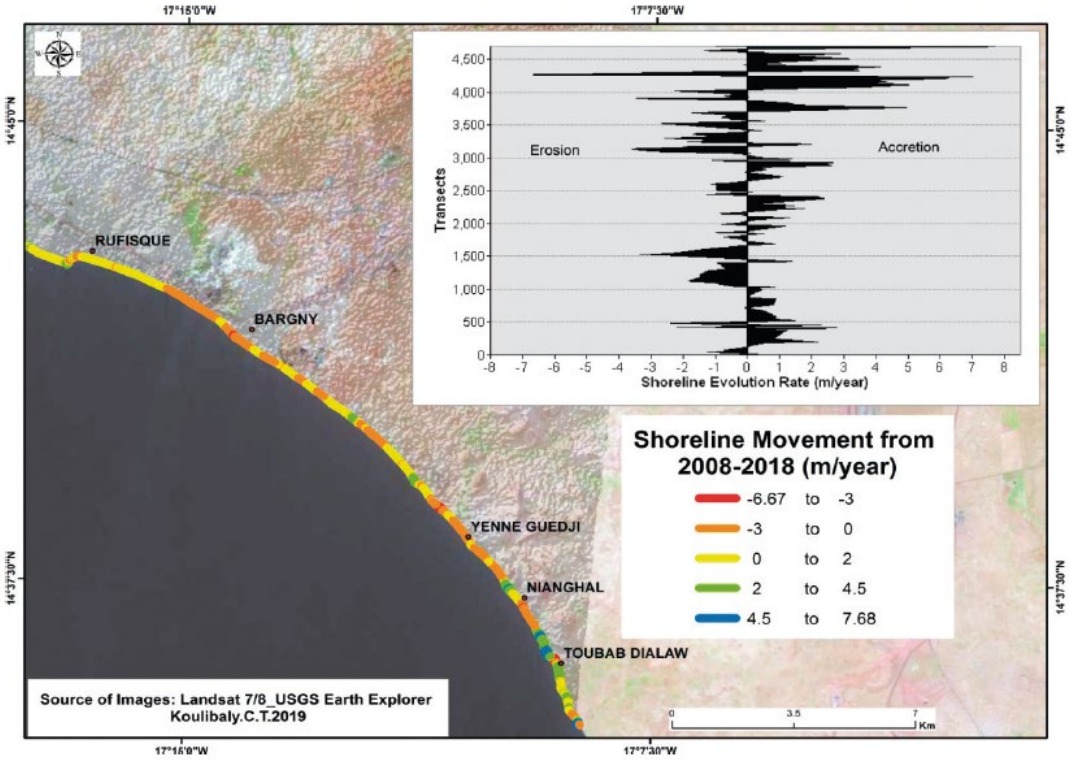
new port farther north to ensure calmness of waves. However, as discussed in Section 3.12 Calmness Analysis for Waves, the effect of waves is not a major obstacle because a calmness area can be maintained even in Ndayane area by taking sufficient measures such as breakwaters.

Table 3.41 Wave Height and Directional Changes at Each Location

Offshore Wave	Direction	S	SSW	SW	WSW	W	WNW	NW	NNW	N	NNE	NE	E	ESE	SE	SSE
	Significant Wave Height (Energy Av.)	1.75	1.69	1.62	1.62	1.62	1.65	1.83	2.07	2.17	2.01	1.96	1.92	1.88	1.83	1.79
	Occurrence probability	0.8%	4.7%	5.0%	3.7%	3.7%	5.2%	13.1%	40.7%	20.9%	1.8%	0.3%	0.0%	0.0%	0.0%	0.1%
Rufisque /Sendou	Wave Height Ratio	0.70	0.82	0.79	0.67	0.47	0.31	0.21	0.15	0.13	0.12	0.21	0.30	0.39	0.49	0.59
	Deformed Direction	208	212	220	228	232	232	236	268	272	272	261	251	240	229	219
Yenne	Wave Height Ratio	0.59	0.79	0.86	0.82	0.66	0.49	0.34	0.23	0.18	0.17	0.23	0.30	0.37	0.44	0.51
	Deformed Direction	216	224	232	244	248	252	256	256	260	272	263	253	244	235	225
Ndayane	Wave Height Ratio	0.67	0.78	0.82	0.82	0.74	0.62	0.46	0.30	0.23	0.22	0.28	0.36	0.43	0.51	0.59
	Deformed Direction	204	216	228	248	264	268	272	276	280	284	271	257	244	231	217
Popenguine	Wave Height Ratio	0.61	0.73	0.79	0.83	0.77	0.63	0.45	0.27	0.20	0.19	0.25	0.32	0.39	0.46	0.53
	Deformed Direction	216	224	228	240	248	256	260	264	268	276	266	256	246	236	226
Somone	Wave Height Ratio	0.66	0.80	0.85	0.85	0.77	0.66	0.49	0.31	0.23	0.22	0.28	0.35	0.42	0.50	0.58
	Deformed Direction	224	232	244	252	260	268	272	276	280	288	277	267	256	245	235

Source: JPT

According to the previous paper (refer to 2.6.4(5)), the shoreline change over the last 10 years shows a slight sedimentation trend around Ndayane area and an erosion trend along the shoreline north of Ndayane. Information on the area south of Ndayane is not available from the paper, but considering the above-mentioned wave energy, it is expected to be not much different from that of Ndayane. Since the amount of shoreline change is determined by topography, wave energy, and amount of supplied sand, it is assumed that the influence of shoreline change due to the construction of new port will be reduced by locating in a more northerly area. On the other hand, since there is a sedimentation trend in the vicinity of Ndayane, it is necessary to properly consider the sand transport mechanism, evaluate the shoreline change impact due to port development, and take countermeasures as necessary.



Source: Prepared by JPT based on the Application of GIS and Remote Sensing in a Spatiotemporal Analysis of Coastline Retreat in Rufisque.

Figure 3.68 Shoreline Changes along the Southern Coast of the Dakar Region from 2008 to 2018

3.9.3 Justification of Ndayane Port Development from Environmental Point of View

Expanding the existing Port of Dakar would be practically difficult because the surrounding area is an urban developed area and would require large-scale relocation of residents and land acquisition. Moreover, there is concern that the expansion may result in traffic congestion, air pollution and noise due to intensified construction activities, and other undesirable cumulative effects in the vicinity of the existing port area.

On the other hand, for the Ndayane area, similar environmental and social impacts are expected. From social aspect, the construction of large port itself and auxiliary facilities will cause large-scale involuntary resettlements and land acquisition, although the impact would be smaller compared to the expansion of the existing Port of Dakar. In addition, though there may not be direct impact, development of Ndayane Multifunction Port may cause negative impact to conventional fishing and tourism activities in and around Ndayane area. Furthermore, the Project will significantly alter the existing coastline, and it may cause significant impact on marine ecosystem and habitat of birds in the estuary.

In general, significant environmental and social impacts are inevitable in conducting large-scale port development projects. Nonetheless, for this Project, it is important to minimize the negative impacts by assessing concreate impacts through SEA procedures and by proposing realistic mitigation measures through discussion with the various stakeholders.

3.10 Arrangement of the Roles of the Existing Dakar Port and the New Port

In many countries, due to the expansion of cargo demand and the urbanization of the hinterland of existing ports, there are the histories of developing new ports that complement and replace the functions of existing ports in locations away from the center of the capital. However, after the opening of new ports, function transfer tends not to proceed quickly as planned, and it is recognized as an issue for new port development. Clarifying the division of roles between the existing port and the new port and developing a roadmap to achieve this will be an issue. A clear division of roles including the legal system is important.

There is no land space for expansion around the existing Dakar Port, however it can be expanded if a breakwater is extended to the offshore side and large-scale landfill is carried out. However, since further expansion of existing ports will contribute to the adverse effects of traffic congestion in Dakar and overconcentration in the capital, it is necessary to prohibit or severely restrict the expansion of existing ports as port policy. Inadequate restrictions on the expansion of existing ports are the biggest cause of the lack of progress in the transfer of functions from existing ports to new ports in many countries. As of 2022, PAD has no plans to expand the existing Dakar Port.

The existing Dakar Port is about -13.5 m of water depth, which is shallow for a hub port in West Africa, and it is considered desirable to handle cargo at Dakar as a feeder port. In the future, it will be waterfront redevelopment, and the amount of cargo handled at the existing Dakar Port will be gradually transferred to Ndayane. However, based on the agreement between JICA and PAD, 3rd Wharf in Dakar Port, which is rehabilitated by Japanese Grant Aid, shall continue to handle transit cargo to Mali as original policy.

Since silos and warehouses have been built at the terminal behind 3rd Wharf to handle transit cargo to Mali, and there are plans to extend the rail line to 3rd Wharf, transit cargo to Mali should not be transferred to Ndayane. DPW have a plan to shift their container terminal business from existing Dakar Port to Ndayane Port within five (5) years after opening the Ndayane Port.

Bargny-Sendou Port has a development plan of ports and hinterland special economic zone of bulk cargos as minerals, energy, grain and related industries.

Ndayane Port will be developed based on the following three points and clarification of the role demarcation with Dakar Port.

(1) An industrial port for the import and export of cargo related to PIZ

(2) A hub port in West Africa to handle transit cargo and transshipment cargo

(3) Energy port such as oil and LNG imports, exports, and stores

It is recommended that the functions of the existing Dakar Port shall be gradually relocated to Ndayane Port. Roles of the existing Dakar Port and the new port are described in Table 3.42 for the balanced development of Senegal.

Table 3.42 Draft Development Policies of each Port and Hinterland

	Draft Policy of Port Development	Draft Policy of Hinterland Development
Dakar Port	✓ Import/export feeder port for cargos only in Dakar city ✓ Water depth is around -10 to -13.5m ✓ Passenger Ports (Cruise Ships and Yachts) ✓ Waterfront development ✓ Fishing ports ✓ Shipyards ✓ However, Wharf 3rd in Dakar Port keeps the faction of transit to Mali as an international port	Small-scale logistics functions
Bargny-Sendou Port	✓ Import/export of bulk cargos (dry bulk, liquid bulk and grain bulk) ✓ Water depth is around -14 to -18m	Minerals-related industries Grain-related industries Energy Storage
Ndayane Port	✓ West Africa's deep-see water hub port ✓ Water depth is around -14 to -20m ✓ MultiFunction Terminals of Container, Grain, Energy, RORO	Logistics functions and logistics nodes Processing industry Energy Storage RORO Parking

Source: JPT

3.11 Tanger MED Port

Tanger MED Port is a deep seaport located about 40 km northeast of Tanger city. The operating entity is Tanger MED, a government-owned company (51% by the Moroccan government and 49% by the private sector). Morocco attaches great importance to its role as a trading hub linking Europe and Africa, the Mediterranean Sea, and the Atlantic Ocean, as well as the significant role it has as an active partner country. With strong economic pillars, Tanger MED Port was planned as an integrated regional development model.

In the past, Tanger Port was located very close to Tanger city, as is the case with Dakar today. However, problems such as rapid population growth, lack of port facility capacity, and traffic congestion in the city have become apparent, therefore the construction started by Tanger MED in 2004, and Phase 1 operation started in 2007. Due to strong cargo demand on the Mediterranean coast, expansion work continued in stages, and Phase 2 started operation in 2019. The current port specifications are shown in the figure below. Tanger MED Port has become a logistics and industrial base for more than 1,100 companies in a wide range of fields, including automobiles, aviation, logistics, textiles and general trade, and exports more than 8.8 billion Euros annually.

There are 4 container terminals in Tanger MED Port namely, TC1, TC2, TC3 and TC4. The 12 remote-controlled Quay Gantry Crane (QGC) and 46 Automated Rail-Mounted Gantry Cranes (ARMGs) are installed in TC4 although a part of equipment will be installed.

Table 3.43 Basic Information on Tanger MED Port (2020)

Number of Employees	Foreign direct investment	Export value	Number of companies	Zone
90,000	$5.9 million	$10.04 million	1100	8

Source: https://www.tangermedzones.com/wp-content/uploads/2021/10/Presentation-Commerciale-TMZ-EN.pdf

Table 3.44 Handling Scale at Tanger MED Port

Container	Passenger	Vehicles	Truck	Employment	Export value
9 million	7 million	1 million	700,000	80,000	£10 billion

Source: https://www.tangermedzones.com/wp-content/uploads/2021/10/Presentation-Commerciale-TMZ-EN.pdf

Table 3.45 Information of Each Terminal in Tanger MED Port

	Container Terminal	RORO Terminal	Bulk Terminal	Remarks
Quay wall Length (m)	4,400	440	500	4 Terminals, TC4: 2000m, TC1, TC2 and TC3: 800m (Container Terminal)
Depth (m)	18	12	13.5	Draft of ship is 13.5m (Bulk Terminal)
Type of Quay wall	Block Type	N/A	N/A	
Yard Width (m)	500	-	-	All terminals are 500m
Yard Area (ha)	200.0	18.5	5.0	+ Logistic Area (Container Terminal) + Renault's Vehicle Terminal: 13ha, Common User Vehicle Terminal :5.5 ha (Ro Ro Terminal) + Quayside 2ha, storage 3ha (Bulk Terminal)
Pavement Type	Concrete/ICB	ICB	Not confirmed	Based on site visit
Berth Number	11	2	-	+ Estimated 400m/berth (Container Terminal) + Confirmed by Google Earth
Annual Cargo Handling Volume (TEU)	7,173,870 (2021)			Capacity: 9.0 mil
Annual Handled Car Volume (Unit)	-	429,509 (2021)		Capacity: 1.0 mil
Annual Cargo Handling Volume (Ton)	-	-	404,007 (2021)	+ Solid Bulk only + Capacity: 0.8 mil
Number of QGC (Unit)	33	-	-	TC1:6 unit, TC2:7 unit, TC3: 8 unit, TC4: 12 unit Confirmed by related documents and Google earth
QGC Cargo Handling Efficiency (Box/Time/Unit)	30	-	-	

Source: JPT

Source: Tanger MED Group

Figure 3.69 General View of Tanger MED Port

Source: Tanger MED Group

Figure 3.70 Container Yard of Tanger MED Port

In addition, Tanger MED Port is actively working to improve overall port efficiency through smart technologies such as berthing simulations based on weather and wave conditions, automation of gantry cranes, and automated berthing technology.

The Tanger MED Port Authority also provides training to PADs on ship maneuvering simulators. The ship maneuvering simulator shown in the figure below is considered an adequate facility for training, because it enables ship maneuvering simulations to be carried out based on a 3D model of the Port of Dakar.

Source: JPT

Figure 3.71 Ship Maneuvering Simulator of Tanger MED Port Authority

3.12 Examination of New Port Development Plan

Considering DPW M/P (2021), the scale and functions of the current plan are judged to be generally appropriate. In the future, in order to deepen the port planning of Ndayane Port, it is necessary to cover and consider the following points.

3.12.1 Examination of Demand Estimates

Based on PAD statistical data, RORO ships were separated from bulk cargo, and initial estimates for container cargo volumes were replaced with actual results.

In the future, it will be necessary to consider port facility plans based on the latest demand forecast results. As a result of a review of the demand forecast, there was a slight decrease from 6,595,000 tons to 6,359,000 tons, but there will be no significant change in future cargo volume.

3.12.2 Determining the Division of Roles with Bargny-Sendou Port

As mentioned above, since Dakar Port is saturated, the future cargo volume of Ndayane Port is the result of subtracting the cargo that cannot be handled at Dakar Port and the cargo that will be shifted to Bargny-Sendou Port from the total future cargo volume.

(Hearing results with SMP: Oil bulk, liquid bulk, agri-bulk, coal, and cement will be transferred to Bargny- Sendou Port)

Considering the possibility of slight changes depending on future hearings, the following values have been set as the future frame (future cargo handling volume).

Table 3.46 Future cargo handling volume of Ndayane Port (2047)

Cargo type	Future cargo handling volume	Setting basis
container cargo	3.1 million TEU	The estimated value of DPW was adopted because it was confirmed that it was generally consistent with the estimated value of DPW from the macro estimation.
RORO cargo	350,000 units	Same as above
bulk cargo	6.5 million tons	Based on micro estimation results

Source: JPT

3.12.3 Width of Navigation Channel and Diameter of Turning Basin

Based on the target vessels and the weather and sea conditions in this project, width of navigation channel and diameter of turning basin for Ndayane Port should be developed. The results calculated by JPT are compared with the existing plan of DPW to verify the validity of the plan. Table 3.47 summarizes the comparison of design conditions between JPT and DPW. A major difference in the design conditions is the increase in draft and width due to the size of the target vessels.

Table 3.47 the Comparison of Design Conditions in JPT and DPW

No	Item	JPT		DPW (PIANC・BS)
		Japanese Port Design Standard	PIANC	
1	Design Standard	Channel- OCDI Turning Basin- OCDI	Channel- PIANC 121 Turning Basin- PIANC 121	Channel- PIANC 121 Turning Basin- BS6349 1-1
2	Target Vessel	24,000 TEU	24,000 TEU	20,000 TEU
3	Length Overall (LoA)	400 m	400 m	400 m
4	Beam Width (B)	61.5 m	61.5 m	60 m
5	Draft (d)	18 m	18 m	16 m
6	Prevailing Cross Winds	-	>17 mph (14.7726 knots)	max 15 knots
7	Prevailing Cross Currents	-	0.68 m/s	0.68 m/s
8	Prevailing Long Currents	-	Negligible	Negligible
9	Significant Hs (Outside Breakwater)	-	1.33 m	1.56 m
10	Significant Hs (Inside Breakwater)	-	Negligible	Negligible
11	Water Depth	-20.0 m	-20.5 m	-19.2 m
12	Bottom Surface	-	Lime Stone	Rock
13	Aid to Navigation	-	Excellent	Excellent
14	Channel Sides	-	Steep and hard embarkment	Steep and hard embarkment

Source: JPT

DPW used both PIANC and BS while JPT used both the Japanese port design standard and PIANC to determine the width of the navigation channel and the diameter of the turning basin.

(1) Depth of Channel

In the case of applying Japanese port design standard, a value of 1.10 times the maximum draft of the vessel can be used as the depth of channel inside port where the effects of swell waves are not expected, and 1.15 times the maximum draft can be used as the depth of channel outside port where the effects of swell waves are expected. Therefore, the depth of channel was calculated as follows.

Outside Port： D = 1.15 x d = 1.15 x 16.0 = 20.7 m≃**21.0m**

Inside Port： D = 1.10 x d = 1.10 x 16.0 = 19.8 m≃**20.0m**

In the case of applying PIANC, depth of channel outside port is obtained by multiplying the maximum draft by a multiple corresponding to the wave height, and adding a constant corresponding to the soil classification of the seabed. On the other hand, depth of channel inside port is obtained by multiplying the draft by a multiple corresponding to the speed of vessel, and adding a constant corresponding to the soil classification of the seabed.

Outside Port： D = 1.23 x 18.0 + 1.0 = 23.2 m≃**23.5m** （JPT）

Inside Port： D = 1.10 x 18.0 + 0.6 = 20.4 m≃**20.5m** （JPT）

Outside Port： D = 1.26 x 16.0 + 1.0 = 21.1 m≃**22.1m** (+1.0m) （DPW）

Inside Port： D = 1.10 x 16.0 + 0.6 = 18.2 m≃**19.2m** (+1.0m) （DPW）

(2) Width of Navigation Channel

In the case of applying Japanese port design standard, the width of navigation channel should be wider than the length of the target vessel in case of low vessel traffic.

W = 1.0 x LOA = 1.0 x 400 = 400 m

In PIANC, it is stated that it can be calculated by using the following formula.

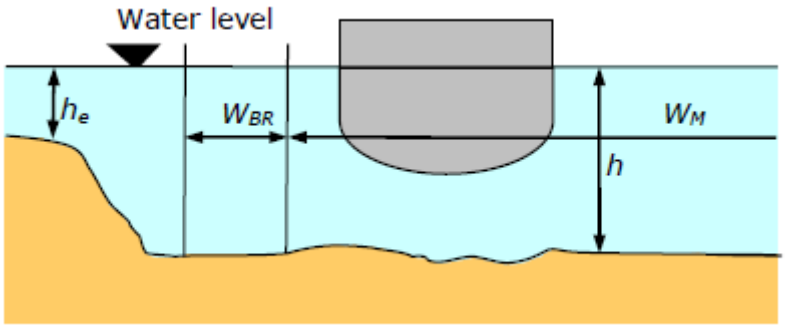
$$W = W_{BM} + \Sigma W_i + W_{BR} + W_{BG}$$

As follows:

W_{BM}: width of basic manoeuvring lane as a multiple of the design ship's beam B

W_i：additional widths to allow for the effects of wind, current etc.,

W_{BR}, W_{BG}: bank clearance of the channel



Source: PIANC 121 Harbour Approach Channels Design Guidelines

Figure 3.72 Image of Bank Clearance

$$W = W_{BM} + \Sigma W_i + W_{BR} + W_{BG}$$

Outside Port： W = (1.5 + 1.7 + 1.0 + 1.0) x B = 5.2 x 61.5 = **320 m** （JPT）

Inside Port： W = (1.3 + 0.9 + 0.5 + 0.5) x B = 3.2 x 61.5 = **197 m** （JPT）

Outside Port： W = (1.5 + 1.7 + 1.0 + 1.0) x B = 5.2 x 60.0 = **312 m** （DPW）

Inside Port： W = (1.3 + 0.9 + 0.5 + 0.5) x B = 3.2 x 60.0 = **192 m** （DPW）

According to the report of DPW, based on the results of the manoeuvring simulation for the inside port channel width, it is planned to extend the channel width to the outside port channel width. In this study, the width of the navigation channel inside port is to be the same as the width of the navigation channel outside port.

(3) Diameter of Turning Basin

The size of the diameter of turning basin was calculated according to the respective criteria as follows.

Japanese port design standard : 2.0 x LOA = 2.0 x 400 = 800 m
PIANC : 2.0 x LOA = 2.0 x 400 = 800 m
DPW (BS 6449-1-1) : 1.5 x LOA = 1.5 x 400 = 600 m

Width of navigation channel and diameter of turning basin calculated from (1) to (3) above are summarized in Table 3.48.

Table 3.48 Size Requirements for Width of Navigation Channel and Diameter of Turning Basin

Item		Japanese port design standard	PIANC	
		JPT	JPT	DPW
Target Vessel (Max)	LOA	400		400
	Beam	61.5		60.0
	Draft	18		16
Depth of Channel	Outer	21.0	23.5	22.1
	Inner	20.0	20.5	19.2
Width of Navigation Channel	Outside	400	320	312
	Inside	400	320	312
Diameter of Turning Basin		800	800	600

Source: JPT

As the target vessels are different between DPW and JPT, the planned values of DPW M/P (2021) indicate that the depth of the channel, the width of navigation channel and the diameter of turning basin are not enough, therefore a larger size of width of navigation channel and diameter of turning basin is deemed necessary than the DPW planned values. As DPW is currently assumed to be constructing breakwaters and dredging navigation channel and turning basin based on the results of DPW, it is desirable to leave space for future widening and deepening of navigation channel and turning basin in the layout plans for RORO terminal and general cargo terminal. The target vessels for the RORO terminal and general cargo terminal are estimated to have a maximum ship size of LOA = 265 m and a draft of 12.4 m and LOA = 220 m and a draft of 13.0 m respectively, which is sufficient

to safely navigate with a channel depth of -19.2 m, the channel width of 312 m and the diameter of turning basin of 600 m.

At the JCC on June 3, 2025, JPT received a request to confirm the draft of the design vessel for container vessels under the African Continental Free Trade Area (AfCFTA) JPT checked the design vessel for container vessels under the AfCFTA, but there was no plan for draft.

We confirmed to PAD the latest specifications of the container terminal quay, the target vessel and the navigation channel, and received the information in Table 3.49. Compared to the terms of the contract between PAD and DPW, the water depth is shallower, and the navigation channel is wider. The channel depths are expected to increase in the future. The JICA survey team believes that the channel depths are reasonable, as they can be increased in the future as the number of vessels visiting the port increases. JPT considers the channel depth to be adequate, as the depth can be increased in the future as the size of vessels increases.

Regarding channel depth and channel width, based on DPW's M/P reviewed above, the current contract between PAD and DPW and the current dimensions of the construction order are considered adequate.

Table 3.49 Dimensions of Container Terminal Quay, Target Vessel and Channel

		Container Terminal Quay	Design Vessel	Inner channel		Outer channel	
		Length	LOA	Depth (MSL)	Width	Depth (MSL)	Width
Agreement between PAD and DPW	Phase 1	840m	366m	-18.7m	164m	-21.5m	266m
	Phase 2 (conditional)	1,250m	400m	-19.2m	192m	-22.1m	312m
Current	Phase 1	840m	400m & 366m	-17.5m to -18.0m	266m	-18.2m to -19.1m	266m to 366m

Note: Turning circle / maneuvering area 600m diameter.

Source: PAD

3.12.4 Number of Berths

(1) RORO terminal

At the wharf 2 of the Port of Dakar, the loading and unloading of vehicles is currently being performed manually. The number of berths required to handle 350,000 vehicles in 2047, the target year of the Master Plan, was calculated based on the results of interviews with Dakar Terminal, which operates the RORO terminal.

[Cargo Handling Efficiency of Roll-on/Roll-off Carriers]

For RORO vessels, the average hourly unloading capacity is 50 vehicles per hour, with three-shift

operations, and a berth occupancy ratio (0.5) allows 219,000 vehicles to be unloaded at a single berth.

[Required Number of Berths for Roll-on/Roll-off Carriers]

RORO vessels: 350,000 units/year ÷ 219,000 units = 1.6 ≒ 2 berths

(In 2030, 1 berth can be used according to the same formula)

(2) Container Terminal

The container terminal of the Port of Ndayane will be the ones with the world's deepest water depth, and it is difficult to say that the application of the case of a medium-scale port in Japan is reasonable.

Therefore, we have decided not to estimate the required number of berths for container terminals based on the actual data of the Port of Kawasaki because we thought that it would be somewhat unreasonable to examine from this data, which has only one berth at the Port of Kawasaki and is congested at present.

Therefore, examine the number of berths based on the handling capacity per berth of container terminals that have recently begun operating.

As shown in the table below, the handling capacity per berth from the typical countries averages 740,000 TEU and the largest 900,000 TEU. Referring to these performance capacities, it is estimated that 4.2 berths on average and 3.4 berths at most will be required to handle the future freight volume of 3.1 million TEU at the Port of Ndayane.

Table 3.50 Handling Capacity of Container Terminals in Service in Recent Years

Port	Terminal name	Yard Area (ha)	Water depth (m)	Extension (m)	Berth number	Processing capacity (thousand TEU)	Number handled per berth (Ten thousand TEU/ Berth)
Busan New Port	HPNT	86	17	1,550	4	200	50
	PNIT	84	16	1,200	3	200	67
	DPWORLD	70	18	1,100	3	250	83
	BNCT		20	700	1	80	80
Port Kerang Port	CT7		11-17.5	5,800	20	1,400	70
Port of Tanden Pella Pass					14	1,050	75
Kaohsiung Port	CT-7		18	2,415	5	410	82
Shanghai Port	Outer Takahashi Phase 6			1,538	3	210	70
Qingdao port	QQCTN		17	3,400	10	600	60
Port of Los Angeles	FenixMarine		15	1,200	3	250	83
Hamburg port	APMTerminalsMaasvlakte2		19.5	1,000	3	270	90
						Average	74

Source: International Transport Handbook 2022 (Ocean Commerce)

(3) Bulk Terminal

According to" New System Civil Engineering (port and harbor planning)," the following is described in the calculation of the necessary berth number.

5.1.5 Determination of the wharf size (berth number)

(1) General method (method based on basic unit)

One of the methods for determining the required number of berths is the basic unit method, which is based on the extension of the mooring facility per amount of cargo handled. This is a method of converting mooring facilities and handling cargo according to certain standards.

First, the cargo handled is divided into two types, miscellaneous goods and bulk cargo, focusing on the packaging style, and the amount of cargo converted into miscellaneous goods is determined by setting miscellaneous goods as 1 and bulk cargo as 1/2.

Next, determine the length of the mooring facility in terms of large quay by water depth, using the following ratios: "Water depth of 7.5 m or more = 1," "Water depth of 7.5 m to 4 m = 2/3," "Water depth of 4 m to 2 m = 1/3."

Then, calculate the maintenance level (m/ton) = (large quay equivalent length (m) ÷ miscellaneous goods equivalent cargo volume (ton)

Source: "New System Civil Engineering (port and harbor planning),"

Since the cargo handled at the multi-purpose terminals in the Port of Ndayane is bulk, t/m shall be obtained after converting it into sundries by the method described above.

The level of development should be 2,000 t/m considering the improvement of cargo handling efficiency in the future. The following table shows the number of berths in each year.

A total of six berths are planned in 2047.

Table 3.51 Required Number of Berths

Target terminal	General cargo terminal					Dry Bulk Terminal				
Target year	2030	2035	2047	2050	Unit	2030	2035	2047	2050	Unit
Maximum loading capacity of the hull form	40000	40000	40000	40,000	DWT	40000	40000	40000	40000	DWT
Draft of the largest hull form	13	13	13	13	m	13	13	13	13	m
LOA of the largest hull form	220	220	220	220	m	220	220	220	220	m
Average load capacity	15000	15000	15000	15000	DWT	15000	15000	15000	15000	DWT
Annual cargo volume	1,195,302	1,564,481	4,027,420	5,178,959	ton	1,051,648	1,311,301	2,331,948	2,698,502	ton
Number of vessels in port	80	104	268	345	ship	70	87	155	180	ship
Required berth water depth	15	15	15	15	m	15	15	15	15	m
Required berth extension	250	250	250	250	m/B	250	250	250	250	m/B
Required number of berths	1	1	4	4	berth	1	1	2	2	berth
Required land area	17.30	29.30	58.20	74.90	ha	15.20	20.70	33.70	39.00	ha

Source: JPT

3.12.5 Examination of the Scale of the Facility

(1) Wharf Size

The size of the port facilities is shown below based on the results of the examination of the maximum hull form of entering vessels and the required number of berths as mentioned above.

Table 3.52 Setting the Wharf Water Depth

	Conventional Planned water depth	Newly Set water depth	Concept of this setting
DPW container terminals	19.2 m	=> 19.2 m	Considering the largest vessels to be built in the future (24,000 TEU class), a depth of 20m is considered desirable for M/P in 2047, but DPW has already started construction and the difference is small, so even DPW's planned value of 19.2 m is considered acceptable.
Roll-on/Roll-off terminals	15.2 m	=> 14 m	Compatible to the largest hull form (40,000 DWT class) to be built in the future (draft reconsideration)
General cargo terminal	15.9 m	=> 15 m	The most frequent hull form: 40,000 DWT class
Dry bulk terminal	17 m	=> 15 m	Agri-bulk, which requires a quay depth of 18m, will be entrusted to Barny-Sendou Port, so Handymax (40,000 DWT class) for mineral products will be assumed at Ndayane Port:

Source: JPT

Table 3.53 Study Results of the Required Wharf Size

		Water depth	Berth number	Berth length	Berth Total length	Remarks
Container Terminal		19.2 m	4	520 m/B	2,000 m	Considering the largest vessels to be built in the future (24,000 TEU class), 520 m/B would be preferable, but DPW has already started construction and the difference is small, so even DPW's planned value of 500m is considered acceptable.
RORO Terminal		14 m	2	300 m/B	600 m	Handle cargo with 2 berths.
Bulk Terminal ※	General Cargo	15 m	4	250 m/B	1,000 m	Handle cargo with 6 berths.
	Dry Bulk	15 m	2	250 m/B	500 m	
Total		-	12	-	4,100 m	

*Alternative functions (redundancy) for bulk cargo and ship types handled by Barny-Sendou Port (maximum -18m pier) will not be secured.

Source: JPT

(2) Size of wharf land

Container Terminals: 166.6 ha

According to the Japanese Standards, Technical Standards for Port and Harbour Facilities, the area width of container terminals (apron width + marshaling area width + backyard area width) should be 400 m to 700 m at terminals deeper than -16 m of berth water depth. Given that the port of Ndayane is deeper than -16 m, an area of 140.0 ha (2,000 m × 700 m) is required if the largest width, 700 m, is adopted. In the DPW M/P (2021), the area size is 130 ha, which likely suggest a planned width of 650 m. In conclusion, it can be determined that the values meet or exceed the average value of the Japanese Standards, and that the grade as the terminal size is secured.

On the other hand, the results calculated by the coefficient setting method of the Japanese Standard

from the viewpoint of port function are as follows.

It is concluded that the area size of 166.6 ha is required for container terminals handling 3.1 million TEU, if it is calculated considering various coefficients of marshalling area.

However, these coefficients were set based on the actual results in Japan, and it cannot be concluded that the coefficients were based on the actual circumstances in the field. Considering this condition, it can be evaluated that a certain grade is planned in DPW M/P (2021) where 650 m is set as the terminal width.

Although two berths are planned in the DPW plan, one berth is enough according to the calculation results. However, considering the required size behind the berths, the construction of two berths will be considered to include one spare berth. For nearly 40 ha that are not enough in the backyard, consider sharing of functions outside the landfill area.

Table 3.54 Estimation of the Container Terminal Size

				Calculation intensity							
Facilities	Handling quantity (thousand TEU)	Grand slot number	Required area (ha)	f	e	g_1	g_2	i	j	Apron area (m^2)	Backyard area (m^2)
Container terminal (L=2,000m)	3,100	24,842	166.6	1.3	40.6 (365 days/9 days)	5	0.8	14.9	4.0	140,000	45,000

Grand slot number: $V_2=fV_0/e/(g_1g_2)$
f:Peak factor, V0: Planned handling quantity (TEU), e: Annual turnover = Annual working days/Average number of days stored in the yard, g: Number of stacks, g2: Effectiveness factor
Marshaling area size $B=V_2ij$
i:Floor space per 1TEU of containers (m^2), j: Marshaling area factor

※For the necessary area calculation formula and calculation intensity, refer to "Technical Standards and Commentaries for Port and Harbour Facilities in Japan (May 2018, The Ports and Harbours Association of Japan)."

f=1.3 (Maximum value as planned level, since it is 1.2 to 1.3 in the above data)
e = 40.6 times/year (maximum value as planned level (365 days/9 days))
g1 = 5 levels (set as 5 levels from the actual situation, as 5 levels were used at the Port of Dakar)
g2 = 0.8 (0.6 to 0.8 in the above data, and therefore the largest planned level)
i = 14. 9m2 (from the above data)
j=4.0 (Maximum value as planned level, since it is 2.0 to 4.0 in the above data)
Apron Area= Berth length (2000m) x Apron width (70m)
(Since the apron width of the container terminal is 40 to 70 m according to the above data, the maximum value is set as a planned level.)
Backyard Area= Outgoing trading 9, 000m2, Incoming trading 7, 500m2 x Backyard area factor (5.0)
(In the above data, marshaling area of 90, 000m2 or more is 9, 000m2)

Source: JPT

RORO Terminals: 16.8 ha

In calculating the area of the yard required for storage space for vehicles, the cargo handling system of Dakar Terminal, which operates at Port of Dakar Wharf 2nd, is used as a reference, but the annual

turnover rate is assumed to improve in the future, considering that the RORO terminal at the Port of Ndayane will be built on reclaimed land.

- Annual handling volume: 350,000 units (2047)
- Annual turnover: 52 times/year
- Area required per car: 15.0 m^2
- Cargo capacity ratio (utilization ratio): 0.60

The yard area was calculated to be 168,300m2 under the above conditions.

General Bulk Terminal: 94.0 ha

According to the Japanese standards, Technical Standards for Port and Harbour Facilities, bulk cargo terminals with a total 94 ha of 32.1 ha of cargo handling areas and 61.9 ha of storage sites are required. In the present plan, bulk cargo terminals with a total 94.5 ha of 75.8 ha of ordinary cargo and 18.7 ha of agri-bulk is planned. In conclusion, the terminal size in the present plan can be assumed as an enough scale. The required number of berths was calculated as 6, and it is determined that six berths can be secured based on the shapes of the master plan in DPW.

Table 3.55 Estimation of the General Bulk Terminal Size

Item	Future (2047) volume handled (1,000 tons)	Required area size (m^2)			
		Cargo handling area (cargo handling area and roof)		Storage site (warehouse/open area)	
	6,500	Cargo handling area A= N/ (α×ω×R) N:Amount of cargo handled (t), α:utilization factor [0.6], ω: Cargo capacity per unit area [2.5t/m^2], R:Turnover [22.5]	320,988	Field storage area A = N/ (α × ω × R) N:Amount of cargo handled (t), α: utilization factor [0.7], ω: Cargo capacity per unit area [2.5t/m^2], R:Turnover [10]	619,048
Total	6,500		320,988		619,048
		940,035			

※For the necessary area calculation formula and calculation intensity, refer to the "Technical Standards and Commentaries for Port and Harbour Facilities in Japan (May, 2018)" by The Ports and Harbours Association of Japan.

R: Rate of turnover (cargo handling area and roof: 22.5 (average of 20-25 times/year), open area and warehouse: 10 (average of 8-12 times/year)

α : Cargo capacity factor [utilization factor] 0.5 to 0.7, cargo handling area and roof 0.6, and field storage area and warehouse 0.7

ω : Load per unit area (2.5 ton/㎡, from New System Civil Engineering 81 p.136-138)

Building-to-land ratio: 0.6

Source: JPT

Table 3.56 Examination of Area Necessary for General Bulk Terminals in 2030 (Reference)

Item	Future (2030) Amount handled (Thousands of tons)	Necessary surface area (m2)	
		Land for cargo handling (land for cargo handling and rooftop)	Land for storage (warehouse and cargo space)
	2,247	Disposal land A = N/ (α×π×R) N:Amount of freight handled (t), α: load factor [0.6], θ: amount of accommodated freight per unit area [2.5t/m^2] 、 R:Turnover [22.5] 110,963	Freight handling A = N/ (α × π × R) N: Freight handling volume (t), α: Utilization rate [0.7], π: Capacity volume per unit area [2.5t/m^2] 、 R:Turnover [10] 214,000
Total	2,247	110,963	214,000
		324,963	

"※""Technical Standards and Explanation of Port Facilities (May 2018) Japan Port Association"" for the calculation formula and basic unit for required area
R:Turnover ratio (cargo handling land, rooftop: 22.5 (average of 20 to 25 times/year), cargo loading and warehousing: 10 (average of 8 to 12 times/year), α: Cargo accommodation ratio [utilization ratio] 0.5 to 0.7, cargo handling land and rooftop 0.6, NO loading and warehousing 0.7)
Weight per unit area (2.5 tons/m2, from ""New System Civil Engineering 81 p.136-138"")
Building coverage ratio: 0.6"

Source: JPT

3.12.6 Wharf Plan

Based on the estimation of demand, it is considered that the plan should be basically formulated in accordance with the DPW landfill plan.

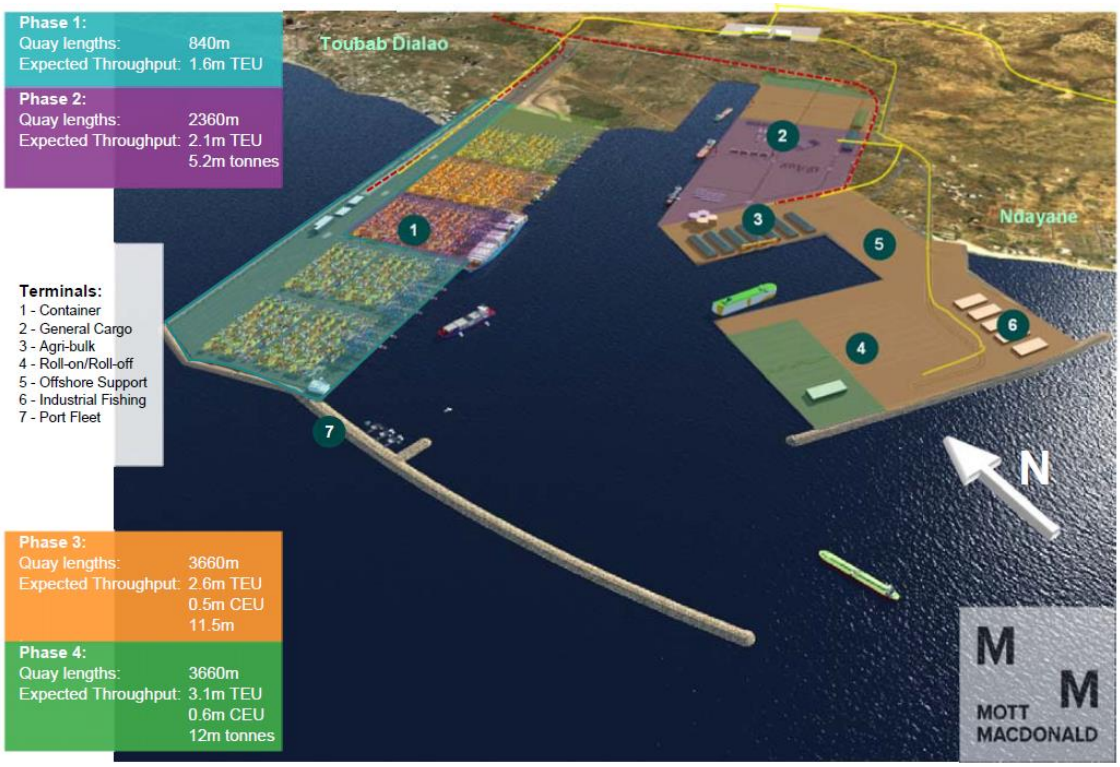
However, in practice, the area size derived from the amount of cargo plus the land for roads within the wharf are necessary, so there may be a shortage of storage site, and it may be necessary to secure the area outside the reclaimed land.

Table 3.57 Summary of the DPW Master Plan (Reference)

※Target year in the DPW Master Plan

Phase	Terminal	Wharf Length	Yard Area	Wharf Apron & Backyard Area	Total Area	Water Depth (MSL)
Phase 1	Container	840 m	55 ha	Including	55 ha	19.2m
Phase 2	Container	1250 m	81 ha	Including	81 ha	19.2m
	General cargo	1110 m	47.6 ha	2.2 ha	49.8 ha	15.9m
Phase 3	Container	1750 m	114 ha	Including	114 ha	19.2m
	RORO	620 m	29.1 ha	1.1 ha	30.2 ha	15.2m
	General cargo	1540 m	65.9 ha	3.1 ha	69 ha	15.9m
	Agri-bulk	775 m	14.5 ha	2.7 ha	17.2 ha	17.0m
Phase 4	Container	2000 m	130 ha	Including	130 ha	19.2m
	RORO	620 m	35.6 ha	1.1 ha	36.7 ha	15.2m
	General cargo	1540 m	72.7 ha	3.1 ha	75.8 ha	15.9m
	Agri-bulk	800 m	15.9 ha	2.8 ha	18.7 ha	17.0m

Source: DPW M/P (2021)



Source: DPW M/P (2021)

Figure 3.73 Image of New Port Development Plan (2047)

Considering the DPW methods of building facilities and the necessity of inhabitants' relocation, it is likely that facility development from offshore will be adopted. Therefore, provisional transportation routes (routes avoiding residential areas) should be secured in the stage where land space is not developed.

3.12.7 Current Situation and Future Plan for Ferry Services in Senegal

(1) Current Situation of Ferry Service in Senegal

Currently, Dakar Port has a ferry terminal to the left (north side) of Mole 1 (see Figure 3.74) and there are only two domestic regular routes. One of the routes is to Gorée Island where is on the opposite coast of Dakar (mainly for sightseeing and passengers only (see Figure 3.75)) and another route is to Ziganjor located in the south of Senegal (passengers, cargo and vehicles (see Figure 3.76)). International ferries operate infrequently, and there are no dedicated moles. The ferry to Gorée Island is used not only by Senegalese citizens but also by tourists. Ziganjor is located in the south of Gambia, and as the distance by land is long, using a ferry is considered advantageous.

(2) Future Vision of Ferry services at Dakar Port

Gorée Island is a significant tourism resource for Senegal, and the importance of ferry services will continue to be maintained. While land road development to Ziganjor is expected to advance in the future, it is unlikely that maritime transportation will become unnecessary, and therefore, maintaining a ferry terminal and ferry operations at Dakar Port are considered necessary.

(3) Future Plans for Ferry Services at Ndayane Port

Ndayane Port and Dakar Port are only about 40km apart and connected with well-developed expressways, therefore, it may reduce the need for passenger ferries. Additionally, there is a railway line between Dakar and Bargny-Sendou, and if it is extended to Ndayane in the future, the need for ferry passengers will decrease even further. Although Ndayane Port is close to tourist spots such as Saly and Somon, it is faster and more convenient to go directly by highway than to go from Dakar Port to Ndayane Port by sea to reach those tourist spots. In addition, it is considered more advantageous for international ferries to dock at Dakar rather than Ndayane, and there is expected to be little demand for a tourist ferry terminal at Ndayane Port. While a feeder ship to Ziganjor is considered to be beneficial for Ziganjor, the cargo handling volume at Ndayane Port is small and the currently planned general cargo terminal and RORO terminal can adequately handle this function. Therefore, a dedicated ferry terminal at Ndayane Port would not be cost-effective and necessary.

Source: JPT

Figure 3.74 Ferry Terminal at Dakar Port

Source: JPT

Figure 3.75 Ferry Ship between Gorée Island and Dakar

Source: JPT

Figure 3.76 Ferry Ship between Ziganjor and Dakar

3.12.8 Overview of Each Port Facility

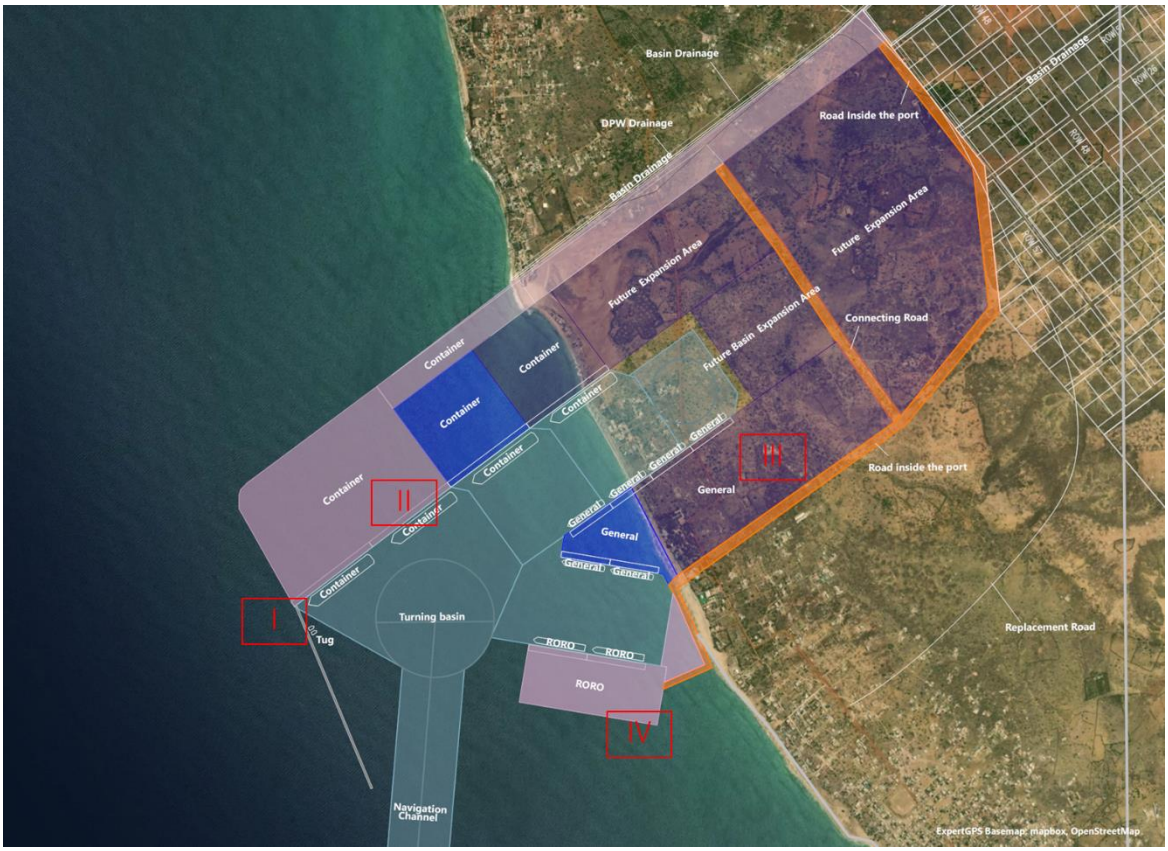
The following facilities are subject to examination, and when creating standard cross-sectional views, those with similar design water depths and design loads will be integrated.

Table 3.58 List of Target Facilities

Items	Water Depth	Number of Berths	Length of Berth	Total Length of Berth	Length of Breakwater
Container Terminal (II)*	20 m	4	500 m/B	2,000 m	
RORO Terminal (IV)*	14 m	2	300 m/B	600 m	
General Cargo (III)*	15 m	6	250 m/B	1,500 m	
Total	—	12	—	4,100 m	
Breakwater （West side） (I)*	10 m	—	—	—	Approx.1,000 m

* The numbers indicate the positions in the following figure.

Source : JPT



Source: JPT

Figure 3.77 Layout of Target Facilities (* Numbers Indicate the Target Facilities to be Designed)

(1) Summary of Design Conditions

a) List of Design Conditions

Table 3.59 List of Design Conditions

Items	I. Breakwater (West Side) ※CT Side	II. Container Berth （DPW）	IV. General Cargo Berth	V. RORO Berth
Planned Water Depth	-10 m	-20 m	-15 m	-14 m
Design Water Depth	-10 m （Average water depth）	-20.5 m （Overbreak of 0.5m）	-16 m （Overbreak of 1 m）	-15 m （Overbreak of 1 m）
Target Vessel	―	250,000 DWT	40,000 DWT	40,000 DWT
Surcharge Load	―	30 kN/m2	30 kN/m2	30 kN/m2
Tractive Force	―	2,000 kN/set ※Set as the maximum value in Port standard (20 m pitch)	1,000 kN/set (20 m pitch)	1,000 kN/set (20 m pitch)
Fender Specification	―	Fender board type 1,600 H (10 pitch）	V type800 H× 2,000 L (10 pitch）	V type 800 H× 1,600 L (10 pitch）
Crest Height	+6.1m	+5.0 m	+5.0 m	+5.0 m
Design Wave	$H_{1/3}$=3.57 m T=9.8 s	$H_{1/3}$=3.57 m T=9.8 s	$H_{1/3}$=1.40 m T=9.8 s	$H_{1/3}$=1.40 m T=9.8 s
Ground Condition	Good ground mainly composed of limestone and sandstone			
Cross-section Integration	Breakwater (west side)	-20 m berth	-15 m berth *Because the water depth is similar and the tractive force is also the same	

Source: JPT

b) Tide Level

Regarding the tide level, it has been shown in DPW EIA (2020) that water level observations Ndayane are approximately consistent with the nominal tide levels in Dakar and Mbour. In this case, the nominal tide level of Mbour, which is closer to Ndayane than Dakar, is used.

・H.W.L.：D.L.+1.7 m

・L.W.L.：D.L.+0.4 m

c) Design Wave

Design wave was calculated by wave deformation calculations using offshore waves with a 50-year probability, referring to the wave conditions in Mbour based in the previous JICA survey (The Project of Improvement in Fish Landing Facilities for Value Adding and Management of the Marine Resources).

50-year probability wave height and period for offshore at Mbour : H1/3=4.9m、T=9.8s

From equivalent offshore waves H0', taking into account the effects of wave breaking and shallow water deformation depending on the water depth of each breakwater facility, the significant wave heights were considered as design waves and are shown below.

Table 3.60 Design Wave at Each Design Location

Item	Offshore wave direction	Equivalent deepwater wave height H0'(m)	Significant wave height $H_{1/3}$(m)	Maximum wave height H_{max}(m)	Period T（s）
Breakwater (west side)	NW	3.40	3.57	5.27	9.8
Revetment (RORO)	NW	2.79	1.40	1.81	9.8

Source: JPT

As swell waves with a long period have been observed in the area around Ndayane, offshore waves were organized based on the ERA5 data for swell waves, and wave deformation calculations were carried out in the same way to calculate the design waves.

Table 3.61 Design Waves for Swell Wave at Each Design Location

Item	Offshore wave direction	Equivalent deepwater wave height H0'(m)	Significant wave height $H_{1/3}$(m)	Maximum wave height H_{max}(m)	Period T（s）
Breakwater (west side)	NW	1.99	2.59	4.67	14.4
Revetment (RORO)	NW	0.95	1.70	3.06	14.4

Source: JPT

d) Soil Condition

From the "Natural condition survey" described later, it has been observed that the ground surface after excavation to the design target water depth is composed of stable limestone and sandstone. Since it is considered that the local ground bearing capacity is sufficient, it has been decided to verify the stability of the pedestal itself including sliding, overturning, bottom reaction force, etc.

e) Design Water Depth

The design water depth of the berth was set as shown below, taking into account the 0.5 m over-digging after dredging from the design water depth of each facility. In addition, the design water depth of the breakwater located farthest from the port, is set at -10 m considering the average current water depth, and -6 m for revetment for RORO terminal as the average value of the current water depth is -3 m to -9 m at the location of the facility.

Table 3.62 Design Water Depth

Items	Breakwater (West Side)	Revetment (RORO)	Container Berth (DPW)	General Cargo Berth	RORO Berth
Planned Water Depth	-10 m	-6 m	-20 m	-15 m	-14 m
Design Water Depth	-10 m (Average water depth)	-6 m (Average water depth)	-20.5 m (Overbreak of 0.5 m)	-16 m (Overbreak of 1.0 m)	-15 m (Overbreak of 1.0 m)

Source: JPT

f) Surcharge Load

Regarding the surcharge load, 30kN/m^2 has been adopted, which is on the safe side from 10kN/m^2 to 30kN/m^2 in the Japanese port standards.

g) Tractive Force

Tractive force was set according to the Japanese port standards by converting the standards of each ship into GT (gross tonnage). For the tractive force of a 250,000DWT container ship, the maximum value was used according to the port standards.

Table 3.63 Gross Ton Conversion

Ship Type	Specification	Unit	Coefficient of Regression Equation	GT
Container Ship	250,000	DWT	0.8817	220,425
RORO Ship	40,000	DWT	0.5285	21,140
Cargo Ship	40,000	DWT	0.5285	21,140

Source: JPT

Table 3.64 Setting of Tractive Force

Ship Type	Specification	Unit	GT Conversion	Tractive Force	Position (m：assumed)
Container Ship	250,000	DWT	220,425	2,000	20
RORO Ship	40,000	DWT	21,140	1,000	20
Cargo Ship	40,000	DWT	21,140	1,000	20

Source: JPT

h) Fender

For fenders, specifications that are capable of absorbing the berthing energy shown below has been selected.

Table 3.65 List of Design Conditions

Items	Container Berth（DPW）	General Cargo Berth	RORO Berth
Target Ship	250,000 DWT	40,000 DWT	40,000 DWT
Docking E	1,394.9 kN・m	281.7 kN・m	217.1 kN・m
Absorption E	1,449 kN・m	284 kN・m	227 kN・m
Fender Specification	Fender board type 1,600H	V type 800H×2,000L	V type 800H×1,600L

Source: JPT

i) Crest Height

The berth crest height is set between +2.7 m and +3.7m because it is required to be 1m to 2 m above high tide level according to Japanese port standards. On the other hand, according to the DPW M/P, 4.1m above the M.S.L. will cause flooding in this area. Therefore, D.L.+5.1 m->D.L.+5.0 m has been set as the crown height to avoid flooding to the terminal facilities behind the berth as much as possible. In addition, since cargo ships with a high freeboard are often berthed and cargo handling equipment are used, increasing the crown height does not hinder the operation.

Furthermore, the crest height of the breakwater was calculated with H.W.L.+1.25×H1/3 according to Japanese port standards from the significant wave height H1/3. The results were "Breakwater (west

side): D.L.+5.6m ", so they were rounded up in increments of 50 cm and set to D.L.+6.0 m.

j) Bottom Reaction Force

Based on the specifications for locally procured stones shown below, the limit value of 500 kN/m^2 used in Japanese fishing port standards is set as the permissible value for bottom reaction force. This is a limit value that is also used for plain concrete in small-scale fishing port facilities, and is chosen because there is no limit value provided in Japanese harbor standards.

k) Characteristics of Local Stone Materials

According to the cross-sectional drawing obtained from PAD, the standard of stones that can be obtained at the Dakar Port is 3 to 50 kg/piece and 40 to 70 kg/piece, therefore it was assumed that it would be a material of about 100 kg/piece or less. However, based on its track record of being used as a foundation mound material, it was concluded to be a material with the minimum bearing capacity as a foundation material for a levee body.

In addition, the rock quality is sedimentary rock such as sandstone, mudstone, and limestone, and it is presumed not to be igneous rock which is usually used for riprap mounds in Japanese port standards.

Source：Provided by Mitsui Consultants

Figure 3.78 The Photo of the Quarry

Japanese port standards stipulate that igneous rock' should be used only where strength is required as a foundation material, and that 'sedimentary rock can be used' for other parts that do not require strength. Therefore, in this design, the stone materials that are readily available at Ndayane Port are relatively low-strength sedimentary rocks, and when using igneous rocks, it is assumed that there is a possibility of obtaining them from areas other than the area around Ndayane Port. In that case, from the viewpoint of stability, it has been decided to carry out the design with consideration given to the following points.

- Point 1: Setting of Allowable Bottom Reaction Force

As mentioned above, in order to prevent extreme bottom reaction force from occurring in the structure above the mound, allowable bottom reaction force of 500 kN/m^2 has been adopted, which is the standard for relatively small-scale Japanese fishing ports, and decided to limit the load acting on the

mound. In addition, the cross-sectional view obtained from PAD confirms that there is no problem in supporting a structure of collapsing block type. Therefore, it has been concluded that it was a realistic allowable value.

- Point 2: Use of Mound Material that Effectively Utilizes the Strength of Conventional Ground (Limestone, Sandstone, etc.)

In this design, excavated mound will be used for the berth to maintain the water depth, while "raised mound" will be used for the breakwater if the local water depth is not excavated to a large extent.

In that case, an excavated mound can effectively use the good strength of the existing ground such as limestone, sandstone, and etc., as support and slip resistance. However," for a raised mound, the strength of the mound material itself is important. Therefore, as a countermeasure when good quality materials are not available, even if the above igneous rock is obtained, there will be a large difference in the amount of excavated mound and the raised mound. As a result, the countermeasure is to design the upper structure to be as light as possible for the raised mound.

Based on the above, it has been decided that the specifications for the berth using the excavated mound will not change. For the breakwater using the raised mound, it was decided that adopting the sloping breakwater type would be appropriate. This design allows to raise the upper structure as it is, without adopting a caisson structure which would increases the weight of the superstructure.

- Point 3: Slope Gradient Setting when used for Mound Material

As a method of setting the slope gradient when the mound material itself is not strong, there is a non-liquefying material called "sandstone mud" that is not used as a support material in Japan. It is crushed sandstone material with relaxed grain size standards, but its physical properties are often used as "internal friction angle $\varphi = 30$ to $35°$, $\gamma = 18kN/m^3$". Therefore, the angle of repose is "1:1.5 to 1:1.8", and the slope gradient of 1:2.0 is often used.

Based on the above, the slope gradient of the sloping breakwater type breakwater structure in this design was set at "1:2.0" with reference to the above. In addition, with this gradient, it is also known that there is a track record of wave-dissipating blocks such as tetrapods, covering in Japan.

l) Effectiveness of Wave-Dissipating Blocks on Breakwaters

In breakwater design according to Japanese port standards, covering with wave-dissipating blocks is common.

It has the effect of reducing reflected waves, reducing wave pressure, and reducing overtopping, and in this design, it is also effective as a covering material for stones with small specifications. For example, in the sloping breakwater type, stone materials weighing less than 100 kg/piece should be covered with a covering material that is stable against wave pressure, and a filter material is required underneath, but even relatively small stones can be used, and it is possible and especially effective for this design.

Because it is effective not only for general reducing of the impact of reflected waves on ships navigating in front and reducing of overtopping during high waves but "it is also effective as a countermeasure when it is difficult to obtain large standard stones", it is beneficial to adopt wave-dissipating block in the design. Therefore, the wave-dissipating block formula is proposed.

(Weight Calculation of Wave-Dissipating Block)

- Breakwater（West Side）

$$M = \frac{2.30 \times 3.57^3}{8.3 \times 2.0 \times \left({}^{2.3}/_{1.03-1}\right)^3} = 3.36 < 4.0t$$

- Revetment（RORO）

$$M = \frac{2.30 \times 1.40^3}{8.3 \times 2.0 \times \left({}^{2.3}/_{1.03-1}\right)^3} = 0.20 < 0.5t$$

(2) Extraction of Structural Form

a) Berth Structure

There are two types of structures commonly used in Dakar Port: the concrete block gravity type and the steel sheet pile type due to the good foundation ground. Based on the previous survey, it is estimated that the ground in Ndayane is as good as in Dakar near the planned depth of water, therefore three types of structures shall be considered: block type that has been widely used in Senegal, caisson type that has been used for construction in the neighboring countries of Senegal, and the steel pipe sheet pile type adopted in the JICA Grant Aid Project for the Rehabilitation of the Third Wharf in Dakar Port.

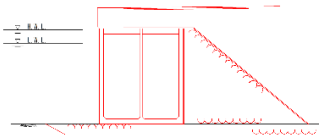
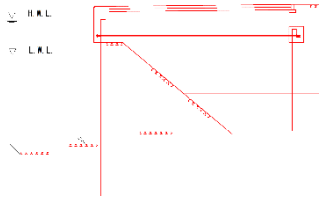
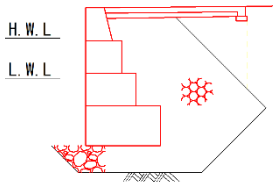
b) Breakwater Structure

In general, the structural type of breakwater is often the gravity type, and sloping breakwater structure is also used for the breakwater at the entrance of Dakar Port. In addition to the gravity type, there is also a sheet pile type structure, but if a wave-dissipating block is installed in front of the sheet pile, it becomes difficult to perform the important maintenance such as anodic replacement and corrosion survey in the sheet pile system. As a result, it is not compatible with the wave-dissipating block used for reducing waves impact. Therefore, three breakwater structures will be considered for comparison: the sloping breakwater type among the gravity type which has been adopted in Senegal, and the caisson type and block type.

c) Comparative Study

An example of typical structure types of a berth is shown below.

Table 3.66 Example of Typical Structure Types of a Berth

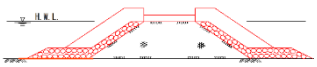
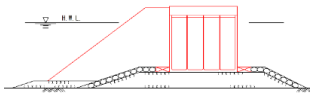
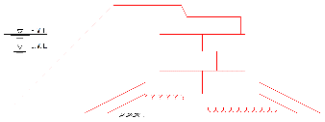
Structural Type	Caisson Type	Steel Pipe Sheet Pile	Block Type
Conceptual Diagram			
Structural Outline	・It is a structure that resists external forces such as earth pressure, due to the weight of caisson.	・It is a structure in which the external force such as earth pressure acting on the front surface of the sheet pile is shared by the retaining pile.	・It is a structure that resists external forces such as earth pressure by the self weight of the block.
Construction Procedure	・After manufacturing the caisson in the manufacturing yard on land, it is launched and installed. ・After that, the filling material is inserted, and after the backfill material is inserted, the superstructure is placed. ・There are two launching methods, one is using a floating dock and the other is using a crane ship. The latter is common in the vicinity of the production yard. ・Since the caisson width is expected to be narrow, floating towing will be difficult, so installation by a crane ship will be advantageous.	・It is necessary to penetrate limestone and sandstone, so it is desirable to use the rotary press-in method as in the case of the Third Wharf. ・After that, tie materials are installed, and after inserting backfill materials, the superstructure is placed. ・Since construction at sea is expected, a crane ship for lifting steel pipe material is required, and other construction requires an offshore work vessel. ・It is necessary to put earth and sand at the position of the anchor pile in advance, and drive the steel pipe pile for anchor work.	・After manufacturing a square block at a manufacturing yard on land, it is installed by a crane ship. ・After that, the backfill material is put in, and the superstructure is placed. ・It requires a crane ship for installation, and other construction requires an offshore work vessel. ・The procedure up to the construction of mound is similar to the caisson type.
Construction Features	・By constructing an excavated mound, even if the strength and grain size of the mound material are low, stability can be expected in the solid ground. ・Requires relatively large offshore work vessels	・It is possible to dredge the front surface of the sheet pile after construction. ・The construction yard is also compact, and construction is relatively quick. ・Requires a medium-sized offshore work boat	・Even in Japan, there are no examples of block stacking of 5 to 6 layers or more, and there are concerns about the stability during construction. ・A construction yard is required, and a medium-sized offshore work boat is required.
Economic Efficiency	・In good ground, the gravity type is generally cheaper. ・The cost of launching and installing a crane ship is expensive, but it depends on the construction function. ・Maintenance costs are basically for crack repairs, and are inexpensive.	・It is expensive to drive piles into solid ground by rotary press-in method . ・Maintenance costs after construction (regular replacement of anode electrodes for corrosion protection, etc.) are required.	・It is necessary to procure strong mound material, but since the block itself requires a smaller crane, it is more economical than the caisson type.
Workability	・Although it takes time to level the foundation mound, construction speed is stable because caissons are installed sequentially. ・Compared to the sheet pile type, the amount of pre-	・There are relatively many types of work to conduct, but the construction speed is stable when driving sheet piles on site. ・Compared to the gravity type, the amount of post-excavation is small	・Workability is good, since the construction procedure is simple and only a small crane is required.

Structural Type	Caisson Type	Steel Pipe Sheet Pile	Block Type
	excavation is large	・It is necessary to fill in the installation position of the bracing pile in advance.	

Source: JPT

An example of typical structure types of a breakwater is shown below.

Table 3.67 Example of Typical Structure Types of a Breakwater

Structural Type	Sloping Breakwater Type	Caisson Type	Block Type
Conceptual Diagram			
Structural Outline	・The structure is stable against wave pressure due to the weight of the stone. ・In general, cover materials and wave-dissipating blocks are used together to protect foundation materials.	・It is a structure that resists external forces such as wave pressure, due to weight of the caisson. ・In general, it is more economical to use a wave-dissipating block in combination.	・It is a structure that uses the weight of the block to resist external forces such as wave pressure. ・In general, it is more economical to use a wave-dissipating block in combination. ・In high waves, individual blocks may exhibit individual behavior, and are inferior to the caisson type in terms of stability.
Construction Procedure	・Stones are thrown in from the sea, leveled, and then the superstructure is placed. ・After manufacturing wave-dissipating blocks and covering blocks at the land-based manufacturing yard, they are installed by a crane ship.	・Launch and install the caisson after manufacturing it in the manufacturing yard on land. ・After that, the filling material is put in and the superstructure is placed. ・After manufacturing wave-dissipating blocks and covering blocks in the land-based manufacturing yard, they are installed by a crane ship. ・There are two methods of launching, one using a floating dock and the other using a crane ship, and the latter is common in the vicinity of the production yard ・Due to the narrow caisson width, which makes floating towing difficult,	・Blocks are manufactured in a production yard on land and then installed by a crane ship. ・After that, the superstructure is placed. ・After manufacturing wave-dissipating blocks and covering blocks at the land-based manufacturing yard, they are installed by a crane ship.

Structural Type	Sloping Breakwater Type	Caisson Type	Block Type
		installation by crane ship is likely to be advantageous.	
Construction Features	・Even when the strength and particle size of the mound material itself are low, the superstructure is light, so there is no problem with structural feasibility. ・There is also the possibility of land construction, and construction is possible with a medium-sized offshore work boat.	・Since it is a structure where heavy objects are loaded on the top of the high mound, there are concerns about the structural feasibility depending on the quality of the mound material. ・The strength of the mound as a whole is important as heavy objects will be loaded, and it is important to ensure its quality. ・Therefore, the quantity will increase when a strong mound material is required. ・Requires relatively large offshore work vessels.	・Since it is a structure where heavy objects are loaded on the top of the high mound, there are concerns about the structural feasibility depending on the quality of the mound material. ・The strength of the mound as a whole is important as heavy objects will be loaded, and it is important to ensure its quality. ・Therefore, the quantity will increase when a strong mound material is required. ・Requires medium-sized offshore work vessels.
Economic Efficiency	・The unit price of stone material has a large impact on economic efficiency, but it is generally inexpensive because it does not require large-scale construction machinery. ・Maintenance cost is low because it is only for raising the height in case of crest subsidence.	・Economic efficiency is poor, since it is necessary to procure a strong mound material and caisson itself is also expensive.	・It is necessary to procure strong mound material, but since the block itself requires a smaller crane, it is more economical than the caisson type.
Workability	・Workability is good due to the possibility of construction from land and the simple construction procedure.	・Workability is poor, since the construction procedure is complicated and a large crane ship is required.	・Workability is good, since the construction procedure is simple and only a small crane is required.

Source: JPT

(3) Determination of Structural Specifications

A standard cross-section is shown below.

[Standard Cross-section of Berth]

For reference, a caisson type standard cross section is shown below as a general berth structure at deep water.

For caissons of -20m and -15m berths, the permissible bottom reaction force (500kN/m^2) was set in consideration of the fragility of the rubble mound, and there is plenty of bearing capacity for sliding

and overturning. Also, from the value of the draft when floating, there is a possibility that floating towing may be difficult at the nearby conventional ground elevation, so it is assumed that it will be suspended.

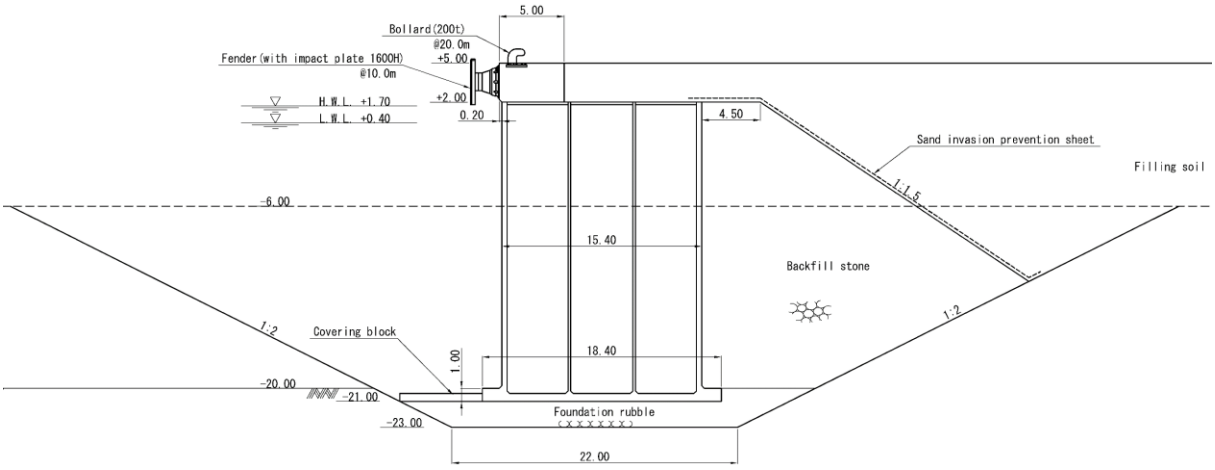
[Standard Cross-section of Breakwater]

For reference, a sloping breakwater type standard cross section is shown below as a general breakwater berth structure.

The slopes of -1 0m breakwater and -6 m revetment are stabilized with a ratio of 1:2.0, which is greater than the angle of repose of the rubble material. As for the superstructure, the minimum width of the pedestal is set at 4 m, so that the crest surface can be used for maintenance during construction and after completion.

Effect Strength Ratio (Caisson)

Sliding	Overturn	Bottom Reaction Force (kN/m2)
0.566 <1.0	0.363 <1.0	497.106 <500
Draft when Floating (m)	Remarks	
d= 13.414	Conventional water depth in the vicinity of the construction position is around 0m～-10m, so suspension installation is advantageous.	

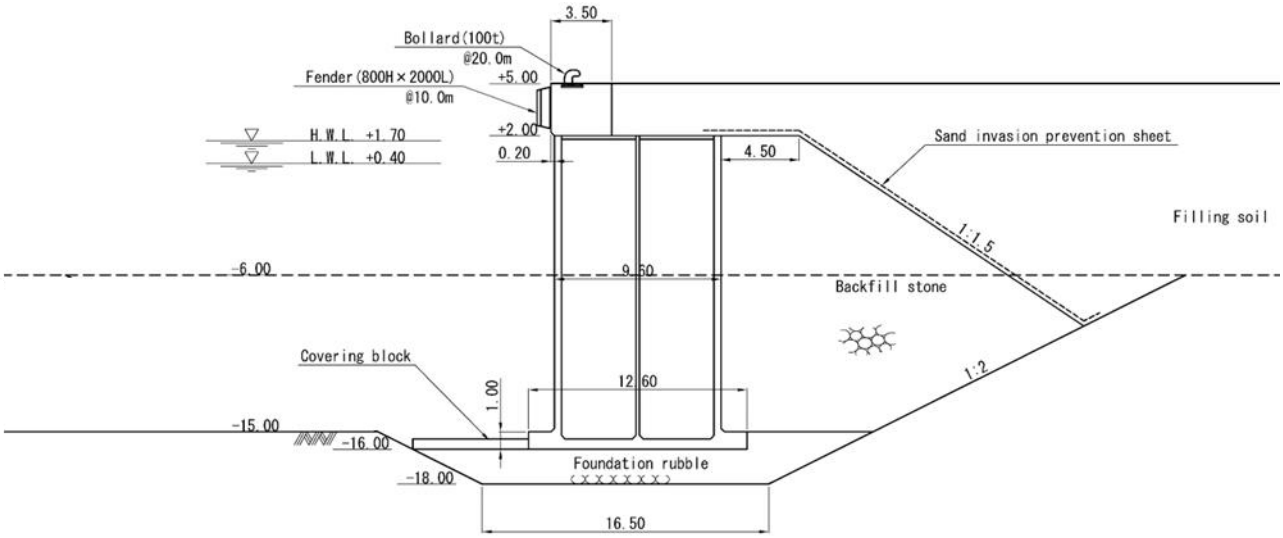


Source: JPT

Figure 3.79 Standard Cross-section of -20 m Berth (Caisson Type)

Effect Strength Ratio (Caisson)

Sliding	Overturn	Bottom Reaction Force (kN/m2)
0.717 <1.0	0.516 <1.0	495.508 <500
Draft when Floating (m)	Remarks	
d= 11.865	Conventional water depth in the vicinity of the construction position is around 0m～-10m, so suspension installation is advantageous.	

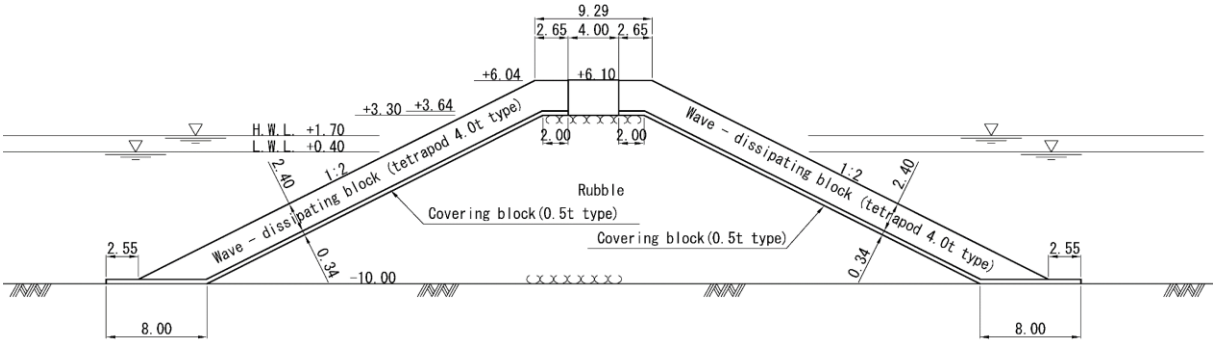


Source: JPT

Figure 3.80 Standard Cross-section of -15 m Berth (Caisson Type)

Effect Strength Ratio (Superstructure)

Sliding	Overturn	Bottom Reaction Force (kN/m2)
0.123 <1.0	0.029 <1.0	69.630 <500
Draft when Floating (m)	Remarks	
d= -	Width of the superstructure for construction and management is set to a minimum of 4.0m.	

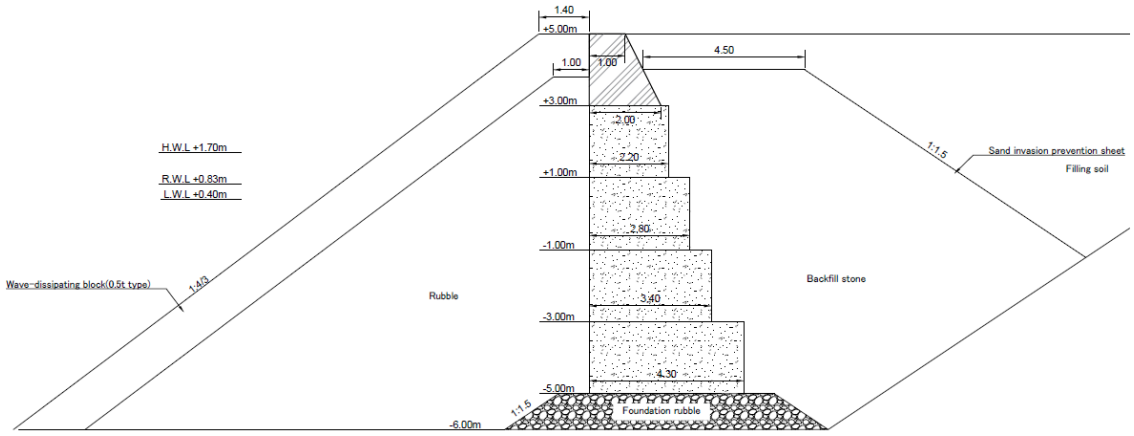


Source: JPT

Figure 3.81 Standard Cross-section of -10 m Breakwater (Sloping Breakwater Type)

Effect Strength Ratio (Superstructure)

Sliding	Overturn	Bottom Reaction Force (kN/m2)
0.602 < 1.0	0.552 < 1.0	483.270 < 500



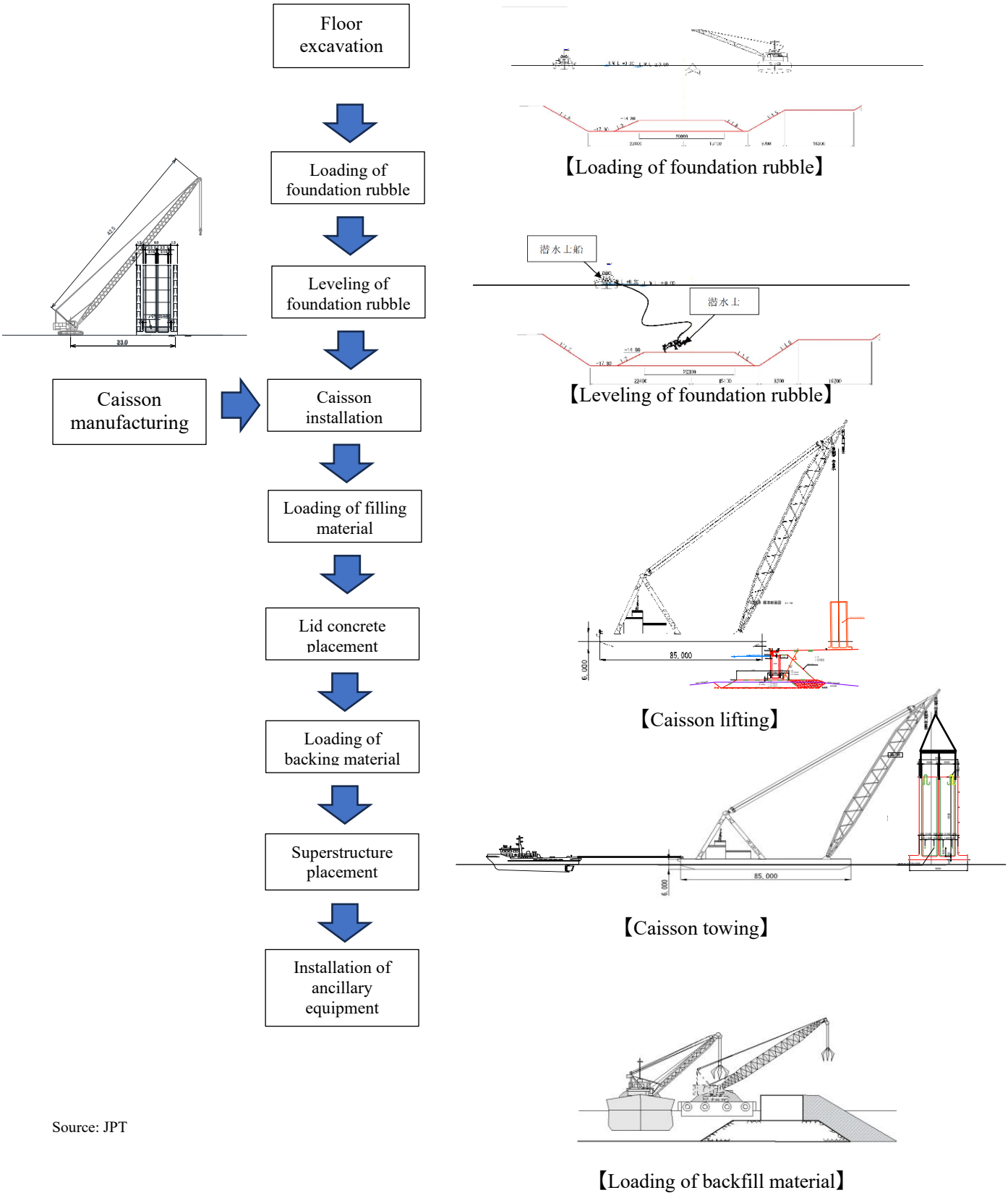
Source: JPT

Figure 3.82 Standard Cross-section of -6m Revetment (Block Type)

(4) Construction Procedures

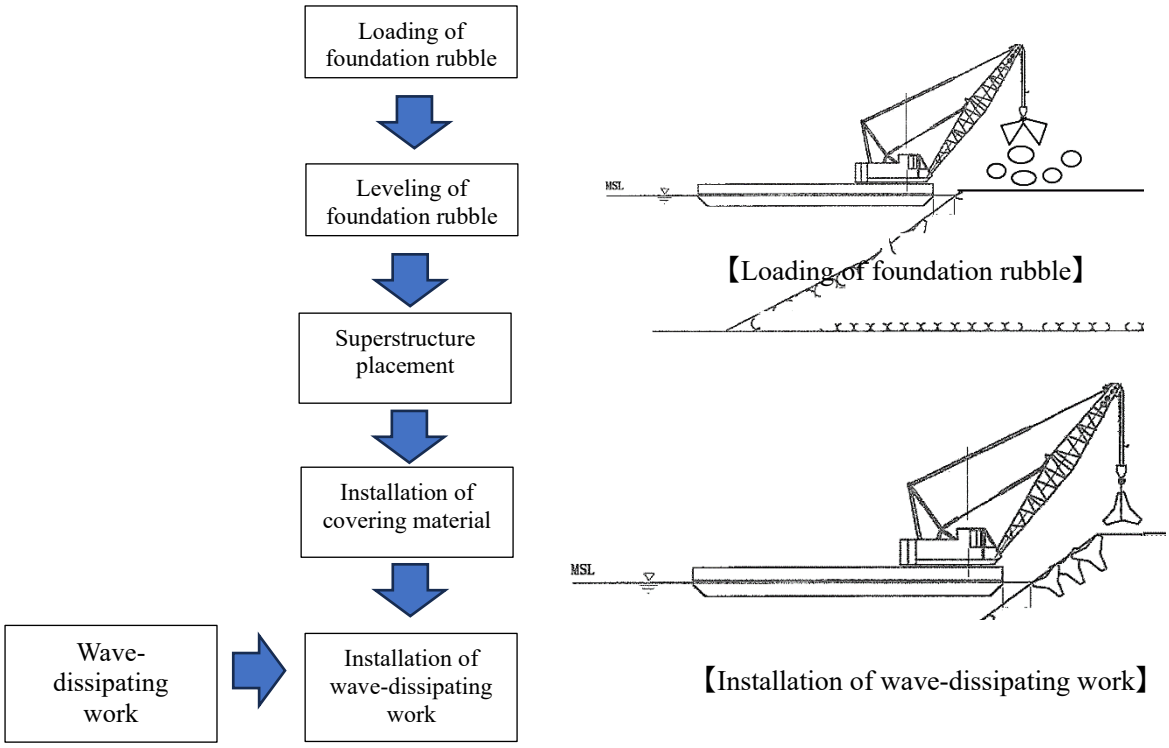
- Procedure of Caisson Berth

*This is a conceptual diagram assuming suspension installation by a crane ship, when stability and draft cannot be secured during floating due to the narrow width of the caisson pedestal.



Source: JPT

Figure 3.83 Procedure of Caisson Berth



Source: JPT

Figure 3.84 Procedure for Rubble Sloping Breakwater/Revetment

(5) Items to be Confirmed during Future FS and DD

As a result of careful examination of the materials received from PAD, there were concerns on the following six points, and additional survey and examination will be required at the time of future FS and DD. The JPT has not received any materials from DPW and has not been able to conduct interviews, so it is unclear, but the expectation is that DPW has already examined the mentioned concerns.

1)Establishment of ground conditions and examination of stability: Excavation to the planned ground height reveals good ground conditions, mainly limestone and sandstone. However, it is necessary to confirm the bearing capacity and resistance to sliding, such as confirmation of strength during weathering, etc.

2)Verification of stability during construction: Berth structure is evaluated for stability during operation, however, it is also a temporary landfill revetment. Therefore it is necessary to verify stability during the construction of breakwaters.

3)Examination of caisson manufacturing, launching, and installation method: Since the width of the caisson is narrow, it is assumed that the caisson will be suspended and installed using a crane ship for stability when floating. On the other hand, it is also necessary to compare the launching and installation method when using a floating dock of the width of the caisson that ensures stability when floating.

4)Confirmation of the quality of foundation rubble material: Since sandstone and mudstone are assumed to be used due to the ease of securing them locally, it is necessary to verify the that it is possible to secure the design value by collecting information on compressive strength and particle size, and to pay attention to the maintenance of structural quality.

5)Availability of local armor stones, the adoption of armor blocks as armor materials depending on the quality. This point is similar to 4). If the performance of the stone material is confirmed and the standards are insufficient, it is necessary to be flexible, and change from armor stones to armor blocks.

6)Adoption of wave dissipation block as countermeasures against reflected wave reduction and wave overtopping. The wave dissipation block has been proposed to perform as countermeasures against reflected wave reduction and wave overtopping, however regarding its standard and type, it is necessary to select the　blocks based on a comprehensive consideration of their standards and types, including performance, ease of construction and economic efficiency.

3.12.9 Cargo Handling Equipment

(1) Cargo Handling Equipment Plan

a) Terminal Functions Shifting Scenario

According to DPW M/P (2021), the functions of the terminal will be shifted from Dakar Port to Ndayane Multifunction Port as scheduled in Table 3.68.

Table 3.68 Terminal Functions Shifting Scenario by DPW M/P（2021）

<table>
<tr><th></th><th colspan="5">2023 2024 2025 2026 2027</th><th colspan="7">2028 2029 2030 2031 2032 2033 2034</th><th colspan="6">2035 2036 2037 2038 2039 2040</th><th colspan="7">2041 2042 2043 2044 2045 2046 2047</th></tr>
<tr><td>Container</td><td colspan="5">Ndayane Phase 1
Dakar / Ndayane</td><td colspan="7">Ndayane Phase 2</td><td colspan="6">Ndayane Phase 3</td><td colspan="7">Ndayane Phase 4</td></tr>
<tr><td>General Cargo Terminal</td><td colspan="7">Dakar</td><td colspan="19">Ndayane</td></tr>
<tr><td>RORO Terminal</td><td colspan="7">Dakar</td><td colspan="19">Ndayane</td></tr>
<tr><td>Agri-bulk Terminal</td><td colspan="13">Dakar</td><td colspan="13">Ndayane</td></tr>
<tr><td>Fishing Port</td><td colspan="13">Dakar</td><td colspan="13">Ndayane
(Local/artisanal fishing remain in Dakar Port)</td></tr>
<tr><td>Mineral Bulk Terminal (Ilmenite, Attapulgite and others)</td><td colspan="26">No plan in DPW M/P (2021).
AFD M/P states from 2035 this will shift from Dakar to Bargny-Sendou.</td></tr>
<tr><td>Liquid Bulk Terminal (Hydrocarbon)</td><td colspan="26">No plan in DPW M/P (2021).
AFD M/P states from 2024 part of the function, such as import of Hydrocarbon will shift from Dakar to Bargny-Sendou.</td></tr>
<tr><td>Ferry Terminal</td><td colspan="26">Dakar</td></tr>
<tr><td>Repair Dock</td><td colspan="26">No plan in in DPW M/P (2021)</td></tr>
<tr><td>Naval Base</td><td colspan="26">Dakar</td></tr>
</table>

Source: JPT base on DPW M/P(2021)

Assumptions in DPW M/P (2021) related to the cargo handling equipment in the Multifunction Terminals are extracted as follows:

- Agri-bulk Terminal includes a railyard facility that will be linked to the Dakar-Bamako rail line. Only containers and agri-bulk are to be transported by rail, general and RORO cargoes are all assumed to be transported by road.
- General Cargo Terminal consists of berths which can be equipped with mobile harbour cranes, although most conventional commodities are assumed to be discharged using ship's crane.
- One flexible multipurpose berth fitted with a pipeline connection for handling edible oil operations. Two modern dedicated berths for import of cereals equipped with modern pneumatic or continuous mechanical unloaders able to discharge to trucks and conveyors. The unloader with the capacity of 600 t/h (pneumatic or mechanical) will be sufficient.

Ferry Terminal and Naval Base will remain at Dakar Port. For Fishing Port, it would be better off remaining in Dakar due to the proximity to the related industries and the city consumption. Repair Dock will also remain in Dakar Port for the following reasons:

- Dock facilities in Dakar Port belong to Senegalese Government, and constructing a competing repair dock in Ndayane is not likely.
- Major docking vessels are the fishing boats.

Bargny-Sendou Port is expected to mainly handle liquid bulk and edible agri-bulk cargoes. (Refer to the relevant sections in Chapter 3). In this scenario, mainly General, RORO, and Dry Bulk (mineral) cargoes will be handled at the Multifunction Terminals.

AFD M/P "Reminder of the possible positions for the Autonomous Port of Dakar" stated that passenger traffic terminals (ferry and cruise), fishing port, and dockyard could be maintained at Dakar Port.

Rest of this section will mainly focus on the facilities and equipment at the General Cargo Terminal, RORO Terminal, and Dry Bulk Terminal in the Multifunction Terminals.

b) Determinant Factors for Equipment at the Multifunction Terminals

Table 3.69 summaries the determining factors to select the cargo handling system at Multifunction Terminals.

Table 3.69 Determining Factors for Cargo Handling System at the Multifunction Terminals

Determining Factor	Items to Consider	Planned Values	Remarks
Terminal Operator	▪ If a concessionaire operates the terminal, the terminal is dedicated to the concessionaires. Thus, they can install rail mounted gantry crane or fixed conveyor. ▪ If PAD operates, multiple port users use the terminal. Thus, the port users need to use movable loader/unloader. ▪ Terminal operator, either PAD or concessionaire, invest the terminal facilities by his own budget.	▪ General Cargo: PAD ▪ Dry Bulk: concessionaire ▪ RORO: concessionaire	At Wharf 4th of the Dakar Port, the port operator (GMD) installed fixed conveyor, but this would be an exceptional case.
Cargo volume per year	▪ Cargo volume per vessel can be calculated from cargo volume and vessel size. This is necessary for determining the productivity of the system, thus staying time at the terminal. Conversely, necessary cargo handling equipment efficiency can be calculated if the limited vessel staying time is given.	▪ General Cargo 4,027,420 ton ▪ Dry Bulk Cargo (mineral) 2,331,948 ton ▪ RORO: 349,667 units (Year 2047)	Refer to Tables in section 6 (2) of Chapter 3
Vessel size	▪ To decide the dimension of the loader/unloader, vessel dimensions are necessary.	▪ General Cargo Max. DWT 40,000 (LOA/Beam/Draft: 220/30/13 m) Average DWT 15,000 (166/24/10 m) ▪ Dry Bulk Max. DWT 150,000 (294/45/17 m) Average DWT 30,000 (186/27.9/10.9 m) ▪ RORO Max. DWT 40,000 Loaded vehicle 8,000 units (265/32.2/12.4 m) Average DWT 30,000	Refer to Tables in section 6 (3) of Chapter 3.

		Loaded vehicle 6,000 units (214/32.2/11 m)	
Berth Length	▪ To calculate the number of vessels berthing concurrently.	▪ General Cargo: 1,000 m ▪ Dry Bulk: 500m ▪ RORO: 600 m	▪ Refer to Tables in section 11 of Chapter 3. ▪ Nonedible agri-bulk is handled at the General Cargo Terminal.
Storage area, delivery location	▪ This is needed for establishing delivering system (railway, truck, and conveyor).	▪ General Cargo: Temporarily stored at the storage areas in the terminal. ▪ Dry Bulk (mineral): Temporarily stored at the warehouse in the terminal or storage areas adjacent to the terminal.	At Wharf 5th of Dakar Port, rail - storage - conveyor – movable loader - vessel system is established to export Ilmenite by GCO.

Source: JPT

c) Container Terminal Equipment (DPW M/P)

Container terminal at Ndayane Multifunction Port will be built and operated by DPW. DPW will upgrade and transfer two quay cranes from Dakar Port for use in Ndayane Multifunction Port, and the seven cranes (nine cranes are necessary for Phase 1 development toward 2027) are to be purchased new. During the first two years of Phase1, the current container terminal at Dakar Port is expected to handle 400,000 TEU with the new container terminal handling the remaining share of the throughput.

It is assumed that vessels of up to LOA 400 m will start berthing at Ndayane Multifunction Port. To service these vessels, super post-panamax quay cranes with outreach of 65 m, twenty-three (23) container rows, including the cranes to be upgraded and transferred from Dakar Port, will be required.

Table 3.70 summaries the DPW's plan for cargo handling equipment.

Table 3.70 Cargo Handling Plan of Contatiner Terminal

Year	Phase 1 -2027	Phase 2 2027-2034	Phase 3 2034-2040	Phase 4 2040-2047
Quay Crane (QC)	9	12	15	17
Electrified Rubber Tyred Gantry Crane (E-RTG)	33	44	56	66
Reach Stacker (RS)	2	3	3	4
Empty Container Handler (ECH)	12	17	21	24
Internal Transfer Vehicle (ITV)	64	88	108	128

Source: DPW M/P (2021)

d) Recommended Equipment at Multifunction Terminals

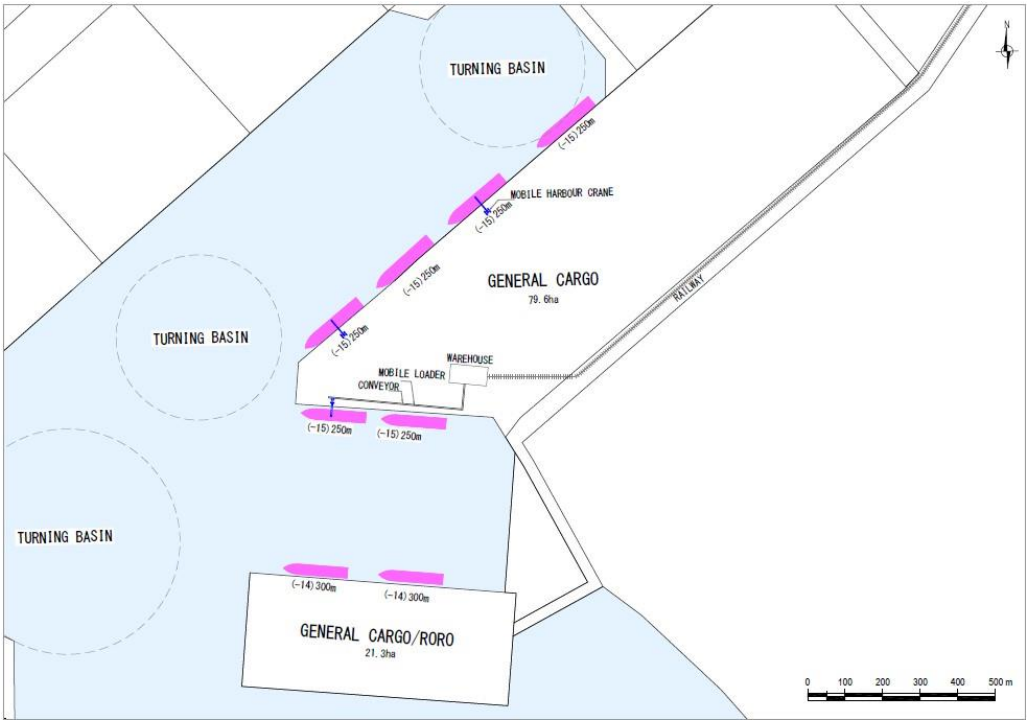
Considering the terminal operator, cargo vessel size, and delivery mode, following operator and equipment are recommended.

Table 3.71 Year 2047 at the Multifunction Terminals (JPT Scinario)

Terminal	Operator	2047 Scenario
General Cargo Terminal	PAD	▪ At least two mobile harbour cranes with at least150 ton lifting capacity will be used at the quayside to handle over 4 million tones (estimation in 2047) cargo. Depending on the cargo type, ship cranes are occasionally used. ▪ Tractor and the chassis transport the cargoes between apron and storage area in the terminal. Various sizes of forklifts are used for loading/unloading.
RORO Terminal	Concessionaire	▪ RORO terminal is planned to operate similarly to the Port of Dakar wharf 2nd, and will primarily handle vehicles and containers.
Dry Bulk Terminal	Concessionaire	▪ Warehouse(s) is near the quayside for temporarily storing the precious placer (mineral sand) such as illuminate or attapulgite. Railway connects between the mines and the warehouse. Fixed conveyor and mobile loader are used to transport the placer from the warehouse onto the vessels.

Source: JPT

Multifunction Terminals in 2047 is depicted in the following figure. Fuel unloading berth is also constructed at the inlet between RORO and Dry Bulk terminals.



Source: JPT

Figure 3.85 Multifunction Terminal in 2047

However, depending on the market demands and PAD's decision as to concession of the terminals, type of the terminal in General Cargo may be partly used for agri-bulk, petroleum oil, or mineral (sulfur, coal, or clinker) terminals.

3.12.10 Railway Line Plan within the Port of Ndayane

As mentioned in Chapter 2.4.2 "Current Situation and Existing Development Plan of Land Transport Network (road and railway)", there is a railway line in Senegal between Dakar, Thiès and Mali, and ilmenite and other ores are transported by rail from the production areas to Dakar port. In the future, in order for these bulk cargoes to be transferred to Ndayane Port and for cargo to be efficiently accumulated at Ndayane Port, a railway line connecting to the port is essential.

Due to aging infrastructures, there are speed restrictions on some sections of the railway between Dakar, Thiès and Mali. Although WB study and a contract with China Railway were conducted to renovate the line, neither have been brought to fruition. JPT requested PAD to provide information on future expansion plans for Senegal's railways and to make appointments with relevant organizations and companies, and held a meeting on October 3, 2024.

At the meeting, the Senegalese side presented two proposed routes: Route D, which would run from the airport via Ndayane to Saly, and Route C, which would run from the airport along the N1 to Saly without passing through Ndayane. Both projects are seeking investors with the goal of completing them within the next five to ten years. They also indicate the plans for both passenger and freight rail lines. However, there are currently no plans to connect the section between Bargny Sendou and Ndayane due to the high social costs associated with resettlement of residents. Senegal's railway standards basically conform to French standards, as Senegal does not have its own railway standards. Currently, passenger lines are electrified, but freight lines are not. It is uncertain whether all lines will be electrified in the future, so this plan assumes that passenger and freight lines will not be shared. In addition, it was assumed that the tracks would not be shared, as the gauge of the railroad tracks is currently different: standard gauge (1435 mm) for passengers and meter gauge (1000 mm) for freight.

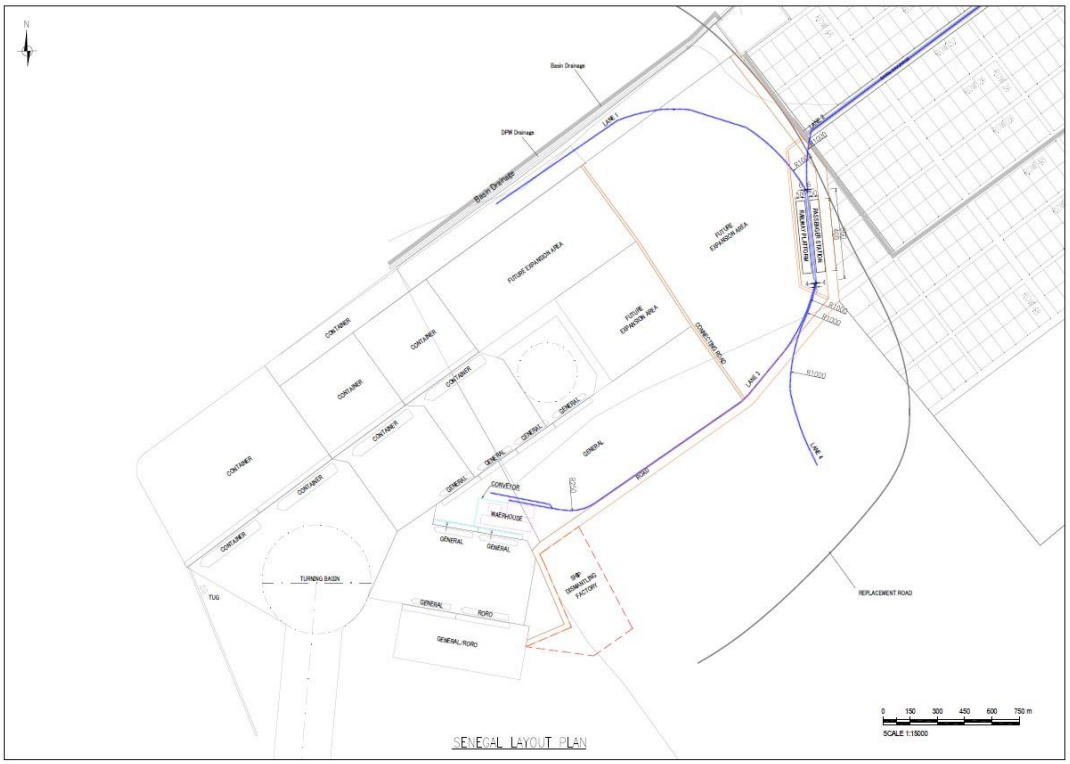
Source: Materials presented by the Senegalese side

Figure 3.86 Two Routes Provided by the Senegalese Side

If route D of the above route map is applied to the current Ndayane Port M/P, it corresponds to the location of the main access road that runs through the center of PIZ. There is a difference in elevation of approximately 40 m between Ndayane Port and the airport, with an average gradient of approximately 1%. For details of the main access road plan, see Chapter 3.12.13.

It is considered desirable to locate the two stations— the passenger railway station and the freight station— in the port expansion area, at an altitude of approximately 10 m, where the difference in elevation between the industrial park and the port area has been reduced. The figure below shows a proposed railway line layout based on Route D, with a route heading southeast towards Sally. It is desirable to provide a detour around the existing road near the railway station to facilitate access for local residents.

Confirming from satellite images, it appears that currently in Senegal, freight cars, each about 10 m long, are operated in approximately 20 rows, totaling just over 200 m. Since freight trains can operate with a maximum length of 35 freight cars, the transfer station requires a line extension of at least 400 m. It is desirable to locate the line so that it extends to both the container terminal and the general cargo terminal. The container terminal is excluded from the railway route map in this M/P since it is under the jurisdiction of DPW. There is information that DPW envisions an area of 1100 m x 80 m as a rail site for a container terminal, but the specific location and other details are unknown. For general cargo and bulk terminals, it would be desirable to have cargo transported by rail to the terminal, temporarily stored in a warehouse, and then transported by conveyor to the quay, as is currently the case at Wharf 5th in Dakar Port.



Source: JPT

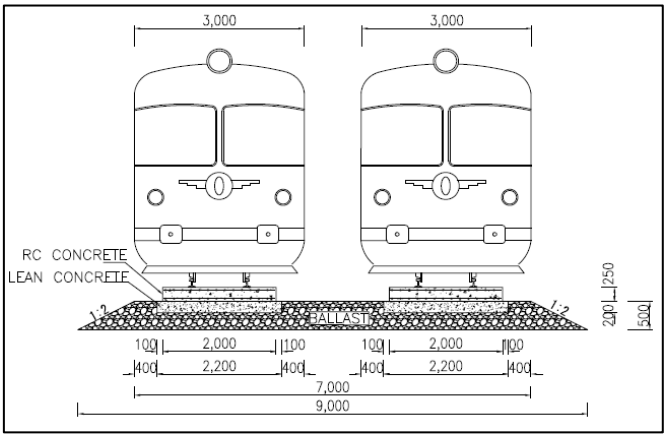
Figure 3.87 Railway Line Layout

Source: JPT

Figure 3.88 Railway Line Layout (with Satellite Image)

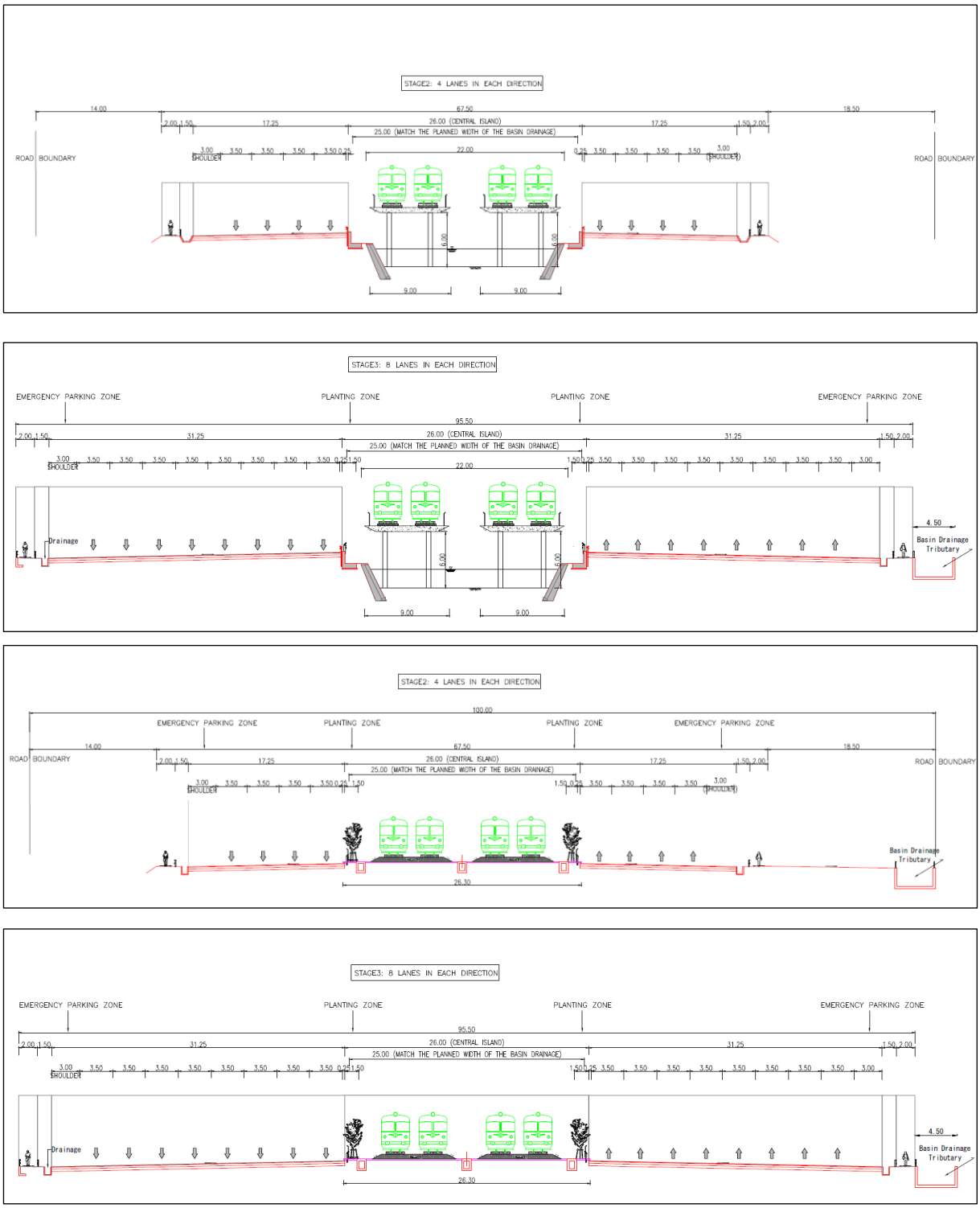
When placing a rail line on a main access road, there are two options— one is to replace the Center Island area and drainage channel area in the center of the road with a railway line area and the other

option is to retain the Center Island and drainage areas and replace some of the roads with rail lines. In this M/P, although the freight volume distribution by mode between railway and road is not forecasted, the idea of railway line layout will be presented. After the railway opens, it is assumed that road traffic capacity will decrease and it may be possible to reduce the number of road lanes; however, this will need to be considered after the railway plan has progressed, based on the latest railway plan at the time of F/S for 2035. The standard cross section of the railway line is shown below.



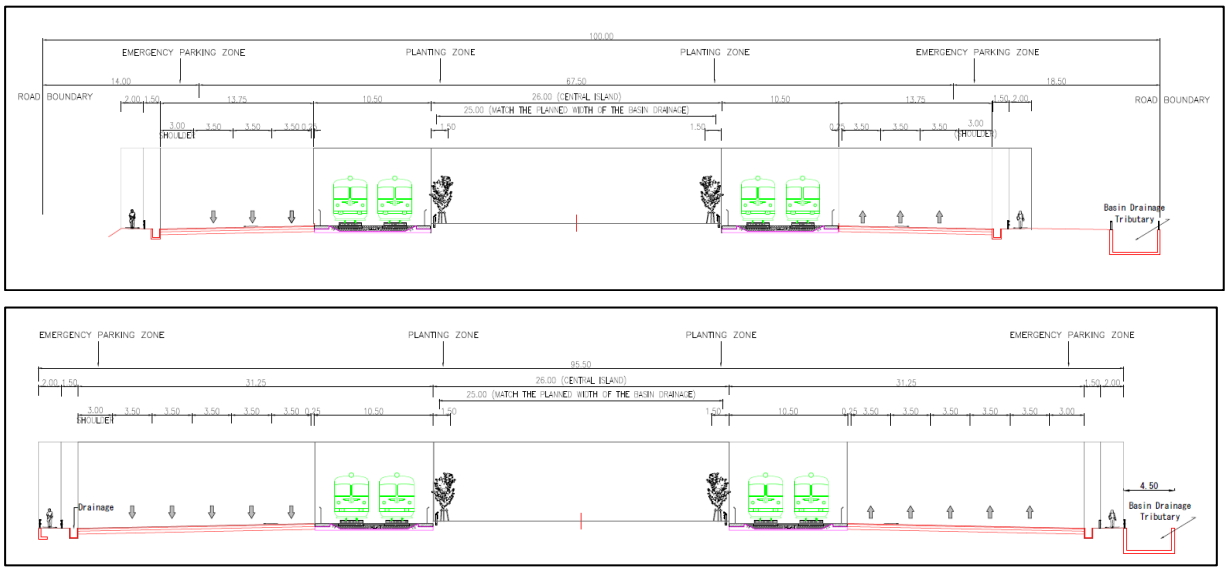
Source: JPT

Figure 3.89 Proposed Standard Cross-section of Railway Line



Source: JPT

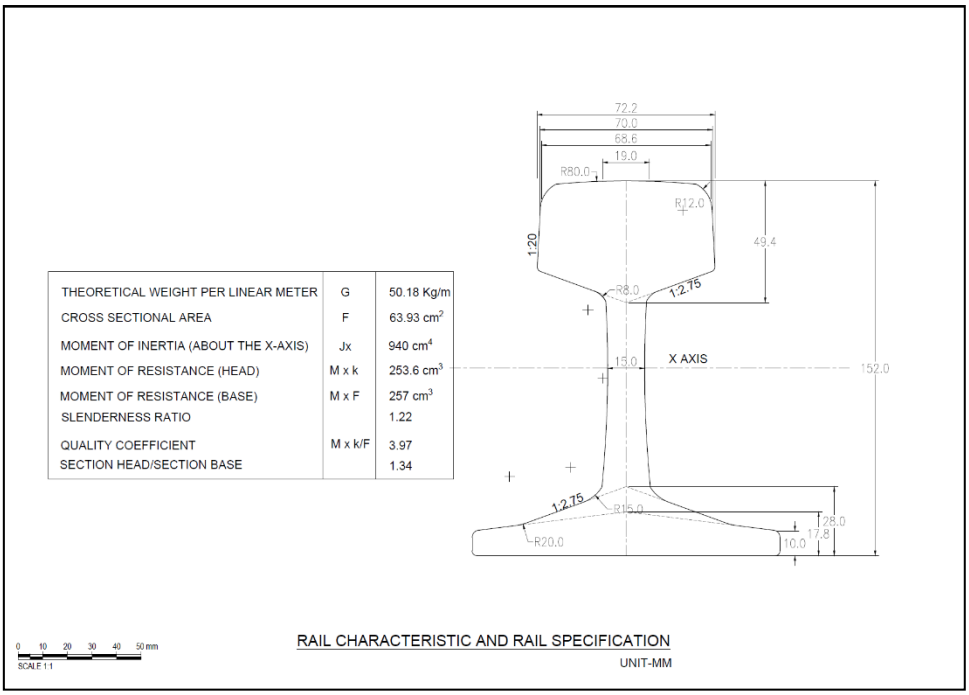
Figure 3.90 Image of Railway Lin on Center Island of Access Road and on Drainage Channel (Option 1)



Source: JPT

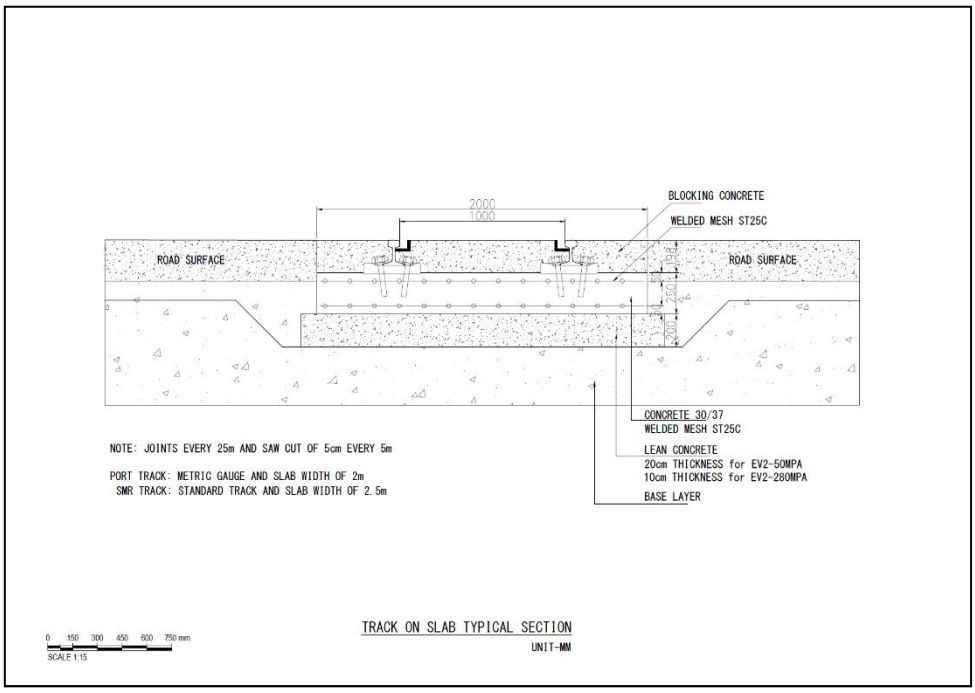
Figure 3.91 Image of Replacing Part of Road with Railway Line (Option 2)

The standard cross-sectional figure of railway rails and tracks provided by PAD is shown below.



Source: PAD

Figure 3.92 Rail Characteristic and Rail Specification



Source: PAD

Figure 3.93 Track on Slab Typical Section

3.12.11 Port Security

a) Proposal of Port Security System/Equipment to be Installed in Ndayane Multifunction Port

JPT was not able to confirm PAD's intentions regarding the proposed port security system and equipment. Therefore, JPT proposed port security system and equipment that are generally required. The intentions of PAD as confirmed by JPT are presented in below table.

Table 3.72 Port Security System/Equipment List

No.	Item
1	**Port Gate/Terminal Gate Security Elements**
	Vehicle management Equipment such as Electro Hydraulic Swing Gate, Car Plate Identification System, etc., Turnstile, Fingerprint and card reader, Access Control System Controller, Traffic light, License plate reader camera, Metal Detection Gate, Optical Character Recognition System, etc.
2	**Access Control System at Admin. Building**
	Access Identification Unit Readers, Access Control System Controller, "Exit" and "Emergency" Pushbutton, etc.
3	**Public Address, Intercom System**
	Intercom, Public Address Horn, etc.
4	**Perimeter Intrusion Detection System**
	Fence with sensor, etc.
5	**Alarm Detection System**
	Pulsed Infrared Detector, etc.
6	**Closed Circuit Television System (CCTV)**
	Thermal Cameras, Fixed Cameras, Dome Camera, Video Motion Detection, etc.
7	**Facial Recognition & Thermography System**
	Face Authentication and Infrared Thermography Camera
8	**Network Video Recording System**
	Network Video Recording System, Viewing Monitor, etc.
9	**Control Centers Equipment & Installations**
	Video wall screen, controller, etc.
10	**Security Management Software Application**
	Hot backup system, servers, Storage Management system, etc.
11	**Dedicated Data Communication System**
	Main modular switch, Field switch, etc.
12	**Supply and Installation of Cable**
	Fiber core including splicing, cable, etc.
13	**Radiation Detection Scanner at Yard and Terminal Gate**
	Equipment of scanner, X ray machine, Radiation Detection Scanner etc.
14	**Data Transfer System**
	Data Transfer System, etc.
15	**WIFI 6 and Private Automated Branch Exchange (PABX)**
	PABX system, WIFI 6, etc.
16	**Walk Security Access**
	Fingerprint and card reader, turnstile, handbag scanner, metal detection gate, etc.

Source: JPT

b) Organization of Port Security

PAD will manage port security for Dakar Port, Ndayane Port and Bargny Sendou Port in the future. It is necessary to establish an organization for each Port similar to that of the Dakar Port. JPT propose to increase three (3) chief of security departments for each port in the future.

3.12.12 Maritime Safety

The outline design, specifications, and quantities of maritime safety at the Ndayane Multifunction Port are below.

a) Vessel Traffic Management System (VTMS)

The Vessel Traffic Management System (VTMS) is a system designed to support Vessel Traffic Service (VTS) operations and specifications shall meet the performance requirements in accordance with International Association of Marine Aids to Navigation and Lighthouse Authorities (IALA) Guideline 1111. It has been confirmed that the Port of Dakar already operates VTS in accordance with IALA V-145 Inter-VTS Exchange Format Service. In the future, the establishment of a Vessel Traffic Management System (VTMS) integrating the systems Port of Dakar and Ndayane Multifunction Port is expected.

The following table provides an outline specification of the Vessel Traffic Management System (VTMS) at the Ndayane Multifunction Port. The radar types will utilize the X-band (8~12G Hz) similar to the Port of Dakar. It shall be capable of night surveillance using visible light and thermal cameras, monitoring vessel traffic at the entrance of the navigation channel and surrounding fishing boats on 24 hours. Towers for installation of these facilities are proposed to be erected using the existing the Central Mast of DPW. The control room installed in the any management building will include workstations equipped with monitor displays, keyboards, mouse, etc. VHF communication devices will also be installed for communication with vessels. Considering the installation of radar on existing facilities, wireless data communication via microwave is being considered.

Table 3.73 Outline Specifications of VTMS at Ndayane Multifunction Port

	Equipment	Q'ty	Specification
1	VTMS System	1	Specifications meeting the performance requirements in accordance with IALA Guideline 1111. Coastal surveillance software capable of accommodating future increases in the number of radars and cameras.
2	Radar	1	X-band radar (8~12 GHz) Output: 600 W or more
3	AIS Receiver （Automatic Identification System）	1	Compliance with IALA A-123 and A-124 Frequency: 156~162.5 MHz, Channel 25kHz, Antenna/Antenna Cable
4	CCTV	1	Visible light/thermal camera / Small ship capture distance: 3.7 nautical miles
	Weather station	1	Atmospheric pressure, Humidity, Rainfall, Temperature, Wind speed, and Wind direction
5	Tower	(1)	Utilization of existing facilities: Ground height 20m Utilization of Central Mast (DPW)
6	Workstation	1 set	Large screen and display
7	VHF Communication System		Frequency range: 136~174 MHz, Channel spacing 12.5/25 kHz, 15/30 kHz International: 57 channels; Using CH14 and CH16 at the Port of Dakar/ Antenna/Antenna Cable
8	Microwave Communication Facility	2	Wireless communication via microwave.

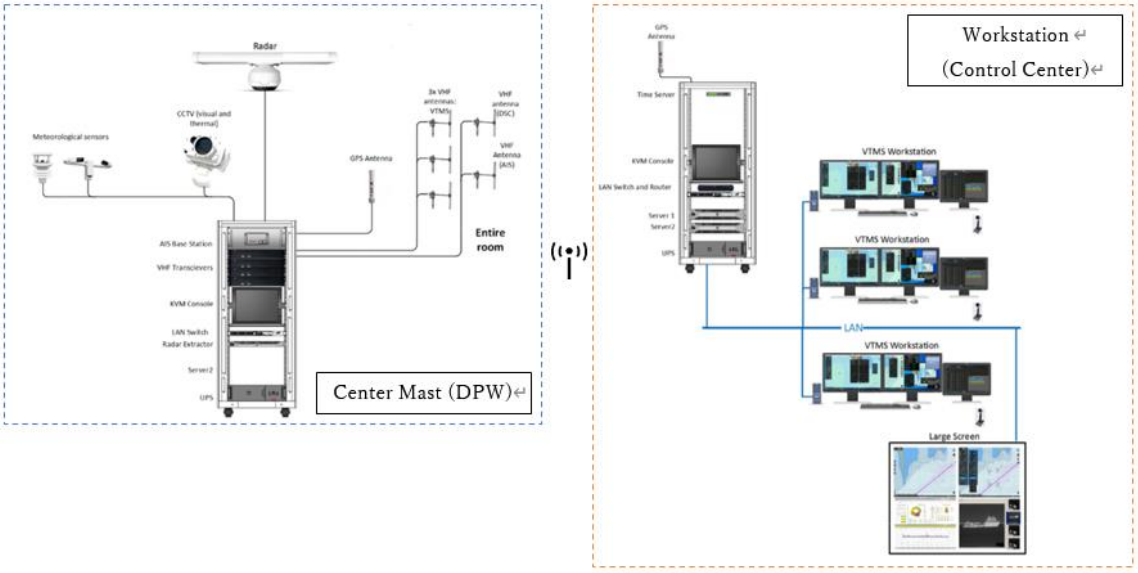
Source: JPT

Based on the assumption that the central mast has a height of 20 me, it is estimated that the radar detection range for target vessels at Ndayane Multifunction Port is 11 nautical miles (NM), as shown in the diagram below. This is deemed sufficient to cover the navigation channel and berth areas of the Ndayane Multifunction Port. Moreover, by complementing Dakar Port's radar, more accurate tracking of vessel positions becomes possible. In the next phase, detailed study including radar installation conditions, marine and weather conditions, and navigating vessels, etc., will be necessary.

Source: Copernicus Sentinel data in Mar 2024 processed by Sentinel Hub, modified by JPT

Figure 3.94 Radar Detection Range

The following Figure illustrates the outline configuration of VTMS at the Ndayane Multifunction Port. Radar, AIS antennas, and cameras are assumed to be wirelessly connected via microwave and connected to workstations via LAN cables through a switching hub.

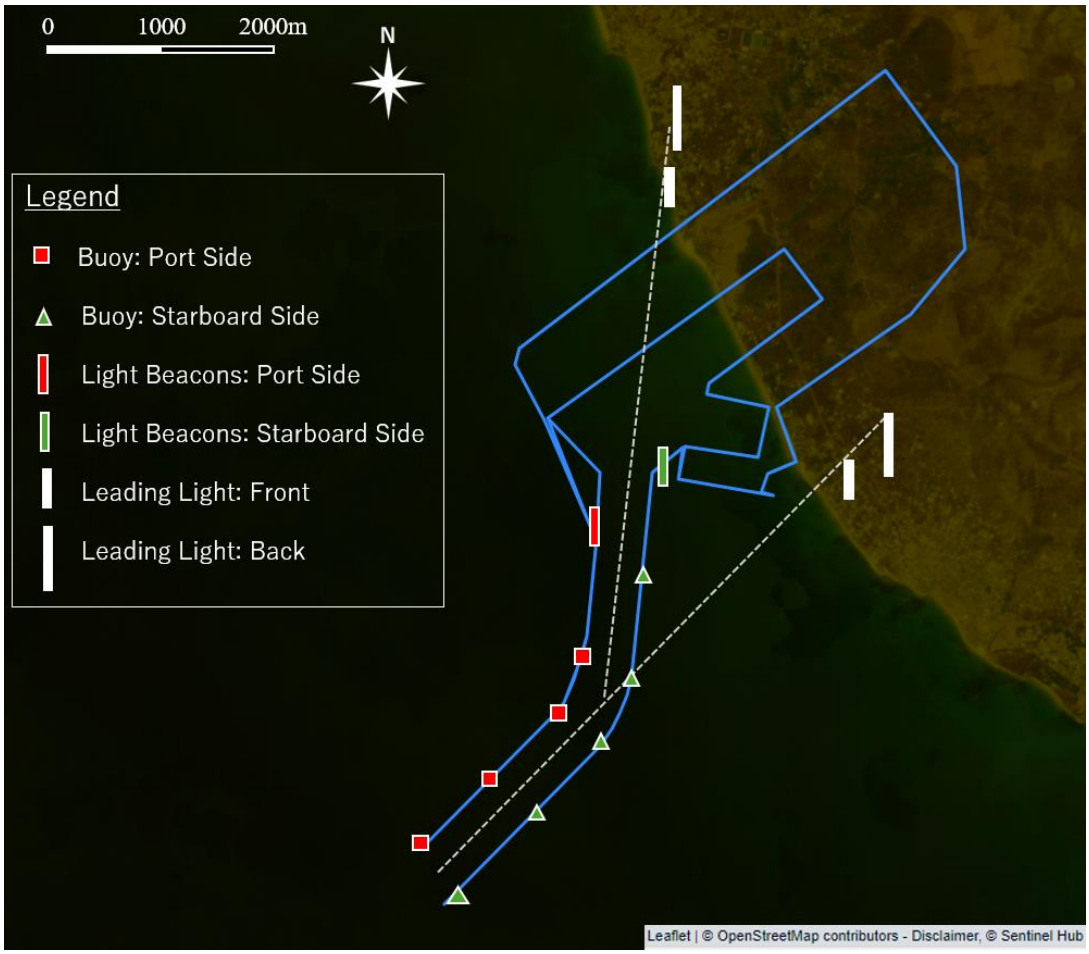


Source: JPT

Figure 3.95 Outline Configuration of VTMS

b) Buoy Lights, Light Beacons, and Navigational Lights

Buoy lights, light beacons, and navigational lights are shared equipment between the Ndayane Multifunction Port and DPW, but it is uncertain which entity will be responsible for maintenance. Therefore, this section will consider buoys, and navigational lights as necessary equipment for the maritime safety of the Ndayane Multifunction Port. Since the area of the Ndayane Multifunction Port lacks significant landmarks or urban structures, the installation of highly visible equipment will be considered for enhanced visibility.



Source: Copernicus Sentinel data in Mar 2024 processed by Sentinel Hub, modified by JPT

Figure 3.96 Configuration of Buoy Lights, Light Beacons, and Navigational Lights

- Light Beacons

To ensure safe navigation, light beacons will be installed at the tips of breakwaters to alert vessels to their presence. Monitoring information such as lantern positions will be broadcast via AIS. To enhance the visibility of the harbour entrance, synchronized flashing with buoy lights will be implemented using a synchronizer. The following table summarizes the outline specifications of the lights on the breakwaters, and a reference photograph is provided in the subsequent diagram.

Table 3.74 Outline Specifications of Light Beacons

	Equipment	Q'ty	Specification
1	Light Beacons		Height: Approximately 12 m / Lamp height: Approximately 11 m (HHWL)
2	Starboard Side	1	LED / Red / Flashing once every 4 seconds / Light reach: 10.0 nautical miles
	Port Side	1	LED / Green / Flashing once every 4 seconds / Light reach: 10.0 nautical miles
3	Solar Power Supply	2	Solar panels / Control unit / Battery
4	Accessories	2	Top mark, radar reflector, AIS, Synchronizer (for synchronized flashing with buoy lights), etc.

Source: JPT

Source: Zeni lite Buoy Co.,LTD.

Figure 3.97 Reference picture of Light Beacons

- Buoy

The approximate specifications of the resilient light beacon such as spar-shaped buoy at the Ndayane Multifunction Port are outlined in the following table. Considering marine conditions and visibility from vessels, the height of the buoy lights above the sea level is approximately 11 m. The light, utilizing LED technology, is expected to have a visible range of 9 nautical miles at the entrance of the navigation channel and 5 nautical miles along the navigation channel. To enhance route visibility, the resilient light beacon will be synchronized for simultaneous flashing using synchronizers. The power source is solar-based, equipped with solar panels, operational devices, and storage batteries. The expected service life of the resilient light beacon is around 10 years.

Table 3.75 Overview Specifications of Resilient Light Beacon

	Equipment	Quantity	Specifications
1	Buoy (Resilient Light Beacon)		Height: Approx. 30 m/ Lamp Height: Approx. 11 m (HHWL) Body (Buoy): Steel/Platform: Aluminum
2	Entrance Buoy	1	LED/ Red/ Fl.R.4s/ Nominal range 9.0 NM
	Entrance Buoy	1	LED/ Green/ Fl.G.4s/ Nominal range 9.0 NM
	Navigation Buoys	3	LED/ Red/ Fl.R.4s/ Nominal range 5.0 NM
	Navigation Buoys	4	LED/ Green/ Fl.G.4s/ Nominal range 5.0 NM
3	Solar Power System	9	Solar Panel/ Control Unit/ Battery

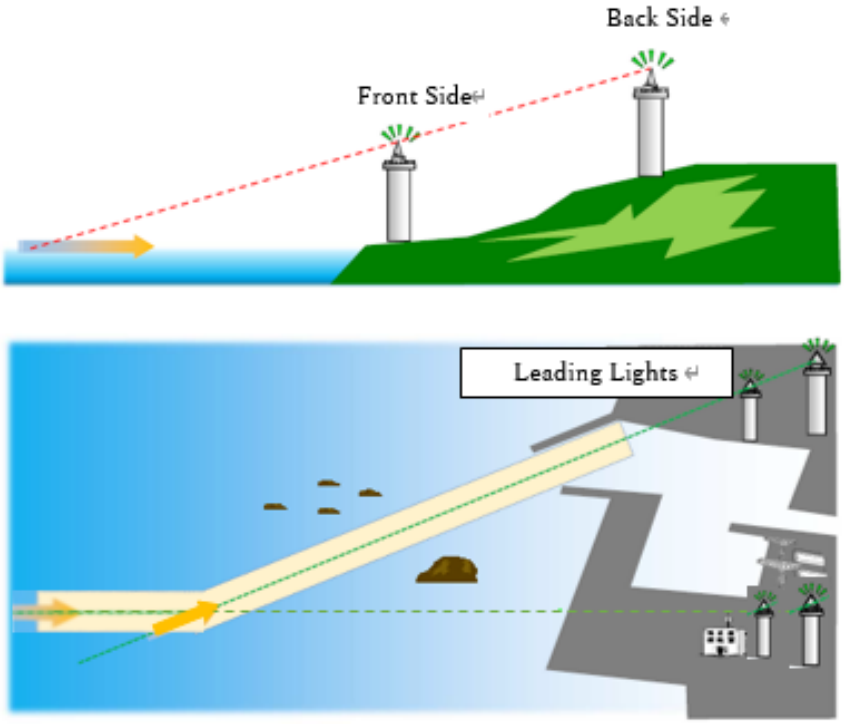
Source: JPT

Source: Zeni lite Buoy Co.,LTD

Figure 3.98 Reference diagram of Resilient Light Beacon

- Leading Lights

Leading lights consist of two lighthouses. When navigating so that the front side and Back side lighthouses are seen in line, the vessel is considered to be navigating the correct course. Due to the changes in the route at the Ndayane Multifunction Port, lead lights are installed in two locations. The concept of leading lights below shows an overview of the lead lights.



Source: Japan Coast Guard, modified by JPT

Figure 3.99 Schematic Diagram of Leading Lights

The following table outlines the specifications of leading lights in the Ndayane Multifunction Port, considering visibility from the navigating vessels. The height of the lighthouses is approximately 22 m for the frontside light and approximately 27 m for the backside light. LED lights are used, with an expected visibility range of over 10 Nautical Miles. The power source is solar-powered, equipped with solar panel, control units, batteries, and AIS.

Table 3.76 Overview Specifications of Leading Lights

	Equipment	Quantity	Specifications
1	Leading Light (Lighthouse)	2 Sets	Front Side Hight: Approx.22 m (GL=5.5 m estimated) Back Side Hight: Approx.27 m (GL=5.5 m estimated) Body: Aluminum
2	Light	4	LED/ White/ Fl (2) W 2s / Nominal range 10.0 NM
3	Solar Power System	4	Solar Panel/ Control Unit/ Battery
4	Accessory	4	AIS

Source: JPT

Source: Zeni lite Buoy Co.,LTD

Figure 3.100 Reference for Leading Lights

3.12.13 Road Planning and Design

a) Roads Inside the Port

- Design standard

In order to confirm the design standards applied to roads inside ports, the interviews were conducted with Directeur des Services Techniques et de l'Aménagement (DSTA; PAD's technical department), and the answers indicated that French standards (AFNOR; Association Française de Normalization) contained in Eurocode were often used, although they differ depending on the project owner. However, since the standard to be applied to Ndayane Port has not been decided, it is necessary to confirm the

final decision at the detailed-design stage, including whether it is necessary to consider compatibility with the roads in the container terminal planned by DPW.

- Width Composition

The width of the port road shall be decided according to the following policy.

Table 3.77 Width Composition of the Road inside the Port

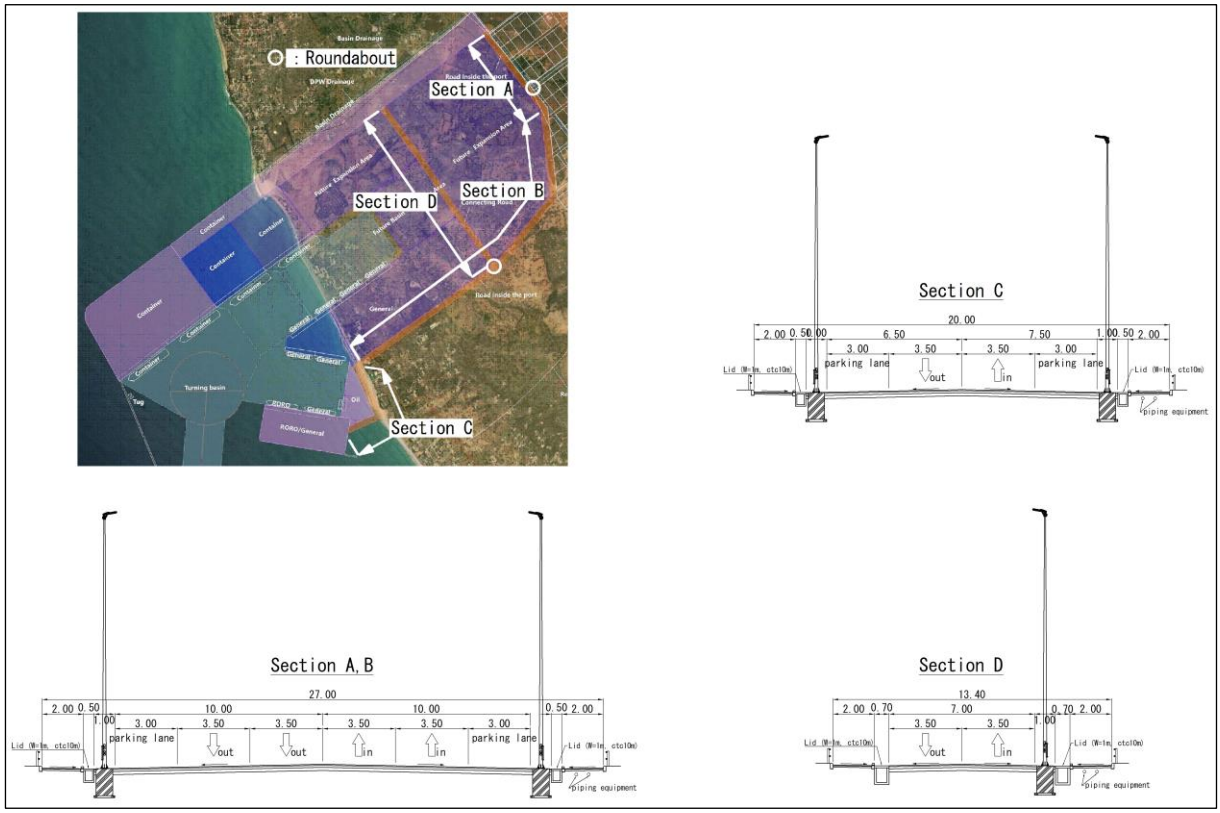
Width Composition		Setting Policy
1.	Number of Lanes	The decision will be made based on a separate study of the number of lanes required for the access road.
2.	Road Width	According to the Japanese port standard, 3.5m is the standard when there is a high traffic volume of large vehicles, and this will also be adopted in this plan.
3.	Median Strip	Not to be installed.
4.	Stopping Lane	To be installed. The width is 2.5 m, which is the vehicle width of a general semitrailer.
5.	Left Shoulder	Although these are often provided for public roads, they will be omitted since this is a road within the port.
6.	Right Shoulder	This will be omitted, as a stopping lane or lighting and drainage gutters will be provided.
7.	Sidewalk	To be installed. The width should be 2.0 m, which is enough for people to pass each other.

Source: JPT

- Width composition for each section

Considering that the roads within the port are divided into sections that connect to each terminal and sections that connect them, the width composition will be determined for each section.

The width composition designed according to the policies in the table above is shown in Figure 3.101.



Source: JPT

Figure 3.101 Width Composition of Roads inside the Port

- Longitudinal and Cross Slope

The longitudinal and cross slope for the roads inside the port shall follow the overall rainwater drainage slope, and a standard mountain shaped slope shall be applied to the straight-line section where the rainwater drainage slope is not restricted. As for the standard mountain shaped slope, it shall be in accordance with the final design criteria similar to the width, but here, it is assumed to be [i = 1.5%].

- Pavement composition

Regarding the pavement composition, asphalt pavement is recommended, which is superior to concrete pavement in terms of initial cost, construction period, and running performance, and is also used for the renovation of 3rd Wharf in Dakar Port. Table 3.78 shows the comparison between asphalt and concrete pavement. At the detailed design stage, concrete pavement may be partially adopted for places where load is likely to be applied to the road surface, such as vehicle turnarounds.

Table 3.78 Comparison between Asphalt Pavement and Concrete Pavement

	Asphalt Pavement		Concrete Pavement	
Initial Cost	Cheap	○	Expensive	—
Service Life	Short (10-20 years)		Long (around 20-30 years)	○
Drainage	Drainable pavement is possible, but it is not suitable for use in Senegal as it will malfunction if sand clogs the voids.	—	It cannot be made into a drainage pavement	—
Construction Length	Short	○	Long	—
Runnability	There are no pavement joints and the runnability is good.	○	Pavement joints will worsen the runnability. Level differences are likely to occur at the joints.	—
Repairability	Repair frequency is high, but the number of days required for repair is short.	—	Repair frequency is low, but the number of days required for repair is long.	—
Evaluation	○		—	

Source: JPT

The pavement composition of asphalt pavement is assumed to be the composition shown in the table below, which is constructable in Senegal. However, the pavement thickness must be calculated after determining the planned pavement traffic volume, design CBR, etc. after determining the width composition and pavement specifications at the Detailed Design stage.

Table 3.79 Proposed Pavement Composition

Pavement composition	
Surface layer and base layer	Dense graded asphalt mixture ・If it is possible to procure it in Senegal, there is a possibility of adopting modified asphalt with increased pavement strength and durability. ・If modified asphalt is difficult to obtain, concrete pavement should also be considered.
Upper subbase	Cement stabilization
Lower subbase	Crusher run

Source: JPT

- Minimum curve radius

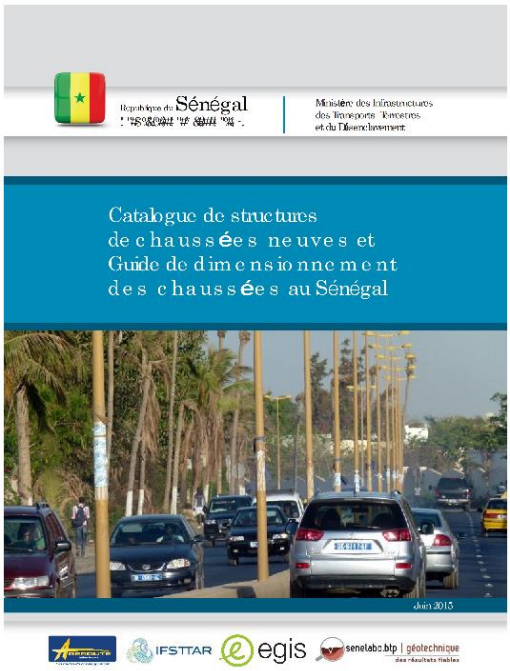
Regarding the minimum curve radius, R=12 m which is defined as the minimum turning radius of a semi-trailer truck, shall be used as the basis, and confirm that the vehicle can be turned according to the vehicle trajectory. If the specifications of the vehicles to be used can be identified, confirm using those specifications.

b) Basic Policy of the Access Road

- Design standard

An interview with AGEROUTE was conducted to confirm the design standard to be applied to access-roads. Senegal has its own road standards based on the French standards (AFNOR), and in some cases

the American standards (ASTM; American Society for Testing and Materials) are also used. As for pavement, Senegal has its own standards, and the standard shown in Figure 3.102 has been provided.



Source: AGEROUTE

Figure 3.102 Senegal Road Standard for Pavement

- Required number of lanes

Regarding the required number of lanes of the access road, it is necessary to confirm the access road plan to be constructed by DPW and the access road plan as a common facility under consideration by PAD. However, such information has not been obtained at the time of writing this report. Therefore, for the examination of the number of required lanes, two scenarios will be considered— one case is where the vehicles of each facility are merged and another case is where it will be individual.

For port facilities, the generated concentrated traffic volume is calculated based on the volume of cargo handled, and for SEZ and PIZ, it is determined based on the average traffic volume for industrial sites. The required number of lanes was calculated based on the calculation results of hourly traffic volume by direction based on the generated concentrated traffic volume.

Case 1: Setting the number of lanes individually at 4 facilities: 10 lanes per direction.

Facility		Concentrated traffic volume generated (vehicles/day)	Required number of lanes (Number of lanes per direction)
A	Container Terminal (DPW)	32,388	4
B	SEZ (DPW)	9,445	1
C	Multifunction Terminals	21,214	3
D	PIZ	12,468	2
Total		75,515	10

Case 2: Setting the number of lanes on the DPW side and the PAD side respectively: 5 lanes per direction/4 lanes per direction

[DPW Side]

Facility		Concentrated traffic volume generated (vehicles/day)	Required number of lanes (Number of lanes per direction)
A	Container Terminal (DPW)	32,388	-
B	SEZ (DPW)	9,445	-
Total		41,834	5

[PAD Side]

Facility		Concentrated traffic volume generated (vehicles/day)	Required number of lanes (Number of lanes per direction)
C	Multifunction Terminals	21,214	-
D	PIZ	12,468	-
Total		33,682	4

Case 3: Setting where vehicles from all 4 facilities are merged: 8 lanes per side

Facility		Concentrated traffic volume generated (vehicles/day)	Required number of lanes (Number of lanes per direction)
A	Container Terminal (DPW)	32,388	-
B	SEZ (DPW)	9,445	-
C	Multifunction Terminals	21,214	-
D	PIZ	12,468	-
Total		75,515	8

Developing individual access roads for each facility is 1) uneconomical, 2) has limited connections to N1, and 3) has no access routes other than N1, so it is preferable to make it a shared road. Therefore, 8 lanes on each direction (Case 3) are planned.

However, since there are only a few examples of roads with eight lanes in each direction, the following points must be considered.

- The number of lanes can be reduced by drawing in railway lines and transferring some cargo to railways.
- Even in the case of 8-lane roads in each direction, it is preferable to construct them in phases depending on the development status of the port facilities and the usage status of access roads.
- It is necessary to improve the intersection and widen the lane of N1 which is connected to the access road, so it is necessary to plan the improvement of N1 according to the phased

development. However, it should be noted that this report does not cover the improvement of intersections and widening of lanes, as they are outside the scope of this project.

- Width composition

The width of the access road is set according to the following policy.

Table 3.80 Width Composition of the Access Road

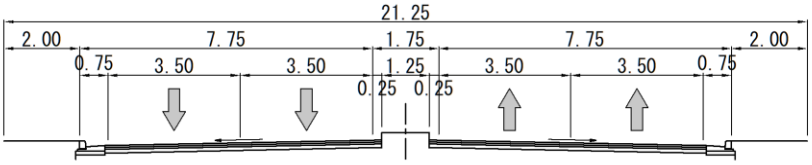
Width Composition		Setting Policy
1.	Number of Lanes	As organized in the previous section, the completed form will have 8 lanes on each direction. However, it will be developed in phases depending on the development status of port facilities and the usage status of access roads.
2.	Road Width	If there is a high traffic volume of large vehicles, it shall be 3.5 m, which is the standard in Japan's port standards. However, if there are separate regulations regarding the width of port roads in Senegal, those regulations shall be applied accordingly.
3.	Median Strip	To be installed for the purpose of preventing accidents caused by passing vehicles.
4.	Stopping Lane	To be installed as a waiting lane that also serves as an emergency parking zone.
5. .	Left Shoulder	To be omitted, as median strip will be installed.
6.	Right Shoulder	The shoulder width shall be 0.75 m, and drainage facilities shall be installed within the shoulder.
7.	Sidewalk	To be installed. The width should be 2.0 m, which is enough for people to pass each other.

Source: JPT

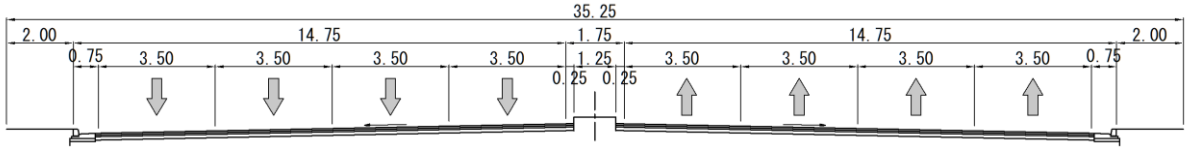
The following figure shows the width configuration diagram set according to the policy in the table above. However, it is just an example as the phased development depends on the development status of port facilities and the usage status of access roads.

The total width of the access road will be described separately, as it is necessary to take into account factors such as the 'basin drainage channel and emergency parking zone and waiting lane.

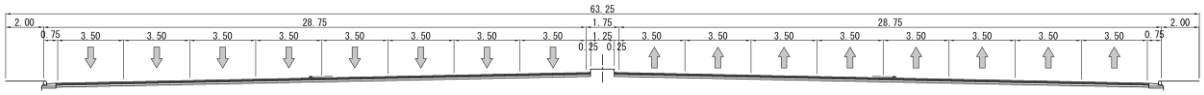
Stage 1: 2 Lanes in Each Direction



Stage 2: 4 Lanes in Each Direction



Stage 3: 8 Lanes in Each Direction



Source: JPT

Figure 3.103 Width Composition of Access Road

- Pavement composition

Asphalt pavement is assumed for this plan. However, the pavement thickness must be calculated after the width composition and pavement specifications are determined in the detailed design stage, and the planned pavement traffic volume and design CBR, etc. are set.

Table 3.81 Pavement Composition Plan

Pavement Composition	
Surface layer/base layer	Dense-graded asphalt mixture • If available in Senegal, modified asphalt with improved pavement strength and durability may also be used • If modified asphalt is difficult to obtain, concrete pavement should also be considered
Upper roadbed	Cement stabilization
Lower roadbed	Crusher run

Source: JPT

- Geometric structure

Regarding geometric structural conditions such as road alignment and cross slope, it is necessary to check Senegal's road standards at the detailed design stage, but it will be determined according to the Japanese standard, as it is considered that there will be no major problems at the M/P stage.

- Route

Organization of the situation regarding route examination

As for the access road, it is necessary to select one of the following two basic policies: 1) Plan as an entire Ndayane Multifunction Port, or 2) plan DPW side and PAD side individually. Considering the land acquisition and connection to N1, the policy 1) is reasonable, but on the other hand, considering

the property ownership and management responsibility of the access road, it is also conceivable to choose the policy to plan individually. In order to determine this basic policy, it is necessary to confirm the details of DPW's plans, but the information obtained is fragmentary and detailed information cannot be available. Therefore, this section summarizes the status of access road route examination, including the information obtained at the time this report was prepared.

Initial examination stage (examination based on the site survey in November 2022)

Based on the information obtained during the site survey in November 2022, the following examinations were carried out. At this point, JPT recommended Plan A-2. Plan A-2 is a proposal to merge the access road for the Multifunction Terminal to the latest access road route planned by DPW for the container terminal.

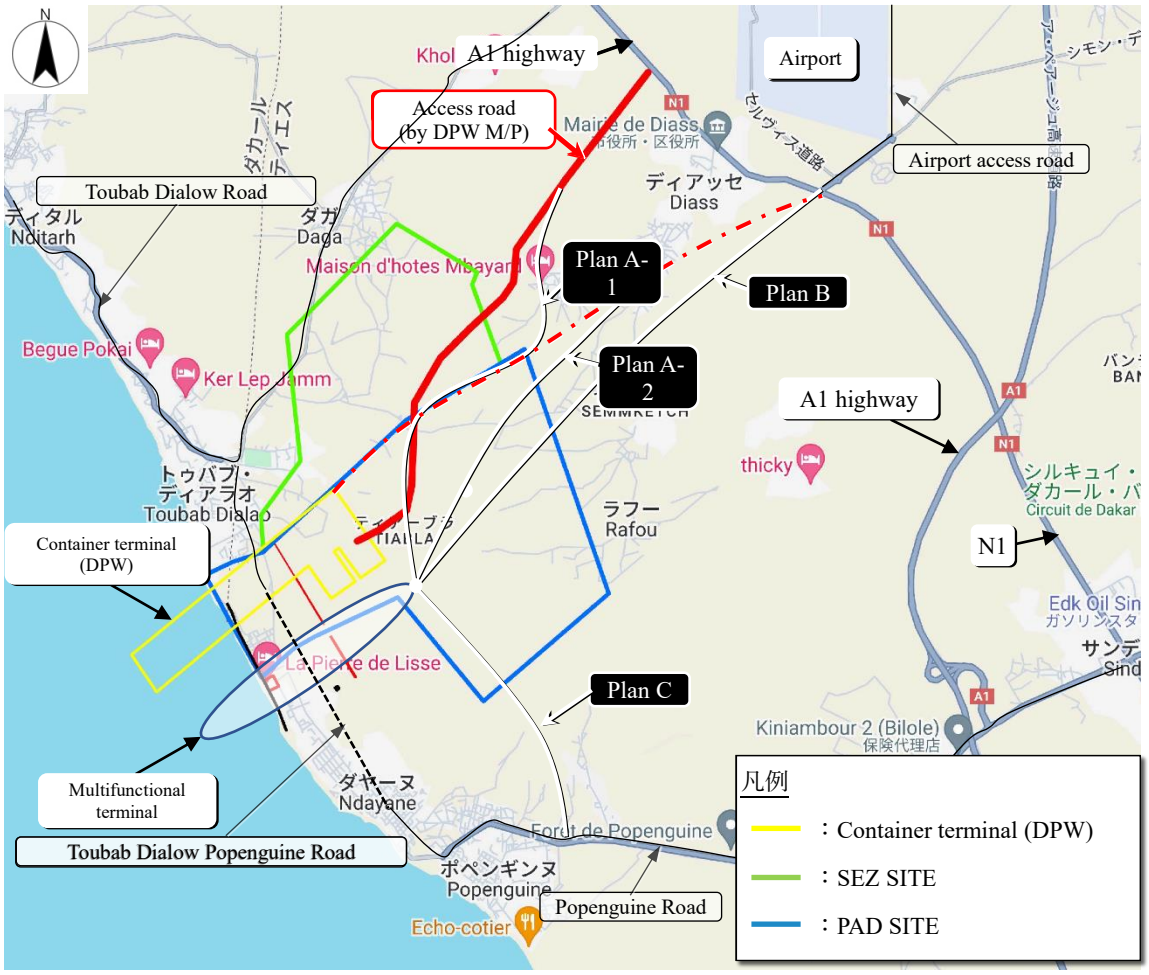
[Content of examination]

The route of the access road from Ndayane Port to N1 is proposed in DPW M/P (2021), but this access road only considers access from the northern container terminal, and access from the multifunction terminal located on the south side is not considered. For this reason, route proposal considering access to N1 from the multifunction terminal is summarized in Table 3.82 and Figure 3.104.

Table 3.82 Proposed Route for Access Road

Merging Plan		Single Plan	
Plan A-1	**Plan A-2**	**Plan B**	**Plan C**
A plan to merge the access road from the general cargo terminal to the route planned in DPW M/P (2021)	A plan to change the connecting point with N1 to the intersection with airport access road	A plan to secure access roads to N1 at the container terminal and general cargo terminal respectively	A plan to access the arterial road without passing through the northern container terminal and DPW land, if other plans cannot be realized.
• Access road can be secured at the lowest cost for the entire Ndayane Port, and land acquisition can also be minimized. • There is only one connection point to N1, so the impact on N1 traffic is less than the "single plan", and the intersection improvement cost can also be reduced.	• Better access to A1 Highway will be achieved by connecting with N1 at the intersection with airport access road. • There is also information that the N1 connection point has been changed to red dashed route in the latest access road plan of DPW.	• It is necessary to construct two access roads, the cost is high compared with the merging plan, and the land acquisition range also increases. • There will be two connections to N1, which will have a greater impact on N1 traffic than the merging plan, and will increase intersection improvement costs.	• Connect to Popenguine Road located on the south side of the Port of Ndayane, if other plans cannot be realized. • Popenguine Road is paved but it is a local street with one lane on each side, so it is necessary to increase the number of lanes and improve the pavement to withstand freight traffic.
○	◎		Popenguine Road is a local road and is not suitable for inflow of large vehicles carrying port cargo.

Source: JPT



Source: Edited by JPT based on DPW M/P (2021)

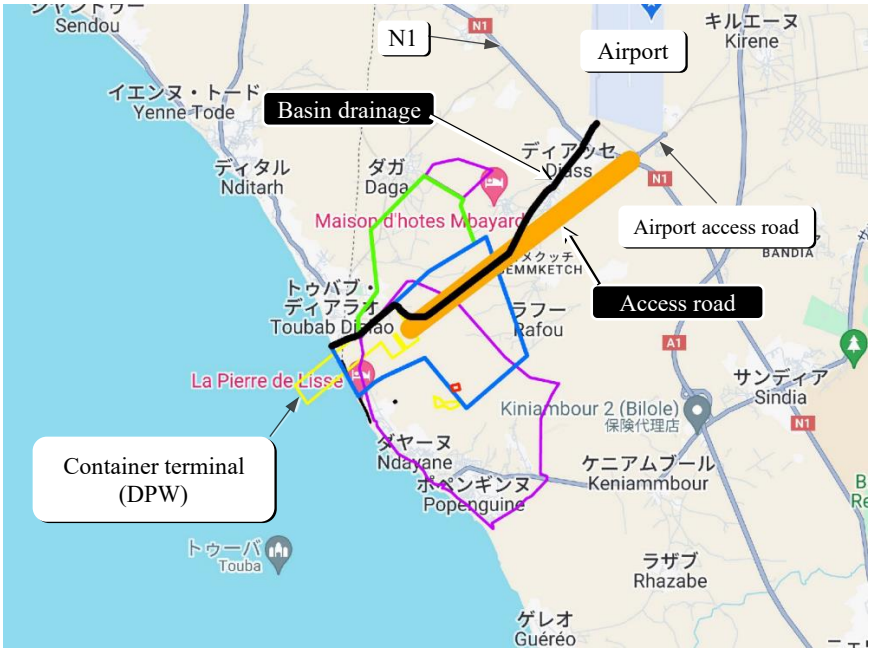
Figure 3.104 Proposed Route for Access Road

Phase 2 (Examination based on the site survey in March 2023)

Key information about the access roads obtained during the March 2023 travel site survey is as follows.

- PAD has a plan to construct an access road as a shared facility for the entire Ndayane Multifunction Port, which will be examined separately.
- The basic route is assumed to be a straight route connecting the "container terminal" and the "intersection of the N1 and the airport access road".
- It is assumed that a road width of 100m will be secured in preparation for future lane widening.

Figure 3.105 shows an image of the access road assumed by PAD. However, in this figure, considering that the road width is 100m, it is planned to merge the route of the basin drainage channel, which is planned separately.



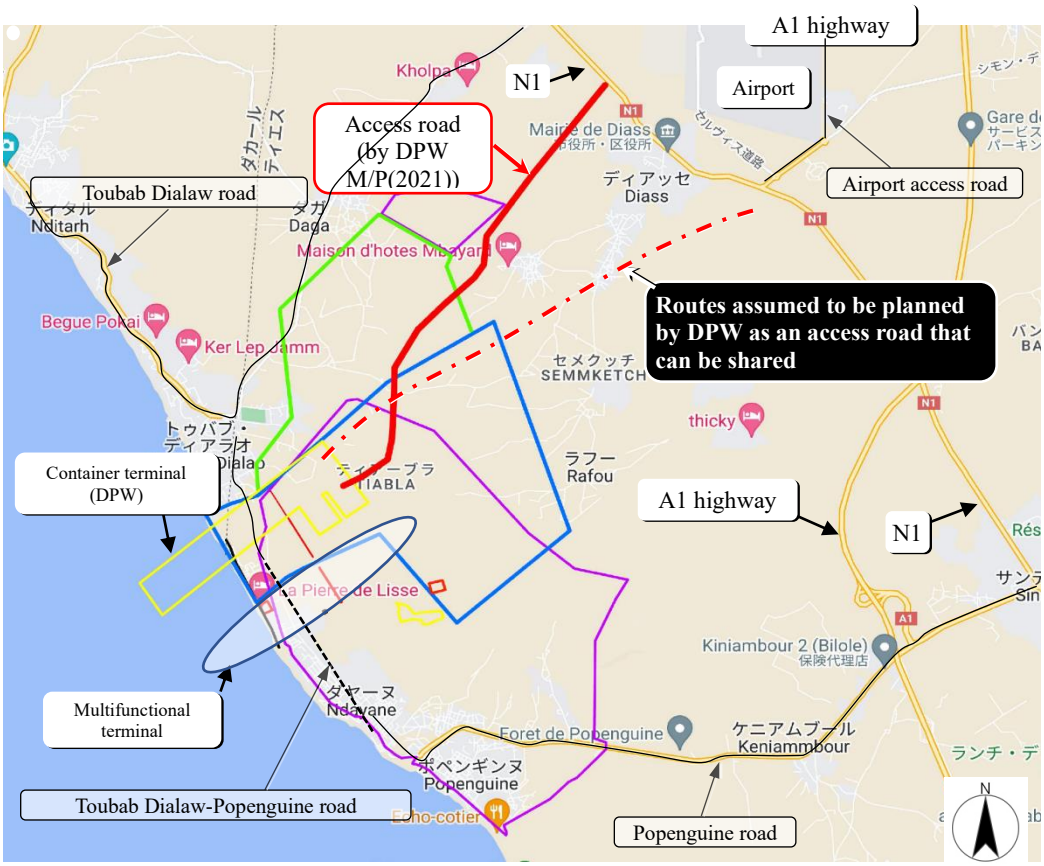
Source: Edited by JPT based on Google Map

Figure 3.105 Image of Access Road Envisioned by PAD

Phase 3 (Information obtained in May 2023)

JPT received information that DPW is planning an access road that will accept vehicles using facilities other than the container terminal that DPW will construct and SEZ. As described in the examination of the number of required lanes, the number of lanes required for the passage of vehicles using the four facilities including Multifunction Terminal and PIZ from the PAD side, will be eight lanes in each direction. However, specific information such as the route, number of lanes and width configuration of the access road planned by DPW has not been obtained. Therefore, arrangement of 1) if the required number of lanes secured, 2) how the access from the PAD side facilities be achieved, and 3) how the N1 intersection be renovated is necessary.

As for the route, if there is no change from the information obtained at the initial study stage, it is assumed that the route shown in Figure 3.106 is being planned as a shared access road.



Source: Edited by JPT based on Google Map

Figure 3.106 Access Road Planned by DPW (Assumed)

c) Access Road Plan

Positioning of access road

The Ndayane Multifunction Port is roughly divided into a container terminal and SEZ managed by DPW, a Multifunction Terminal and PIZ managed PAD, so in planning the access road, it was difficult to unify the policy as described above.

However, constructing access roads with multiple routes for each administrative division is not a rational choice considering the following factors.

- Building multiple routes requires more land acquisition and increases construction costs.
- The intersection of the airport access road is preferable as the connecting point to N1, and it is difficult to handle multiple routes at one intersection.
- If the route will be divided between the DPW side and the PAD side, Plan C in Table 3.82 can be considered. However, the Popenguine Road which this route connects to, is a local road (community road) and is not suitable as a road for large vehicles carrying port cargo. In addition, even if large vehicles are allowed to flow in, large-scale repairs to the Popenguine Road will be required, and towards Dakar, a large detour will be necessary.

Therefore, an access road shared by both the DPW side and the PAD side is planned.

Access road route, number of lanes, etc.

Based on the positioning of the access road organized in the previous section, the following policies are planned. The plan and width configuration of the planned access road are shown in Figure 3.107 and Figure 3.109.

In addition, the width configuration diagram in Figure 3.109 is created for the case of 4 lanes on each direction, which is the intermediate stage of the phased development.

i. Route

- A straight route connecting “PIZ” and “intersection of N1 and airport access road”. (Same route as the shared access road envisioned by PAD)
- Access to the Multifunction terminal within PIZ will need to be adjusted separately once the layout of the PIZ is finalized.
- The houses along the alignment of the access road have been confirmed separately in the environmental and social considerations as follows:

  - There are no houses within PIZ, from what can be seen in the aerial photographs.

  - From what can be seen in the aerial photographs, 10 houses can be seen in the section from PIZ to N1. However, there are no settlements.
- It is possible to avoid interfering with the houses by adjusting the alignment, but this adjustment will not be made at the M/P stage.

ii. Number of lanes

- The road will be shared by the four facilities: "Container Terminal", "SEZ", "Multifunction Terminal" and "PIZ", and will have eight lanes on each direction.
- However, it will be developed in phases according to the development status of port facilities and the usage status of access roads.

iii. Median strip

- Based on PAD's wishes, the access road will be a 100m road with a plaza space in the median strip.
- In some sections of the access road, the drainage channel described below is planned to be placed in the median strip, so the width necessary for this placement shall be secured.
- Since plants will be placed in the median strip, the width necessary for this arrangement shall also be secured.
- Wide median strips are often used as parks, but they could also be used to set up sports facilities such as mini tennis courts, or rented out to the private sector for commercial facilities. However, since these are roads exclusively for port facility users, whether or not to

open the median strip to the public depends on the views of the property owner and maintenance agency of the access road.

iv. Basin drainage

- The basin drainage will be located between the upper and lower lines of the access road, taking into account the following items.

✓ Additional land will be required if the basin drainage is planned outside the road site.

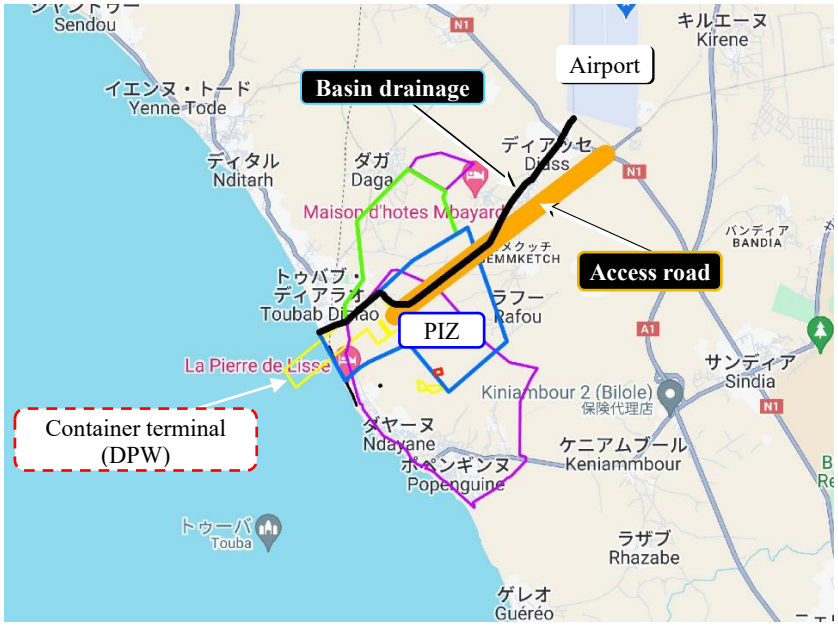
✓ If the basin drainage is planned at the edge of the road site (along the road site on the north side), it may hinder future lane widening.

v. Emergency parking zone and waiting lane

- An emergency parking zone will be established outside the driving lane to serve as an evacuation area in case of an emergency, and will normally be used as a waiting lane for vehicles handling cargo.

Access Road Route Map/Width Composition Diagram

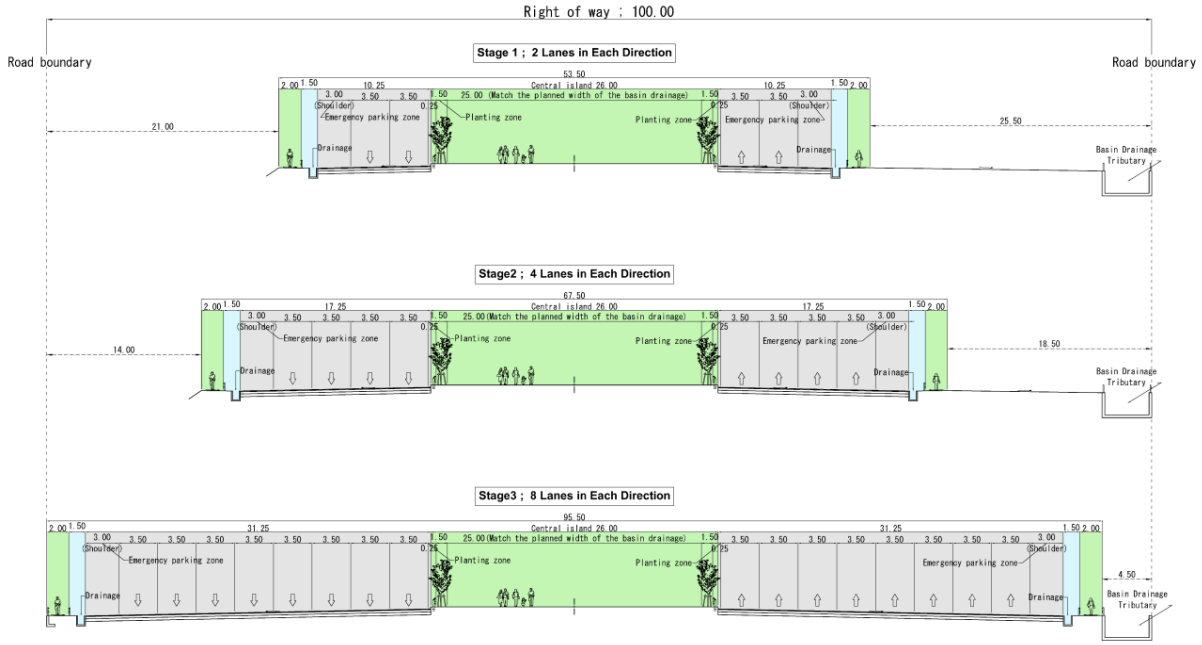
Access Road Route



Source: Edited by JPT based on Google Map

Figure 3.107 Access Road Route

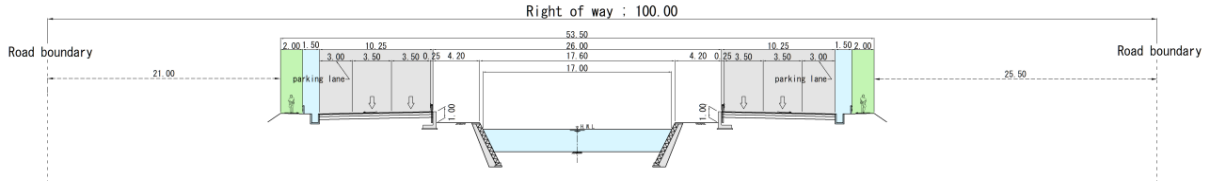
Width Composition of the Standard Section (Staged Construction)



Source: JPT

Figure 3.108 Width Diagram of the Access Road (1)

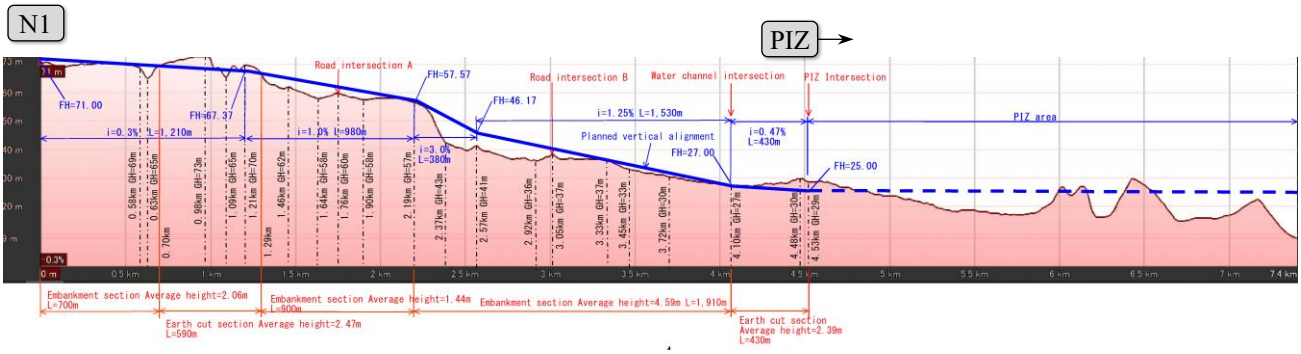
Width Composition of the Basin Drainage Confluence (Second Stage: 4 Lanes on Each Side)



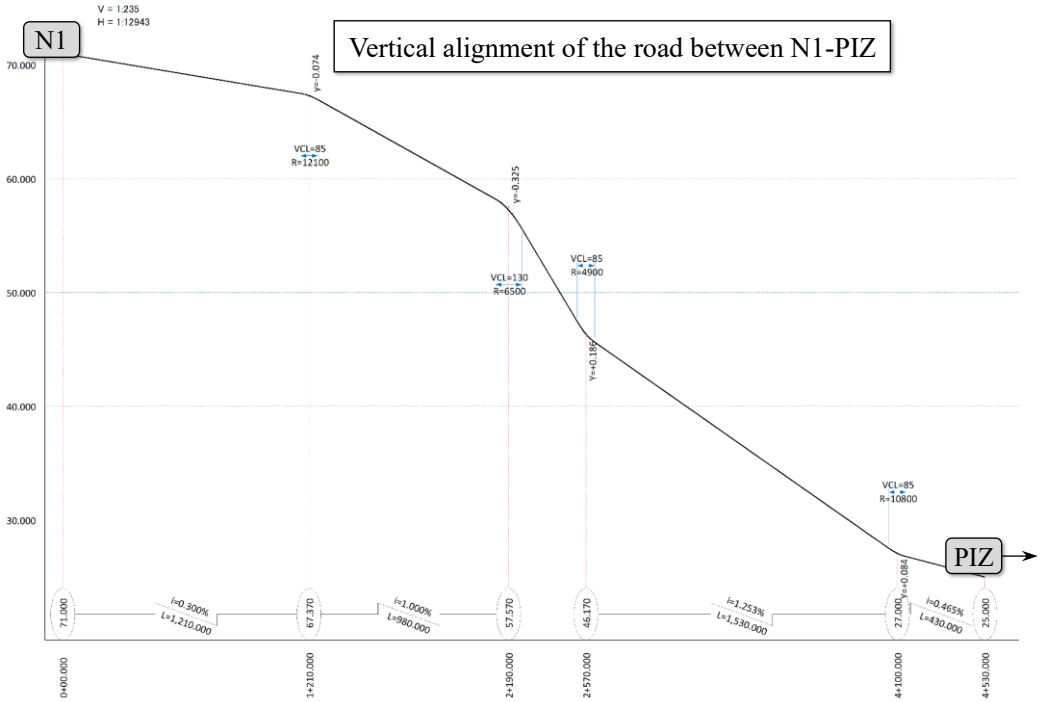
Source: JPT

Figure 3.109 Width Diagram of the Access Road (2)

Vertical Alignment of the Access Road



Source: Edited by JPT based on Google Earth altitude profile information



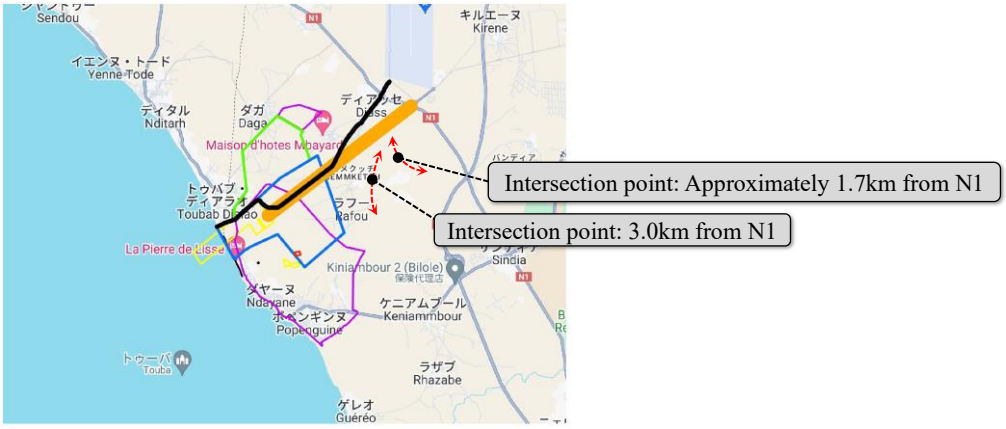
Source: JPT

Figure 3.110 Vertical Alignment of the Access Road

d) Small-scale Community Roads as Reference

There are two small community roads along the route of the access road described in the previous section, which will be separated by the access road. For this reason, the routes will be secured for these small-scale community roads to cross the access roads not to cut off communication between regions.

Note that securing routes for small-scale community roads, which are public roads, will not be included in the port development master plan for Ndayane Port proposed in this report.

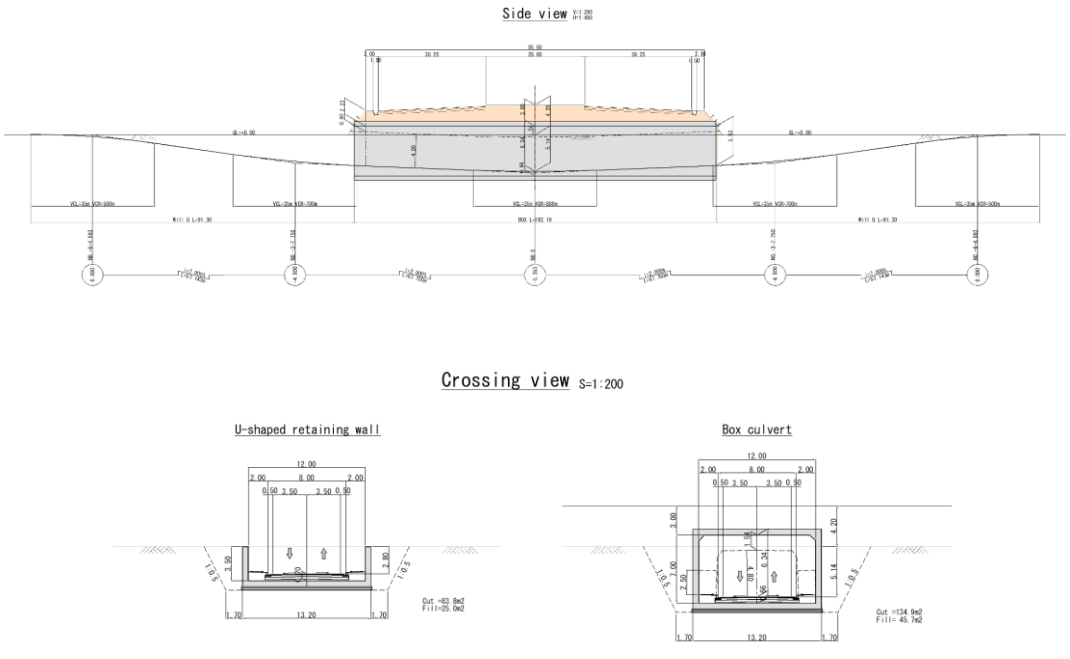


Source: Edited by JPT based on Google Map

Figure 3.111 Location Map of the Small-scale Community Road

Possible crossing methods include grade crossing, overpass, and underpass. Among these, grade crossings will be excluded as they will obstruct access road traffic, and will be replaced by underpasses, which are considered advantageous in terms of cost. An image of the underpass is attached below.

Regarding the width, since the existing road is unpaved and the width is unclear, the total width is assumed to be 12.0 m, including one lane on each side (3.5 m), sidewalks on both sides (2.0 m*2), and a shoulder (0.5 m).



Source: JPT

Figure 3.112 Image Diagram of the Underpass Part

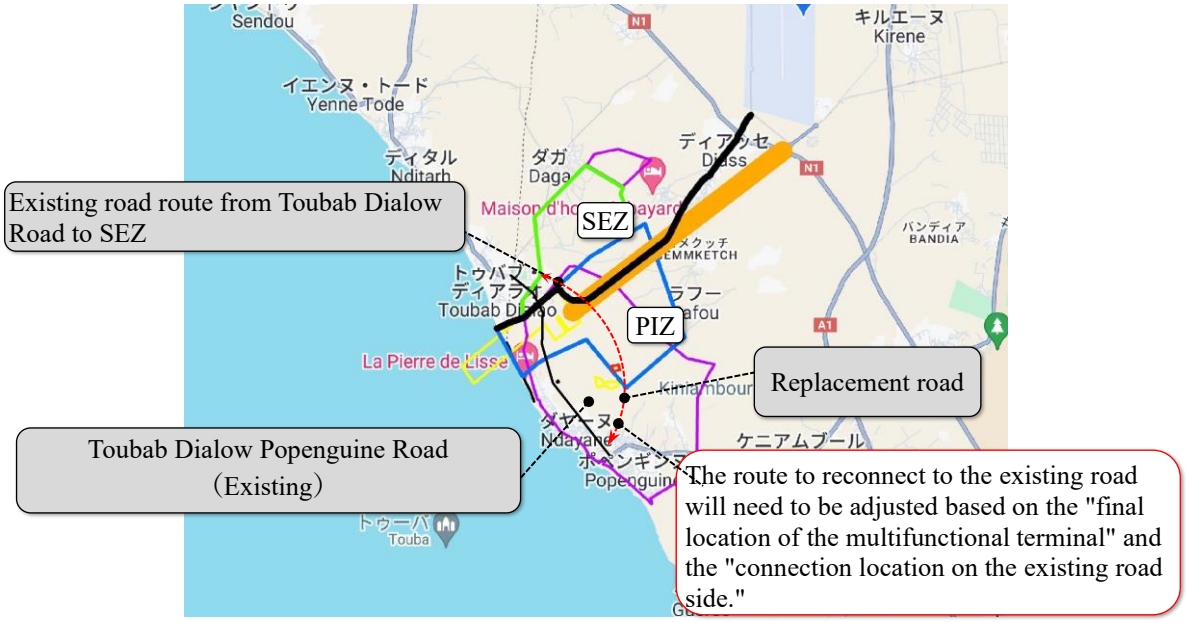
e) Replacement of the Existing Road as Reference

The current " Toubab Dialow Popenguine Road", which crosses the Ndayane Multifunctional Port site in the north-south direction, is a local road that connects the Toubab-Dialow district with the Ndayane and Popenguine districts. Since this road is an essential arterial road for these regions, plans will be made to replace the road in order to maintain its function as a regional arterial road even after the construction of Ndayane Multifunctional Port.

Note that the replacement of the existing public road will not be included in the port development master plan for Ndayane Port proposed in this report.

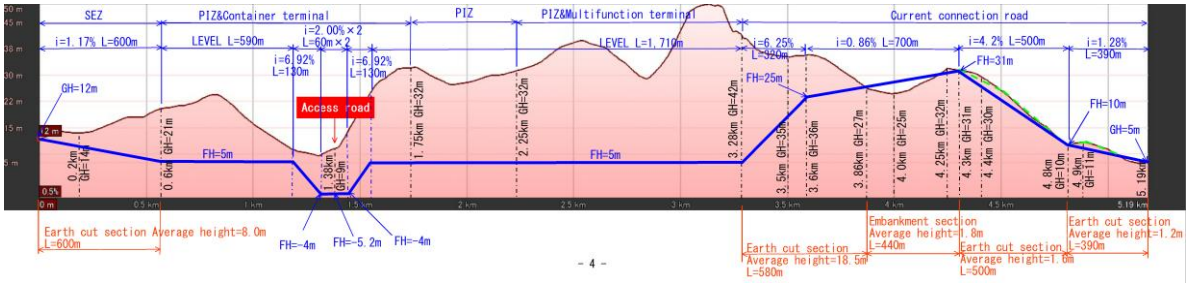
The plan for the replacement road will be based on the following policy.

- The replacement road, which will become a public road, will be separated from the internal port road, which will be used exclusively for vehicles accessing port facilities. (Future increase in traffic on the Toubab Dialow Popenguine Road also needs to be taken into consideration)
- Existing roads should be used as much as possible.
- Passing through the terminal should be avoided and the shortest route should be used.
- The terminal site will not be used, but the SEZ and PIZ sites will be used.
- At intersections with access roads, cross underpasses should be used not to obstruct access road traffic.
- The width of the replacement road will be 12.0 m in total, including one lane on each side (3.5 m), sidewalks on both sides (2.0 m*2), and shoulders (0.5 m).



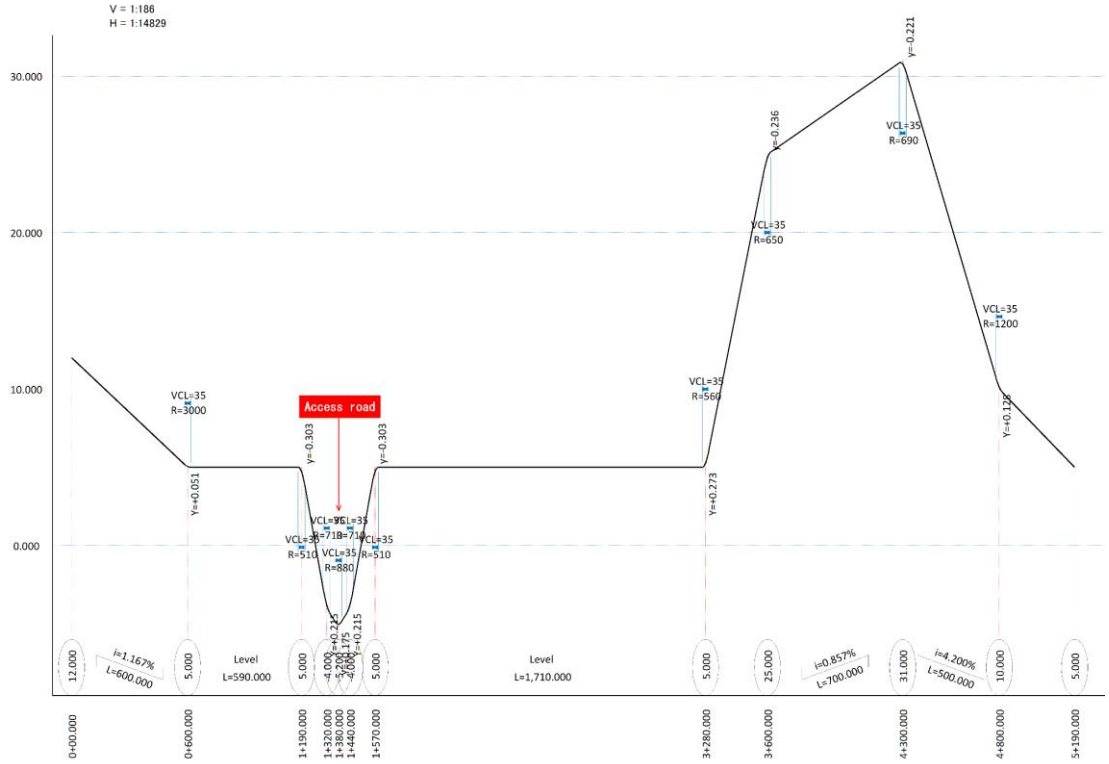
Source: Edited by JPT based on Google map

Figure 3.113 Route Map of the Replacement Road



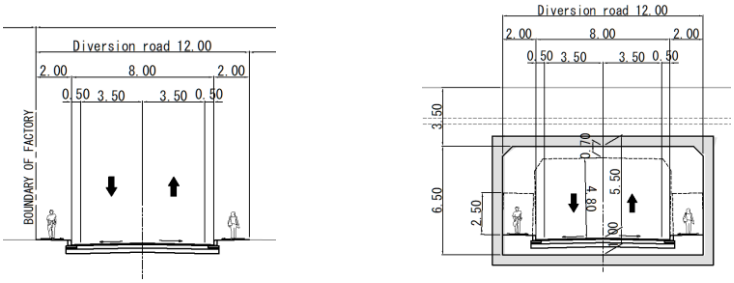
Source: Edited by JPT based on Google Earth altitude profile information

Figure 3.114 Vertical Alignment of the Replacement Road



Source: JPT

Figure 3.115 Vertical Alignment of the Replacement Road



（General part） （Underpass part）

Source: JPT

Figure 3.116 Width Composition of the Replacement

f) Cost Burden/Management Classification

The various roads that will be constructed in conjunction with the development of the Ndayane Multifunctional Port will have different positions and construction purposes, so it is necessary to determine the cost burden and management classification.

Table 3.83 Positioning/Construction Purpose

Name of Road		Positioning	Construction Purpose
Access road	Between N1 and PIZ (Outside port site)	Port dedicated road	Connection between port facilities and public roads
	Inside PIZ (within port site)		
Port road	Port road	Same as above	Part of the port facilities
	Pier-to-pier connecting road	Same as above	Same as above
Small-scale community road			Maintaining the functionality of the existing road that will be divided by the access road
Replacement of the existing road			Maintaining the functionality of the existing road that will be divided due to the terminal construction

Source: JPT

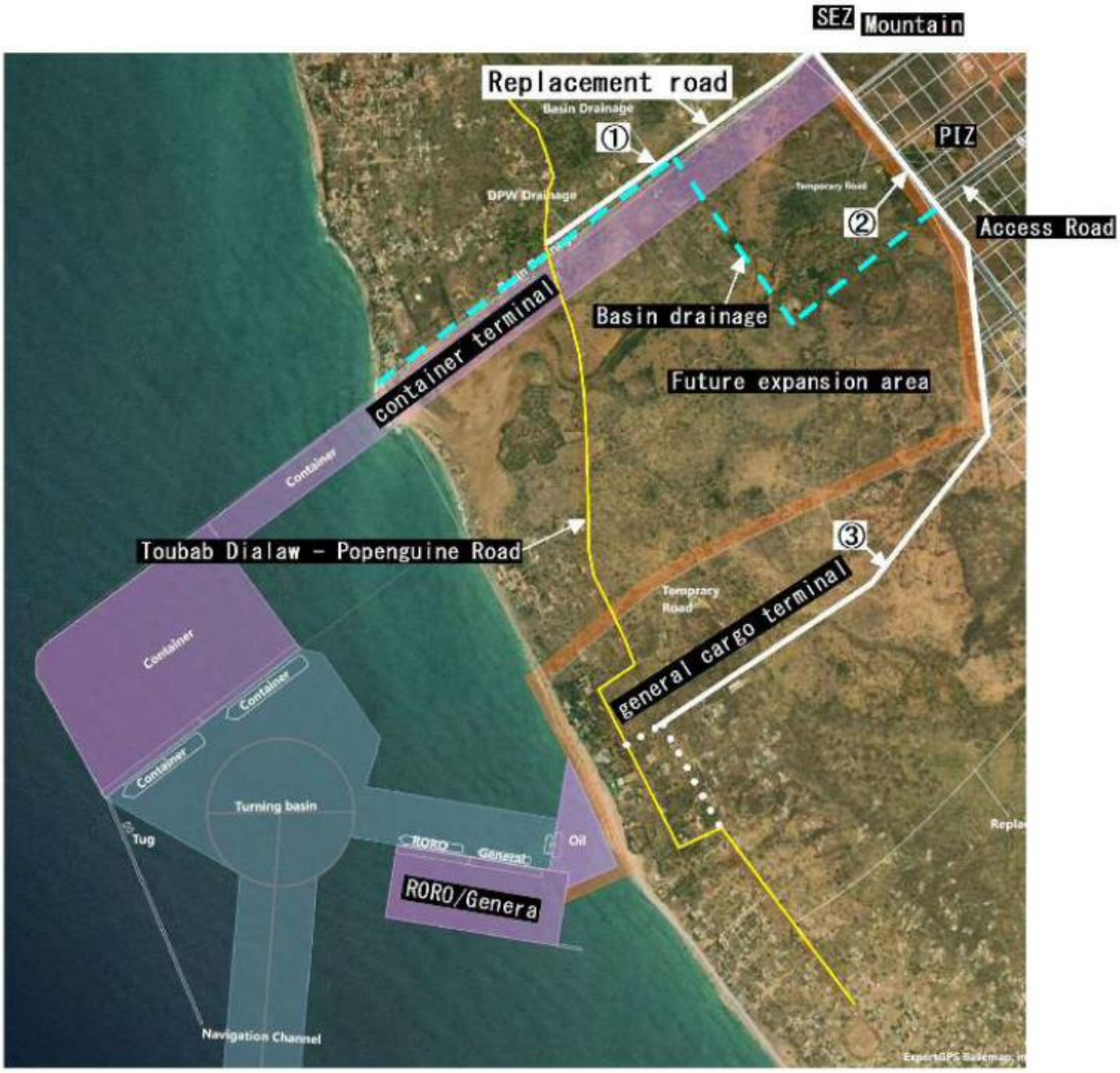
Table 3.84 Cost Burden/Management Classification (Reference)

Name of Road		Cost Burden		Management Classification
		Initial construction cost	Maintenance and management costs	
Access road	Between N1 and PIZ (Outside port site)	PAD	PAD or Ageroute	PAD or Ageroute
	Inside PIZ (within port site)	PAD	PAD	PAD
Port road	Port road	PAD	PAD	PAD
	Pier-to-pier connecting road	PAD	PAD	PAD
Small-scale community road		PAD	PAD or Ageroute	Ageroute
Replacement of the existing road		PAD	PAD or Ageroute	Ageroute

Source: JPT

g) Organization of issues to be confirmed and adjusted

The issues related to the replacement road that need to be confirmed and adjusted in the future, including the contents described in the previous paragraphs, are summarized in Figure 3.117 and Table 3.85 Issues Regarding the Replacement Road. The replacement road route in Figure 3.117 is the route currently envisioned by PAD.



Source: JPT

Figure 3.117 Issue Number Diagram for the Replacement Road

Table 3.85 Issues Regarding the Replacement Road

No.	Target Area	Contents of the Issues
-	Overall	• Cost burden and management classification need to be clarified. • DPW has stated that they will maintain the road in its current state until 2028, but plans beyond that have not been decided.
①	Section running parallel to the container terminal	• Land acquisition is required. ✓ The road will have sharp corners, so when acquiring land, it is necessary to take into account widening to allow vehicles to turn. • The road will run parallel to a river basin drainage channel being constructed by DPW, so plans must be coordinated. ✓ DPW's plans for a container terminal have not been confirmed on the landward side of the existing road. ✓ The alignment of the replacement road will affect the current foot of the mountain, so the development plan for the container terminal and SEZ will be important.
②	Section running parallel to PIZ	• It needs to be aligned with the PIZ plans being made by DPW. ✓ Currently there is a large difference in elevation, so it will be necessary to coordinate the timing of when this difference in elevation will be eliminated through construction of the PIZ and future expansion areas. • It is expected that the replacement road will have an underpass at the intersection with the access road, but if the access road is constructed first, construction of the underpass will be difficult.
③	Section running parallel to general cargo terminal	• Land acquisition is required. • It needs to be aligned with the final plans for the future expansion area and the general cargo terminal. • There are multiple possible routes for connecting with the existing road, so it will be necessary to consider the route while taking into account land acquisition and coordination with local residents.

Source: JPT

3.12.14 Rainwater Drainage Planning and Design

The river from the airport flows through the port area, in addition to facilities to drain rainwater from within the port area. Therefore, a watershed drainage channel will be planned to safely drain rainwater from upstream, after the port is developed.

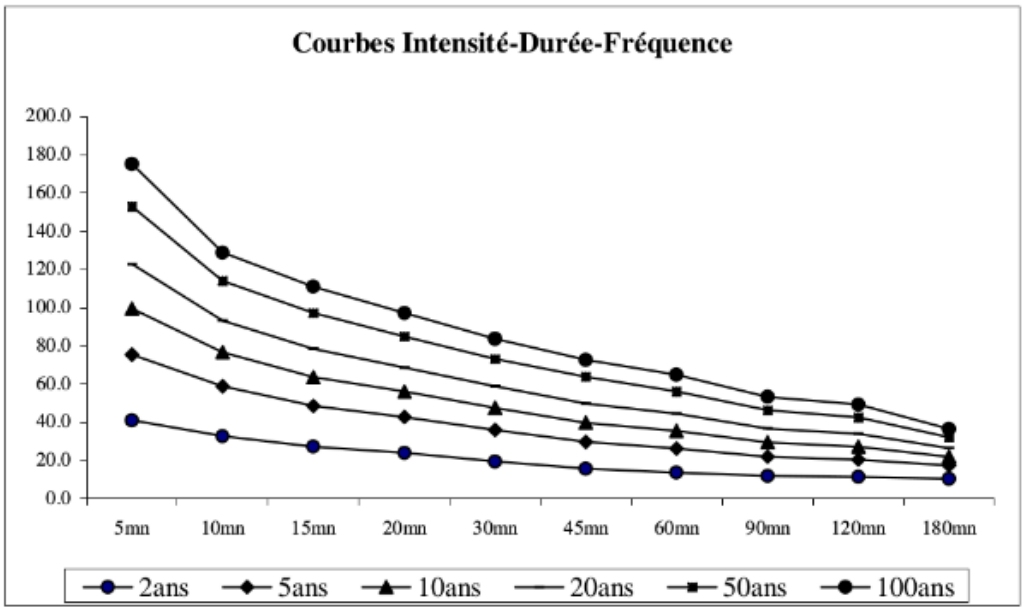
a) Rainfall Intensity

Rainfall stations near the proposed project site are Yoff, Thies, and Mbour rain station, of which rainfall intensity curves at Yoff and Thies have been compiled by the National Agency of Civil Aviation and Meteorology of Senegal (ANACIM). In this project, the design rainfall intensity is determined based on the rainfall intensity curve of the Thies rain station, which is the closest station in terms of location. The probable rainfall intensity at Thies rain station is shown in Table 3.86 and Figure 3.118. This rainfall intensity curve was created based on rainfall data from 1957 to 1999, and it is hoped that the rainfall intensity curve will be updated by adding recent data when carrying out detailed designs in the future.

Table 3.86 Estimated Rainfall Intensity at Thies Rain Station

Fréquence	0.5	0.8	0.9	0.95	0.98	0.99
Récurrence	2ans	5ans	10ans	20ans	50ans	100ans
Intensités en 5 mn	41	75.2	99.3	122.7	152.8	**175.2**
Intensités en 10 mn	32.6	58.8	76.5	93.1	113.8	**128.8**
Intensités en 15 mn	27.1	48.5	63.6	78.2	97	**111**
Intensités en 20 mn	23.8	42.7	55.9	68.6	84.9	**97.1**
Intensités en 30 mn	19.3	35.9	47.5	58.7	73	**83.5**
Intensités en 45 mn	15.6	29.7	39.6	49.8	63.7	**72.5**
Intensités en 60 mn	13.7	26.2	35.3	44.3	56	**64.8**
Intensités en 90 mn	11.7	21.9	29.3	36.7	46.2	**53.3**
Intensités en 120 mn	11.3	20.3	27.1	33.8	42.5	**49.1**
Intensités en 180 mn	**10.2**	**17.2**	**21.8**	**26.3**	**32**	**36.3**

Source: ANACIM



Source: ANACIM

Figure 3.118 Estimated Rainfall Intensity Curve for Thies Rain Station (Right)

b) Watershed Drainage Plan

Runoff Calculation Method

The purpose is to calculate the peak flow, there are no flood control facilities such as dams upstream, and the river has a relatively small catchment area of less than 50 km^2. Therefore, the widely adopted Rational Method shall be used to perform runoff analysis.

$$Q_p = \frac{1}{3.6} f \cdot R_t \cdot A$$

Where, Qp : peak flow (m^3/s)

f : runoff coefficient (see Table 3.89 for details)

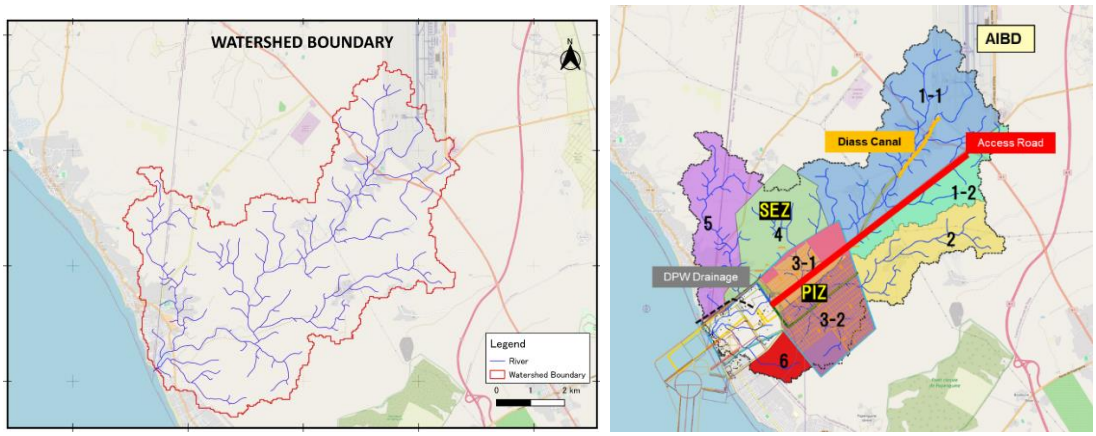
R_t : averaged rainfall intensity within T (mm/hr)

A : catchment area (km^2)

Division of the Watershed

A watershed boundary map of the river flowing into the lagoon was created, based on HydroSHEDS (surface water flow direction data) published by USGS (U.S. Geological Survey) (see Figure 3.119). According to the data, the airport is included in the watershed. In addition, the main waterway overlaps with the route of the rainwater drainage channel being developed by the airport, which will be described later. Since the topography of the catchment area changes due to port development, the watershed boundary of the drainage canal was set as a watershed area of 47.48 km^2, taking port development into consideration. The future divided watershed map is shown on the right side of Figure 3.119.

Area 1-1 includes the airport site. Nevertheless, no response was received from AIDB, the airport management company, regarding the inquiry about the catchment area within the airport. Therefore, the catchment area is based on the topography before the airport was built. In the future, when making detailed designs, it is desirable to check and update the water catchment areas within the airport. Area 1-2 has been split since it is an area divided by an access road and requires a separate collection waterway. Area 2 is a tributary watershed of the current river. Areas 3-1 and 3-2 are PIZ areas. The area within the PIZ is divided into two areas: Area 3-1 is the area that flows into the main river that handles the watersheds of Area 1-1 and Area 1-2, and Area 3-2 is the area that flows into the tributary river that handles the Area 2 basin. Area 4 is an SEZ area developed by DPW. Area 5 is the watershed of tributaries that meet in the downstream area. According to an interview with DPW, a drainage channel (called the DPW drainage channel) is being constructed that will discharge water from the port area being developed by DPW to the sea on the north side of the container terminal. The DPW drainage channel plan will take into account not only the water within the terminal, but also the rainwater drainage flowing down from the airport area. Therefore, the plan is based on the assumption that the drainage water from Areas 4 and 5 will flow into the DPW drainage channel. Area 6 is a tributary basin, but the flow is obstructed by the port area, making it difficult to connect to the DPW drainage channel. The area between Areas 4, 5 and Area 6 is the port area of DPW and PAD, and rainwater that falls within the port area is excluded from the catchment area of the watershed drainage canal, as it is discharged directly to the sea through the drainage canal within the port area.



Source: JPT

Figure 3.119 Current Watershed Map (Left) and Future Watershed Map (Right)

River Route

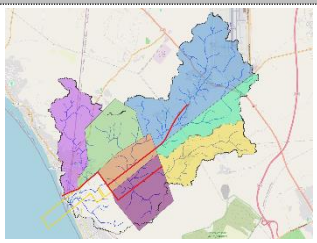
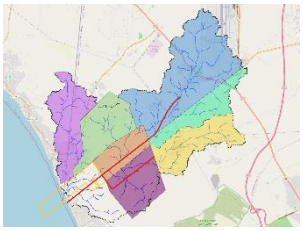
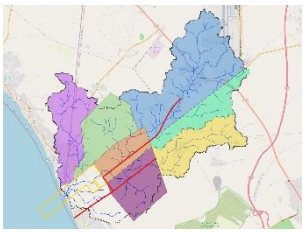
The route of the watershed drainage channel shall be the route of the current river channel for the section upstream of the PIZ area.

In the PIZ area, it will be located between the inbound and outbound access roads, taking into consideration the following:

- If the watershed drainage channel is planned outside the road site, additional land will be required.
- If the basin drainage channel is planned at the edge of the road site (along the north side of the road site), it may hinder future lane widening.

The following three routes were considered for the downstream part of PIZ area of the watershed drainage channel. Plan A is the route that is closest to the existing river and passes through a geographically lower area compared to the other two options. Plan B is the shortest route, but since the end of the river is in the berth area of the port, there is a risk that sediment from the river channel will accumulate in the channel. Plan C's route detouring around the south side of the port site does not follow the current topography, so it is expected that earthwork costs such as embankment and excavation will increase. Hence, Plan A, which runs a drainage canal between the DPW and PAD sites, was adopted.

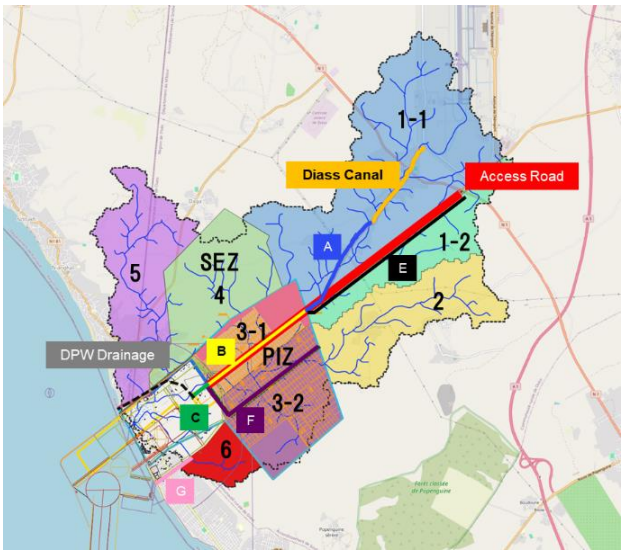
Table 3.87 Comparison Table of Watershed Drainage Channel Route

Plan A	Plan B	Plan C
		
Plan to drain the north side of container terminal to the sea	Plan to drain the south side of container terminal to the sea	Plan to flow down the south side of the PAD port area to the sea
The amount of excavation will be small as the project will be constructed at a low elevation near the existing river channel. However, the length of the river channel will be the longest due to the detour.	Similar to Plan A, the amount of excavation will be small as it will be constructed relatively close to the existing river channel. As it will be developed within the PAD site, no new land acquisition is required. However, since the end of the river is in the berthing area of the port, there is a risk that the channel will be silted by sediment flowing down from upstream.	Since it will be constructed at a high altitude and far from the existing river channel, a large amount of excavation will be required, leading to higher costs for developing the channel.
◎	–	–

Source: JPT

For Plan A, based on the fact that this route roughly coincides with the DPW drainage channel and that the DPW drainage channel was planned with flow rates from upstream in mind according to the interview, the basin drainage channel will be connected to the DPW drainage channel.

In addition, a route will be set up for rainwater drainage from Area 6 to be discharged into the sea on the south side of the port area along the port area boundary.

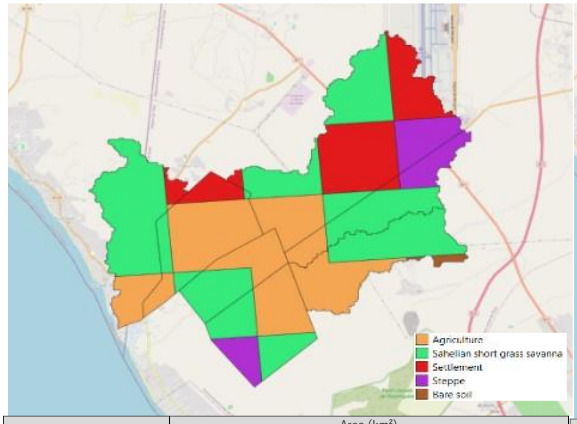


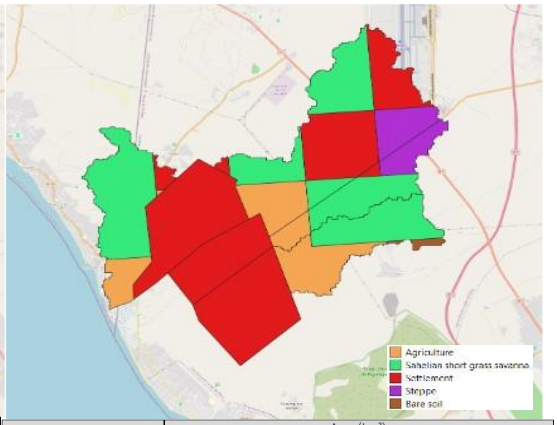
Source: JPT

Figure 3.120 Drainage Channel Route

Runoff Coefficient

The current land use of the target area was organized using the 2 km mesh data by USGS. Future land use was set assuming that the entire port area would be developed. The current situation and future land use map is shown in the figure below.





Landuse	Area (km²)							
	1-1	1-2	2	3-1	3-2	4	5	Total
Agriculture	2.10	0.69	2.66	1.57	2.20	4.30	1.27	14.78
Sahelian short grass savanna	5.24	2.46	3.19	1.84	2.33	0.78	5.13	20.96
Settlement	6.18	0.14	0.00	0.00	0.00	0.89	0.35	7.56
Steppe	1.71	1.22	0.00	0.00	1.03	0.00	0.00	3.95
Bare Soil	0.00	0.00	0.22	0.00	0.00	0.00	0.00	0.22
Total Area	15.22	4.50	6.07	3.40	5.56	5.98	6.75	47.48

Landuse	Area (km²)							
	1-1	1-2	2	3-1	3-2	4	5	Total
Agriculture	2.10	0.69	2.66	0.00	0.00	0.00	1.27	6.71
Sahelian short grass savanna	5.24	2.46	3.19	0.00	0.00	0.00	5.13	16.01
Settlement	6.18	0.14	0.00	3.40	5.56	5.98	0.35	21.61
Steppe	1.71	1.22	0.00	0.00	0.00	0.00	0.00	2.93
Bare Soil	0.00	0.00	0.22	0.00	0.00	0.00	0.00	0.22
Total Area	15.22	4.50	6.07	3.40	5.56	5.98	6.75	47.48

Source: JPT

Figure 3.121 Land Use Map Current Status (Left) and Future (Right)

The above land uses were classified as shown in the table below, and the runoff coefficient for each watershed was calculated using an area weighted average. The runoff coefficient normally used in Senegal is currently being confirmed.

Table 3.88 Runoff Coefficient by Land Use

Land use classification	Run-off coefficient
Congested residential area	0.9
General residential area	0.8
Fields, moors	0.6
Rice fields	0.7
Mountains	0.7

Source: River and Sabo Technical Standards (planning edition) by Ministry of Land, Infrastructure, Transport and Tourism

Table 3.89 Runoff Coefficient for Each Divided Watershed

Land use classification	1-1	1-2	2	3-1	3-2	4	5	6	Total	Remarks
Congested residential area	0%	0%	0%	100%	100%	100%	0%	0%	31.5%	Port area, PIZ, SEZ
General residential area	41%	3%	0%	0%	0%	0%	5%	0%	14.0%	Settlement
Fields, moors	59%	97%	100%	0%	0%	0%	95%	100%	54.5%	Others
Run-off coefficient	0.7	0.6	0.6	0.9	0.9	0.9	0.6	0.6	0.7	

Source: JPT

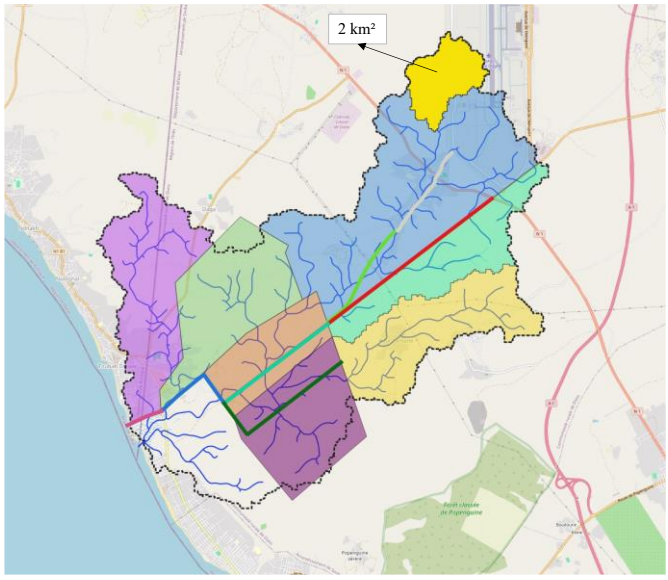
The Time of Concentration

The time of concentration is calculated using the Kraven method, which is commonly used in Japan,

and it was calculated as the sum of the "travel time of overland flow t1" from the upstream area to the upstream end of the river channel and the "travel time of channel flow t2" during which it flows down the river channel.

i. Travel time of overland flow t1

The Kraven method is a method that selects a fixed travel time of overland flow (30 minutes for drainage development areas and mountainous basins, 20 minutes for areas with steep slopes) for the 2 km^2 upstream area of the watershed. The upper 2km^2 area is as shown in Figure 3.122, and since it includes the urban area of Diass and the airport, the travel time of overland flow t1 was set to 30 minutes by applying the value for the drainage development area.



Source: JPT

Figure 3.122 Location Map of Upstream Area

ii. Travel time of channel flow t2

In the Kraven formula, the travel time of channel flow is calculated using the following formula.

$$t_2 = \frac{1}{3600} L/W$$

Where, t_2 : travel time of channel flow (hr)

L : length of channel reach (m)

W : velocity of flood wave (m/s)

The velocity of flood wave W is set as below.

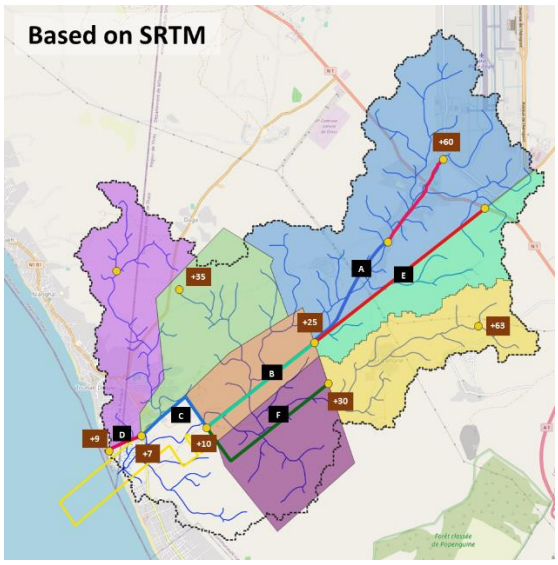
I=above 1/100: W=3.5m

I=1/100～1/200: W=3.0m

I=below 1/200: W=2.1m

where I: difference in elevation between the upstream end of the river channel and the flow rate study point divided by the length of channel reach (L)

Gradient I was set using the SRTM elevation data below. The slope of each section is shown in Figure 3.123.



$$\text{Slope A} = \frac{35}{4674} = \frac{1}{134} = 0.007488$$

$$\text{Slope B} = \frac{50}{7531} = \frac{1}{151} = 0.006639$$

$$\text{Slope C} = \frac{53}{9528} = \frac{1}{180} = 0.005563$$

$$\text{Slope D} = \frac{51}{10335} = \frac{1}{203} = 0.004935$$

$$\text{Slope E} = \frac{47}{4540} = \frac{1}{97} = 0.010353$$

$$\text{Slope F} = \frac{53}{7138} = \frac{1}{135} = 0.007425$$

Source: JPT

Figure 3.123 River Channel Gradient

The time of concentration at the downstream end of each river channel section is shown in Table 3.90.

Table 3.90 Time of Concentration for each Location

	A	B	C	D	E	F
channel length (L) (m)	4674	7531	9528	10335	4540	7138
slope (in 1/)	134	151	180	203	97	135
flow velocity Kraven (W) (m/s)	3	3	3	2.1	3.5	3
t2	25.97	41.84	52.93	82.02	21.62	39.66
Tc (t1+t2)	**55.97**	**71.84**	**82.93**	**112.02**	**51.62**	**69.66**

Source: JPT

Design Scale

The attempt to obtain rainwater drainage standards applied in Senegal involved a request for information from ONAS, yet confirmation remained unattainable. Therefore, the design scale was set to 1/10 based on the information below. The design scale is 1/5 larger than the estimated design scale of the upstream Diass drainage canal, and the plan is to allow rainwater flowing in from the Diass drainage canal to flow away without any problems. It should be noted that the proposed scale of the DPW drainage channel has not been confirmed and will need to be confirmed at the time of detailed design.

- Design scale of the Diass anal being developed upstream

Information has been requested since November 2022 from the Blaise Diagne International Airport (AIBD), responsible for the development of the Diass drainage canal, however any information were not available.

Therefore, the flow capacity was estimated based on the cross section of the Diass drainage canal and

the surrounding ground height, and backwards from the flow capacity were calculated, and the estimated planned scale was 1/5.

- Design scale of urban stormwater drainage in Senegal

In the Master Plan for Sewage and Drainage in the Dakar Metropolitan Area (Etude d'Actualisation du Plan Directeur d'Assainissement Liquide de Dakar 2025), as part of Dakar City's rainwater drainage plan, the main drainage canal is planned to be 1/10th the planned size. In addition, JICA's "Project for Treatment of Sewage, Rainwater and Wastes in Kaolack City" is also considering urban drainage in Kaolack to be 1/10 of the planned scale.

Planned Flow Rate

The results of calculating the planned flow rate with the above planned scale of 1/10 are shown below. In this study, the entire amount will be discharged through the river channel.

Table 3.91 Planned Flow Distribution

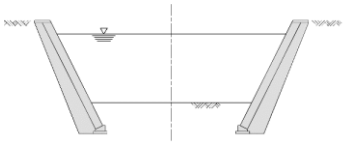
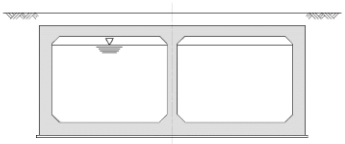
Section	A	B	C	DPW Drainage	E	F	G
Catchment area (km2)	15.22	23.13	34.76	47.48	4.50	11.62	1.45
Design Discharge (m3/s)	105	155	219	272	29	81	11

Source: JPT

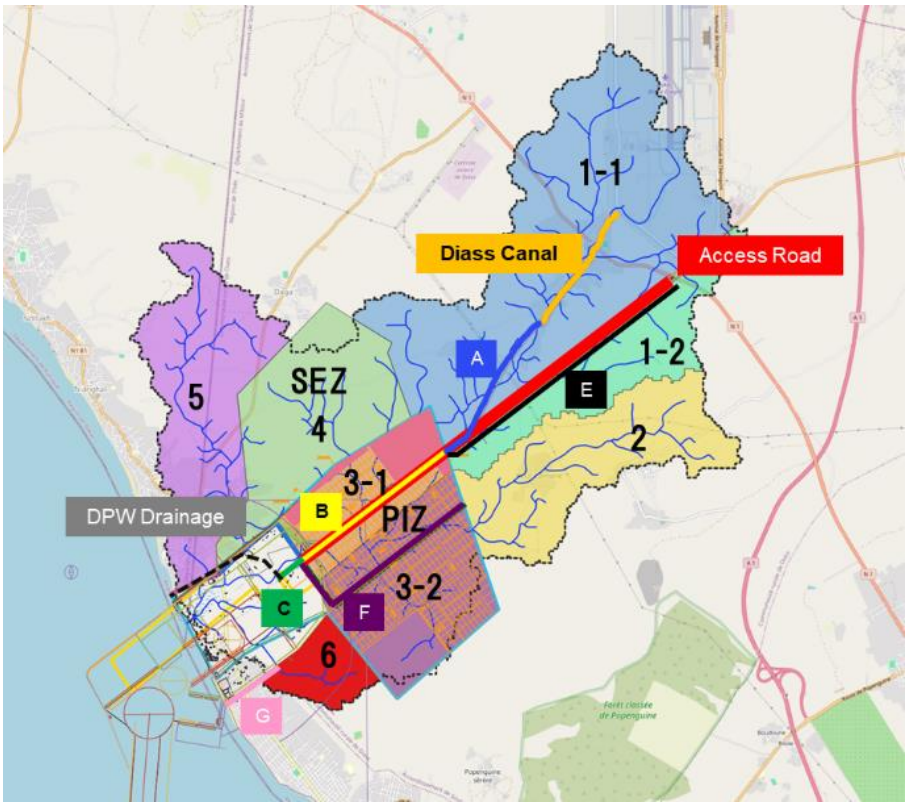
Drainage Channel Cross Section

As the drainage channel cross section, culvert, and open channel were compared and examined. The open channel cross section has been adopted from the viewpoint of maintenance management and development costs.

Table 3.92 Proposed Comparison of Drainage Channel Cross Section

Open channel	Culvert
 Source: JPT	 Source: JPT
• Maintenance costs such as cleaning of drainage channels can be reduced. • Construction cost is lower than culvert. • Additional countermeasures against excessive flooding are also possible, by installing parapets along drainage channel, etc.	• There is room for effective utilization of the land above the culvert. • Cleaning costs will increase when dirt, sand, etc. accumulates. If it is not cleaned, the flow capacity cannot be secured, and the risk of flood damage increases. • The construction cost is higher compared to the open channel.
◎	

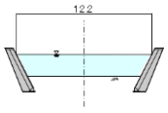
Source: JPT



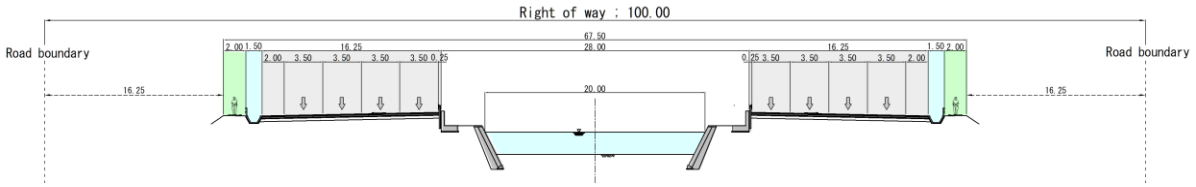
Source: JPT

Figure 3.124 Drainage Channel Route

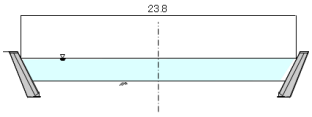
Section A



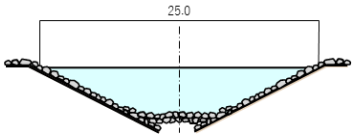
Section B



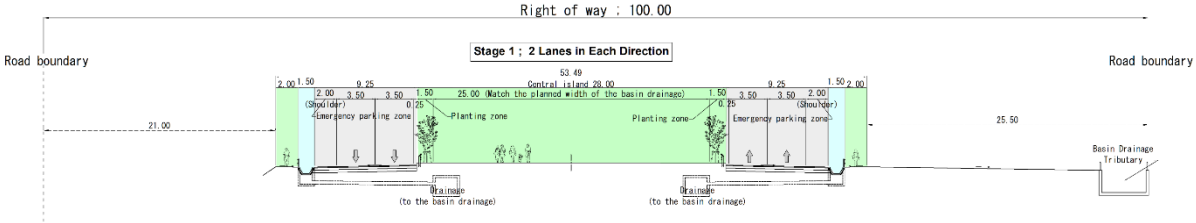
Section C



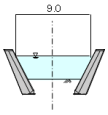
Section D （DPW Drainage）



Section E



Section F



Section G

Source: JPT

Figure 3.125 Cross Section of Basin Drainage

Utilization of River Water from the Basin Drainage

When considering the utilization of river water from the drainage channel, potential applications include water supply and greening.

However, the use of this water for potable purposes presents several challenges, making it a less effective option. First, rainfall in the area is concentrated between July and September, and without a large-scale dam, stable year-round supply would be difficult to achieve. In addition, the Diass Canal, located upstream of the Basin Drainage, receives not only rainwater but also domestic wastewater. Therefore, the construction of a water treatment facility would be essential for water supply usage.

On the other hand, using the water for greening purposes is considered a more feasible option. A retention pond is currently planned at the upstream end of the drainage channel being developed by the DPW. By utilizing this facility as a biotope, it is expected to contribute to the greening of the surrounding area.

Source: MLIT

Figure 3.126 Example of a biotope within an industrial area

c) Drainage Plan within the Port Facility Area

Design standard

In order to confirm the design standards to be applied to drainage channels within the port, an interview was conducted with DSTA, and it has been confirmed that the French standard (AFNOR; Association Française de Normalization) included in the Eurocode was often used, although it differs depending on the project owner. However, the standards to be applied to Ndayane Port have not been decided yet. During Detailed Design stage, consideration will be given to ensuring consistency with the standards to be applied within the port area planned by DPW.

Structure

U-shaped gutter and box culvert structures are assumed. A detailed study is required once the layout plan for the port area is decided. Specifically, when installing a U-shaped groove in a port area where large vehicles are expected to pass, it should be noted that a strong lid/grating is required to withstand the load of large vehicles.

Terminal treatment

Oil filters shall be installed at the outlets to the ocean, as the rainwater drainage from port facilities may be contaminated with oil. The respective facility operators are responsible for their installation as necessary. According to the interview with DSTA, the quality standard for oil filters is based on the standards of WHO, WB and GEOD, and it is necessary to consider the applicable standards, taking into consideration consistency with the applicable standards within the port area planned by DPW.

d) Drainage Plan for the Access Road

Design standard

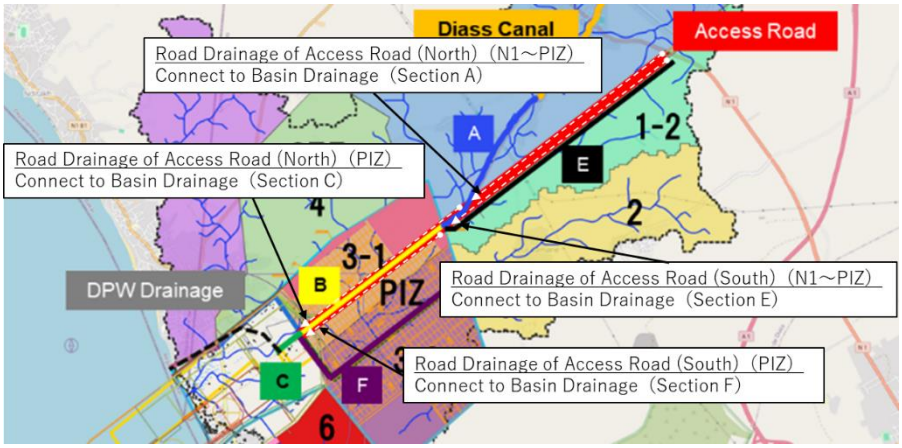
An interview was conducted with AGEROUTE to confirm the design standards to be applied to the access road, but the standards for road drainage could not be confirmed. In the detailed design, it is necessary to consider consistency with the applicable standards planned by DPW.

Road drainage route

The road drainage route for the access road will be as follows.

- It is preferable to have a slope toward the outside of each lane from the viewpoint of ease of driving, so the drainage ditch shall be installed on the outside of the road.
- Road drainage for the south lane of the access road shall merge with the end of the waterway of the tributary Section E of the watershed drainage channel.
- Road drainage for the north lane of the access road shall be drained into the main watershed drainage channel at the junction of the main watershed drainage channel Section A and the access road.
- Regarding road drainage in the PIZ area, the north and south lanes shall merge into the river basin drainage channel at the downstream end of the PIZ.
- Drainage channels shall be placed on the outside of the road, and road gutters shall be relocated in accordance with road expansion at each construction stage.
- Drainage of vacant land for roads in the early and middle stages of construction shall also be handled by gutters installed on the side of the road.

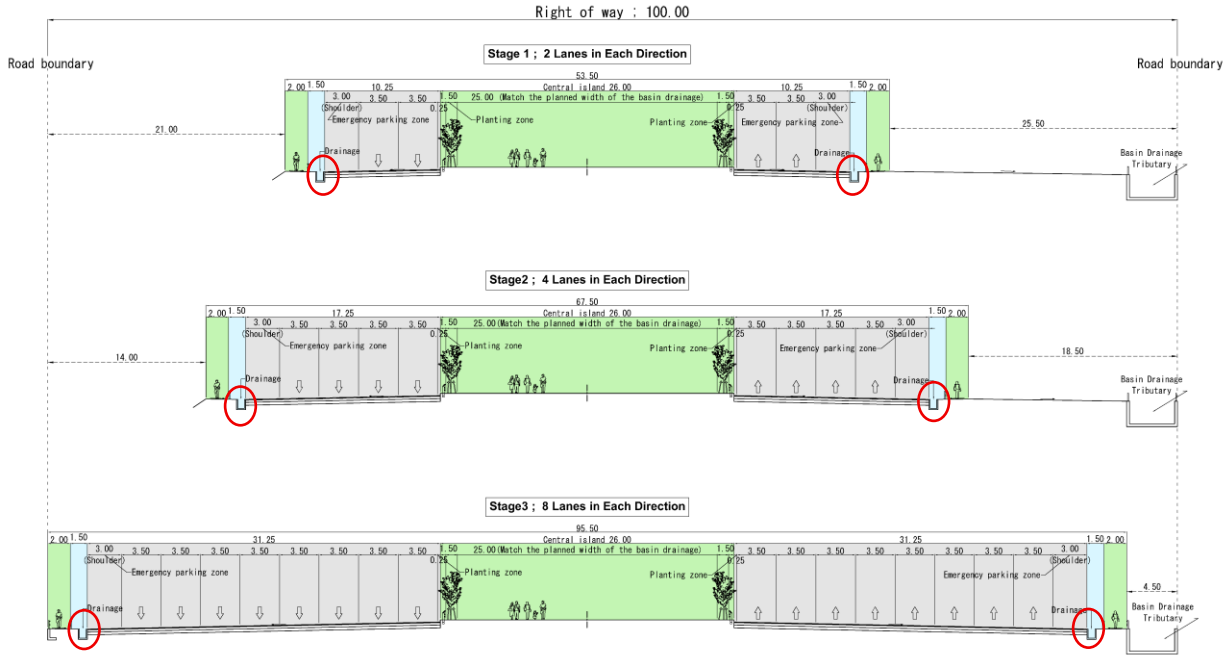
Access road route



Source: JPT

Figure 3.127 Drainage Route Map of the Access Road

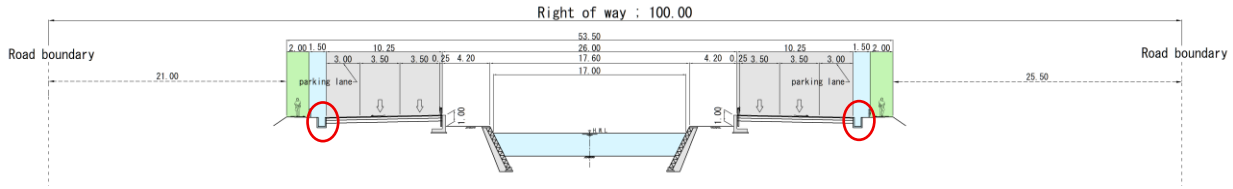
Standard section (N1 to PIZ) width configuration (staged construction)



Source: JPT

Figure 3.128 Drawing of Access Road Width Configuration (road gutters shown in red) (1)

Basin drainage channel junction (PIZ area) width configuration (2nd stage: 4 lanes on each side)



Source: JPT

Figure 3.129 Drawing of Access Road Width Configuration (road gutters shown in red) (2)

3.12.15 Preliminary Cost Estimate and Construction Period

(1) Preliminary Cost Estimate

a) Conditions of Cost Estimate

Cost estimation was made with reference to the Manual for Design and Cost Estimation of Preparatory Survey (JICA, 2009). The funding method is not determined except for the work items which are carried out by DPW since this study is Master Plan (M/P), therefore, the preliminary project cost shall be estimated in consideration of the JICA ODA Loan, etc.

i. Base Year used in Cost Estimation

The base year for the estimation is 2025.

ii. Exchange Rate

The exchange rates are applied as of February 2025 (T.T.S., Tokyo Mitsubishi UFJ Bank) as shown below.

- USD: 150.67 JPY
- EUR: 157.10 JPY

iii. Construction Cost

Regarding the unit price of the work items for which approximate construction costs have been examined in DPW M/P (2021) such as Dredging, reclamation, excavation, etc., these unit costs shall be applied after verifying its validity. For the other items, the construction costs for the past similar projects were used as the references. To reach the current price, the factors such as scale, specification, price escalation were considered.

iv. Design and Supervision Cost

As an engineering services cost, 10% of the construction cost are assumed for the local currency and foreign currency.

v. Contingencies

Contingencies for price escalation are set as 20% and physical contingency are set as 10% respectively of the construction cost for the local currency and foreign currency.

vi. Preparation Cost (Land Acquisition Cost and Compensation)

The preparation cost such as land acquisition and compensation are not considered.

vii. Others

Since the funding method is not determined, it is difficult to set the required cost items and its amount, thus, 20% of the construction cost shall be provisionally as the taxes and other expenses.

b) Major Project Component

The major scope of this Project is summarized in Table 3.93 Major Project Components. This list includes the quantities for the construction works to be carried out by DPW in addition to the PAD portion.

Table 3.93 Major Project Components

No.	Work Items		Unit	Quantity		
				2030	2035	2047
(1)	General/Temporary Works		L.S.	1	1	1
(2)	Breakwater	Breakwater (East side)	m	0	0	0
		Breakwater (West side)	m	1,000	0	0
(3)	Dredging	Channel	m3	6,440,000	0	0
		Basin	m3	9,700,000	4,000,000	11,300,000
		Navigation Aids	L.S.	1	0	0
		VTMS	L.S.	1	0	0
(4)	Excavation		m3	445,500	502,000	532,000
(5)	Reclamation		m3	13,145,000	3,680,000	0
(6)	Berth	Container Terminal	m	1,000	500	500
		RORO Terminal	m	600	0	0
		General Cargo	m	0	500	1,000
(7)	Revetment	Outer Revetment	m	4,140	0	0
		Inner Revetment	m	1,380	0	0
(8)	Pavement and Drainage		m2	1,300,000	300,000	1,200,000
(9)	Access Road	Roads Inside Port Temporary	m	3,761		0
		Roads Inside Port Permanent	m	2,666	7,400	7,400
(10)	Basin Drainage		m	5,525	0	0
(11)	Railway		L.S.	0	1	0
(12)	Building and Utilities		L.S.	1	1	1
(13)	Security Equipment	Gate, Fence, CCTV, PA, etc.	L.S.	1	1	1
(14)	Cargo Handling Equipment		L.S.	1	1	1

Source: JPT

c) Cost Estimation Result

The estimated results of construction and project costs for each target year (2030, 2035 and 2047) as the stepwise development plans are summarized in Table 3.94 - Table 3.96 including both cases— the overall project including DPW implementation and PAD implementation only.

Table 3.94 Estimation Result of Construction Cost and Project Cost (Target Year: 2030)

No.	Work Items	Overall (PAD + DPW)			PAD		
		Local Currency	Foreign Currency	Total	Local Currency	Foreign Currency	Total
(1)	General/Temporary Works	144,000	36,000	180,000	48,000	12,000	60,000
(2)	Breakwater	72,000	8,000	80,000	0	0	0
(3)	Dredging	171,490	177,610	349,100	34,650	34,650	69,300
(4)	Excavation	4,060	1,740	5,800	1,360	340	1,700
(5)	Reclamation	45,990	19,710	65,700	10,880	2,720	13,600
(6)	Berth	144,100	117,900	262,000	36,000	36,000	72,000
(7)	Revetment	245,870	88,030	333,900	101,290	43,410	144,700
(8)	Pavement and Drainage	224,640	24,960	249,600	48,420	5,380	53,800
(9)	Access Road	54,396	3,504	57,900	46,320	11,580	57,900
(10)	Basin Drainage	30,900	0	30,900	19,600	0	19,600
(11)	Railway	0	0	0	0	0	0
(12)	Building and Utilities	51,030	5,670	56,700	25,522	2,836	28,358
(13)	Security Equipment	91,136	39,058	130,194	26,352	11,294	37,645
(14)	Cargo Handling Equipment	0	172,000	172,000	0	6,290	6,290
Construction Cost		**1,279,612**	**694,182**	**1,973,794**	**398,394**	**166,499**	**564,893**
(i)	Price Escalation	255,922	138,836	394,759	79,679	33,300	112,979
(ii)	Physical Contingency	127,961	69,418	197,379	39,839	16,650	56,489
(iii)	Consulting Services	127,961	69,418	197,379	39,839	16,650	56,489
(iv)	Others such as TAX, etc.	255,922	138,836	394,759	79,679	33,300	112,979
Project Cost		**2,047,379**	**1,110,691**	**3,158,070**	**637,430**	**266,399**	**903,829**

Source: JPT

Table 3.95 Estimation Result of Construction Cost and Project Cost (Target Year: 2035)

No.	Work Items	Overall (PAD + DPW)			PAD		
		Local Currency	Foreign Currency	Total	Local Currency	Foreign Currency	Total
(1)	General/Temporary Works	48,000	12,000	60,000	24,000	6,000	30,000
(2)	Breakwater	0	0	0	0	0	0
(3)	Dredging	42,000	42,000	84,000	8,200	8,200	16,400
(4)	Excavation	4,550	1,950	6,500	3,920	980	4,900
(5)	Reclamation	12,880	5,520	18,400	5,040	1,260	6,300
(6)	Berth	88,000	72,000	160,000	32,500	32,500	65,000
(7)	Revetment	0	0	0	0	0	0
(8)	Pavement and Drainage	51,840	5,760	57,600	17,280	1,920	19,200
(9)	Access Road	99,085	5,215	104,300	83,440	20,860	104,300
(10)	Basin Drainage	0	0	0	0	0	0
(11)	Railway	4,690	2,010	6,700	4,690	2,010	6,700
(12)	Building and Utilities	20,430	2,270	22,700	10,209	1,134	11,343
(13)	Security Equipment	21,436	9,187	30,622	14,429	6,184	20,613
(14)	Cargo Handling Equipment	0	92,000	92,000	0	35,800	35,800
Construction Cost		**392,911**	**249,912**	**642,822**	**203,707**	**116,848**	**320,556**
(i)	Price Escalation	78,582	49,982	128,564	40,741	23,370	64,111
(ii)	Physical Contingency	39,291	24,991	64,282	20,371	11,685	32,056
(iii)	Consulting Services	39,291	24,991	64,282	20,371	11,685	32,056
(iv)	Others such as TAX, etc.	78,582	49,982	128,564	40,741	23,370	64,111
Project Cost		**628,657**	**399,859**	**1,028,516**	**325,932**	**186,957**	**512,889**

Source: JPT

Table 3.96 Estimation Result of Construction Cost and Project Cost (Target Year: 2047)

No.	Work Items	Overall (PAD + DPW)			PAD		
		Local Currency	Foreign Currency	Total	Local Currency	Foreign Currency	Total
(1)	General/Temporary Works	80,000	20,000	100,000	32,000	8,000	40,000
(2)	Breakwater	0	0	0	0	0	0
(3)	Dredging	118,650	118,650	237,300	33,600	33,600	67,200
(4)	Excavation	4,830	2,070	6,900	3,360	840	4,200
(5)	Reclamation	0	0	0	0	0	0
(6)	Berth	123,750	101,250	225,000	65,000	65,000	130,000
(7)	Revetment	0	0	0	0	0	0
(8)	Pavement and Drainage	207,360	23,040	230,400	55,260	6,140	61,400
(9)	Access Road	99,085	5,215	104,300	83,440	20,860	104,300
(10)	Basin Drainage	0	0	0	0	0	0
(11)	Railway	0	0	0	0	0	0
(12)	Building and Utilities	48,510	5,390	53,900	24,246	2,694	26,940
(13)	Security Equipment	40,394	17,312	57,706	29,194	12,512	41,706
(14)	Cargo Handling Equipment	0	109,400	109,400	0	9,500	9,500
Construction Cost		**722,579**	**402,327**	**1,124,906**	**326,100**	**159,146**	**485,246**
(i)	Price Escalation	144,516	80,465	224,981	65,220	31,829	97,049
(ii)	Physical Contingency	72,258	40,233	112,491	32,610	15,915	48,525
(iii)	Consulting Services	72,258	40,233	112,491	32,610	15,915	48,525
(iv)	Others such as TAX, etc.	144,516	80,465	224,981	65,220	31,829	97,049
Project Cost		**1,156,127**	**643,723**	**1,799,850**	**521,760**	**254,633**	**776,394**

Source: JPT

(2) Preliminary Construction Period

The construction periods for each target years are presented in Table 3.97– Table 3.99, which is including the preparatory works for the construction of civil, building, and equipment. It is noted that only the construction periods for PAD portion as a realistic schedule are shown since the construction by DPW has already commenced.

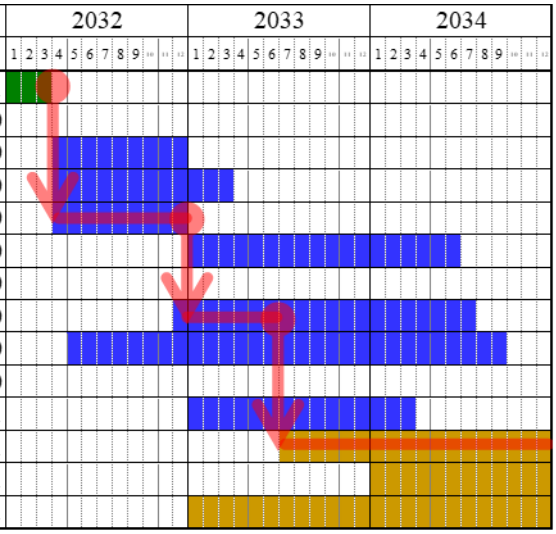
Table 3.97 Preliminary Construction Period (Target Year: 2030)

	Work Items	Project Year		2026	2027	2028	2029
		Unit	Quantity	1 2 3 4 5 6 7 8 9 10 11 12	1 2 3 4 5 6 7 8 9 10 11 12	1 2 3 4 5 6 7 8 9 10 11 12	1 2 3 4 5 6 7 8 9 10 11 12
1	General/Temporary Works	L.S.	1				
2	Breakwater	m	0				
3	Dredging	m3	3,300,000				
4	Excavation	m3	132,000				
5	Reclamation	m3	2,720,000				
6	Berth	m	600				
7	Revetment	m	2,320				
8	Pavement and Drainage	m2	280,000				
9	Access Road	m	6,427				
10	Basin Drainage	m	3,501				
11	Railway	L.S.	0				
12	Building and Utilities	L.S.	1				
13	Security Equipment	L.S.	1				
14	Cargo Handling Equipment	L.S.	1				

Source: JPT

Table 3.98 Preliminary Construction Period (Target Year: 2035)

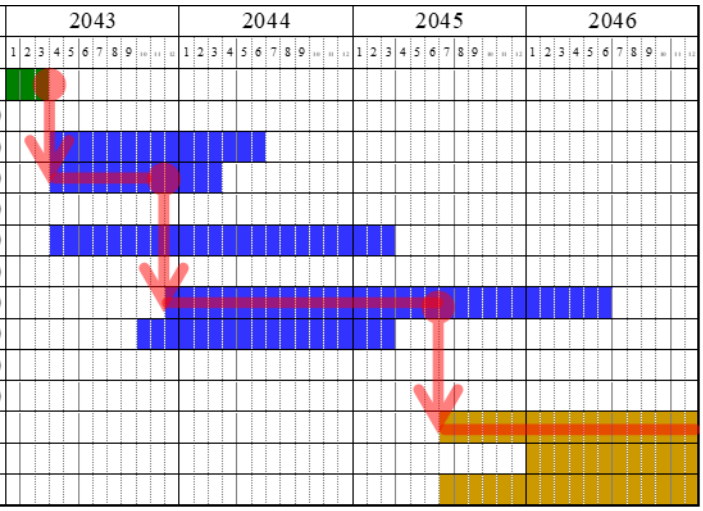
	Work Items	Unit	Quantity
1	General/Temporary Works	L.S.	1
2	Breakwater	m	0
3	Dredging	m3	780,000
4	Excavation	m3	379,500
5	Reclamation	m3	1,265,000
6	Berth	m	500
7	Revetment	m	0
8	Pavement and Drainage	m2	100,000
9	Access Road	m	7,400
10	Basin Drainage	m	0
11	Railway	L.S.	1
12	Building and Utilities	L.S.	1
13	Security Equipment	L.S.	1
14	Cargo Handling Equipment	L.S.	1



Source: JPT

Table 3.99 Preliminary Construction Period (Target Year: 2047)

	Work Items	Unit	Quantity
1	General/Temporary Works	L.S.	1
2	Breakwater	m	0
3	Dredging	m3	3,200,000
4	Excavation	m3	320,000
5	Reclamation	m3	0
6	Berth	m	1,000
7	Revetment	m	0
8	Pavement and Drainage	m2	320,000
9	Access Road	m	7,400
10	Basin Drainage	m	0
11	Railway	L.S.	0
12	Building and Utilities	L.S.	1
13	Security Equipment	L.S.	1
14	Cargo Handling Equipment	L.S.	1



Source: JPT

At the current stage, the preliminary construction periods for each stepwise development plans are assumed as four (4) years for target year 2030 and 2047, and three (3) years for target year 2035. The arrows by red in the table indicate work items that can be critical paths.

The expected implementation years are also mentioned in the table, but it generally takes four (4) to five (5) year until the commencement of construction works to complete the feasibility study, loan procedures, detailed design, etc. in case of the JICA ODA Loan. It is noted that the necessary period is already insufficient for the implementation of the stepwise development plan targeted at 2030.

- Feasibility Study (F/S) by JICA: approximately 1 year
- Loan Procedures such as Appraisal, Pledge, L/A, etc.: approximately 6 months – 1 year

- Procurement of the Consultant: approximately 6 months – 1 year
- Detailed Design (D/D): approximately 1 year
- Tender Assistance (T/A): approximately 1 year

3.12.16 Economic/Financial Analysis

(1) Purpose and Assumptions of Economic and Financial Analysis

The purpose of the economic analysis is to analyze the impact of M/P developed in this study on the national economy of Senegal. This analysis determines whether a project's investment decision is appropriate from the perspective of economic benefits. The investment effect of a project is calculated by accounting for the effect not only on the project operator but on society as a whole as a benefit and comparing it with the cost required for the project. In other words, economic analysis is used to evaluate the efficiency of public investments (projects).

On the other hand, the purpose of financial analysis is to analyze the financial feasibility of a project from the perspective of financial soundness. This analysis is performed from the standpoint of the project entity, and the income from the project is recorded as benefit. In other words, financial analysis is used to evaluate the profitability of a project.

(2) Prerequisites

a) Project Period

Although the final completion year for facility development is 2047 (Long-term development plan), this research envisions 2-step phases starting of the service targeting for 2030(Short-term development plan) and the next fiscal year of 2035(Mid-term development plan). Therefore, the project period will be determined as shown below, and the benefits and costs will be analyzed and evaluated based on the start of service.

- Construction is scheduled to start in 2024 (first year).
- The container terminal is schedule to open in 2028 (5th year)
- From 2031 (8th year), partial service for general cargo and provision of RORO terminals will begin. The benefit of the container terminal will create from the year.
- In 2036 (13th year), the use of container and general cargo terminals will be expanded, and benefits will increase accordingly.
- In 2048 (25th year), all terminals and associated facilities will be in service.
- From there on, benefits will be measured up to 2097 (74th year), but demand forecast data for 2047 will be used, and it is assumed that there will be no additional demand increase. The target period for the economic analysis is the construction period plus 50 years, which is the useful life of the main structures. According to PAD's accounting policy, the useful life of the main facilities

such as the wharf ranges from 5 to 50 years. Therefore, after consulting with PAD's accountant, the useful lives were considered as shown in the table below.

Table 3.100 Useful Life of Fixed Assets

Property, Plant and Equipment	Useful Life
Dredging/Reclamation/Excavation	50yrs
Revetment/Breakwater	50yrs
Berth	50yrs
Building and Utilities	50yrs
Access Road, Drainage	50yrs
Security Equipment	20yrs
Cargo Handling Equipment	10yrs
Vehicle	5yrs

Source: JPT

b) Foreign exchange rates

The exchange rate used was the same as for the calculation (Mitsubishi UFJ Bank's TTS at the end of February 2025).

- USD: 150.67 JPY
- EUR: 157.10 JPY

c) with Project/without Project

Economic analysis compares cases where a project is implemented (with project) and cases where a project is not implemented (without project). The difference is the total benefit of implementing the project. The background to this study is that in order to respond to the rapidly increasing cargo demand at the existing Dakar port in recent years, Senegal has formulated a plan to construct a multifunctional port in Ndayane, and has already proceeded with the construction of a container terminal with DPW. Based on this background, JPT set up “with project / without project” as follows. Although there is no difference “with/without” for Bargny-Sendou Port, both have been taken into consideration.

[without Project]

- JPT assume that the Port of Dakar will continue to be used, and a multifunctional terminal will not be constructed.
- In order to respond to the increase in demand, JPT have calculated the transportation benefit using the following settings.
  - The upper limit of Dakar Port capacity is based on the actual value for FY2022.
  - For cargo that cannot be handled at Dakar Port, alternative ports are envisaged. The alternative port is set at Abidjan port (Ivory Coast).

[with Project]

- Assuming the case of constructing a Multifunctional Terminal in Ndayane as “with project.” The container terminal (2028) and RORO terminal (2031) will be relocated from the existing Dakar Port.
- ”With project" will be an analysis of the entire Ndayane Port, including the benefits and costs of the container terminal that DPW is currently constructing.
- PIZ is NOT included in the economic and financial analysis of ports, as both “with” or “without” are considered separately.

d) without project: Reasons for setting alternative ports and cargo volume limits

i. Alternative port Abidjan (Ivory Coast)

In selecting an alternative port, consideration was made based on "Table 2.15 Specifications of Major Ports in West Africa." A comparison table of the alternative three (3) ports, Dakar and Ndayane, is shown as below. The numbers in underlined indicate the values considered to be the most appropriate as an alternative port to Dakar Port. In particular, non-quantitative comparisons take into account distance and urban congestion.

Table 3.101 Consideration of Alternative Ports

Name of Port (Country)	Unit	Dakar (Senegal)	Lome (Togo)	**Abidjan (Ivory Coast)**	Conakry (Guinea)	Ndayan (Senegal) Assumptions as of 2047
Container Handling	TEU	73,800	**1,986,131**	760,149	250,000	3,100,000
Depth	m	13.0	16.6	**18.0**	13.0	20.0
Berth Extension	m	720	1,050	**1,100**	600	2,080
Distance to Dakar	k m	0	3,098	2,419	**1,209**	78
Note			**Distance is an issue**	**Intermediate distance, also meets other**	**Congestion in urban areas is also an issue**	

Source: JPT

Lomé (Togo) has the closest container throughput to Ndayane Port, but considering the current trade situation and distance, it is inferior to Abidjan and Conakry as alternative port options. Although Conakry is reasonable as an alternative port to Ndayane in terms of distance, it faces the same challenges as Dakar in terms of container handling volume and urban congestion. Therefore, after considering various conditions, it was decided that Abidjan would be suitable as an alternative port in the case of "without".

ii. Cargo volume limits and cargo volume settings (Dakar Port)

Next, in order to set the cargo volume in the case of "without", we examined the cargo volume that can be handled at Dakar Port as well as the cargo volume when the berth occupancy rate is set to 100% and the actual cargo volume in FY2022. As a result, Dakar Port is theoretically able to handle additional cargo in terms of berths and other facilities. However, the idea of Ndayane Port was started against the background that ships were already delinquent and congestion in urban areas was serious,

making it impossible to withstand future increases in demand. Therefore, we regard the actual cargo volume in 2022 as the upper limit of Dakar Port's capacity and assume that Abidjan Port will be used as an alternative port for all subsequent increases in demand. The table below summarizes cargo volumes with project and without project.

Table 3.102 Setting of cargo handling volume

with project　Quantity（**Ndayane**）

Terminal/Year	Unit	FY2030	FY2035	FY2047
Container	TEU	1,560,000	2,140,000	3,100,000
RORO	Cars	210,227	250,374	350,000
Bulk/General	ton	2,247,000	2,876,000	6,359,000

without project　Quantity（**Dakar**）

Terminal/Year	Unit	FY2030	FY2035	FY2047
Container	TEU	738,000		
RORO	Cars	120,000		
Bulk/General	ton	1,606,000		

without project　Quantity(Abidjan）

Terminal/Year	Unit	FY2030	FY2035	FY2047
Container	TEU	822,000	1,402,000	2,362,000
RORO	Cars	90,227	130,374	230,000
Bulk/General	ton	641,000	1,270,000	4,753,000

Source: JPT

e) Conversion to economic prices

The costs used in the economic analysis need to be converted to economic prices. The local currency portion of the cost estimate includes VAT, so the economic analysis uses prices excluding VAT. In addition, although the construction cost includes various contingencies, monetary and nominal contingencies (e.g., inflation contingency) are excluded. On the other hand, as in the cost estimate, consulting services costs and physical contingencies are estimated at 10% of the construction cost, respectively.

Note that tariffs and other factors cause price differences between the domestic and international markets. In order to convert the project costs estimated based on market prices into economic prices, a standard conversion factor (SCF) is calculated. In this analysis, the conversion factor is set at 0.96, as shown in the table below.

Table 3.103 Trade statistics and calculation of standard conversion factors (SCF)

Unit： '000Euro

	Item/ Formula	FY2019	FY2020	FY2021
a)	Import Amount	7,491,560	7,187,040	8,923,080
b)	Export Amount	3,841,000	3,841,000	4,785,840
c)	Import Duties	442,710	557,257	421,154
d)	Export Duties			920
e)	=a+b	11,332,560	11,028,040	13,708,920
f)	=(a+c)+(b-d)	11,775,270	11,585,297	14,129,154
SCF	=e/f	0.96	0.95	0.97
		SCF (Average)		**0.96**

Source: Prepared by JPT based on World Integrated Trade Solutions (WITS) and OECD website

f) Discount Rate and Residual Value

A discount rate of 10-12%[1] is generally used in economic analysis of development projects. However, the person in Minister of Finance and Budget advised JPT that projects in Senegal should be adapted 9% as a discount rate at JCC held in June 2025. Therefore in this analysis, a discount rate of 9% is used to perform a more conservative evaluation. Furthermore, the various facilities and equipment at a port are generally considered to generate benefits together. Therefore, the residual value of each individual facility and equipment after project development is set to 0.

Note that benefits that may arise from other facilities are not included (for example, offshore supply bases and fishing port reservoirs). The impacts of other facilities are expected to be relatively small compared to the benefits discussed here. Therefore, although they are included in the costs to obtain conservative results, they are not included in the benefits.

(3) Economic Analysis

a) Overall Picture of Benefits

The following two benefits (cost reductions) are quantified.

- Compared to Dakar Port (without project), Ndayane Multifunctional Port (with project) is designed to accommodate larger ships. ” with Project" allows more cargo to be transported at once, contributing to reductions in maritime transportation costs. Therefore, this is considered a benefit.
- In the case where the Ndayane Multifunctional Port is not constructed (without project), the increased cargo volume will be transported to Senegal by land from a distant alternative port (Abidjan). In the case of the Ndayane Multifunctional Port (with project), the distance to the hinterland is generally closer to each hinterland than the alternative port (Abidjan), and the benefit will be reduced land transport costs.

[1] “Research on economic evaluation methods in development studies – common edition” (Japan International Cooperation Agency, 2002)

In quantifying specific benefits, 26 scenarios were set for each terminal, import/export, hinterland, and shipping route, as shown in the table below, and calculations were made.

Table 3.104 Benefit Scenarios

Terminal	Im-Ex	Hinterland	Route	**Scenario**
Container	Export	SEZ4 & Mali	Europe/ Asia	**22**
	Import	Population5 & Mali		
RORO	Im / Ex	SEZ1. Diamniadio	Europe/ Asia	**2**
Bulk/General	Im/ Ex	Dakar	Europe/ Asia	**2**
			Total Scenario Numbers	**26**

Source: JPT

b) Calculation of Benefits

The unit values shown in the table below are used to calculate benefits.

Table 3.105 Basic units used in calculating marine transport costs

Cargo		Ship Type	Unit（Euro/Box day）
Container	20ft	1,000TEU	32.85
		4,000TEU	22.53
		6,400TEU	21.04
	40ft	1,000TEU	49.27
		4,000TEU	33.80
		6,400TEU	31.55
Cargo		Ship Type	Unit（Euro/Ship hour）
Vehicle		12,000DWT	460.55
		30,000DWT	707.13
Bulk/General		10,000DWT	460.55
		15,000DWT	544.01

Source: Guideline for Evaluation of Port Investment, 2017, Waterfront Vitalization and Environment Research Foundation

Table 3.106 Basic units used to calculate land transportation costs

Cargo Type		Euro	Unit
Container	20ft	1.42	Euro/box・km
	40ft	2.11	
Vehicle	Truck	4.65	Euro/Day・km
Bulk/ General	Truck	1.63	Euro/Day・km

Source: JPT based on USAID

The details of the benefit calculation for each terminal are described below in a) to c).

i. Benefits of Container Terminal

➢ Cargo Volume/Container Classification

The current cargo volume ratio was calculated based on PAD's statistical data (RAPPORT STATISTIQUES SYNTHESE 2017-2022) and the DPW M/P (2021). Based on this, the future cargo handling volume of 3.1 million TEU at Ndayane Port was allocated according to the benefit generation pattern.

➢ Land Transport: Setting Up the Hinterland

- As for exports, the items are diverse, including petroleum, polyphosphate, peanuts, and frozen fish, making it difficult to classify by industry. Therefore, focusing on the fact that companies located in SEZs generally export more than 50% of their products, it was assumed that exports would occur from each SEZ.
- As for imports, since assigning consumption areas to each item would result in segmentation, it was assumed for the sake of simplicity that consumption would be the population ratio, and the container ratio was calculated as a population ratio.

➢ Maritime Transportation: Setting Routes and Ship Types

Two routes were set up: Europe and Asia. In both Europe and Asia, France and China are the two destinations that account for the largest amount of trade for Serbia, and Marseille and Shenzhen, the main ports of those countries, were set as the starting and ending points of the maritime transport, respectively. The vessel type was assumed taking into account the DPW M/P (2021).

Table 3.107 Route/Ship Type Settings

Route	Project	Sea-Route	km	TEU
Europe	without	Marseille ⇔ Dakar	6,650	1,000
		Marseille ⇔ Abidjan	4,500	
	with	Marseille ⇔ Ndayane	4,535	4,000
Asia	without	Shenzhen ⇔ Dakar	20,000	4,000
		Shenzhen ⇔ Abidjan	4,500	
	with	Shenzhen ⇔ Ndayane	19,965	6,400

Source: JPT

ii. Benefit of RORO Terminal

➢ Cargo Amount

Similar to the Container Terminal, the current cargo volume ratio from PAD statistical data ("RAPPORT STATISTIQUES SYNTHESE" 2017-2022) was calculated. Based on this, the future cargo handling volume of Ndayane Port of 350,000 units was allocated according to the benefit generation pattern.

➢ Land Transport: Setting Up the Hinterland

The hinterland is assumed to be Diamniadio. The reason is that Dakar Terminal, the RORO terminal concessionaire at Pier 2 in Dakar Port, is operating there. The RORO terminal mainly handles completed vehicles. These completed vehicles are transported by land to Dakar Terminal's storage facility in Diamniadio[2]. This assumption is made because it was confirmed with the company that they will continue this operation even after the relocation to Ndayane Port.

➢ Maritime Transportation: Setting Routes and Ship Types

The import points were set based on the ratio of imported finished vehicles to imported destinations and the market share of each import destination in Senegal, with imaginary points A (Abidjan Port is farther than Ndayane Port) and B (Ndayane Port is farther).

- Point A: Routes arriving at each port from the north, such as Europe
- Point B: Routes arriving at each port from the south, such as Asia

The vessel types were set as follows, taking into account the DPW M/P (2021).

without : 12,000 DWT with : 30,000 DWT

iii. Benefit of Bulk – General Cargo Terminal

➢ Cargo Amount

Similar to the other terminals, the current cargo volume ratio from the estimate was calculated. Based on this, the future cargo handling volume of Ndayane Port of 6.35 million tons was allocated according to the benefit generation pattern.

➢ Land Transport: Setting Up the Hinterland

Creating patterns by item and consumption/producing country would result in an infinite number of patterns, so for simplicity's sake, we have assumed that consumption/production takes place in Dakar, which we consider to be a hinterland.

➢ Maritime Transportation: Setting Routes and Ship Types

The shipping routes were set in the same manner as for containers, after quantitatively confirming that most exports are to Europe and Asia, using the same procedure as for containers.

The ship size was set as follows, taking into account the DPW M/P (2021).

without : 10,000 DWT with : 15,000 DWT

c) Calculation of Costs

[2] Dakar Terminal (formerly Bollore Company Profile) p.45 and minutes of the meeting with the JICA survey team on July 5, 2023.

i. Project Cost

Since the economic analysis is conducted from the perspective of the national economy, taxes such as import duties and VAT are excluded from the costs used in the economic analysis. Therefore, taxes, etc. are excluded from the initial investment, and standard conversion factors are used to convert from market prices to economic prices. The project costs used in the economic analysis (for the short-term development plan, medium-term development plan, and long-term development plan) are shown in the table below.

Table 3.108 Project costs at economic prices ('000 Euro)

- Short-term development plan (up to 2030)

Year	2024	2025	2026	2027	2028	2029	2030
Construction	34,335	17,168	412,020	412,020	412,020	412,020	17,168
Physical Contingency	3,434	1,717	41,202	41,202	41,202	41,202	1,717
Consulting Services	3,434	1,717	41,202	41,202	41,202	41,202	1,717
Total	**41,202**	**20,601**	**494,425**	**494,425**	**494,425**	**494,425**	**20,601**
Local Currency	25,183	12,591	302,193	302,193	302,193	302,193	12,591
Foreign Currency	16,019	8,010	192,231	192,231	192,231	192,231	8,010

- Mid-term Development Plan (up to 2035)

Year	2030	2031	2032	2033	2034	2035
Construction	11,250	5,625	179,994	179,994	179,994	5,625
Physical Contingency	1,125	562	17,999	17,999	17,999	562
Consulting Services	1,125	562	17,999	17,999	17,999	562
Total	**13,500**	**6,750**	**215,993**	**215,993**	**215,993**	**6,750**
Local Currency	7,732	3,866	123,720	123,720	123,720	3,866
Foreign Currency	5,767	2,884	92,273	92,273	92,273	2,884

- Long-term development plan (up to 2047)

Year	2042	2043	2044	2045	2046	2047
Construction	17,862	8,931	214,343	214,343	214,343	214,343
Physical Contingency	1,786	893	21,434	21,434	21,434	21,434
Consulting Services	1,786	893	21,434	21,434	21,434	21,434
Total	**21,434**	**10,717**	**257,212**	**257,212**	**257,212**	**257,212**
Local Currency	12,270	6,135	147,244	147,244	147,244	147,244
Foreign Currency	9,164	4,582	109,967	109,967	109,967	109,967

Source: JPT

ii. Operation and maintenance costs

In addition to the project cost, operation and maintenance costs will include personnel costs, administrative costs, repair costs, and maintenance and dredging costs. For facilities and equipment with a useful life of less than 50 years, equipment renewal costs will be recorded taking into account the depreciation period of each. Operation and maintenance costs are set as shown in the table below.

Table 3.109 Operation and maintenance costs

Expense	Explanation
Personnel	Revenue×20%
Administration	Revenue×7%
Operation	Revenue×5%
Maintenance& Repair	Sum of below Infrastructure×1% Handling Equip.×3%
Renewal Cost	Categorized by Useful time 20years 10years 5years
Dredging	Based on required quantity

Source: JPT

d) Economic evaluation

i. Economic evaluation results

The results of the economic analysis of this M/P are shown in the table below. The discount rate in this M/P is 9%.

Note that it may take a certain amount of time to transition to the new operating system at each construction stage. Therefore, in order to prevent overestimation, it is assumed that it will take three years for a complete transition, and the annual benefit amounts for the first and second years of benefit generation have been adjusted (first year: 1/3, second year: 2/3).

Table 3.110 Economic analysis results

EIRR	B/C	NPV('000EURO)
29.98%	2.19	6,060,414

Source: JPT

ii. Sensitivity analysis

To confirm the feasibility of the project when the conditions of benefits and costs change, a sensitivity analysis was conducted for the following cases. The results are shown in the table below.

- Case 1) When costs (construction costs) increase by 10%
- Case 2) When benefits decrease by 10%
- Case 3) When the above two occur simultaneously

Table 3.111 EIRR Sensitivity Analysis Results

Base	Case1	Case2	Case3
29.98%	27.00%	26.69%	23.86%

Source; JPT

iii. Conclusion (Economic Analysis)

The EIRR exceeds the discount rate of 9%. B/C also exceeds 1.0. NPV is a positive value. Additionally, in the three cases of sensitivity analysis, all economic analysis indicators exceeded the benchmark values. From the above analysis results, it can be said that there are no issues with the efficiency of the project even if a certain degree of change in circumstances occurs.

Qualitative effects of this project include job creation through the construction and operation of the port, and a ripple effect on the region due to increased production in import-export related industries.

Table 3.112 EIRR calculation sheet

'000Euro

Year	Construction Cost			Maintenance and Operation Cost						Total Cost	Benefit			Total Benefit	Balance
	Phase1 Short	Phase2 Mid	Phase3 Long	Personal	Administration	Operation Expense	Maintenance and Repair	Renewal Cost	Dredgeing Cost		Container	RORO	Bulk・General Cargo		
2024	41,202									41,202					-41,202
2025	20,601									20,601					-20,601
2026	494,425									494,425					-494,425
2027	494,425									494,425					-494,425
2028	494,425			50,316	17,611	12,579	16,548		664	592,143	271,668			271,668	-320,475
2029	494,425			105,694	36,993	26,424	16,548		2,645	682,729	570,665			570,665	-112,064
2030	20,601	13,500		166,134	58,147	41,533	16,548		664	317,127	896,989			896,989	579,862
2031		6,750		182,891	64,012	45,723	16,548		2,645	318,569	937,980	56,514	42,246	1,036,741	718,172
2032		215,993		200,407	70,142	50,102	16,548		664	553,857	978,972	117,185	88,972	1,185,129	631,272
2033		215,993		218,703	76,546	54,676	16,548		2,645	585,111	1,019,964	182,013	140,178	1,342,154	757,043
2034		215,993		227,475	79,616	56,869	16,548		664	597,165	1,060,955	188,248	146,897	1,396,101	798,935
2035		6,750		236,087	82,630	59,022	22,547	16,071	2,645	425,752	1,100,955	194,493	153,616	1,449,065	1,023,313
2036				244,722	85,653	61,180	22,547		664	414,766	1,140,956	200,738	169,120	1,510,813	1,096,047
2037				253,381	88,683	63,345	22,547		2,645	430,602	1,180,956	206,983	184,623	1,572,562	1,141,959
2038				262,066	91,723	65,516	22,547		664	442,517	1,220,956	213,228	200,126	1,634,310	1,191,793
2039				270,777	94,772	67,694	22,547		2,645	458,436	1,260,956	219,473	215,629	1,696,058	1,237,623
2040				279,516	97,830	69,879	22,547	191,745	664	662,181	1,300,956	225,718	231,132	1,757,807	1,095,625
2041			21,434	287,166	100,508	71,792	22,547		2,645	506,093	1,334,742	232,276	246,636	1,813,653	1,307,560
2042			10,717	294,847	103,196	73,712	22,547		664	505,684	1,368,527	238,834	262,139	1,869,499	1,363,816
2043			257,212	302,559	105,896	75,640	22,547		2,645	766,499	1,402,312	245,392	277,642	1,925,346	1,158,847
2044			257,212	310,304	108,607	77,576	22,547		664	776,910	1,436,097	251,950	293,145	1,981,192	1,204,282
2045			257,212	318,084	111,329	79,521	22,547	75,553	2,645	866,891	1,469,882	258,509	308,648	2,037,039	1,170,148
2046			257,212	325,899	114,065	81,475	22,547		664	801,862	1,503,667	265,067	324,151	2,092,885	1,291,023
2047			10,717	338,649	118,527	84,662	31,235		2,645	586,436	1,537,452	271,625	339,655	2,148,731	1,562,295
2048				340,509	119,178	85,127	31,235		664	576,714	1,537,452	271,625	365,667	2,174,744	1,598,029
2049				342,444	119,855	85,611	31,235		2,645	581,790	1,537,452	271,625	392,694	2,201,771	1,619,981
2050				344,451	120,558	86,113	31,235	357,122	664	940,142	1,537,452	271,625	420,736	2,229,813	1,289,670
2051				344,451	120,558	86,113	31,235		2,645	585,001	1,537,452	271,625	420,736	2,229,813	1,644,811
2052				344,451	120,558	86,113	31,235		664	583,020	1,537,452	271,625	420,736	2,229,813	1,646,792
2053				344,451	120,558	86,113	31,235		2,645	585,001	1,537,452	271,625	420,736	2,229,813	1,644,811
2054				344,451	120,558	86,113	31,235		664	583,020	1,537,452	271,625	420,736	2,229,813	1,646,792
2055				344,451	120,558	86,113	31,235	216,981	2,645	801,982	1,537,452	271,625	420,736	2,229,813	1,427,830
2056				344,451	120,558	86,113	31,235		664	583,020	1,537,452	271,625	420,736	2,229,813	1,646,792
2057				344,451	120,558	86,113	31,235		2,645	585,001	1,537,452	271,625	420,736	2,229,813	1,644,811
2058				344,451	120,558	86,113	31,235		664	583,020	1,537,452	271,625	420,736	2,229,813	1,646,792
2059				344,451	120,558	86,113	31,235		2,645	585,001	1,537,452	271,625	420,736	2,229,813	1,644,811
2075				344,451	120,558	86,113	31,235	216,981	2,645	801,982	1,537,452	271,625	420,736	2,229,813	1,427,830
2076				344,451	120,558	86,113	31,235		664	583,020	1,537,452	271,625	420,736	2,229,813	1,646,792
2077				344,451	120,558	86,113	31,235		2,645	585,001	1,537,452	271,625	420,736	2,229,813	1,644,811
2078				59,695	20,893	14,924	31,235		664	127,411		271,625	420,736	692,361	564,950
2079				59,695	20,893	14,924	31,235		2,645	129,392		271,625	420,736	692,361	562,969
2080				59,695	20,893	14,924	14,687	16,348	664	127,211		271,625	420,736	692,361	565,150
2081				27,102	9,486	6,776	14,687		2,645	60,696			378,490	378,490	317,794
2082				23,786	8,325	5,947	14,687		664	53,409			331,764	331,764	278,355
2083				20,143	7,050	5,036	14,687		2,645	49,561			280,558	280,558	230,997
2084				19,642	6,875	4,911	14,687		664	46,778			273,839	273,839	227,061
2085				19,119	6,692	4,780	8,688	164,873	2,645	206,796			267,120	267,120	60,323
2086				18,572	6,500	4,643	8,688		664	39,068			251,616	251,616	212,549
2087				18,002	6,301	4,500	8,688		2,645	40,136			236,113	236,113	195,977
2088				17,406	6,092	4,351	8,688		664	37,201			220,610	220,610	183,409
2089				16,783	5,874	4,196	8,688		2,645	38,186			205,107	205,107	166,920
2090				16,133	5,647	4,033	8,688	10,345	664	45,510			189,604	189,604	144,094
2091				15,454	5,409	3,864	8,688		2,645	36,060			174,100	174,100	138,040
2092				14,745	5,161	3,686	8,688		664	32,945			158,597	158,597	125,653
2093				14,005	4,902	3,501	8,688		2,645	33,741			143,094	143,094	109,353
2094				13,231	4,631	3,308	8,688		664	30,522			127,591	127,591	97,069
2095				12,424	4,348	3,106	8,688	101,230	2,645	132,440			112,088	112,088	-20,353
2096				11,580	4,053	2,895	8,688		664	27,879			96,584	96,584	68,705
2097				5,802	2,031	1,450	8,688		2,645	20,616			81,081	81,081	60,466
														EIRR	**29.98%**

Note: The years 2060-2074 have been omitted.

Source: JPT

(4) Financial Analysis

a) Assumptions for Financial Analysis

Financial analysis calculates the profitability of the entire project. Cash in and cash out throughout the project period are estimated, and FCF (Free Cash Flow) is derived from the difference. Since this FCF does not take into account the time value of money, it is multiplied by a preset discount rate to get the present value (NPV, discounted present value). In addition, the FIRR at which NPV becomes 0 is calculated.

i. Project Period and Other Factors

The project period will be the same as in the economic analysis.

- Construction is scheduled to start in 2024 (first year).
- The container terminal will begin in 2028 (5th year).
- From 2031 (8th year), partial service for general cargo and provision of RORO terminals will begin. The revenue of the container terminal also begins.
- In 2036 (13th year), the use of container and general cargo terminals will be expanded, and profits will increase accordingly.
- In 2048 (25th year), all terminals and associated facilities will be in service.
- From here on, FCF will be measured up to 2097 (74th year), but the data necessary for various forecasts will be from 2047, and it will be assumed that there will be no additional increase in cash in/out.

ii. Setting the discount rate

As an example of fund procurement, the weighted average capital cost of 2.75%, which is the West African Central Bank's commercial bank lending rate used in the financial analysis of JICA (yen loan) and PIZ, will be used as the discount rate. Payments and interest payments will be fixed for 7 years, followed by repayment over 18 years (payment terms).

Table 3.113 Weighted Average Cost of Capital(WACC)

Funding Sources (Examples)	Interest Rate	Ratio	Interest Rate x Raio	Notes
JICA (Yen Loan)	1.95%	75%	1.46%	LDC or Poor Countries; General; Fixed Rate
West African Central Bank	2.75%	25%	0.69%	Interest as per financial analysis in PIZ
Weighted Average Cost of Capital（WACC)			**2.15%**	

Source: JPT

b) Calculation of Revenue

i. Cargo Handling Volume

In this chapter, JPT considers future cargo demand. In the financial analysis, the demand forecast

results are used to determine the volume of containers, vehicles, bulk and general cargo handled. Regarding the container terminal, since it was confirmed by DPW during a visit in July 2024 that the port is scheduled to open in 2028, it is assumed that the container terminal will be relocated to Ndayange Port from that year, and revenue will increase.

ii. Calculation of Revenue

Revenue which comes from Handling fee etc., are calculated by DPW tariff (2019) for the container terminal. Revenue in other terminals is calculated as below based on the hypothesis that other terminal operators also operate like DPW and pay Royalties to PAD at the same ratio.

- Based on Financial Statements of PAD, at first, JPT distributes PAD royalty to each terminal and develop each royalty unit per 1 cargo (1TEU, 1 Car, 1ton), shown as (A) at the table below.
- Based on DPW tariff, JPT assumes revenue of DPW and revenue unit per 1 TEU, shown as (B) at the table below.
- JPT develops the ratio, 14.32% by dividing (A)royalty unit by (B)revenue unit. This ratio would be the same for other terminals as DPW, container terminal. Then, JPT divides (A)royalty unit again by the ratio, 14.32%. This figure should be (B)revenue unit for other terminals, RORO terminal and Bulk/General cargo terminal.

Table 3.114 List of unit price developed in the calculation process

Terminal	(A)Royality	(B)Revenue	(A)/ (B)
Container Terminal	**€ 68.29** / TEU	**€ 476.97** / TEU	**14.32%**
RORO Terminal	**€ 62.99** / Car	**€ 439.94** / Car	**Same as 14.32%**
Bulk/General Terminal	**€ 2.85** / ton	**€ 19.88** / ton	

Source: JPT

- JPT multiplies 2 revenue unit for other terminals and cargo volume based by demand forecast, which become revenue forecast for RORO Terminal and Bulk/General Terminal.
- In calculating revenues from cargo handling charges the ship size was assumed to be the same as that used in the economic analysis.

c) Calculation of Costs

i. Project Cost

The costs in the financial analysis are estimated based on market prices. The project costs used in the financial analysis (short-term development plan, medium-term development plan, and long-term development plan) are shown in the table below.

Table 3.115 Project costs at market prices ('000Euro)

- Short-term development plan (up to 2030)

Year	2024	2025	2026	2027	2028	2029	2030
Construction	39,476	19,738	473,711	473,711	473,711	473,711	19,738
Physical Contingency	3,948	1,974	47,371	47,371	47,371	47,371	1,974
Consulting Services	3,948	1,974	47,371	47,371	47,371	47,371	1,974
Total	**47,371**	**23,686**	**568,453**	**568,453**	**568,453**	**568,453**	**23,686**

- Mid-term Development Plan (up to 2035)

Year	2030	2031	2032	2033	2034	2035
Construction	12,856	6,428	205,703	205,703	205,703	6,428
Physical Contingency	1,286	643	20,570	15,428	20,570	643
Consulting Services	1,286	643	20,570	15,428	20,570	643
Total	**15,428**	**7,714**	**246,844**	**246,844**	**246,844**	**7,714**

- Long-term development plan (up to 2047)

Year	2041	2042	2043	2044	2045	2046	2047
Construction	20,412	10,206	244,946	244,946	244,946	244,946	10,206
Physical Contingency	2,041	1,021	24,495	24,495	24,495	24,495	1,021
Consulting Services	2,041	1,021	24,495	24,495	24,495	24,495	1,021
Total	**24,495**	**12,247**	**293,935**	**293,935**	**293,935**	**293,935**	**12,247**

Source: JPT

ii. Operation and Maintenance Costs

Operation and maintenance costs are calculated using the same principles as in the economic analysis. Interest was recorded in line with the payment terms.

d) Financial Evaluation

i. Financial Evaluation Results

The results of the financial analysis of this M/P are shown in the table below. WACC is 2.15%. As in the economic analysis, since it may take a certain amount of time to transition to the new operating system at each construction stage, in order to avoid overestimation, we have assumed that it will take three years for the transition to be complete and adjusted the annual revenue amounts for the first and second years after construction of each terminal (first year: 1/3, second year: 2/3).

Table 3.116 Financial analysis results

FIRR	NPV('000EURO)
20.38%	22,489,808

Source: JPT

ii. Sensitivity Analysis

In order to confirm the feasibility of the project when revenue and cost conditions change, a sensitivity analysis was conducted for the following cases. The results are shown in the table below.

- Case 1) When costs (construction costs) increase by 10%
- Case 2) When revenues decrease by 10%
- Case 3) When the above two occur simultaneously

Table 3.117 FIRR Sensitivity Analysis Results

Base	Case1	Case2	Case3
20.38%	17.91%	18.55%	16.23%

Source: JPT

iii. Conclusion (Financial Analysis)

The FIRR exceeds the discount rate of 2.15%. The NPV is also positive. All financial analysis indicators exceed the benchmark figures in the three cases of sensitivity analysis. From the above analysis results, it can be said that there will be no issues with the profitability of the project even if certain changes in circumstances occur.

Table 3.118 FIRR calculation sheet

'000 Euro

年	建設費			運営・維持管理費						営業外	費用計	収益			収益計	収益－費用
	Phase1 短期	Phase2 中期	Phase3 長期	人件費	事務費	運営費	修繕費	更新費	浚渫費用	利息		コンテナ	RORO	バルク・一般		
2024	47,371									82,314	129,685					-129,685
2025	23,686									82,314	105,999					-105,999
2026	568,453									82,314	650,766					-650,766
2027	568,453									82,314	650,766					-650,766
2028	568,453			52,330	18,316	13,083	18,960		745	82,314	754,200	261,650			261,650	-492,549
2029				109,924	38,474	27,481	18,960		2,969	82,314	280,122	549,621			549,621	269,500
2030		15,428		172,782	60,474	43,196	18,960		745	82,314	393,899	863,912			863,912	470,014
2031		7,714		190,224	66,578	47,556	18,960		2,969	82,314	416,316	903,392	32,006	15,723	951,121	534,806
2032		246,844		208,470	72,965	52,118	18,960		745	79,981	680,083	942,872	66,367	33,113	1,042,352	362,269
2033		246,844		227,521	79,632	56,880	18,960		2,969	77,584	710,391	982,352	103,081	52,171	1,137,604	427,214
2034		246,844		236,623	82,818	59,156	18,960		745	75,121	720,268	1,021,832	106,613	54,671	1,183,117	462,849
2035		7,714		245,536	85,938	61,384	25,833	17,400	2,969	72,590	519,364	1,060,357	110,150	57,172	1,227,679	708,315
2036				255,102	89,286	63,776	25,833		745	69,990	504,732	1,098,883	113,686	62,942	1,275,511	770,779
2037				264,669	92,634	66,167	25,833		2,969	67,319	519,591	1,137,408	117,223	68,712	1,323,343	803,752
2038				274,235	95,982	68,559	25,833		745	64,574	529,928	1,175,933	120,760	74,482	1,371,175	841,247
2039				283,801	99,330	70,950	25,833		2,969	61,753	544,638	1,214,458	124,297	80,252	1,419,007	874,369
2040				293,368	102,679	73,342	25,833	207,600	745	58,855	762,421	1,252,983	127,833	86,022	1,466,838	704,417
2041			24,495	301,772	105,620	75,443	25,833		2,969	55,877	592,010	1,285,523	131,548	91,792	1,508,862	916,852
2042			12,247	310,177	108,562	77,544	25,833		745	52,817	587,926	1,318,062	135,262	97,561	1,550,885	962,959
2043			293,935	318,582	111,504	79,645	25,833		2,969	49,673	882,141	1,350,601	138,976	103,331	1,592,908	710,767
2044			293,935	326,986	114,445	81,747	25,833		745	46,443	890,134	1,383,140	142,690	109,101	1,634,932	744,798
2045			293,935	335,391	117,387	83,848	25,833	81,800	2,969	43,124	984,286	1,415,680	146,404	114,871	1,676,955	692,669
2046			293,935	343,796	120,328	85,949	25,833		745	39,713	910,299	1,448,219	150,118	120,641	1,718,978	808,679
2047			12,247	352,200	123,270	88,050	35,787		2,969	36,209	650,733	1,480,758	153,832	126,411	1,761,001	1,110,268
2048				354,137	123,948	88,534	35,787		745	32,608	635,759	1,480,758	153,832	136,092	1,770,683	1,134,923
2049				356,148	124,652	89,037	35,787		2,969		608,594	1,480,758	153,832	146,151	1,780,741	1,172,148
2050				358,236	125,382	89,559	35,787	386,651	745		996,361	1,480,758	153,832	156,587	1,791,178	794,817
2051				358,236	125,382	89,559	35,787		2,969		611,933	1,480,758	153,832	156,587	1,791,178	1,179,244
2052				358,236	125,382	89,559	35,787		745		609,709	1,480,758	153,832	156,587	1,791,178	1,181,468
2053				358,236	125,382	89,559	35,787		2,969		611,933	1,480,758	153,832	156,587	1,791,178	1,179,244
2054				358,236	125,382	89,559	35,787		745		609,709	1,480,758	153,832	156,587	1,791,178	1,181,468
2055				358,236	125,382	89,559	35,787	234,922	2,969		846,856	1,480,758	153,832	156,587	1,791,178	944,322
2056				358,236	125,382	89,559	35,787		745		609,709	1,480,758	153,832	156,587	1,791,178	1,181,468
2057				358,236	125,382	89,559	35,787		2,969		611,933	1,480,758	153,832	156,587	1,791,178	1,179,244
2058				358,236	125,382	89,559	35,787		745		609,709	1,480,758	153,832	156,587	1,791,178	1,181,468
2059				358,236	125,382	89,559	35,787		2,969		611,933	1,480,758	153,832	156,587	1,791,178	1,179,244
2075				358,236	125,382	89,559	35,787	234,922	2,969		846,856	1,480,758	153,832	156,587	1,791,178	944,322
2076				358,236	125,382	89,559	35,787		745		609,709	1,480,758	153,832	156,587	1,791,178	1,181,468
2077				358,236	125,382	89,559	35,787		2,969		611,933	1,480,758	153,832	156,587	1,791,178	1,179,244
2078				62,084	21,729	15,521	35,787		745		135,867		153,832	156,587	310,420	174,553
2079				62,084	21,729	15,521	35,787		2,969		138,091		153,832	156,587	310,420	172,329
2080				62,084	21,729	15,521	16,827	17,700	745		134,607		153,832	156,587	310,420	175,813
2081				28,173	9,861	7,043	16,827		2,969		64,873			140,864	140,864	75,991
2082				24,695	8,643	6,174	16,827		745		57,084			123,474	123,474	66,390
2083				20,883	7,309	5,221	16,827		2,969		53,210			104,417	104,417	51,207
2084				20,383	7,134	5,096	16,827		745		50,186			101,916	101,916	51,730
2085				19,883	6,959	4,971	9,954	178,506	2,969		223,243			99,415	99,415	-123,827
2086				18,729	6,555	4,682	9,954		745		40,666			93,645	93,645	52,979
2087				17,575	6,151	4,394	9,954		2,969		41,044			87,875	87,875	46,832
2088				16,421	5,747	4,105	9,954		745		36,973			82,106	82,106	45,132
2089				15,267	5,343	3,817	9,954		2,969		37,351			76,336	76,336	38,985
2090				14,113	4,940	3,528	9,954	11,200	745		44,480			70,566	70,566	26,085
2091				12,959	4,536	3,240	9,954		2,969		33,658			64,796	64,796	31,138
2092				11,805	4,132	2,951	9,954		745		29,588			59,026	59,026	29,438
2093				10,651	3,728	2,663	9,954		2,969		29,965			53,256	53,256	23,291
2094				9,497	3,324	2,374	9,954		745		25,895			47,486	47,486	21,591
2095				8,343	2,920	2,086	9,954	109,600	2,969		135,873			41,716	41,716	-94,156
2096				7,189	2,516	1,797	9,954		745		22,202			35,946	35,946	13,744
2097				6,035	2,112	1,509	9,954		2,969		22,580			30,176	30,176	7,596
															FIRR	**20.38%**

Note: The years 2060-2074 have been omitted.

Source: JPT

3.13 Formulation of M/P of Port Industrial Zone at Ndayane

3.13.1 Survey of Existing Conditions

3.13.1.1 Senegal's National Strategy

(1) Plan Sénégal Emergent

The country of Senegal established the Plan Sénégal Emergent (Plan Sénégal Émergent; hereinafter referred to as "PSE") with the goal of becoming an emerging country by 2035 was formulated in January 2014, and since 2014, the PSE has been the cornerstone of the country's economic and social development plan.

The PSE is subdivided into five-year Priority Action Plans (PAPs), with the 2014-2018 period being PAP 1 and the 2019-2023 period being PAP 2. In the second phase of the PAP, the three strategic pillars of PSE, 1) Economic Structural Transformation and Growth, 2) Human Capital, Social Security, and Sustainable Development, and 3) Governance, Institutions, Peace, and Security, are being followed, and various infrastructure and other infrastructure development projects are being promoted based on these strategies.

Currently in Phase 2, the plan was revised to focus on economic resilience in response to the COVID-19 crisis. Under the plan, the country aims to achieve an average economic growth rate of 8.7% between 2021 and 2023 by promoting private investment, diversifying growth engines, and strengthening economic resilience.

a) Strategic Direction

The PSE, with a target year of 2035, is a new development model that will serve as a reference for medium- and long-term economic and social policies to accelerate progress toward emerging economies. The following three axes have been set forth as the direction of this strategy.

To strengthen the current growth engines and to transform the economy structurally by developing new sectors with strong capacity to generate wealth, jobs, social inclusion, and attract exports and investment. *This axis is part of a more balanced development option that promotes the development of viable economic areas to stimulate development potential throughout the country.

Significant improvements in the living conditions of the population, a more sustained fight against social inequalities, while maintaining the resource base and promoting the emergence of viable neighborhoods.

To promote security, stability, strengthening of governance, protection of rights and freedoms, and strengthening of the rule of law in order to create the best conditions for social peace and to promote the full development of potential.

b) Industrial development

PSE intends to position the Senegalese country as a logistics and industrial hub for industrial products and services for the West African market, particularly Mali, to maximize the country's geographical

advantages and industrialization, which is essential for the long-term balance of trade adjustment. In particular, it aims to foster industries in the fields of agri-food, textiles, and building materials, and to form high value-added manufacturing clusters. It also aims to become one of the top three French-speaking service outsourcing centers in Africa.

The Diamniadio SEZ is supposed to serve as a multifunctional platform for such activities, with one of its objectives being to encourage companies to relocate outside the capital, diversify their activities, and attract new investors.

c) Strengthen logistics infrastructure and infrastructure

The PSE indicates the need for infrastructure development based on the following perspectives to accommodate the future economic growth of the Senegalese country.

Structural networking for a more balanced development of the region by promoting hubs of economic activity in the agro-pastoral, mining, tourism, and fisheries sectors

Improve competitiveness of production areas by building a rural road network

Development of an integrated intermodal transportation network (road, air, rail, sea, river)

Enhancing economic competitiveness through trade promotion by strengthening infrastructure to sub-regional markets

The transportation sector, in particular, also faces problems such as an uneven and deteriorating road network, inadequate public transportation services in urban areas, aging vehicle and rail infrastructure (small suburban trains, Dakar-Bamako line), and poor concessions between Dakar and Bamako. To address this issue, the following are being considered as integrated logistics hubs.

- Revitalization of the corridor by restoring the rail line between Dakar and Bamako
- Modernization of the Port of Dakar to increase container throughput in response to trade growth
- Further facilitation of domestic and regional logistics through the construction of multiple logistics platforms (transit cargo handling facilities and warehouses for landlocked countries)

A proposal to expand the container terminal to the outer port of Dakar was previously considered, but as of 2022, the development of a container terminal at the port of Ndayane by DPW has materialized as an alternative. The PSE's Priority Action Plan (PAP 2, 2019-2023) also identifies the development of Ndayane Port as an infrastructure for maritime transport services, and it is expected that the port will be responsible for improving container throughput as described above.

(2) Industrial Senegal - Senegal's industrialization policies and strategies 2021-2035 (Le Sénégal Industriel - Politique et stratégie d'industrialisation du Sénégal 2021- 2035

Industrial Senegal, hereafter referred to as "SI", is the policy and strategy that combines import substitution to proactively secure Senegal's food and medicine, and promotion of export and development of Senegal's mineral resources and carbohydrates. This strategy takes into account the supreme imperative to maximize the contents that the regions have and to develop new growth axes

of industrialization. It also focuses on the strategic positioning on the global and West African regional value chain.

a) Strategic policy

The SI aims to industrialize the country by 2035, with the following strategic policies.

b) Vision

Formation of a competitive industry, driven by a strong national private sector, that contributes to inclusive and sustainable development.

c) Long-term results

i. Job creation in the industrial sector: 32,000 to 35,000 jobs per year (13.5% to 20% of new employment),
ii. Leverage effect: rate of public investment is 1/5 of private investment,
iii. Annual growth rate of private investment in industry: indicator not yet determined,
iv. Employed labor productivity: 7,600 FCFA in 2016 to 22,000 FCFA in 2035,
v. Senegalese economy competitiveness index: 49 points in 2018 to 70 points in 2035 (maximum 100 points)
vi. Innovation index: 23.75 points in 2018 to 40 points in 2035 (maximum 100 points)

d) 4 vertical axes and 6 horizontal axes

The SI is supported by four vertical axes as main axes and six supporting horizontal axes.

The four main axes are the choices to be made and priority activities to be taken for industrial development until 2035, according to the report.

Table 3.119 Four Main Axes in Senegal's Industrialization Policy and Strategy

Axis	Contents	Short-term Indicators
Axis 1	Primary products processing (agriculture, forestry, fisheries)	Processing rate of primary products from 13% in 2017 to 25% in 2025
Axis 2	Industrial processing of mining resources and hydrocarbons (*hydrocarbure*)	50% of local content to extractive industries activities Per capita consumption of household products from 4.2 tons in 2008 to 5 tons in 2023
Axis 3	Pharmaceutical industry and drug Development	Emergence of 2 or 3 industries in the packaging segment Formation of at least 5 business entities in 5 years starting in 2021 Domestic production to meet 20% of demand by 2025
Axis 4	Development of highly technology-intensive and innovative industries Specifically, digital economy, assembly industry, creative industry	Industries of highly intensive technology will account for 15% of the processing industry sector GDP in 2025.

Source: JPT, based on "Industrial Senegal: Senegal's Industrialization Policies and Strategies 2021-2035.

The horizontal axis of this policy is reforms to leverage industrialization. The SI believes that the four main axes cannot be achieved without reforms. The reform targets are as follows.

(A)Improvement of business environment for industrialization

(B)Strengthening capabilities in technical, technological, commercial and innovation at the industrial units

(C)Development of human capital

(D)Development of infrastructures

(E)Facilitation of access to funds and encouragement of private investment

(F)Governance framework and implementation

e) Application of the SI to the Ndayane PIZ M/P

This M/P proposes in the section 1.1.3.3 Industry to be attracted proposes the attractive industries based this SI.

3.13.1.2 Senegalese Laws, Regulations, and Institutions related to Hinterland Development

(1) Special Economic Zone (SEZ, French: zone économique spéciale : ZES)

a) What is SEZ?

World Bank (2008) as "geographically delimited areas administered by a single body, offering certain incentives (generally duty-free importing and streamlined customs procedures, for instance) to businesses which physically locate within the zone." Further, UNIDO (2015) defines SEZ as "estates where trade laws such as tariffs, quotas or duties differ from the rest of the country." The reasons for granting incentives to SEZ are the following:

(i) To make it easier to achieve goals set by higher policies and plans that cannot be realized at present

(ii) To resolve national-level economic issues.

SEZs are not limited to the manufacturing industry but are applied to a wide variety of industries including finance, distribution (logistic), and tourism. However, in many developing countries, they are commonly applied to secondary industries, mainly manufacturing industries. Ndayane PIZ is one of the SEZs focusing on the manufacturing industry.

There are typically three main targets for establishing a SEZ: namely (i) promotion of exports, (ii) job creation, and (iii) technology improvement including the introduction of new industries. In some cases, correction of interregional economic disparities is also a goal, but cases of success in SEZs based on the projection of the location of manufacturing industries are still rare.

The development of SEZs differs from ordinary industrial park development in the following two aspects.

(i) SEZs are developed with the objective of realizing national policy.

(ii) Private sector enterprises related to SEZs are granted incentives from the governments concerned.

b) Positioning of SEZs in the National Strategy

In the Axis 1 of the PSE, "Structural Transformation of the Economy and Growth," it proposes the establishment of a platform for industrial development, and specifically recommends the development

of a Diamniadio SEZ that will build a multifunctional platform.

c) Legal framework

Laws and decrees (presidential decrees) governing establishment and operation of SEZs are in force in Senegal. The SEZ-related laws and regulations presently in effect are summarized in the table below.

Table 3.120 SEZ- Senegalese Laws and Decrees relating to SEZ

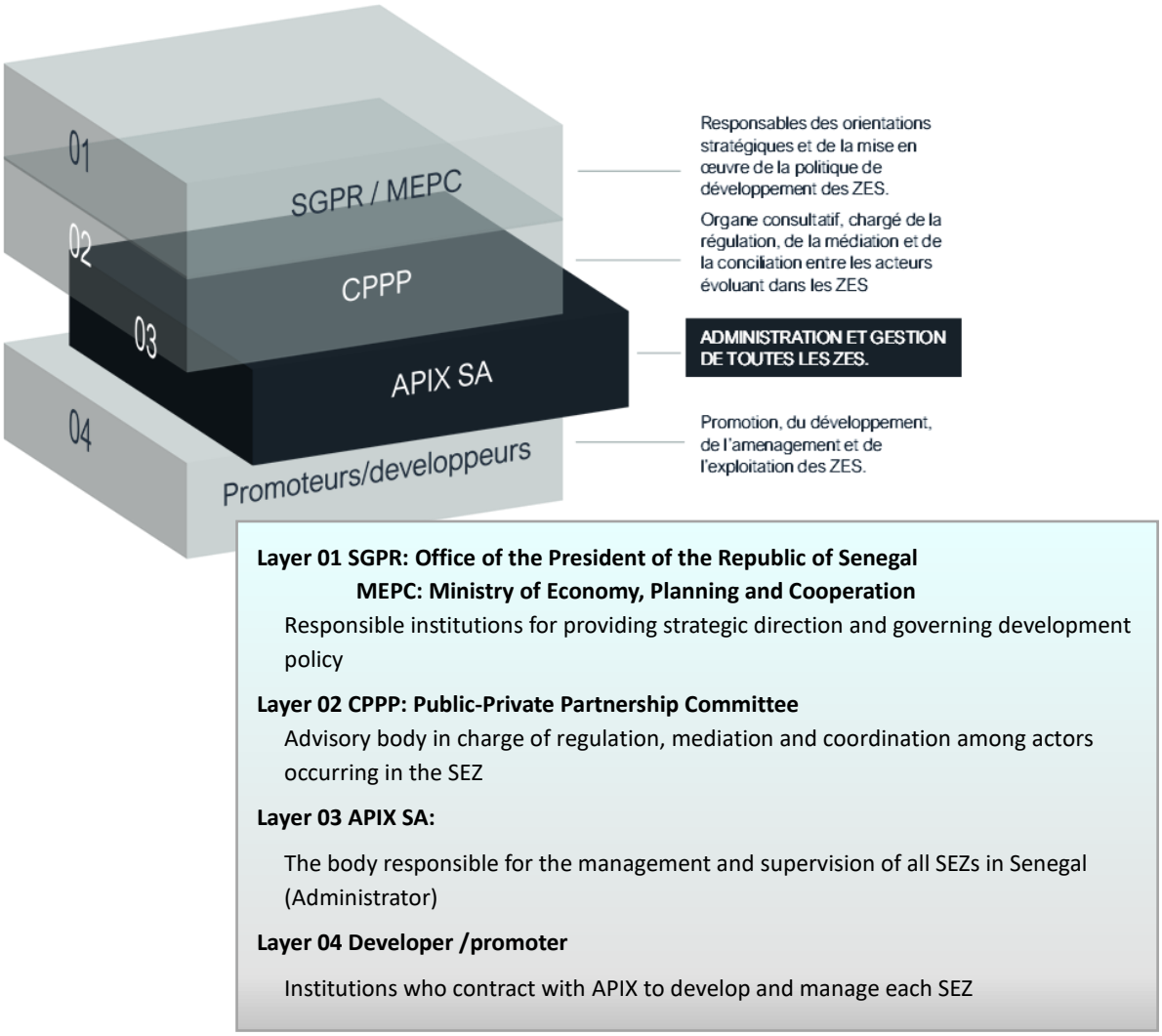
Title of Laws and Decrees	Description.	Main contents
Law No. 6 of 2017 on Special Economic Zones (ZES) (January 6, 2017) *Loi n° 6 2017-06 du 06 janvier 2017 portant sur les zones économiques spéciales (ZES)*	A law that should be regarded as the basic law for the establishment of SEZ at present.	・ SEZ establishment and boundaries ・ SEZ governing framework ・ SEZ tenant companies and eligible economic activities ・ Appeals and dispute resolution
Law No. 7 of 2017 on incentives applicable in special economic zones (January 6, 2017) *Loi n°2017-07 du 06 janvier 2017 portant dispositif d'incitations applicable dans les zones économiques spéciales*	Regulations on the incentives in SEZs	・ Land ownership in SEZ ・ Taxation and tariffs in the SEZ ・ Foreign exchange provisions ・ Exemptions pertaining to labor laws ・ Electricity usage
Decree No. 2017-534 on the organization and regulation of the functioning of committees composed of public and private partnership (April 13, 2017). *Décret portant création et fixant les règles d'organisation et de fonctionnement du Comité paritaire public-privé*	Details of public-private representative committees for coordination, mediation, and reconciliation, as provided in the SEZ Law.	・ Composition of Public-Private Representative Committee ・ Institution of the Public-Private Representative Committee ・ Functions of Public-Private Representative Committees ・ Financial basis
Decree No. 2017-535, Decree on the Application of Law No. 6 of 2017 (April 13, 2017). *Décret portant application de la loi n°2017-6 du 06 janvier 2017 portant sur les zones économique spéciales (ZES)*	Means of concrete application of the SEZ Law	・ Selection of SEZ Promoter/Developer ・ Requirements for SEZ tenants ・ Rights and obligations of SEZ tenants ・ Procedures for prior authorization and reception of permits for the implementation of activities authorized in the SEZ ・ Measures related to environmental norms applicable in the SEZ ・ Social responsibility of SEZ-related actors ・ Evaluation of companies, promoters/developers and administrators
Decree on the establishment of each SEZ (Presidential Decree)	Establishment of each SEZ and establishment of specific regulations	・ Location and boundaries of the target SEZ ・ Eligible activities ・ Selection criteria for tenants, ・ No mention of promoter/developer

Source: JPT

It is assumed that PAD will apply the draft Decree of Ndayane PIZ to APIX based on this M/P proposed by the JPT, and that it will be approved and enforced through the procedures stipulated by the laws and decrees and APIX's Lite of Procedures (*Liste des procedure de l'APIX*).

d) SEZ Governance Framework

The following figure shows the legal governance framework of the SEZ.



Source: Created by JPT based on APIX documents

Figure 3.130 SEZ Governance Framework

e) SEZ Actors (parties involved)

The roles of each of the main actors in the SEZ are shown below.

Table 3.121 Actors in the SEZ

Role	Duties	Responsible organization
Ministry of Economy, Planning and Cooperation (*Ministère de l'économie, du planning, et de la coopération*)	There is no fixed department in charge of SEZ. Minister and undersecretary control overall SEZ issues.	Ministry of Economy, Planning and Cooperation
Public-Private Partnership Committee (*Le Comité paritaire public-privé*)	It consists of relevant ministries (Ministry of Economy, Planning and Cooperation, Ministry of Finance, Ministry of Industry, Ministry of Environment), APIX, promoters/developers of each SEZ, and tenant companies. The meeting is held every three months to discuss the results and issues of each SEZ, as well as the establishment of new SEZs.	(Public-Private Partnership Commitee)
Administrator	Attracting investment Select one or more, public or private SEZ promoters/developers Promoting a business and living environment of high quality in the SEZ Coordination with other ministries and agencies Assurance that the SEZ area is defined and maintained in accordance with the law Approval of SEZ tenants, issuance of permits and licenses, and monitoring of activities Interface between tenant companies and central government agencies and public services Management and supervision of SEZ operations through one-stop service Management of SEZ sites	APIX (*Agence pour la promotion des investissements et des grands travaux)*, an agency under the Ministry of Economy, Planning and Cooperation
Promoter/Developer	Carrying the following operations with the approval of the MEPC, the Ministry in charge of Investment Licensing and Promotion, after concluding a convention (concession contract) with the Administrator. ・ Construction of factory buildings and other infrastructure inside the SEZ, ・ Provision of services in the SEZ as needed by the tenant companies, ・ Marketing and sales promotion of SEZ to domestic and foreign investors, ・ Management of locations and assets in SEZs belonging to themselves	Different in each SEZ The Ndayane PIZ assumes PAD
SEZ Tenants	Any economic entity registered as a legal entity in Senegal can be qualified as SEZ tenant company under the following conditions ・ Receipt of consent form issued by the Administrator ・ Receipt of land (or factory, if renting a factory) lease agreement with the promoter/developer of the SEZ in concern.	

Source: JPT

f) Type of industry

Decree No. 2017-535 defines the main vocations of the SEZs as agro-business, industry, digital economy, tourism, the provision of medical services, and related services.

Each SEZ also defines its own eligible activities or *activités éligibles*, which are the industries to be selected for occupancy, by its own decree. See Figure 2.13 for each SEZ.

g) Incentives

In general, for the purpose of attracting domestic and foreign companies to SEZ development, SEZ sets up incentives by providing various privileges to promote establishing business in the SEZ. Applicable incentives can be broadly divided into "tax incentives" and "procedural deregulation incentives. The former is a measure to reduce or exempt taxes, for a certain period, imposed on companies locating and doing business in a SEZ, and the latter is a measure to increase convenience for tenant companies by establishing a one-stop service (French: *guichet unique*) in the SEZ to serve as a window for the various procedures necessary for companies to locate and operate in the SEZ and handle them all together. The latter is a measure to enhance the convenience of companies by establishing a one-stop service (guichet unique) in the SEZ to serve as a single point of contact for all procedures necessary for tenant companies to locate and operate. In many cases, SEZs impose some kinds of restrictions on the type of industry, etc., to tenant companies in order to achieve results through their policies, and incentives can be interpreted as a kind of guarantee against such restrictions.

According to Senegalese legislation, SEZs are divided by the Administrator into Zone A, where tax incentives are applied, and Zone B, where they are not. Tenant companies that are approved to occupy Zone A receive tax exemptions and are exempt from customs duties and domestic taxation. The preferential period is 25 years, after which only one renewal is permitted. Among the tenant companies, those who purchase, process, or sell hydrocarbon (petroleum products), or those who operate banking, finance, or insurance businesses in Zone A are not eligible for receiving incentives, except those who specialize in export.

The Law on the incentive measures applicable in the SEZ *(Loi n°2017-07 du 06 janvier 2017 portant dispositif d'incitations applicable dans les zones économiques spéciales,* 2017) provides that "enterprises eligible for receiving incentives are entitled to exemption from all taxes (taxes and indirect taxes levied on each taxpayer, and taxes and fees (fr. *droit)* collected in exchange for the award of permits and licenses) except local levies, and cross-border", and these enterprises enjoy the export of goods to regions beyond the national borders. Subjects include goods, products, primary raw materials, equipment, and services.

- In accordance with the provisions of the General Tax Law, taxable income is subject to corporate income tax at a rate of 15% (reduced from 30%).
- An additional tax of 3% is imposed on income in the customs territory (outside the SEZ).
- Permission to import goods, products, primary commodities, equipment, etc. with tax exemption. Domestic taxes, excluding local surcharges, and customs duties on their exports are exempted. All end products recognized in Zone A are exempt from paying the tax. When exporting, goods staying in Zone A are free from all taxes and export duties.

- Taxes and customs payments collected for state and municipal budgets are exempt from taxation. Examples: income on securities, employer-paid fixed contributions or other taxes based on company-paid wages, etc.

The law also allows for exemptions to the provisions of the Labor Code.

- Exceptions to the application of the legal working period: transfer of working hours, extension of working hours, etc.
- Exemptions from the application of labor laws pertaining to fixed-term employment contracts:
- Elimination of prior administrative authority in case of dismissal for economic reasons or due to internal reorganization
- There is no mention of simplification of other procedures.

h) One-Stop Service

The SEZ Law stipulates that the Administrator shall establish a one-stop service (French: *guichet unique*) to manage the SEZ. The cornerstone of the incentive application is introduction of the One-Stop Service (OSS), which allows tenant companies to handle all administrative procedures necessary to move in and operate in the SEZ. OSS therefore plays an important role mainly in the operational phase of the SEZ. OSS is considered as one of the reasons for companies to decide to move into an SEZ, because it is unlike ordinary industrial parks.

The procedures required for a company to enter a SEZ are divided into (i) investment approval and (ii) various other administrative procedures. Obtaining investment approval is the most important procedure for companies wishing to enter the SEZ, and other procedures are required after approval is obtained. The main services implemented in the OSS of SEZs in many countries include the following activities.

Investment Permits

Investment approval, renewal or amendment procedures

Various procedures after investment approval

- Procedure for amendment of company establishment registration
- Issuance, renewal, or modification of business conduct permits or commercial licenses
- Work permit
- Preparation of recommendation letters for visa issuance
- Environmental Permit
- Infrastructure connection permission
- Export and import license
- Tax collection, exemptions

In addition to these services, many other services are provided according to the actual conditions and

needs of each country and each SEZ.

In the four SEZs currently operating in Senegal, APIX has opened a one-stop service in the Diamniadio SEZ, but not in the other three SEZs which are managed by the Diamniadio OSS. This is different from the purpose of the OSS, which is to complete procedures for various administrative services within the SEZ, and it may be less attractive to businesses.

The Diamniadio SEZ and three other SEZs handle following activities: applications for investment in SEZs, procedures for occupancy of authorized companies, issuance of registration numbers for taxes, issuance of work permits, approval of employment conditions, issuance of construction permits, issuance of visas and residence permits, import and export taxes, and issuance of certificates of origin. On the other hand, there is no sanitation control. Therefore, it is essential for APIX and related ministries to establish an OSS that fulfills these functions within the SEZ in order to facilitate the attraction of companies in the Ndayane PIZ.

i) Issues

The SEZ in Senegal renewed its legal system in 2017, and four SEZs are established and tenant companies moving in and occupying them. However, according to the interviews with APIX, not much goals have been accomplished at this point due to (i) insufficient infrastructure in the SEZ and (ii) difficulties in importing hydrocarbon feedstock due to the abandonment of export contracts by Covid-19 and the war in Ukraine.

A JETRO's report shows an example. It indicates that smooth operations, especially with regard to incentives, are problematic in terms of inconsistency between the target industries to attract and institutional design, infrastructure development, and environmental management. Ndayane PIZ M/P should take these points into consideration.[3] Infrastructure such as drains and roads are not constructed. Appropriate placement of industries is not being done. Air pollution is also observed, and environmental and social considerations are inadequate.

For example, officials of Sandiara city, Sandiara SEZ promoter/developer, told JETRO officials who visited the site that they do not address environmental regulations, water quality and soil management in the SEZ as a whole.

Also, SENELC's Coal Power Plant constructed near the Bargny-Sendou SEZ also has a history of causing air pollution and discharging untreated water. They did not conduct livelihood restoration activities for the affected residents, causing opposition movement among them. As a result, the plant has rarely operated since its completion. In development projects in Senegal, there is a need to increase the awareness and implementation capacity of implementing agencies with regard to environmental

[3]JETRO Regional and Analytical Report, "Exploring the Attractiveness and Challenges of West Africa's Largest Special Economic Zone (Senegal)," March 30, 2023

and social considerations.[4]

(2) Public-Private Partnership (PPP)

a) Legal framework

The Senegalese legislation on Public Private Partnership (hereinafter reffered to as PPP) consists of Law No. 23 of 2021 on PPP contracts "*Loi n° 2021- 23 du 02 mars 2021 relative aux contrats public-privé*", considered as the basic law of PPP in Senegal, and Decree No. 2021-1443 « *Décret n° 2021-1443 portant application de la loi n°2021-23 du 02 mars 2021 relative aux contrats de partenariat public-privé* ». The responsible agency for PPP is the National Unit of Assistance for Public-Private Partnership (*Unité nationale d'appui aux partenariat public-privé*, UNAPPP), a national unit for PPP support under the Ministry of Economy, Planning and Cooperation. The UNAPPP is a new organization established in accordance with the provisions of the Law and is neither in charge of supervising concession contracts made under the old Law, nor does it take over the information.

Below is an overview of the legal framework of PPP.

- PPP in Senegal refers to concession and *affermage.* Although there is no mention of BOT, BTO, or other methods specifically involving ownership of the subject facility, the system is designed to address these in effect.[5]
- PPP is defined as a written, paid contract between the contracting public agency and the economic operator (*opérateur économique*) [6] for a defined fixed term. Depending on the form of compensation of the nominee and the risk transferred, there are "PPP agreements with payment from the public," and "PPP agreements with payment from the facility user.[7]
- Concession is defined as a contract in which the contracting public agency outsources work to a concessionaire. The scope of work is the development of public facilities, the execution of investments to such facilities, and the management of the facilities with a view to guaranteeing services for the benefit of the whole. In all of these cases, the concessionaire performs the services under its own name and at its own risk and receives remuneration from users of the facility or the beneficiary of the authorized services (PPP contract paid by the facility user).
- When a PPP contract involves occupation of public lands, it gives (the concessionaire) the right to occupy the lands for the term of the contract.

[4]Republic of Senegal Feasibility Study on Ammonia/Urea Fertilizer/Methanol Co-production Plant Project with Environmental Consideration and Digital Technology in Low Carbon Society, Research Report, Ministry of Economy, Trade and Industry, 2023.

[5]Covers contracts between the contracting public agency and private operator, development and maintenance of existing facilities. Public institutions will not bear the initial investment. It primarily covers modernization, expansion or repair of facilities.

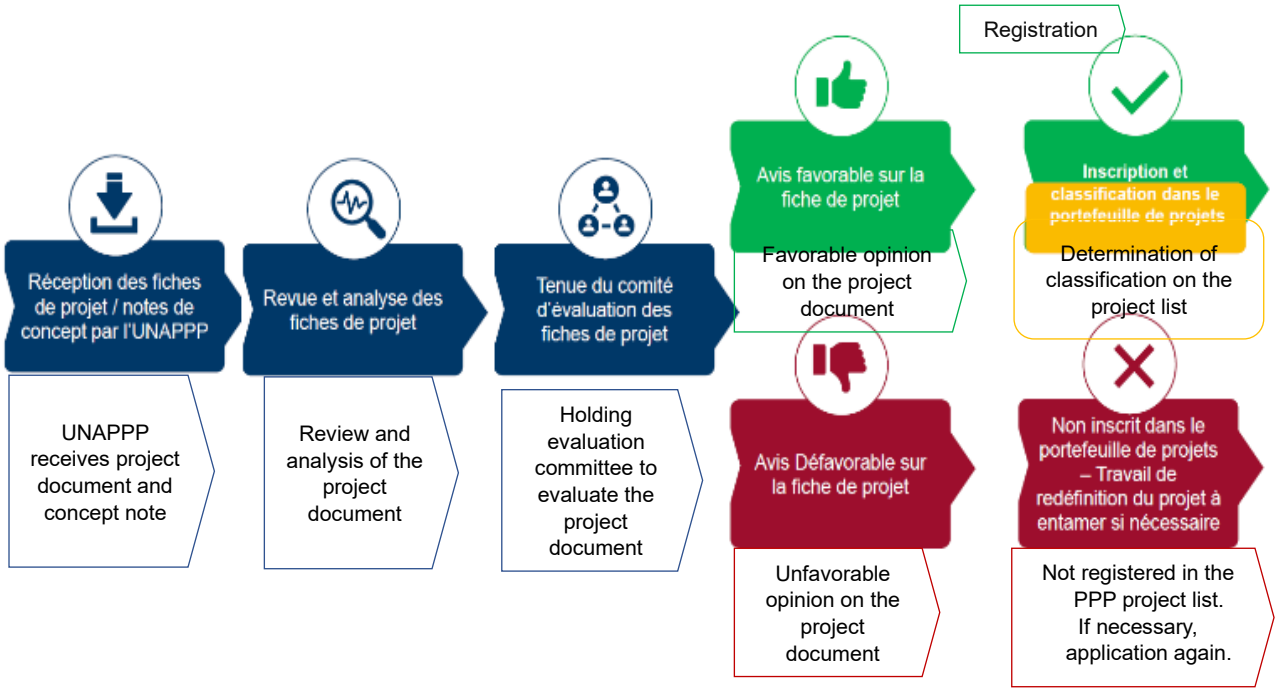
[6] A corporation or group of corporations. Perform construction work, supply facilities, equipment, tangible and intangible assets, products, or provide services to the market.

[7]

- Ownership of the facility during the term of the contract depends on whether it is the "PPP contract with payment from the public" or the "PPP contract with payment from the facility user".
- Duration of a PPP contract is determined by the nature of the benefit obligations required, the time required to realize and perform the object, the debt amortization period if the investment is borne by the private operator, and the method of financing.
- The contracting public agency is free to use its control authority to ensure that the PPP contract is well implemented. The right holder (concessionaire) is obliged to regularly submit legal, accounting, financial, and technical documents related to the PPP project to the public authority (contracting public agency). The concessionaire must also submit a detailed annual report to the contracting public agency.
- PPP contracts are subject to periodic evaluation by UNAPPP. It is also subject to periodic audits by the agency in charge of auditing.

b) Approval process for PPP projects

The figure below shows the process from application to approval of the PPP project by UNAPPP. If selected, the project will be listed on the UNPPP's list of PPP projects.



Source: Prepared by JST based on information on UNAPPP website

Figure 3.131 Process to enroll PPP

c) Achievements of PPP Projects

Implementation of priority projects through PPPs was proposed in the PSE but was not significantly developed in practice. In addition to the weak financial capacity of the private sector, the reasons for

this are said to be inadequate systems and immaturity of business plans. The law and executing organization were subsequently reformed to make it easier for the private sector to be included in the PPP.

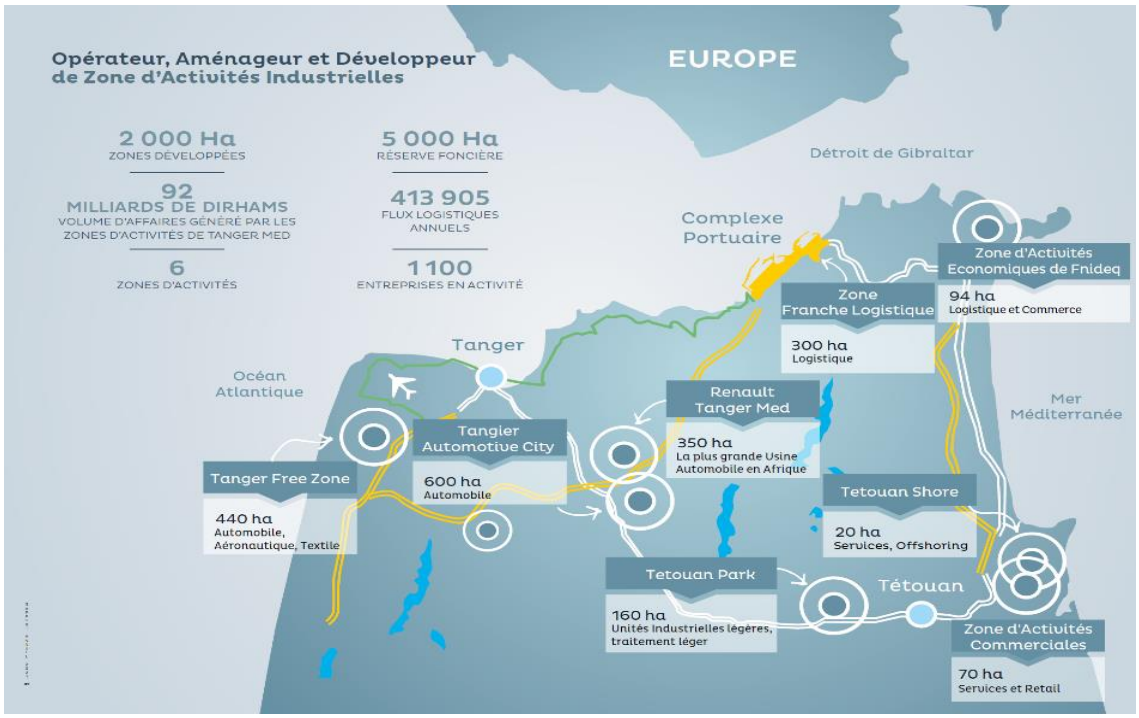
According to the list prepared by UNAPPP, as of March 8, 2023, 53 projects have been registered with UNAPPP and 56 are in preparation. Of the 53 registered projects, 14 are considered eligible for PPP (category P1), while remaining 39 are under evaluation (category P2). Applicants are from ministries (49%), public institutions (36%), and local governments (9%). The largest number of registered projects is in the training, research and employment sector, followed by tourism and digital and road infrastructure and ports sectors.

The concession contract between PAD and DP World for the development of Ndayane Port is an extension of the Dakar Port Concession Agreement between the two parties signed during the old law era, and it was found that the new law was not applicable. Therefore, UNAPPP is not in charge of this contract and this project is not included in the above list of 53 projects. The Dakar Port Concession Agreement was signed in 2007 as a 25-year concession. This concession agreement, including the Ndayane Port development, will expire in 2032, but is likely to be extended (discussed 5 years prior to expiration) if there are no major financial or other issues.

If PPP is envisioned for the port development under this M/P, the above registration process needs to be followed. The length of the contract will be determined by the size of the project and other conditions, but, according to interviews with UNAPPP, the size of the project cost will be a major indicator in setting the length of the contract. For example, assuming a yen loan of 40 billion JPY, UNAPPP's answer was that the loan would last about 20 years.

3.13.2 Case Studies

3.13.2.1 Tanger MED



Source: Tanger MED Group[8]

Figure 3.132 Location of Tanger MED Port and Free Zones

(1) Tanger MED Overview

a) Tanger Free Zone

Tanger MED is a complex consisting of port, commercial and industrial activities (Port, Tanger Free Zone, Tanger Automotive City, Tetouan Park, etc.) and, as shown in Figure 3.132 it is not located in one place. They are managed by Tanger MED.

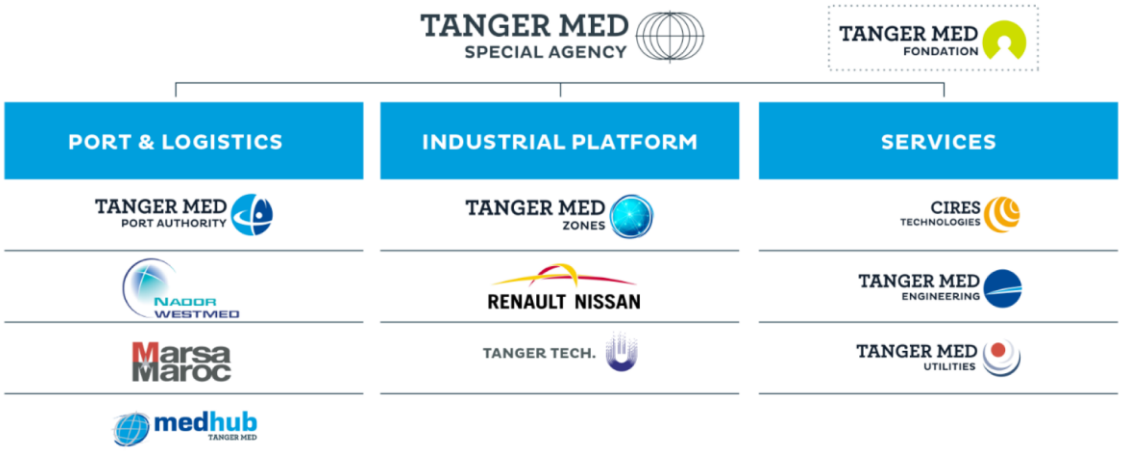
There are a total of five Free Zones operated by Tanger MED. Of these, three are located in the surrounding areas of Tangier: Tanger Free Zone, Tanger Automotive City, and Renault Tanger MED. All these free zones are connected to the Tanger MED port by highways. Of these, the Tanger Free Zone was the first to start operations and opened in 1999 as an industrial park with a total site area of 400 ha. In addition, Tanger Automotive City and Renault Tanger MED are also large-scale industrial parks where automobile-related industries are concentrated on premises exceeding 300ha each.

Incentives are applied to each free zone. They are: several tax exemption (five-year exemption of corporate tax, reduction of 8.75% in following 20 years), exemption of customs duty, one-stop service, and governmental subsidies (support of education, and financial support to projects). If tax-exempted or bonded, the area is strictly demarcated, and permits are required for entry and exit. Products for

[8] "TANGER MED ZONES" https://www.tangermedzones.com/

export from Tangier Free Zone and Tangier Automotive City are said to be transported to the Tanger Port under bonded conditions. Adjacent to the Tanger MED port and customs, there is a free logistics zone (*zone franche logistique*), which serves as a transshipment base for cargo.

b) Tanger MED Company



Source: Tanger MED Group

Figure 3.133 Organization Structure of the Tanger MED Group

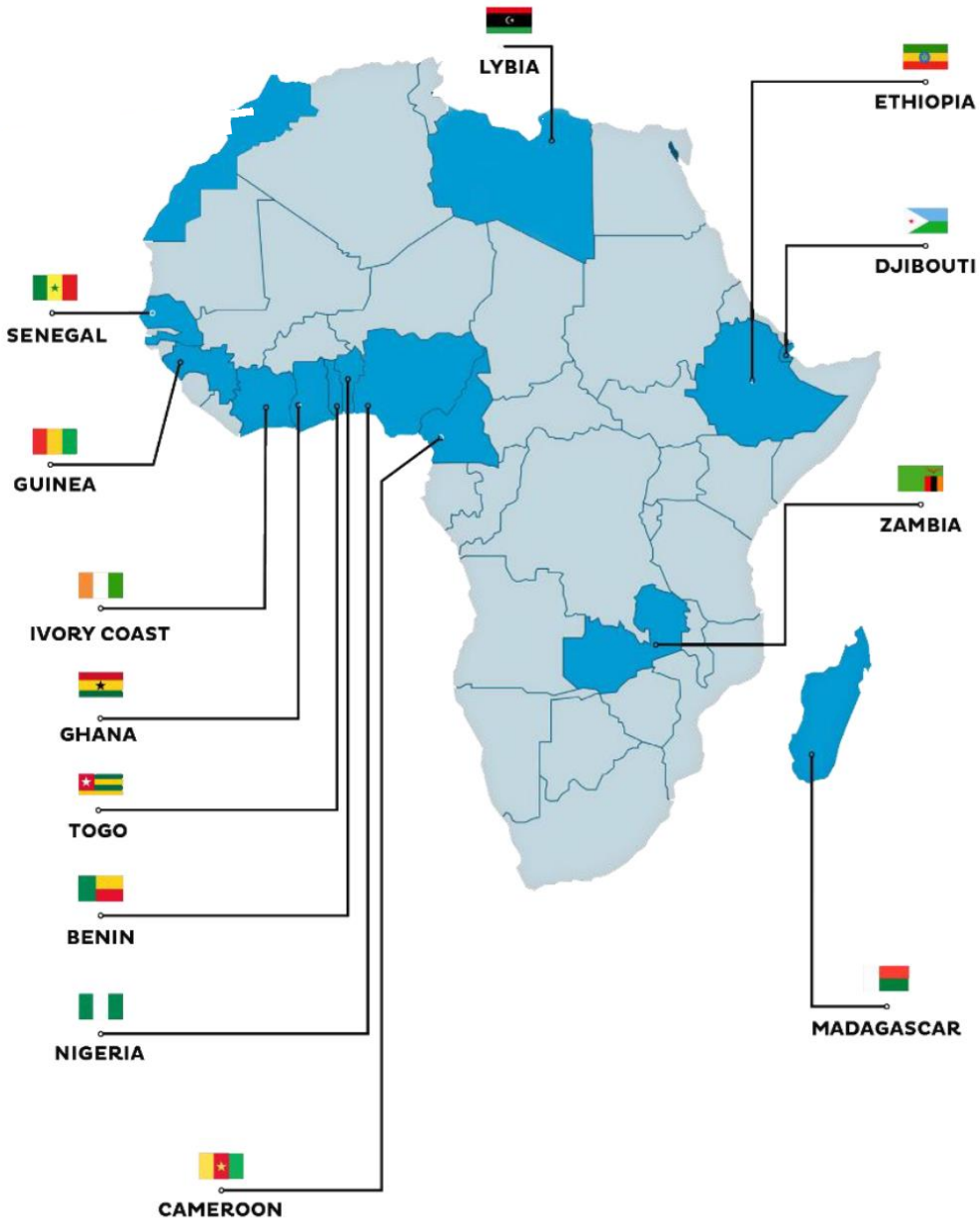
Tanger MED is a subsidiary of the Tanger Med Special Agency (TMSA), a government-owned public limited company established for the purpose of developing industrial parks and ports. As TMSA is a public company and implements industrial development following the government policy, it is thought that the Government invests to Tanger MED.

Tanger MED Group handles everything from planning and designing of ports, industrial parks and special economic zones to construction and subsequent operations. In recent years, he has been involved in projects related to ports, industrial parks, and special economic zones in African regional plots, making use of his know-how in Morocco. Senegal is no exception. For example, training for PAD navigators has been conducted twice a year in Tangier for more than 10 years, and experienced engineers from Tanger MED Engineering are regularly dispatched to APIX as SEZ advisors. and support the planning, design and operation of the SEZ.

Table 3.122 Services Provided by Tanger MED Group

Enterprise	Field	Services
TANGER MED ENGINEERING	Infrastructure Design	Design and dimensioning of major infrastructure projects in Morocco and abroad
CIRES TECHNOLOGIES	Communication, Security	Information technology such as remote monitoring and security/ network management
TANGER MED UTILITIES	Basic Infrastructure	Provision of water/ power supply and service to vessels Development of Energy Efficiency Solution

Source: https://www.tangermedzones.com/wp-content/uploads/2021/10/Presentation-Commerciale-TMZ-EN.pdf



Source: Tanger MED Group with additions and corrections by JICA research team

Figure 3.134 African countries where Tanger MED has experiences

(2) Preferential Measures

The preferential measures offered by the Tanger Free Zone are as follows:

a) Preferential tax treatment

- Exemption from registration and stamp duty on the establishment/ increase of capital and acquisition of land.
- Exemption from patent taxes for 15 years.
- Exemption from business taxes for 15 years.

- Exemption from corporate income taxes for 5 years, then 8.75% for 20 years.
- Exemption from taxes on equity instruments, shares and similar income for non-residents.
- Exemption from VAT on goods from foreign countries or eligible areas.
- Free repatriation of profits and capital.

b) Free Trade Agreement

Government of Morocco has signed the Free Trade Agreements with more than 60 countries in the European Union, Africa, the United States and the Middle East.

c) Simplified Administrative Procedures

The One-Stop Center has been set up in the Tanger Free Zone to support and guide investors in their projects. It has a special customs system that exempts import duties, import taxes, import surcharges and consumption taxes. In addition, the Foreign Trade and Foreign Exchange Control Laws do not apply within the region.

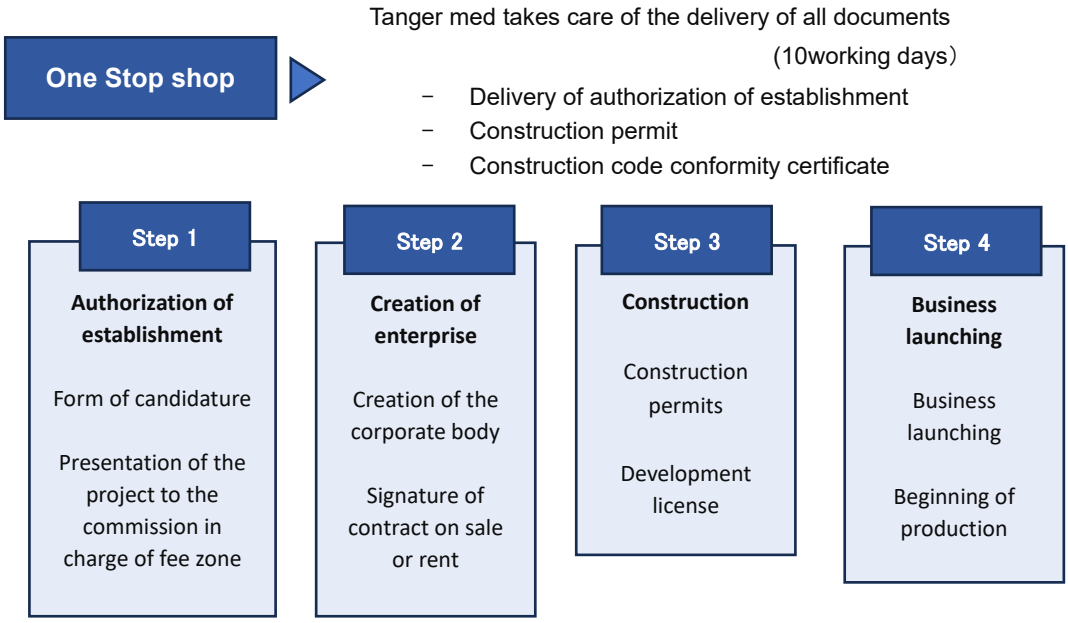
(3) Move-in Procedures

Prospective tenants in these free zones will receive the One-Stop Service from Tanger MED regarding all administrative procedures from application for opening to start of business.

Specifically, when a business plan is first submitted, a decision is made as to which free trade zone the company can locate in, taking into account the industrial area and availability. Then, all administrative procedures, from operational consideration to the start of operation and after the start of operation, can be carried out through Tanger MED.

Tanger MED provides all procedure required to investors who intend to invest, such as (investment) authorization, construction permit, and facility management services.

- Before investment: defining business plan, construction files for approval, and connecting with local business communities;
- During investment: providing greenfield land for sale or construct and rent in six months;
- After investment (during business operation): operating and managing free zones with complete services (security, hygiene, digitizing all exports and imports processes, etc.)



Source: Tanger MED

Figure 3.135 One-Stop Services provided by Tanger MED

(4) Utility Services

In addition to basic infrastructure such as water supply and sewerage, electricity and telecommunications, we provide 24-hour monitoring and security, emergency response, firefighting services, and on-site maintenance and management services.

(5) Industrial locations

The main industries located in the region are automotive-related, aviation, textile, agribusiness, electrical/ electronics and services (information and telecommunications, mechanical design, call centers, etc.), with more than 1,100 companies in total.

Source: Tanger MED

Figure 3.136 An example of Industries and Companies located in Tanger MED Free Zone

Source: JPT

Figure 3.137 Tanger Automotive City

Source:JPT

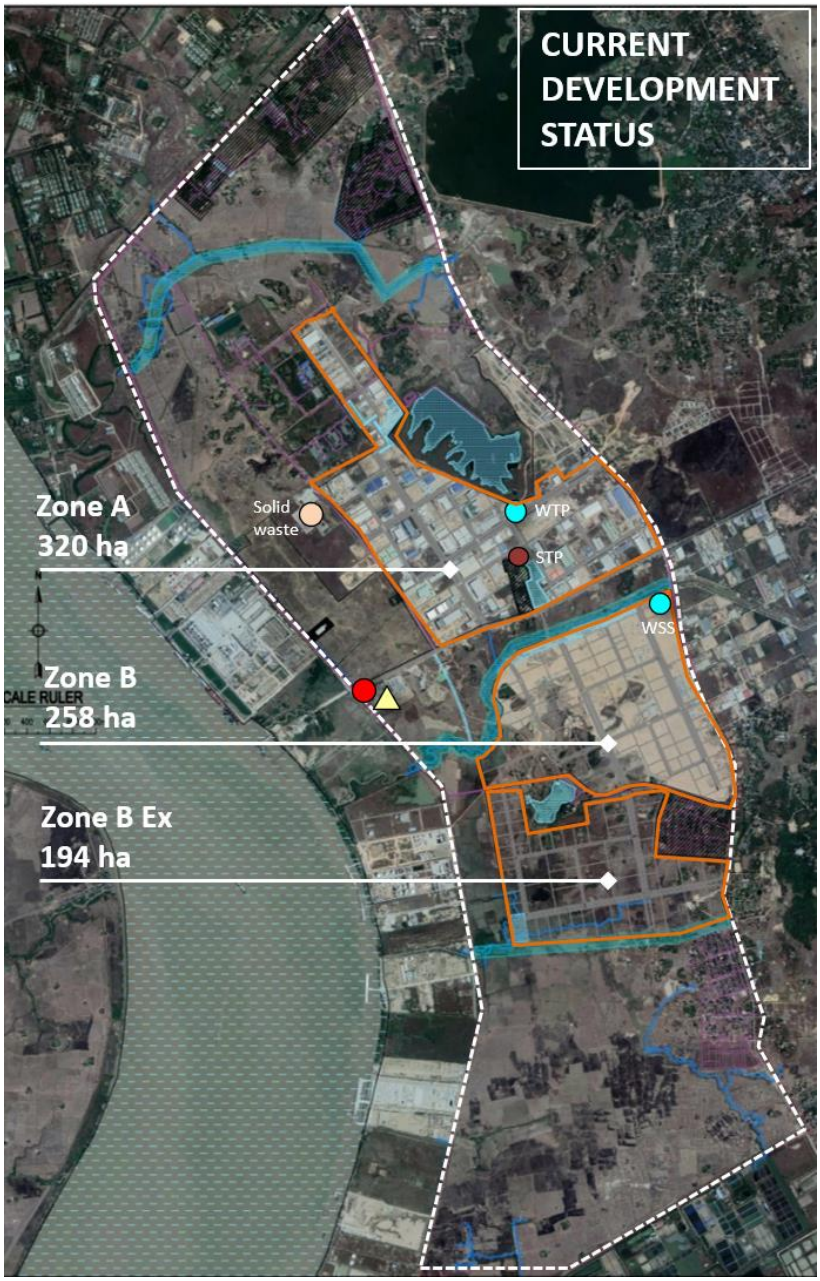
Figure 3.138 Tanger Automotive City

Source: JPT

Figure 3.139 Tanger Automotive City

3.13.2.2 Thilawa SEZ

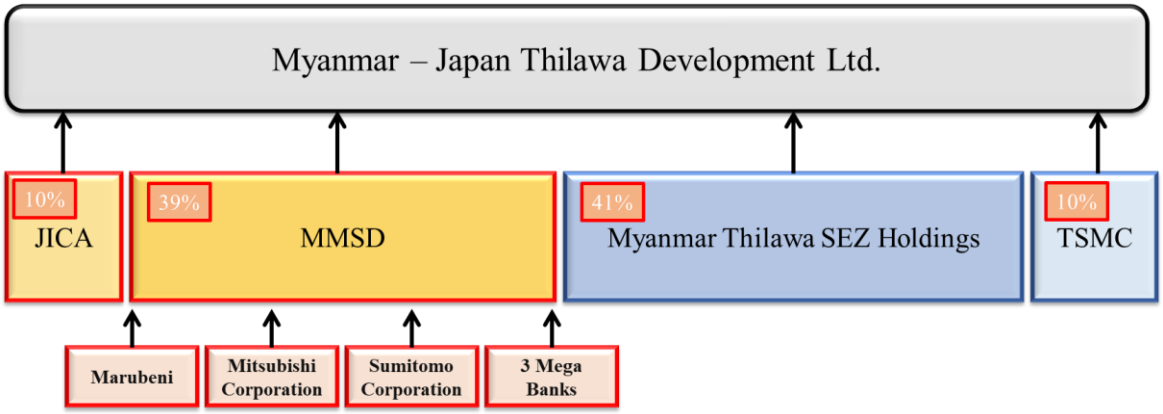
(1) Overview of Thilawa SEZ



Source: Ministry of Economy, Trade and Industry

Figure 3.140 General map of Thilawa SEZ

Thilawa SEZ is an SEZ that Japan and Myanmar are jointly developing with the public and private sectors. In 2012, MJTD (Myanmar – Japan Thilawa Development Limited) was established based on an MOU between two governments, and is promoting development, sales, and maintenance. The project is progressing better than initially expected, and in addition to Zone A (370 ha), the development of the next development zone - Zone B (260 ha) is also progressing, and more than 100 companies have already signed contracts.



Source: Marubeni Corporation

Figure 3.141 Organization Chart of MJTD

(2) Preferential Measures

Preferential measures in the Thilawa SEZ are as follows:

Table 3.123 Investment Incentives in Thilawa SEZ

Tax-exempt Category		Foreign Investment Law	SEZ Law		
			Free Zone	Promotion Zone	SEZ Developer
Corporation tax	Tax exemption	5 years	7 years	5 years	8 years
	50% Tax exemption	-	Next 5 years	Next 5 years	Next 5 years
	50% tax exemption on reinvested earnings	After 6 years	Next 5 years	Next 5 years	Next 5 years
Exemption from import duties, etc.	Import of construction materials and manufacturing equipment	Tax exemption	Tax exemption	50% tax exemption for 5 years + the following 5 years	Tax exemption
	Exemption from import duty on raw materials	3 years	Tax exemption	-	-
Net operating loss carry-forward period		3 years	5 years	5 years	5 years
Commercial tax (VAT) on raw materials used for export of finished goods		Tax exemption	Tax exemption	Tax exemption	-
Taxation on exports		50% tax exemption on	All tax exempt	All tax exempt	-
Land Lease Period		50 years+10 years+50 years =Maximum 70 years	50 years+25 years=Maximum 75 years		

Source: KPMG

(3) Move-in Procedures

The One-Stop Center (OSSC) has been established inside Thilawa SEZ, and it is possible to complete all approval procedures within SEZ, from application for opening to the start of operations. Specifically, the following procedures are included.

- Acceptance and approval of investment applications within SEZ
- Registration of investment projects (enterprises)
- Registration of tax identification number
- Issuance of work permits to foreigners
- Approval of employment regulations (conditions)
- Issuance of construction permit
- Issuance of VISA and residence permit

- Customs services related to imports and exports
- Quarantine services
- Issuance of Certificate of Origin
- Handling of other licenses, permits and authorization documents related to business within SEZ

(4) Utility Services

Within SEZ, the following services are provided by MJTD, SEZ Management Committee and Tenant Companies.

Table 3.124 Utility Services of Thilawa SEZ

Utility Services	Supplier
a. Electricity (33kV)	MJTD
b. Water supply and Drainage (Purified water supply : 6,000㎥/ day Wastewater Treatment : 4,800㎥/ day)	MJTD
c. Telecommunication (Fiber-optic Line)	MJTD
d. Personnel Placement	MJTD
e. One-Stop service (Consultation Service for Administrative Procedures)	Thilawa SEZ Management Committee
f. Industrial waste disposal and Inspection	Tenant Companies
g. Job training	Tenant Companies
h. Logistics centers, Bonded warehouses, Banks, Non-life insurance, Clinics, etc.	Tenant Companies

Source: MJTD with additions and corrections by JICA research team

(5) Industrial locations

Industrial locations are as follows.

Table 3.125 Industrial locations of Thilawa SEZ

Business Expansion (as of November 1, 2019)

〈**Progress**〉	Reservation Agreement concluded :	109	(Including 5 Rental Factories)
	Contract signed / Investment approval obtained :	107	-
	Underconstructed :	24	(Including 1 Rental Factory)
	In operation :	75	(Including 4 Rental Factories)
〈**Export / Domesitc**〉	Export-oriented: 43	Domestic market type: 65	Other (Development) : 1
〈**Industry**〉	Construction Materials : 17	Packaging and Containers : 11	Sewing : 9
	Food and Beverage : 9	Agriculture : 8	Power and Electricity : 8
	Automobile : 7	Medical : 6	Resin molding : 2
	Paint, Industrial gases, Fertilizer, Tanks, Conveying equipment, Lubricants, Telecommunications, Shoes, Chemicals, Logistics warehousing (Including frozen refrigeration), Industrial waste disposal, Job training, Rentals, etc.		
〈**Nationality**〉	Japan : 55	Thailand : 16	South Korea : 8
	Taiwan : 6	Malaysia : 4	Hong Kong : 3
	Myanmar : 3	Singapore : 3	Switzerland : 2
	U.S., Germany, Netherlands, France, Australia, China, Vietnam, India, Indonesia : 1 each		
〈**Investment type**〉	Foreign investment : 92	Joint management : 14	Myanmar solely funded : 3

Source: MJTD with additions and corrections by JPT

3.13.3 Market Research and Economic Analysis

3.13.3.1 Focused Sector by National Strategies

In order to discuss the sectors to be attracted to Ndayane PIZ, this section summarizes the existing national plan in terms of its treatment of the industrial sector.

(1) Senegal Emerging Strategy (PLAN SÉNÉGAL ÉMERGENT, PSE) Focus Areas

PSE is reviewed in 3.13.1.1(1)Plan Sénégal Emergent, (i) "Economic Structural Transformation, Growth," (ii) "Human Capital, Social Security, and Sustainable Development," and (iii) "Governance, Institutions, Peace, and Security," economic relations are addressed in (i), while the industrial sector is treated somewhat fragmented, with the following classification. In connection with these, 27 "flagship projects" are listed. In addition to this, ICT promotion is listed as the content of (iii).

PSE is subdivided into five-year Priority Action Plans (PAPs), with the 2014-2018 period being PAP 1 and the 2019-2023 period being PAP 2. The PAP 2 period has been revised and is now PAP2A. Here, pharmaceutical sector and DX were added. As for DX, it can be said to be a further advancement of PSE's axis (iii) ICT.

Table 3.126 Sectors described in the Senegal Emerging Plan (PSE)

PSE		
Sector	Subsector	Futhersubsector
Agriculture, Livestock, Fisheries, Aquaculture and Fisheries Processed Foods	Agriculture, Livestock, Fisheries, Aquaculture and Fisheries Processed Foods	――――――――――――――――
Housing & Construction Systems	――――――――――――――――	Craft Production Vegetable and Fruit Wholesale Function Promotion of the "Senegalese Product Label"
Construction Materials (Flagship Projects)	Integrated Industry Platforms Integrated Logistics Hubs	Diamniadio SEZ Home appliances, Shipyard for fishing boats, Wires for automotive, Railroad, Aviation (Wire harnesses), Steel Railroad rehabilitation, Port of Dakar Renovation, Construction of logistics base
Phased Socioeconomic Modernization	Export-related services Business Parks for Regional Headquarters Regional Education Hub Dakar Medical City Integrated Tourism Area	BPO (Business Process Outsourcing) for foreign companies, Tourism, Aviation
Dakar Multiservice Tourism hub	――――――――――――――――	――――――――――――――――
Mining and Fertilizer	――――――――――――――――	――――――――――――――――
PAP2A		
Pharmaceuticals	Dispensing package, Logistics	――――――――――――――――
DX	――――――――――――――――	Senegal Digital Strategy Ultra Broadband E-commerce E-payment

Source: JPT

(2) Senegal Industrial Strategy (SI) Sectors of Focus

SI was announced in 2022 with the assistance of UNIDO and other organizations. The strategy is for the period 2021-2035, on the other hand, PAP2A is for the period through 2023. The sectors described in PSE and PAP2A are followed almost verbatim as "priority sectors," although the names and classifications are different. In addition to these, assembly and parts manufacturing (automotive) and creative industries are listed.

Table 3.127 Priority Sectors in the Senegalese Industrialization Strategy (SI)

Sector	Subsector	PSE/PAP2A	Remarks
Agriculture, Forestry and Fisheries Processing	Processed Agricultural, Forestry and Fisheries Products Processed Livestock Products Processed Marine Products	PSE PAP2A	SI Axis 1
Mineral Processing	Natural Gas Gold, Copper, Tin, Zinc, Lead, Uranium	PSE	SI Axis 2
Pharmaceuticals	Preparation, Packaging, Logistics	PAP2A	SI Axis 3
Assembly and Component Manufacturing	Automotive	PSE	The Ministry of Industry and SMEs is considering changing its policy from attracting complete vehicle manufacturers to attracting parts manufacturers, SI Axis 4.
DX and IT		PSE PAP2A	PSE aims to become one of the top 3 service outsourcing centers in the French-speaking world (Business operations, Call centers, etc.), SI Axis 4.
Creative Industries	Art, Design, Visual, Media		SI Axis 4.

Source: JPT

Pharmaceuticals in particular are described in more detail from PAP2A, following COVID-19 pandemic. The company aims to play a role in the pharmaceutical value chain, both in blending and packaging and in logistics. In response to this policy, the government is formulating a decree aimed at promoting the pharmaceutical sector starting in 2022. Regarding automobiles, the strategy is to work with Morocco, where two French companies, Renault and PSA (Peugeot), have manufacturing bases in Africa.

According to the Ministry of Industry and SMEs of Senegal, the country has apparently focused on attracting complete vehicle manufacturers but is now considering changing its policy to emphasize the attraction of parts manufacturers in cooperation with Morocco.[9]

In the DX (IT) sector, PSE has been aiming to become a French-speaking business agency (call centers, etc.), taking advantage of the fact that it belongs to a French-speaking country, and is basically continuing in this direction.

[9] "PLAN D'ACTIONS PRIORITAIRES 2 AJUSTÉ ET ACCÉLÉRÉ (PAP 2A) POUR LA RELANCE DE L'ÉCONOMIE 2019 – 2023", ttps://www.economie.gouv.sn/sites/default/files/2021-04/PAP2_FINAL_VFINALE_14_12_WEB.pdf

(3) Natural Gas Utilization Strategy

The Gas M/P developed by the Government of Senegal in 2019 presents a future plan for the development and utilization of natural gas, including the following.

- Creating jobs, improving living conditions, and reducing negative impacts on the environment
- Strengthening the domestic fiscal base through increased exports and reduced imports
- Reduction of electricity costs, fulfillment of domestic demand in agriculture and other sectors

In response to these policies, the following sectors of measures are envisioned in Table 3.128.

Table 3.128 List and Summary of Measures included in the Senegalese Government's Future Plan for Natural Gas Development and Utilization

No	Project	Target Year	Strategy	Strengths/ Opportunities	Weaknesses/Threats
1	Refineries	2025	Meet increasing domestic petroleum demand. Export of petroleum products is possible except for Cote d'Ivoire.	Expected quality and production of the new refinery. Many years of experience in refinery operations. Increased sales prices of petroleum products. Abundant domestic oil and natural gas reserves. Growth markets in Japan and neighboring countries	Delays in domestic infrastructure development. Fears that oil production will become low-scale and high-cost. Inability to meet future domestic demand for petroleum products. Existence of oil producing country (Cote d'Ivoire) and refining country in West Africa.
2	Onshore LNG	2032	Exports to promising markets such as China, South Asia, Latin America, Europe, etc.	High potential for market entry due to rising gas demand and supply shortages. Favorable location for export. LNG development experience gained from GTA Phase 1 operations in 2022. Abundant gas reserves (Yakar-Telanga)	No existing LNG projects currently Fear that gas production will be low scale and high cost. Risk of new projects entering the LNG market at the same time. Delay in domestic infrastructure development.
3	Methanol	2038	Exports to promising markets such as the Asia-Pacific region and China, where large volumes of methanol are consumed.	Abundant gas reserves (Yakar-Telanga) Expansion of the global methanol market. Decline in competitiveness of methanol producers in other countries.	Fear that gas production will be low scale and high cost. Demand and prices for methanol may change in the export market. Underdevelopment of the chemical industry in the country and neighboring

No	Project	Target Year	Strategy	Strengths/ Opportunities	Weaknesses/Threats
					countries.
4	Ammonia/urea fertilizer	2038	Contribution to domestic agricultural development. Export to neighboring countries where fertilizer consumption is expected to increase.	Increased demand for urea in the country and neighboring countries. The optimal production scale of urea, the main nitrogen fertilizer for agricultural development	Small and immature urea market in Japan and neighboring countries Demand for urea may be lower than expected. Gas production may be low scale and high cost
5	Phosphate fertilizer	2044	Contribution to domestic agricultural development.	Increased demand for DAP/MAP in Japan and neighboring countries. High versatility of phosphate fertilizers.	Small and immature DAP/MAP market in Japan. Demand for DAP/MAP may be less than expected.

Source: JPT

3.13.3.2 Market Survey

(1) Macroeconomic Forecasts

a) Senegal's Economic Situation in 2022

The Senegalese economy slowed more than projected in 2022, with GDP annual growth rate falling from a projected 4.7% to an actual 4.0%. According to the March 2023 IMF press release, the slowdown is mainly due to a drop in agricultural production and a contraction in industrial production. The annual inflation rate was 9.7%, the highest in decades, mainly due to high food prices. State revenues were slightly lower than projected while expenditures exceeded budgeted amounts due to the public wage increase bill. Subsidies for energy were also a record 692 billion CFA francs (4% of GDP), and investment spending was cut to keep the deficit down. Public debt is estimated at 75% of GDP, of which 67.5% was central government debt. The current account deficit widened markedly due to soaring import prices and debt interest payments.[10]

The table below summarizes macroeconomic trends based on the World Bank and IMF statistics. According to the World Bank criterion, Senegal is positioned as a lower middle-income country (USD 1,006 - USD 3,955).

[10]Source: IMF Press Release No. 23/71 "Staff Concludes Visit to Senegal," March 14, 2023

Table 3.129 Macroeconomic Data of Senegal

GDP 2021	GDP growth rate 2022.12 (month on month %)			
(million USD)	All sectors	Agriculture sector	Industry sector	Services sector
27,625	3.30	-1.6	3.9	3.8
Inflation rate 2022.12 (month on month %)	**GDP /capita 2021** (constant USD 2015)	**GDP per capita growth rate 2021** (%/y)	**Trade Balance 2023.2** (billion FCFA)	
12.8	1,437	3.30	-167.2	

Note: Growth and inflation rates are percent change from the same month last year.

Source: JPT, based on IMF Trading Economics and World Bank WDI.

b) Macroeconomic Forecast[11]

The IMF expects Senegal's economic activity to rebound in 2023, albeit at a slower pace than expected, while the inflation rate will fall to 5%. In the medium term, the Senegalese economy is expected to remain desirable and will benefit from the start of oil and natural gas production and from structural reforms (in the context of PSE 3) aiming at strengthening private sector participation in the economic activity.

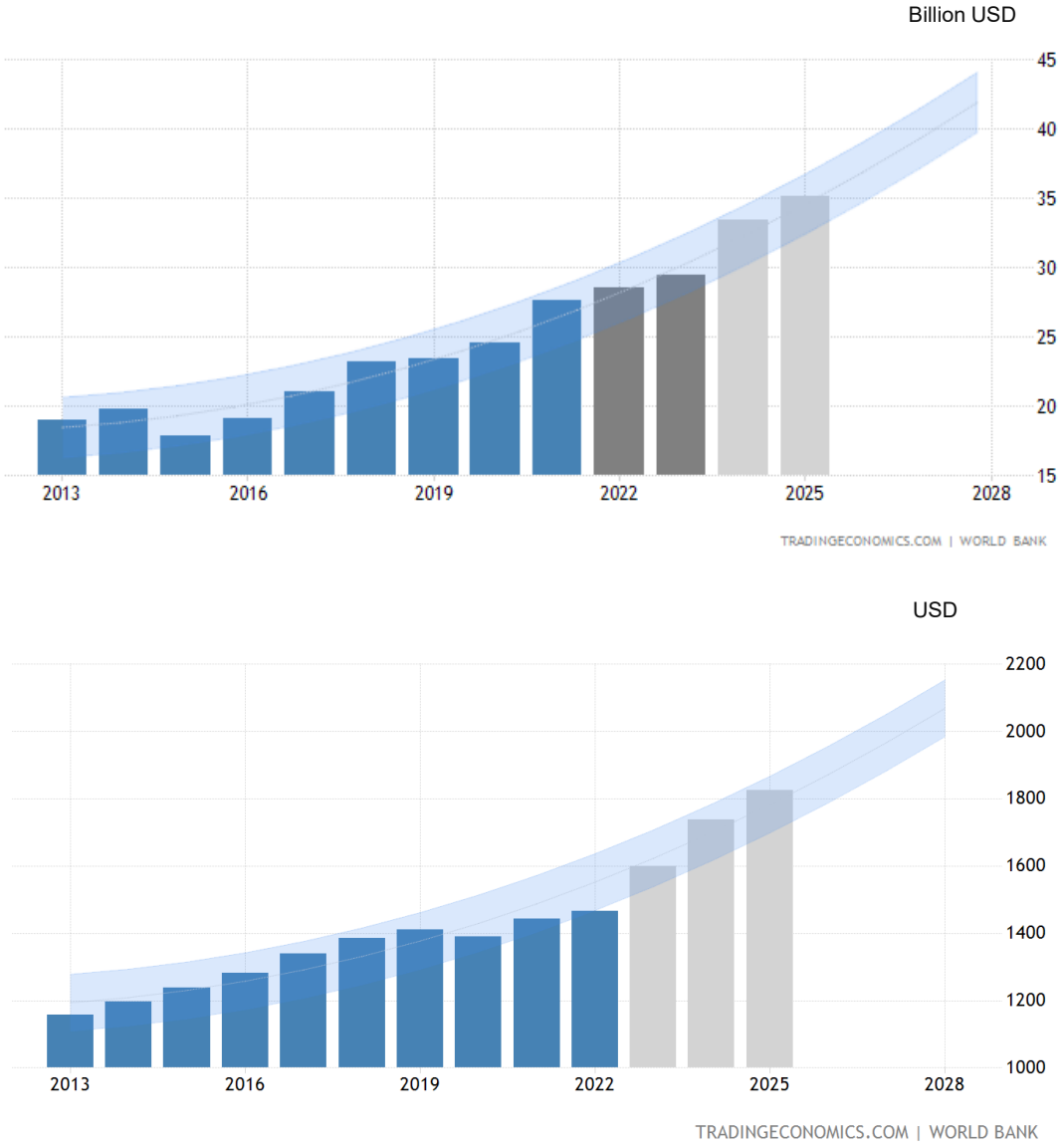
The IMF's short-term forecast projects GDP growth of 8.3% and a consumer price index (CPI) of 5.0% in 2023. In addition, the GDP and GDP per capita projections for the period 2023-2025 are as follows.

Table 3.130 GDP Projections to 2025

GDP forecast (billion USD)			GDP per capita forecast (USD)		
2023	2024	2025	2023	2024	2025
30.28	33.43	35.10	1,575	1,738	1,825

Source: IMF Trading Economics

[11]Source: IMF website and Trading Economics

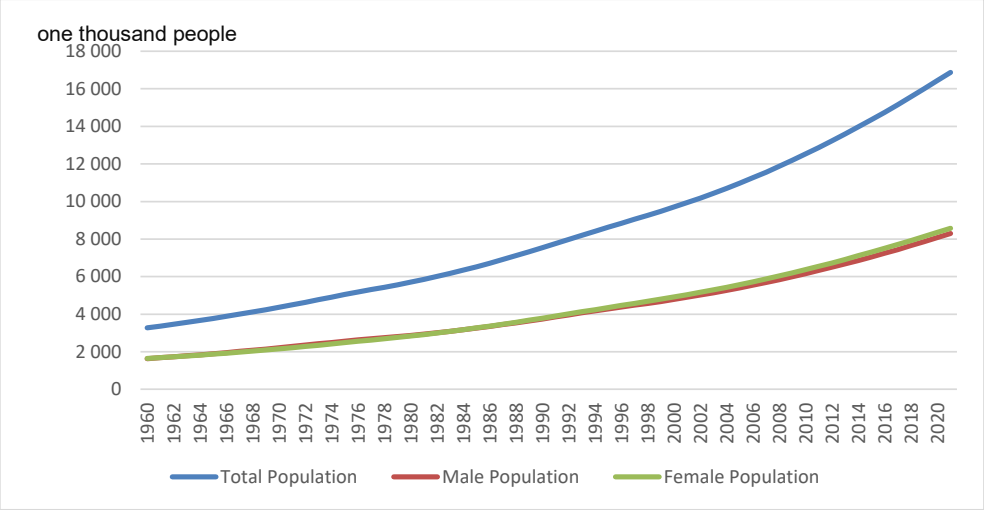


Source: IMF Trading Economics

Figure 3.142 Senegal GDP (top) and GDP per capita (bottom) Growth Trends-

(2) Population Dynamics

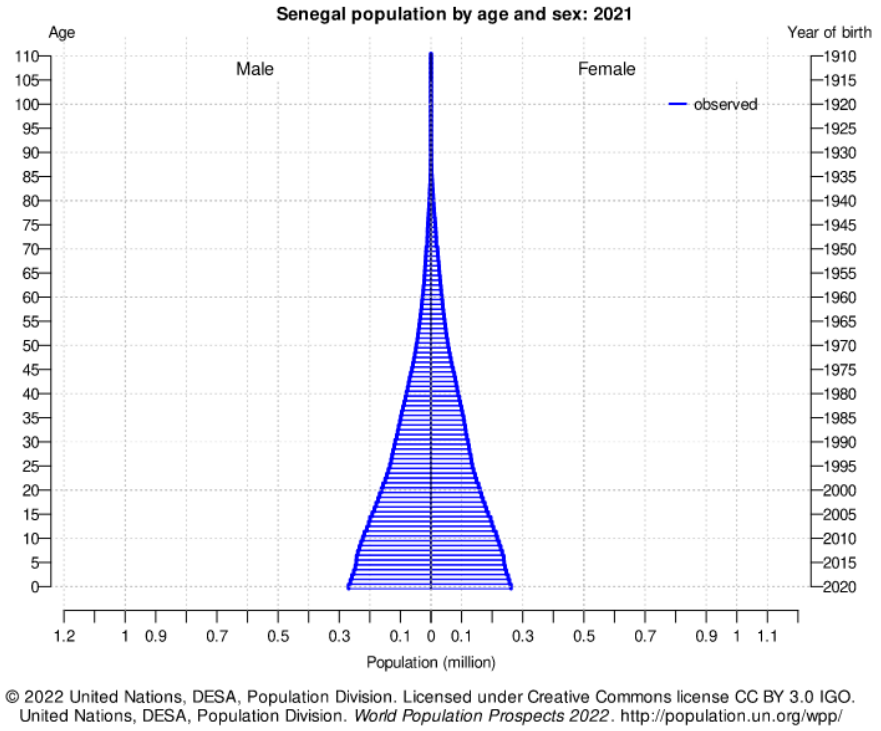
The population of Senegal on 1st July 2021 is 16,877 thousand, consisting of 8,297 thousand males and 8,580 thousand females. It has increased 5.2 times since independence in 1960. The annual population growth rate for 2021 is 2.61%.



Source: JPT based on the United Nations World Population Prospects 2022

Figure 3.143 Demographics of Senegal since Independence to 2021 (as of July 1 of each year)

The median population in 2021 is 17.8 years old, and the life expectancy at birth is 67.09 years. The distribution of the population by sex and age is an elongated pyramid. The urban population rate is 48.12 %. (both in 2021).[12]

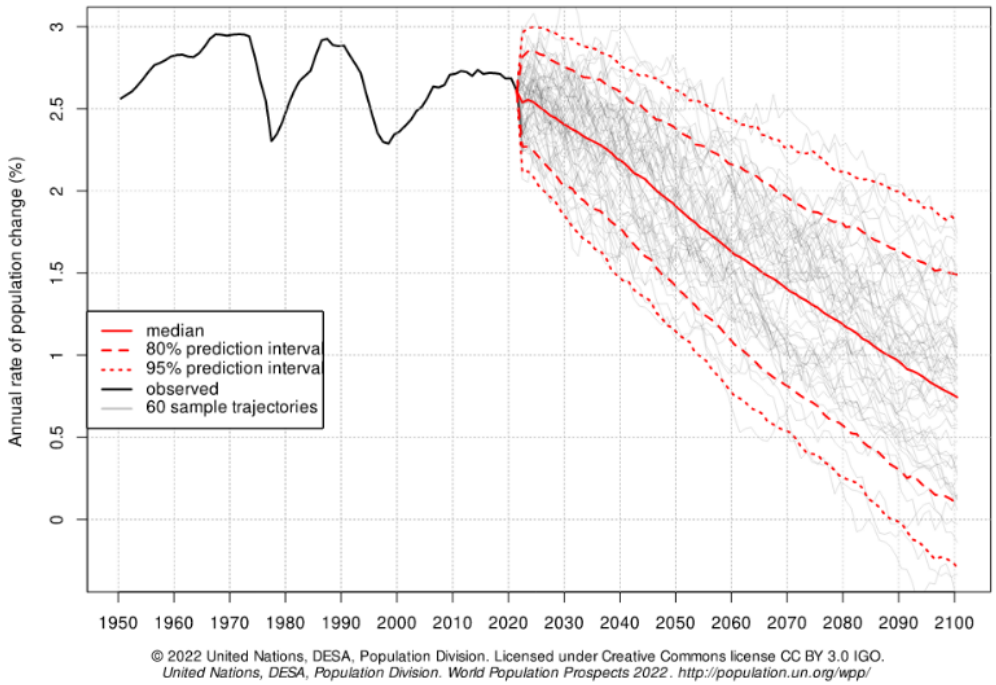


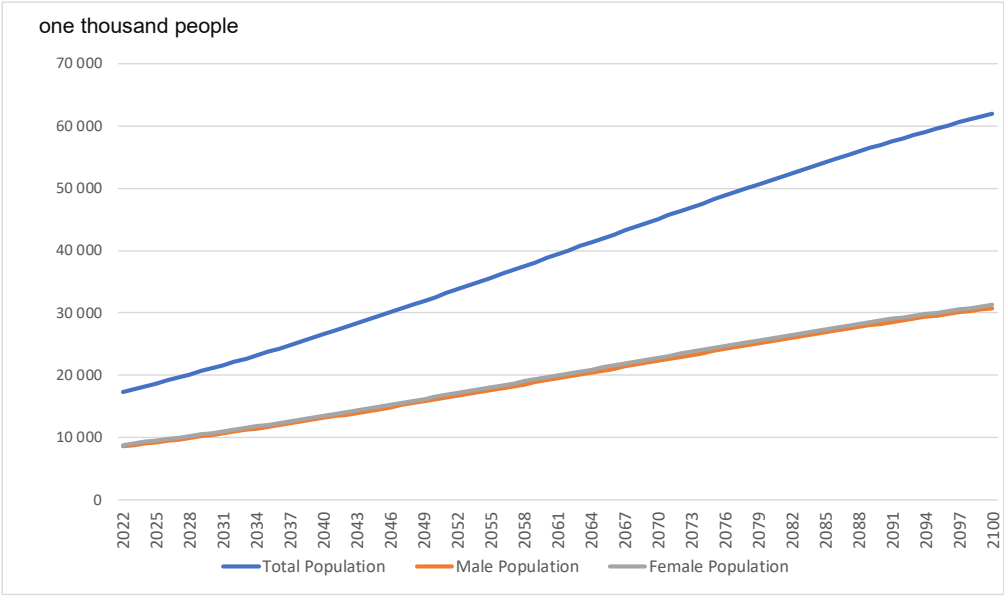
Source: DESA, United Nations

Figure 3.144 Population Distribution by Gender and Age (2021)

[12]Source: United Nations Department of Economic and Social Affairs

The UN Department of Economic and Social Affairs estimates that under the high scenario, Senegal's population growth rate will rise to 3% per year in the early 2020s before declining and becoming negative by 2100 under the lowest projection. The population in 2100 varies widely from 30 million to 100 million depending on the scenario used, but applying the medium scenario yields an estimate of 62.06 million.





Source: Prepared by JPT based on the estimates by UN Department of Economic and Social Affairs

Figure 3.145 Senegal's Estimated Population Growth Rate (top) and Future population under the Medium Scenario (bottom)

(3) Industrial Structure and Market Environment

a) GDP Composition by Industry

The ratios of each sector's value added to GDP in 2020 and 2021 are approximately 16% for the agricultural sector, 24% for the mining and manufacturing sector, and 50% for the services sector.[13] In 2020, the industrial, mining, manufacturing and services sectors will grow negatively from the previous year due to Covid 19, and agriculture grew negatively in 2021. Although these statistics do not total 100%, as remittances from foreign countries are estimated to be 10% of GDP, it is considered to be the fourth industry.

Table 3.131 Value Added as % of GDP by Industry Sector

Year 2020				Year 2021			
Agricultural and marine products Include. added value	(Manufacturing) industry including added value	Service Include. added value	Personal remittance	Agricultural and marine products Includ. added value	(Manufacturing) industry including added value	Service include. added value	Personal remittance
16.22	23.23	50.26	10.57	15.32	24.67	49.60	9.62

Source: JPT based on World Bank World Development Indicators

The National Agency of Statistics and Demography (*Agence nationale de la statistique et de la démographie,* ANSD) of Senegal organizes the GDP value of each industry as follows.

Table 3.132 GDP by Industry

Unit: Million CFA francs

	Year 2020	Year 2021
Primary industry	2,280,100	2,364,800
Secondary industry	3,277,000	3,714,900
Tertiary industry	7,133,800	7,721,500
Net tax on products	1,428,500	1,486,700
GDP total	14,119,400	15,287,900

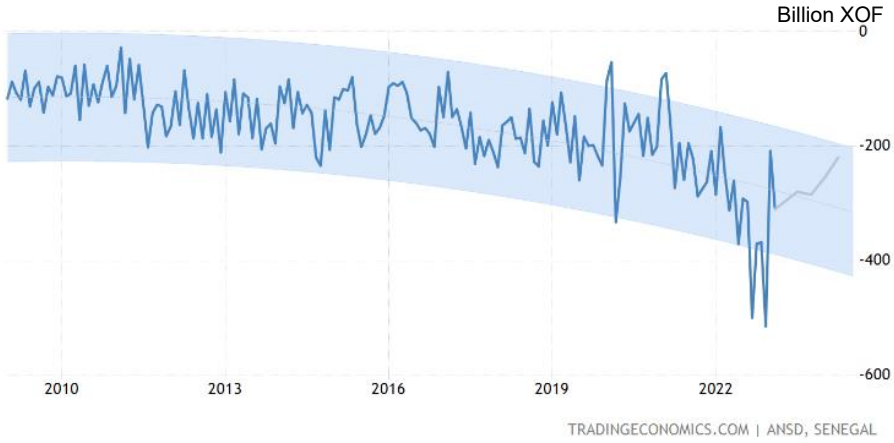
Source: National Bureau of Statistics and Population https://senegal.opendataforafrica.org/tzexqff/produit-int%C3%A9rieur-brut-par-branches-d-activit%C3%A9shttps://senegal.opendataforafrica.org/tzexqff/produit-intérieur-brut-par-branches-d-activités

(4) Trade (foreign)

Senegal's balance of trade has been consistently in the red for the past 15 years, and has been particularly so in the resent years. As of February 2023, the trade deficit increased to 310.4 billion FCFA/XOF from 167.2 billion FCFA/XOF in the same month previous year. Imports increased by 42.7% to 5,63.2 billion FCFA/XOF, while exports grew moderately, up 11.2% to 252.8 billion FCFA/XOF. The IFM forecasts -280 billion FCFA/XOF for the first quarter of 2023. In the longer

[13] Agricultural sector: agriculture, forestry, fisheries, and pastoralism. Industrial sectors: industrial, mining, construction, electricity, water, gas. Service sectors: wholesale retail, transportation, tourism, public service, education and medical services, import taxes.

term, Senegal's trade balance is projected to be a deficit of 330 billion FCFA/XOF in 2024 and 450 billion FCFA/XOF in 2025. [14]



Source: IFM Trading Economics

Figure 3.146 Senegal's Balance of Trade

(5) Employment

a) Unemployment rate

In the fourth quarter of 2022, the unemployment rate in Senegal was 22.0%, down 0.9% from the previous quarter. IMF Trading Economics forecasts that the rate will be 23.8% in the second quarter of 2023. Meanwhile, the unemployment rate in 2021, according to ILO estimates, is 3.34% for men, 3.75% for women, and 3.50% overall.[15]

b) Wages

Wages are highly variable, but according to the ANSD statistics, the average of the amount for each quarter since 2021 is 96,722 CFA francs per month.[16]

Table 3.133 Employment Environment in Senegal

Minimum wage	The minimum wage in 2021 is 58,900 FCFA/XOF per month
Average wage	The average of the amounts for each quarter after 2021 is 96,722 FCFA/XOF per month
Social insurance	Employer-paid social insurance or contributions sociales ranges between 22% and 31.5%, while employee-paid social insurance ranges between 10% and 15.5%.

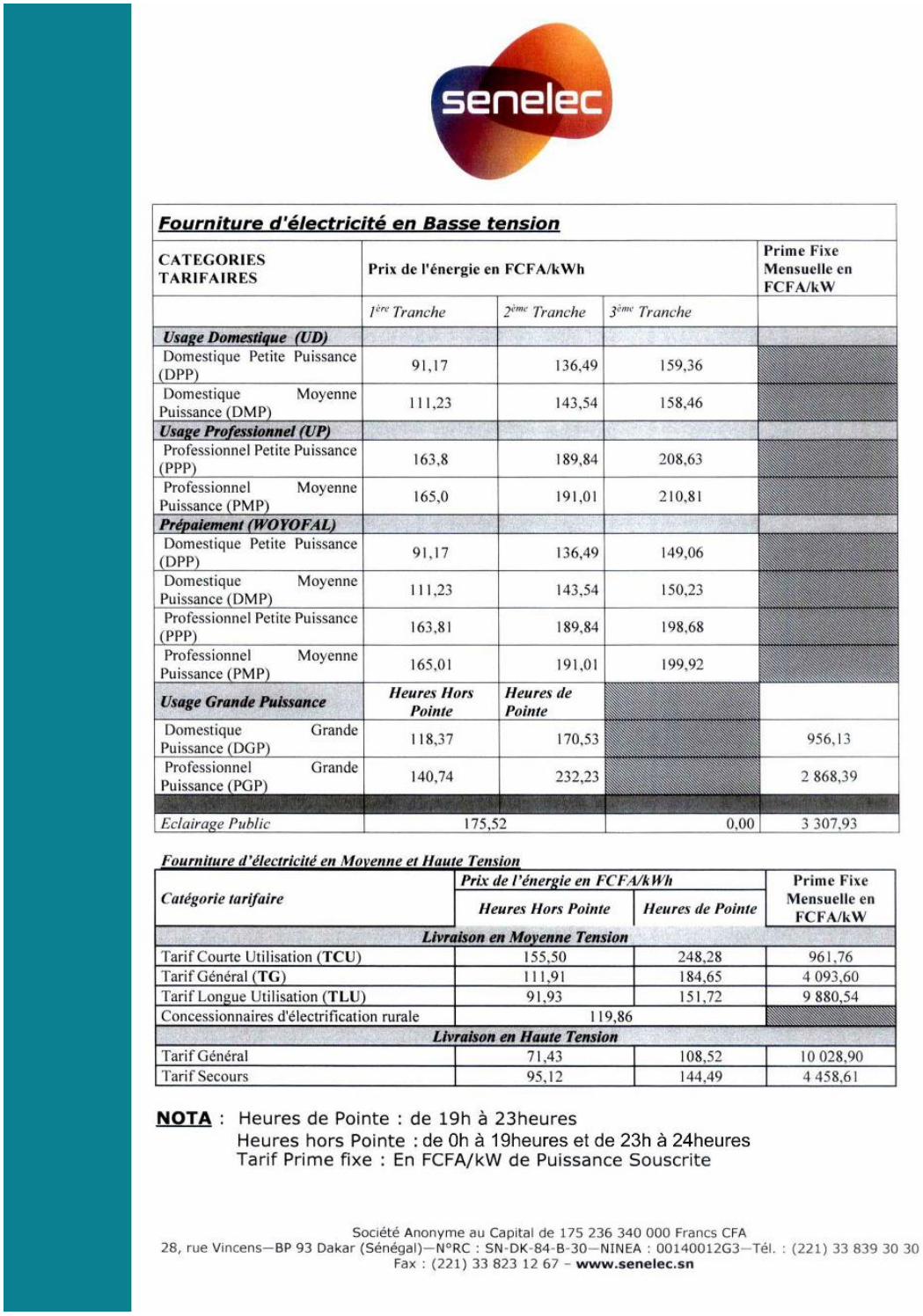
Source: Prepared by JICA Study Tea based on ANSD database, and. Ministry of Labor, Social Dialogue, Professional Organization and Institutional Cooperation

[14] Source: IMF Trading Economics
[15] Source: ANSD
[16] Sources: ANSD, https://senegal.opendataforafrica.org/muhgux/indicateurs-du-march%C3%A9-du-travail-emploi-ch%C3%B4mage-salaires-gain

(6) Investment Environment

a) Electricity price

The maximum industrial electricity price set by SENELEC, Senegal National Electric Company, is 199.92 FCFA/XOF per kWh.



Fourniture d'électricité en Basse tension

CATEGORIES TARIFAIRES	Prix de l'énergie en FCFA/kWh			Prime Fixe Mensuelle en FCFA/kW
	1ère Tranche	*2ème Tranche*	*3ème Tranche*	
Usage Domestique (UD)				
Domestique Petite Puissance (DPP)	91,17	136,49	159,36	
Domestique Moyenne Puissance (DMP)	111,23	143,54	158,46	
Usage Professionnel (UP)				
Professionnel Petite Puissance (PPP)	163,8	189,84	208,63	
Professionnel Moyenne Puissance (PMP)	165,0	191,01	210,81	
Prépaiement (WOYOFAL)				
Domestique Petite Puissance (DPP)	91,17	136,49	149,06	
Domestique Moyenne Puissance (DMP)	111,23	143,54	150,23	
Professionnel Petite Puissance (PPP)	163,81	189,84	198,68	
Professionnel Moyenne Puissance (PMP)	165,01	191,01	199,92	
Usage Grande Puissance	***Heures Hors Pointe***	***Heures de Pointe***		
Domestique Grande Puissance (DGP)	118,37	170,53		956,13
Professionnel Grande Puissance (PGP)	140,74	232,23		2 868,39
Eclairage Public	175,52		0,00	3 307,93

Fourniture d'électricité en Moyenne et Haute Tension

Catégorie tarifaire	*Prix de l'énergie en FCFA/kWh*		Prime Fixe Mensuelle en FCFA/kW
	Heures Hors Pointe	*Heures de Pointe*	
Livraison en Moyenne Tension			
Tarif Courte Utilisation (**TCU**)	155,50	248,28	961,76
Tarif Général (**TG**)	111,91	184,65	4 093,60
Tarif Longue Utilisation (**TLU**)	91,93	151,72	9 880,54
Concessionnaires d'électrification rurale	119,86		
Livraison en Haute Tension			
Tarif Général	71,43	108,52	10 028,90
Tarif Secours	95,12	144,49	4 458,61

NOTA : Heures de Pointe : de 19h à 23heures
Heures hors Pointe : de 0h à 19heures et de 23h à 24heures
Tarif Prime fixe : En FCFA/kW de Puissance Souscrite

Société Anonyme au Capital de 175 236 340 000 Francs CFA
28, rue Vincens—BP 93 Dakar (Sénégal)—N°RC : SN-DK-84-B-30—NINEA : 00140012G3—Tél. : (221) 33 839 30 30
Fax : (221) 33 823 12 67 – **www.senelec.sn**

Source: SENELEC website, downloaded on May 15, 2023

Figure 3.147 Electricity Price List for Senegal

b) Water tariff

Water tariff in the Ndayane Port PIZ according to the Ordinance no 20 of Ministry of Water and Sewerage is considered to fall under the category of "other than households, public taps and vegetable growers", other than the State administrative service facilities. In this case, it is 878.35 FCFA per cubic meter, including tax.

Table 3.134 Water Tariff

Unit: FCFA (XOF)/m3

Code	Category	price without tax			TVA 18%	Additional tax on water	municipal additional tax	Total cost Tax-inclusive (total price)
		water (esp. cool, fresh water, e.g. drinking water)	sewage	Water + Sewage				
ND	Regular purchases other than for general households (single category)							
	State administrative services	1,100.00	755.00	1,855.00	333.90-	1.95	3.25	**2,194.10**
	Other, outside of ordinary households	655.65	84.31	739.96	133.19	1.95	3.25	**878.35**

Source: Prepared by JPT based on the Ordinance no 20, Ministry of Water and Sewerage.

c) Ease of doing business

According to the World Bank's Doing Business 2020[17], Senegal's ease of doing business score is 59.3/100, ranking 123rd out of 190 economies. Comparing Côte d'Ivoire, Ghana, and Nigeria, which are potential competitors among the Economic Community of West African States (ECOWAS, French CEDEAO) countries, Senegal is ahead of Nigeria but slightly behind Côte d'Ivoire and Ghana.

Of the 10 indicators, starting a business index is ranked at 60th with a score of 91.2 and getting credit index is ranked 67th with a score of 65, making it easy to proceed with business in terms of regulations and funding. On the other hand, paying tax index ranks 166th with a score of 51.2, and trading across the border index ranks at 142nd with a score of 60.9, which may be a challenge in attracting foreign companies to the SEZ.

Table 3.135 Ease of Doing Business Score Comparison

Country	Senegal	Côte d'Ivoire	Ghana	Nigeria
Score (out of 100)	59.3	60.7	60.0	56.9
Rank (out of 190 countries)	123	110	118	131

Source: Doing Business 2020, World Bank.

[17] Data manipulation was found to have occurred and the World Bank stopped indicator calculation and reporting in 2021. The 2020 edition is the final report.

Source：Doing Business 2020, World Bank.

Figure 3.148 Ease of doing business in Senegal

d) Foreign Direct Investment in Senegal

In 2021, foreign direct investment (FDI) in Senegal was USD 2.23 billion, up 21% from the previous year. The stock of direct investment at the end of the same year was USD 10.5 billion. Development of offshore gas fields began in 2020 in Senegal, with the largest SNE Oil Field being developed by a consortium of Woodside Petroleum of Australia, Cairn Energy of the UK, FAR of Australia, and PETROSEN of Senegal.-FDI has been tied to PSE since 2014. The main project is the high-speed rail TER connecting Dakar and Blaise-Diagne International Airport, implemented by the French Engie and Thales Group. In addition, DP World is investing USD1.1 billion in the development of the Ndayane Mutifunction Port.

France is the largest investor, but in recent years investment from China, Turkey, and the United Arab Emirates has expanded. Other major investment countries are Canada, Mauritius, Morocco, and Cote d'Ivoire.[18]

e) Corruption indicator

In Transparency International's Corruption Perceptions Index (CPI), an indicator of the extent to which the public sector in each country is corrupt, Senegal ranks 72nd out of 180 countries with a score of 43/100 in 2022. Côte d'Ivoire, a potential competitor among the Gulf of Guinea countries, has a slightly higher level of corruption than Senegal, and Ghana is tied with Senegal. Nigeria, on the other hand, has the highest level of corruption among the four countries.

[18]Source: Lloyd Bank, https://www.lloydsbanktrade.com/en/market-potential/senegal/investment

Table 3.136 Corruption Perception Index Comparison

Country	Senegal	Côte d'Ivoire	Ghana	Nigeria
Score (out of 100)	43	37	43	24
Rank (out of 165 countries)	72	99	72	150

Source: Corruption Perceptions Index (CPI), Transparency International

f) Public debt

Public debt to GDP is 71.6% of the projected 2022 figure, of which 57.2% is external debt. According to the IMF, Senegal's risk of external debt crisis and public debt is judged to be medium.[19]

(7) Other Social Environment

a) SDGs Achievement Status

Senegal's score on achieving the SDGs in 2021 is 58.4/100, ranking 126th out of 165 countries. Ghana, a potential competitor, is more advanced than Senegal. Côte d'Ivoire is slightly behind Senegal. Nigeria is the least advanced of the four countries in achieving the SDGs.

Table 3.137 Comparison of SDGs Status

Country	Senegal	Côte d'Ivoire	Ghana	Nigeria
Score (out of 100)	58.4	57.6	62.5	48.9
Rank (out of 165 countries)	126	131	114	160

Source: Sustainable Development Report 2021, Cambridge, 2022

The SDGs judged to have been achieved in Senegal are "SDG 12: Ensure sustainable consumption and production patterns " and "SDG 13: Take urgent action to combat climate change and its impacts" (most sub-Saharan African countries with low carbon emissions have achieved SDG 13). While "SDG 15: Protect, restore and promote sustainable use of terrestrial ecosystems, sustainably manage forests, combat desertification, and halt and reverse land degradation and halt biodiversity loss" and "SDG 17: Strengthen the means of implementation and revitalize the Global Partnership for Sustainable Development" are judged as significant challenge, but other SDGs are judged as major challenges are those that have a long way to go to be achieved.[20]

[19]Source: "2021 Article IV Consultation, Fourth Review under the Policy Coordination Instrument, First Reviews under the Standby Arrangement and the Arrangement under the Standby Credit Facility, and Request for Modification of Performance Criteria and Quantitative Targets." IMF, January 2022
[20]Source: Sustainable Development Report 2021, Cambridge, 2022

Source: Sustainable Development Report 2021, Cambridge, 2022

Figure 3.149 Senegal's SDG Dashboards and Trends (2021)

b) Human Development Index (HDI)

According to the 2021 Human Development Report, Senegal's Human Development Index (HDI) for the same year was 0.511, ranking 170th out of 191 countries. It is the lowest among the four potential competitors. Among the indicators, the average years of schooling and gross national income (GNI) are particularly low, which affects the ranking.

Table 3.138 Comparison of Human Development Index

Country	Senegal	Côte d'Ivoire	Ghana	Nigeria
Score (out of 100)	0.511	0.550	0.632	0.535
Rank (out of 191 countries)	170	159	133	163

Source: Human Development Report, 2021, UNDP

c) Poverty

The UNDP Multidimensional Poverty Index (MPI) is an index that identifies, beyond monetary index, multiple deprivations at the household and individual level in health, education and standard of living. According to the 2022 report, Senegal's index is 0.236, about the same as Nigeria's. Ghana has the best figure among the four potential competitor countries.

Table 3.139 Multidimensional Poverty Index Comparison

Country	Senegal	Côte d'Ivoire	Ghana	Nigeria
Score (out of 100)	0.263	0.236	0.111	0.254

Source: Multidimensional Poverty Index Report, 2022, UNDP

3.13.3.3 Industry to be attracted

(1) Perspectives and Considerations on Attracting Industries

PAD will attract core industries or sectors for the establishment of a PIZ to be located in the hinterland of the Ndayane Mutifunction Port (hereinafter "Ndayane PIZ"). The following are three perspectives and points to keep in mind when selecting these "priority sectors for attraction" respectively.

Table 3.140 Three Perspectives and Notes on Priority Sectors to Attract to the Ndayane PIZ

Perspective 1	【Capitalization on port functions】 The sectors to be attracted should require product exports, raw material imports, or logistics, as it has port functions that are not available in the existing SEZ. (Basic preconditions for attracting companies)
Perspective 2	【Sectors with international competitiveness】 It is necessary to attract sectors that are internationally competitive in order to contribute to industrial development and economic development in Senegal
Perspective 3	【 Pollution prevention】. When selling PIZs, it is necessary to consider the mix of sectors to be attracted to the PIZs on a commercial basis, some of the sectors and firms with environmental concerns should be avoided
Note 1	[Response to request to avoid overlapping attraction sectors]. Although government agencies such as APIX and the Ministry of Industry and SMEs have expressed their desire to avoid overlapping sectors with existing SEZs, this will be a constraint on PIZ sales by PADs. The intentional sector allocation and limitation of the competitions among SEZs and the industrial zones by the government should be avoided
Note 2	【Attracting companies to the Ndayane PIZ to begin in 2029 or later 】. Since the JPT assumed the completion of the Ndayane PIZ to be in 2028, we assume that the start of attracting companies to the PIZ will be after 2029. We would like to envision the situations of the sectors to be attracted in the next 5-10 years, considering the growth of the sector and technological advancements.
Note 3	【Watch for moves to eliminate AfCFTA tariffs】. Watching the elimination of import tariffs by the African Continental Free Trade Area (AfCFTA) and revising the strategy for attracting as necessary.

Source: JPT/interviews with government agencies and companies

a) Three Perspectives

Perspective 1 Since the Ndayane PIZ is a port hinterland, we aim to attract sectors that make best use of port functions, particularly of product exports, raw material imports, or logistics.

Perspective 2 In alignment with Perspective 1, PAD, which is part of the Senegalese government agency, will be expected to contribute to the industrial development and economic development of Senegal in developing the PIZ. Perspective 2 is to give priority to attracting sectors with international competitiveness. To achieve this, a SWOT analysis of Senegal's industrial location will first be conducted to categorize the types of competitive sectors. Then the priority sectors listed by the PSE and SI that fit the above categories and types will be listed first. Additionally, we propose sectors other than priority sectors that meet Perspective 2 and are expected to grow in the future.

Perspective 3 To successfully develop and operate a PIZ on a commercial basis, consideration should be given to the mix of sectors to be attracted within the PIZ. As an example, metal refining (mineral resource processing) mentioned in the SI is a sector that requires advanced pollution and

environmental measures, but even if the measures are thoroughly implemented, the image is incompatible with agriculture, forestry, fisheries processing, which requires food safety, and DX/ITC, which is a support sector and mainly white collar. The absence of an existing SEZ with metal refining as an attraction sector suggests that there were similar concerns.

b) Three key points

POINT 1: Government agencies such as APIX and the Ministry of Industry and SMEs, which oversee the management of SEZs, have requested that the sectors attracted to the SEZs should not overlap with existing SEZs during online interview. On the other hand, APIX is reviewing the division of roles of each SEZ from the perspective of sectors to be attracted and mentioned that the planned Ndayane PIZ will be discussed at that time. Currently, for each existing SEZ, the sectors to be attracted are defined by government ordinance according to the division of roles. However, there is some overlap in the actual sectors presented in each existing SEZ, just expressed differently. In fact, the report states that priority sectors are broadly interpreted, and tenant companies are screened. Inherently, establishment industrial parks such as SEZs and PIZs is premised on competition in design, development, quality of services and sales efforts. According to existing SEZ tenants (manufacturing companies), some companies have expressed dissatisfaction with the quality of service provided in SEZ. These service issues would naturally improve with competition among SEZs and PIZs, rather than an arbitrary "division of roles" among industrial parks and would contribute to the overall industrial development of Senegal. As PAD that provides leases for PIZs, it is advantageous to avoid arbitrary "role-sharing" by the government as much as possible. Therefore, it is recommended that the sectors to be attracted to the Ndayane PIZ should be negotiated with the government and APIX under broad categories such as Manufacturing and Assembly Processing.

POINT 2: Since JPT assumed the completion of the Ndayane PIZ by 2028, we assume that the effort to attract the companies to PIZ will begin after 2029. Consequently, the status of the sectors to be targeted in the next 5-10 years will be considered, taking into account the growth of the sector and technological progress.

POINT 3: The prospect of eliminating import tariffs through the African Continental Free Trade Area ("AfCFTA") is essential. ECOWAS member countries and other West African countries are small, with the exception of Nigeria. Senegal also has a small population and weak domestic demand, making exports essential, but import tariffs in intra-African countries pose a barrier.

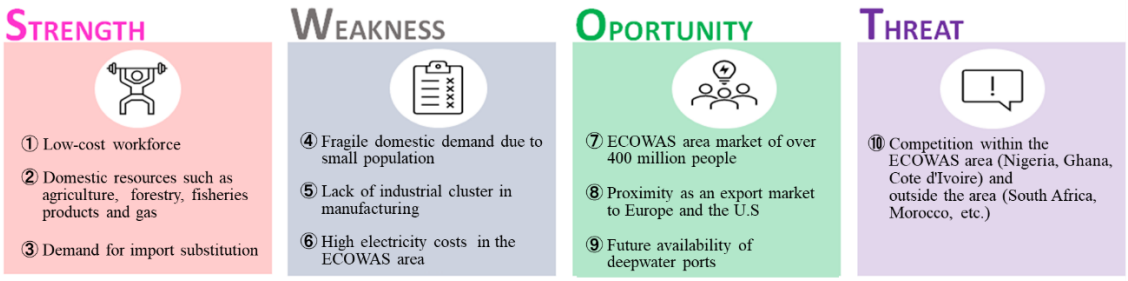
Tariff exemptions are available among ECOWAS member countries[21], but barriers are high due to the requirement of certificate of origin with a minimum of 60% local value added. On the other hand, in

[21] "Economic Common External Tariff (CET) of the Economic Community of West African States (ECOWAS) and Economic Partnership Agreement with the European Union (EU)," January 2016, Japan External Trade Organization (JETRO) Abidjan Office, p10
https://www.jetro.go.jp/ext_images/_Reports/02/2016/3e251fd24fa70d4a/CIV_ECOWAS.pdf

the AfCFTA[22], the gradual elimination of import tariffs, which should have started in 2021, has not been implemented in 2023. The fundamentals of actual trade practice, such as the table of concessions and certificate of origin in the Annex to the Protocol on Trade in Goods[23], which stipulates the elimination of tariffs, have not yet been agreed upon. Therefore, the future remains uncertain[24]. Lack of clarification on this matter will increase uncertainty for companies considering expansion into the Ndayane PIZ[25].

(2) Selection of Sectors with International Competitiveness

Based primarily on Perspective 1 and in alignment with Perspective 2, a SWOT analysis is conducted on the industrial location in Senegal to identify and categorize sectors with international competitiveness. In the SWOT analysis, S (strengths), W (weaknesses), O (opportunities), and T (threats) were identified as follows.



Source: JPT

Figure 3.150 SWOT Analysis of Industrial Location in Senegal

[22] The objectives of the CET are to create a single market for goods and services; promote the movement of capital and persons and investment; lay the foundations for a continental customs union; promote sustainable and inclusive socio-economic development; enhance the competitiveness of member entities; and promote industrial development through industrial diversification through regional value chains (Article 3 of the AfCFTA, "General Objectives (General Objectives" "The Agreement Establishing the African Continental Free Trade Area").

[23] Table stipulating the method and schedule for elimination or reduction of tariffs on individual items

[24] Takeshi Tsukamoto, above p. 65, and "What is the African Continental Free Trade Area (AfCFTA) - The Expected Birth of a Single Market", Makoto Saito, Nissay Basic Research Institute, Inc.
Makoto, Nissay Research Institute, March 01, 2023, https://www.nli-research.co.jp/report/detail/id=74041?site=nli

[25] Under the AfCFTA, goods, services, and investment move through the market without tariffs, with some exceptions, such as sensitive items agreed to in negotiations among member entities. Member countries are classified according to their level of economic development as (1) developing countries, (2) least developed countries (including Senegal), or (3) countries requiring special treatment, and tariffs are eliminated in a stepwise manner. Developing countries with relatively high levels of development (1) can eliminate tariffs on 90% of their Thai frines for five years and 7% of sensitive items for 10 years, while 3% of sensitive items can be exempted from tariff elimination. (2) Least developed countries may eliminate tariffs on 90% of tariff lines for 10 years and 7% of sensitive items for 13 years, and may exempt 3% of sensitive items. (3) Countries requiring special treatment: More concessional conditions are imposed, such as elimination of tariffs within 15 years for 90% of tariff lines.

Table 3.141 Important Aspects of the SWOT for Industrial Location That should be Addressed

SWOT to be addressed	SWOT Number	Contents of response
Weakness (W = Weakness)	W⑤	Attract sectors that can be located without industrial accumulation
		Or process domestic resources
	W④	Export to ECOWAS countries, Europe, the U.S., etc.
Strength (S=Strength)	S①	Attract labor-intensive sectors or processes

Source: JPT

Important points regarding the response to and use of each of these points are listed below.

When attracting manufacturing companies, it is necessary to attract companies for which W⑤ is not an issue. In many cases, manufacturers, who are investors, consider the accumulation of relevant industries, such as the supporting industry, and the depth of it as conditions for expansion, in order to secure raw materials. Therefore, in Senegal, where there is no industrial accumulation, it is essential that the sectors to be attracted do not require any industrial accumulations, agglomerations and clusters in the manufacturing sector.

Considering the demand for products and services, each sector needs to clear W④. Therefore, a sector that can export to West Africa, Europe, and the U.S., such as ECOWAS, as described in O (7), is required.

In order to ensure cost competitiveness in export destinations, it is desirable to take advantage of S①. In addition, in order to add values and export, the manufacturing industry will become more competitive if it secures labor-intensive processes such as assembly in the value chain.

Based on these three points, the priority sectors are classified into the following four categories

Table 3.142 Sector Selection and Classification of Sectors Attracted to the Ndayane PIZ

broad category	Classification.	Specific Sectors	Applicable SWOT
a)	Manufacturing and assembly (Sectors that can be attracted without industrial agglomeration)	Electrical products (air conditioners, printers, etc.), construction machinery	(1) (3) (5) (6) (8)
		Automobiles (subject to government leverage)	
		Pharmaceuticals	
b)	Resource-based (existing)	agricultural, forestry and fisheries processing	(1) (2) (7) (8)
c)	Resource-based (new)	Fertilizer (urea fertilizer)	(2) (3) (6) (8)
d)	Support Sector	Logistics, BOP, IT, Software, Data Center	(1) (7)

Source: JPT; black areas are sectors listed in PSE or SI; red areas are JICA survey team's own suggestions

Based on these considerations, the priority sectors are classified into the following four categories

a) Manufacturing and assembly processing; b) Resource-based (existing); c) Resource –based (new); d) Support sector

The production of industrial products, such as machinery industry, is classified as "a) Manufacturing and assembly Processing". In order to expand the possibility of attraction, the name was broadly classified so that any manufacturing process could be attracted to the area. Specifically,

pharmaceutical sector listed under SI and electrical products listed under PSE are examples. In particular, the JICA survey team envisions air conditioners and printers, which are expected to be widely used in the future, and construction machinery as an original proposal. These do not necessarily require industrial agglomeration. Pharmaceutical sector, although currently a small domestic market, will be incorporated into the Ndayane PIZ as the government has proposed the promotion of dispensing and packaging and logistics. These sales are expected to be made in Japan and West Africa. In addition to these, at the request of the PAD, the automobile will be listed on condition of further policy support from the Senegalese government.

On the other hand, sectors such as agriculture, forestry, fisheries processing, etc., where the raw materials are in principle domestic, are defined as "resource-based. Of these, those that are based on the premise of expanding production of existing resources, such as agriculture, forestry, fisheries processing, etc., are defined as b) Resource-based (existing). the JICA survey team proposes animal (Compounded) feed, fishmeal/fish oil, and aquaculture and fisheries as subsectors of agriculture, forestry, and fisheries processing. These will be retroactive so that the production of raw materials can be integrated from compound feed to aquaculture fisheries.

Furthermore, the sector that uses natural gas as a newly generated resource is designated as "c) Resource-based (new)". Specifically, we propose fertilizers, especially urea fertilizers.

In addition, the areas of logistics, DX/ITC, BPO, software, and data centers, which are also mentioned in the PSE and SI as supporting these sectors, shall be designated as "d) Support Sector. The sales target markets are expected to include domestic companies such as those within PIZ and European companies, especially those in the French-speaking countries.

The status of each sector is discussed separately below.

(3) Overview of each sector

a) Manufacturing and assembly

In the assembly process, home appliances, which are expected to become popular in Africa in the future as incomes rise, can be produced even without industrial agglomeration. In PSE, the phrase "integrated industry 'bets'" also includes "white goods". As a JICA research team, we will take as examples air conditioners, which have an estimated 1% market penetration rate within Africa, and printers, for which demand is expected to continue to grow within Africa. In addition, construction machinery, for which demand is expected to increase due to infrastructure development, is also a possibility. Regarding automobiles, we will also analyze measures that would allow them to be located Senegal, subject to government policy support.

Electrical appliances

- Air-conditioning

One industrial product that can be located in the absence or scarcity of industrial accumulations is electrical products. In the past, the former Matsushita Electric Industrial Co. (currently Panasonic)

began importing all components to Malaysia in the late 1960s to manufacture televisions, refrigerators, and air conditioners for the domestic markets. In Indonesia and other countries, local home appliance manufacturers produced air conditioners and air conditioning systems domestically, even in the absence of industrial accumulations. These factors make it easier to attract them to Senegal.

Africa sold 2.68 million room air conditioners in 2018, a global share of 2.8%, or only 28% of Japan's 9.61 million units. Sales (shipments) in Japan for the year totaled 791 billion yen. From this fact, simply estimating on a volume basis, the overall market size of room air conditioners in Africa in 2018 is estimated to be more than 220.3 billion yen. In fact, it is estimated that most room air conditioners in Africa are imported, and given the cost of imports, the market is likely to be more than simply divided by the number of units.

Meanwhile, the average annual growth rate from 2013 to 2018 was 3.2% in Africa, higher than the global growth rate of 1.0%. The penetration rate of air conditioning equipment, including room air conditioners, in Africa is estimated at 1%[26], and economic growth is expected to lead to an increase in residential air conditioners due to the expansion of the middle class and an increase in demand for commercial air conditioners. According to the market research firm, the air conditioning market is expected to increase by an average of 5.7% per year between 2019 and 2025, higher than the five-year growth rate through 2018. As the rate of increase is expected to increase gradually in the future, it is expected that the trend to manufacture air conditioners in Africa will intensify.

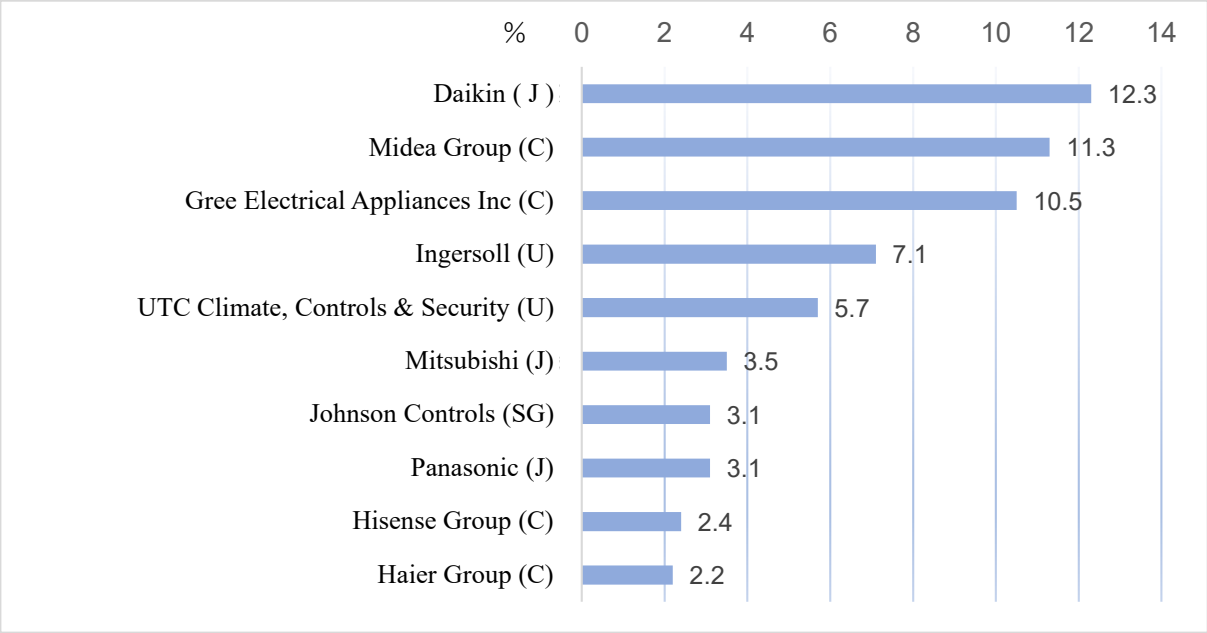
Table 3.143 Sales of Air Conditioning Equipment (Room Air Conditioners Only) Worldwide and in Africa

Area	2013 (thousand units)	2018 (thousand units)	CAGR
world	91,432	96,071	1.0%
Japan	9,113	9,650	1.2%
Africa	2,294	2,687	3.2%
Egypt	696	761	1.8%
Nigeria	533	444	-3.6%
Algeria	192	411	16.4%
South Africa	158	195	4.3%
Libya	186	141	-5.4%
Morocco	120	137	2.7%
Ghana	84	113	6.1%
Tunisia	N.A.	59	N.A
Other	325	426	5.6%
Africa / World	2.5% (2.5%)	2.8% (2.8%)	2.2%

Note: 2013 Tunisia data not available

Source: World Air Conditioner Demand by Region, June 2019, Japan Refrigeration and Air Conditioning Industry Associationhttps://www.jraia.or.jp/english/World_AC_Demand.pdf

[26] http://japanese.china.org.cn/jp/txt/2021-09/03/content_77731808.html



Source: deallab, https://deallab.info/hvac/

Figure 3.151 Top Global Air Conditioning Equipment Sales Market Share (2021)

Of these, the companies in Japan and China manufacture and sell both residential and commercial air conditioners, while the companies in the U.S. and Singapore are involved in air conditioning as a part of commercial equipment for office buildings. The U.S. and Singapore companies are involved in air conditioning as a part of commercial facilities such as office buildings.

Of these, Daikin, the world market share leader, has announced that it will establish a manufacturing base in Nigeria in 2022. Panasonic also has a local subsidiary in Lagos, Nigeria's largest city, which sells air conditioning equipment to corporate clients.[27]

The air conditioner is said to have 3,000 components, but there are three types of core components assembled from these components, and if it is manufactured in Senegal, it would be assembled mainly from the core components that have already been assembled.

The strategy to attract air conditioner manufacturers to Ndayane PIZ will likely include Chinese manufacturers with strengths in North Africa and El-Araby, an Egyptian home appliance manufacturer that has a partnership with a Japanese trading house, Sojitz.[28] It is safe to assume that Daikin's chances of making it to Senegal have been eliminated. Panasonic's Nigerian subsidiary currently only sells and imports products, which does not eliminate the possibility of manufacturing elsewhere in West Africa.

- Printer

Global shipments of printers were 57.86 million units in 2021, down 1.2%. With the progress of digitization, demand for printers is expected to remain flat or gradually decline in developed countries,

[27] Reuters, September 30, 2022, https://jp.reuters.com/article/goodman-daikin-idJPKBN2QU2F7
[28] https://www.sojitz.com/jp/news/2002/05/20020515.php

while demand in China and emerging countries is expected to maintain an upward trend for the foreseeable future. In Africa, we expect continued strong growth due to demand for the replacement from black and white printers to color printers and other factors.[29]

Table 3.144 Global Printers (Inkjet Printers) Sales Market Share (2021)

Name of firms	Percentage of units sold (market share)
Hewlett-Packard	43.0%
Epson	29.6%
Cannon	22.7%
Brother	3.9%
Other	0.8%

Source: Nikkei Data https://vdata.nikkei.com/newsgraphics/share-ranking/#/year/latest/chart-cards

Only Hewlett-Packard (HP) of the United States and Japanese companies such as Canon have global operations in printers. HP (43.0%) is the leader in terms of volume of low-priced inkjet printers, Epson (29.6%) is second, and Canon (22.7%) is third, but according to data from another market research firm, which includes sales of large MFPs and copiers, HP 13.9%, Canon 11.9%, Ricoh 7.3%, Xerox 4.8%, and Epson 4.6%, followed by four Japanese companies. It is the former that has production potential in Africa.[30]

As for printers, there are examples of successful development in the absence of industrial clusters and markets. Canon built a 20ha printer production plant in Hanoi Thang Long Industrial Park in 2001 and began exporting in 2002. When we interviewed the factory in 2006, all products were exported, and all parts were imported. This experience can be used in Senegal.[31]

There is also a movement toward local production of printers within Africa. According to press reports, there were reports that Samsung of Korea was planning to place production facilities in Ethiopia and Kenya, as well as a similar move to place a printer production facility in Egypt. Note that Samsung's printer business was acquired by HP in 2017.[32] Ricoh has also partnered with the MFI Group, a Kenyan company based also in Senegal, to strengthen its sales in Africa. In the future, such a move may spread and establish a base in West Africa as well. Ethiopia is based on labor-intensive industries such as sewing, but the industrial accumulations of machine components are weak. [33]We would like to attract companies such as HP and Canon to the Ndayane PIZ.

[29]https://www.globenewswire.com/en/news-release/2022/04/08/2419360/0/en/Africa-Printers-Market-to-Develop-at-CAGR-of-7-5-During- Forecast-Period-Observes-TMR-Study.html
[30] https://deallab.info/mfp/
[31]Canon websiteSamsung to open laptop, printer assembly plant in Kenya - The Loadstarhttps://theloadstar.com/samsung-to-open-laptop-printer-assembly-plant-in-kenya/
Interview with the head of Canon Singapore's representative office in VietnamCanon, Vietnam is a priority market for Canon in the world - HOTNAM!http://hotnam.com/news/081119083908.html
[32] https://www.afpbb.com/articles/-/3149435
[33] Ricoh Website, https://www.ricoh-europe.com/news-events/news/ricoh-partners-with-the-mfi-group-to-extend-access-to-leading-sheetfed-production-printers-across-africa/

Table 3.145 Intra-African Production Movements of Printers

Country Name	Printer Manufacturer	Remarks
Kenya	Samsung[34]	Produced together with laptop PCs
Egypt	CPG InternationalGlobalis International	The Egyptian Arab Organisation (AOI) is planning on contract production[35]
Ethiopia	Samsung[36]	

Source: JPT

- Automobile

The automotive industry has been identified as a priority industry in SI and will be attracted in cooperation with Morocco. According to a meeting with the Director of the Industry Bureau of the Ministry of Industry and SMEs, a feasibility study is being conducted currently to attract parts manufacturers, rather than sticking to attracting complete vehicle manufacturers. On the other hand, the target announced by the Ministry at a seminar held jointly with UNIDO in March 2023 calls to produce 60,000 finished vehicles by 2030, and at present there seems to be no consistency in policy. In addition, the environment for attracting the automotive industry to Senegal is difficult, and strong government policy sport is essential to make this possible.

First, currently there are only a limited number of finished vehicle manufacturers that have the potential to produce in Africa. South Africa and Morocco are the two largest car producers in Africa, while former sovereign nations Renault and Peugeot of France are using Morocco as a production base for their parts manufacturers, and Volkswagen of Germany has announced that it will begin production in 2018.[37] These three companies are unlikely to produce in Senegal in the foreseeable future.

Table 3.146 South Africa and Morocco Vehicle Sales and Production (2021)

	Morocco	South Africa
Number of units sold	154,123	499,087
Number of units produced	403,007	464,493

Source: JETRO, International Automobile Manufacturers Association (OICA)

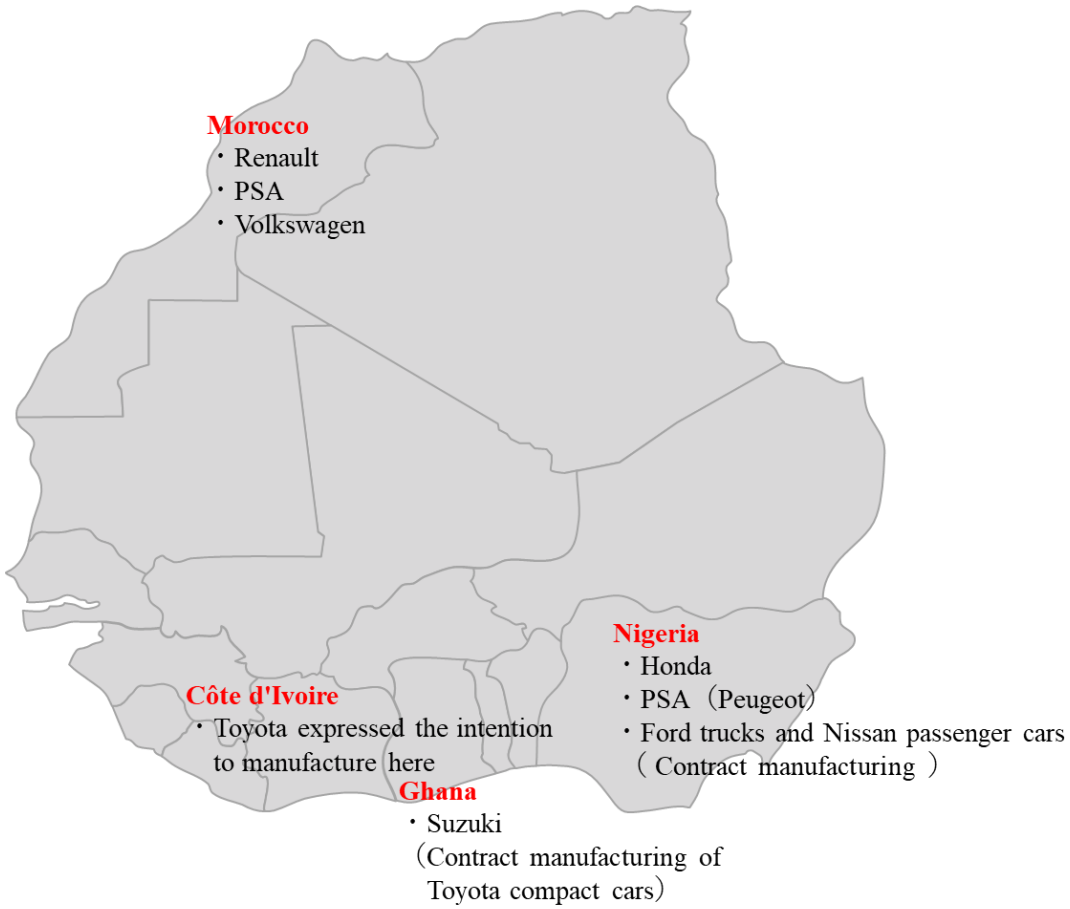
As for Japanese manufacturers in West Africa, Toyota has commissioned Toyota Tsusho to begin production of the Hilux truck in Ghana in 2021. The company has also announced plans to begin SKD production of the Swift, a compact car of Toyota's partner Suzuki Motor Corporation ("Suzuki"), at

[34]Samsung to open laptop, printer assembly plant in Kenya - The Loadstarhttps://theloadstar.com/samsung-to-open-laptop-printer-assembly-plant-in-kenya/
[35]Egyptian manufacturer signs deal to begin printer production - Edge Middle East (itp.net)https://www.itp.net/news/475898-egyptian-manufacturer-signs-deal-to-begin-printer-production
[36]Ethiopia: First Printer Assembly Plant Starts in Ethiopia - allAfrica.comhttps://allafrica.com/stories/201406061428.html
[37]https://www.moroccoworldnews.com/2018/09/253840/volkswagen-renault-morocco-automobile-industry https://www.thenationalnews.com/uae/2023/06/02/how-moroccos-answer-to-volkswagen-aims-to-drive-economic- prosperity/

the same plant starting in 2022.[38] Furthermore, Reuters reported that Toyota Tsusho announced that it had signed a written agreement with the government of Cote d'Ivoire regarding the construction of a vehicle assembly plant,[39] but no further developments have been confirmed. Honda already produces passenger cars in Nigeria. Nissan is also utilizing Morocco because of its relationship with Renault, in which it has an equity stake. Mitsubishi Motors, which has a capital relationship with Nissan-Renault, is reluctant to develop new overseas operations. The possibility of Japanese manufacturers entering the Senegalese market has almost disappeared for the time being. U.S. companies such as GM have little desire to expand overseas in the first place, and are accelerating investment in electric vehicles in their home countries, making it unlikely that they will take the risk of entering Africa and Senegal, which suffer from electricity shortages, on their own. [40]The attitude of the Chinese will be similar.

Automobile manufacturers that may be able to enter Senegal and mass produce gasoline-powered vehicles are likely to be limited to South Korea's Hyundai and others that have not established bases in West Africa other than those mentioned above. It is rare for a parts manufacturer to locate in a place where there are no automobile manufacturers. This is due to the high logistics costs for car manufacturers and other parts manufacturers to which they deliver. The idea of "linking" with Morocco (i.e., exporting parts produced in Senegal to Morocco) to produce parts and export them to Morocco is not impossible for some parts, as described below, but it would not be easy because it would not be beneficial to the Moroccan government and it would be difficult to find parts manufacturers that would enter the Senegalese market.

[38] Toyota Tsusho Press Release https://www.toyota-tsusho.com/press/detail/210630_004853.html
[39] https://jp.reuters.com/article/toyota-tsusho-ivorycoast-idJPKCN1VK05I
[40] The exception is Ford trucks, which are produced on consignment in Nigeria and South Africa, but they are large and are considered difficult to convert to electric vehicles.



Source: JPT

Figure 3.152 Finished Vehicle Manufacturers' Expansion in West Africa and the Maghreb Region

The first prerequisite is that the quality of Senegalese-made parts procured by Moroccan finished vehicle manufacturers and primary or secondary parts suppliers be comparable, and that the procurement (and for Senegalese companies, delivery) costs be low. There are then three conditions that must be met in order to realistically attract the automotive industry.

- Import duties on parts produced in Senegal should be exempted. Imported parts by sea make it difficult to get parts just in time in Morocco. Instead, it is expected that they will be required to lower their procurement costs to those of Moroccan-made parts. In that case, if import duties are levied, it is difficult to reduce delivery costs.
- The Moroccan government is in the process of promoting the parts industry in Morocco, and Senegal will be deprived of the parts that it can originally produce at home and expand employment. In this case, Senegal's partnership with Morocco may require some kind of quid pro quo, such as increased incentives for investment in Senegal by component manufacturers.
- It should be limited to labor-intensive components. Use the difference between Morocco's GDP per capita of $3,934 in 2021 and Senegal's of $1,607. In the case of primary components,

typical labor-intensive parts are not numerous, such as wiring harnesses and seats. Of these, wire harnesses are featured in the PSE as "wires for automotive, rail, and aviation," as noted above, and are described as an "integrated industry 'bet,'" but the focus at this point is excellent.

However, with Ukraine, a major producer of wire harnesses in Europe, becoming a war zone and cutting off supplies in 2022, wire harness manufacturers are rapidly switching to automated production in developed countries.[41] This is believed to be aimed at avoiding political risk in developing countries with low labor costs where production is located, as well as at responding to the high value-added with digital-enabled functions and for electric vehicles. On the other hand, the sheet's bulk and weight make it more costly to ship than a wiring harness, which dilutes the benefits of expanding into Senegal. In addition, labor productivity is often low in the first few years of operation, and production costs may temporarily exceed those of Moroccan production facilities in this regard.

In light of the above, it is assumed that labor-intensive secondary or tertiary components to be delivered to Moroccan primary or secondary component manufacturers could be produced in Senegal. Since the cost of electricity is significantly lower in Morocco, the target market will be assembly and fabrication type components with low electricity consumption. There are virtually limited SMEs in Senegal that perform machining work of that scale, and they will need to be fostered or direct investment by SMEs overseas, but for tertiary component manufacturers, which are SMEs, overseas investment is risky and difficult.

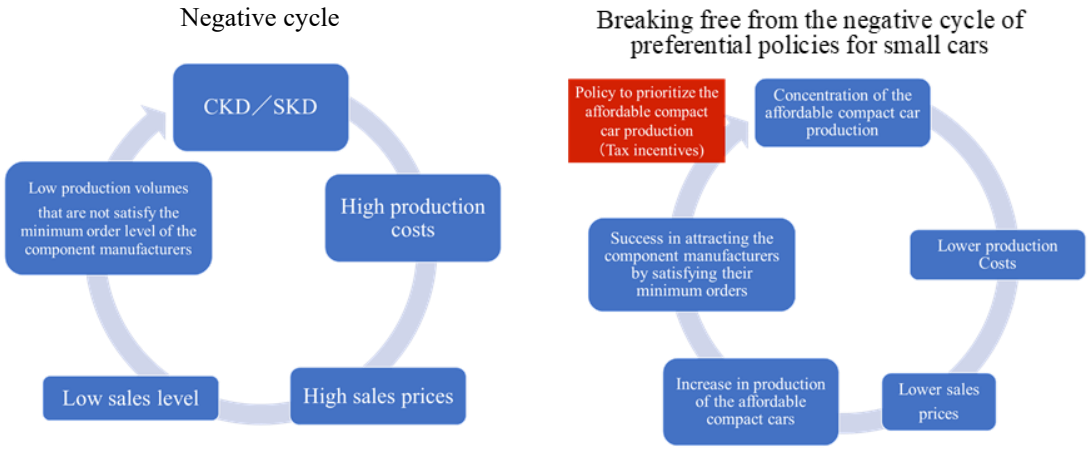
Therefore, the following two methods are more likely to find more potential than the above. The first is the local manufacturing of replacement parts, and the second is the concentrated production of finished vehicles of specific car models.

The first is the production in Senegal of replacement parts for used cars that are flowing into West Africa. According to a Thai components manufacturer, if the model numbers of parts in high demand for replacement parts for used cars in Africa and the country of manufacture are known, the size of the demand can be confirmed, and if the demand is large, local production is possible after export first.[42] In this case, the government of the destination country requested that the market research be conducted. APIX is preparing materials on the investment environment in the pharmaceutical industry, and a joint survey on Senegal and ECOWAS countries with the Thai parts manufacturers' organization could lead to the entry of Thai parts manufacturers, as the volume of demand for replacement parts for used cars is high. In addition, if component suppliers expand into the region, it will also serve as an incentive to attract finished vehicle manufacturers.

[41] Nikkei Business June 3, 2022 , https://business.nikkei.com/atcl/seminar/19/00030/060300377/?P=3

[42] Comments from auto parts suppliers participating in the seminar at the "Nigeria Automotive Seminar" co-hosted by the Automotive Research Institute of Thailand and JICA, June 2019. He explained the investment environment in Nigeria and Africa for Thai auto parts manufacturers.

Next, as a remaining possibility to attract, Senegal will strive to attract finished car manufacturers for mass production of specific car models, with significant additional incentives. There are not many automobile manufacturers that could potentially enter the market, such as Hyundai of South Korea, but there is still a possibility that other manufacturers could enter the market, depending on the type of car. Usually, in developing countries where there is no component (base) industry, automobile manufacturers start production in CKD or SKD[43] on a scale of a few thousand to 10,000 units. It is estimated that the manufacturing cost for such a facility is about three times higher than that of a production facility with 100% local content rate. Since high cost translates directly into high selling price, sales volume will not increase in low-income developing countries. Local production by component suppliers, which is necessary to reduce production costs, will not start the local production in response to the entry of automobile manufacturers unless a certain level of production is achieved.[44] Therefore, if sales volume does not increase, CKD and SKD will continue, and it is easy to fall into a "negative cycle" in which continued high costs suppress sales volume, causing parts suppliers to forgo local production. Even when multiple automobile manufacturers come to start the local production in a small market, it is easy to fall into such a negative cycle. In some cases, because high-income earners are the buyers in the early stages of production, only luxury cars are produced and low-priced compact cars with low profit margins are not produced, their sales volume does not increase due to high prices.



Source: JPT

Figure 3.153 The "Negative Cycle" of Finished Vehicle Manufacturers in Developing Countries and How to Break Out of It

[43] CKD stands for Complete Knock Down, a manufacturing technique in which all the components of an automobile are sent overseas and assembled, welded, painted, outfitted, and finished locally to create a complete automobile. SKD stands for Semi Knock Down, which differs from CKD in that, in addition to CKD, it is exported in units of parts at a level where only bolts, screws, and other fasteners are used to make a complete vehicle.

[44] Nissan, which had entered St. Petersburg in 2011, tried to attract a primary parts manufacturer with an annual production capacity of about 30,000 units. September 2011, Interviews at Nissan's St. Petersburg Plant with the Consulate of St. Petersburg

It is estimated that 80,000 to 100,000 units per car model will reach "economy of scale" where full-scale production cost reductions are activated.[45] When this level is reached, the auto industry will grow steadily, attracting local production by parts suppliers.

In the case of ASEAN and India, the auto industry was able to grow over time in an environment where used car imports were banned in principle. However, in the case of West Africa, most of the vehicles are used, and the majority of them is believed to be smuggling. For example, in Nigeria, with a population of about 190 million, it is estimated that 400,000 to 500,000 vehicles are smuggled each year. New vehicles produced by CKD or with a local parts procurement rate of 10-20% lack price competitiveness against inexpensive "new used vehicles" smuggled from the U.S., Japan, Europe, and other countries. The challenge is how to get out of the "negative cycle" to reach economy-of-scale, and local production may not necessarily take root if we wait for income and purchasing power to increase in the dwarf Senegalese market and leave it to market forces.

This is where policy measures to stimulate demand become effective. In particular, a preferential scheme for small cars that extends corporate tax exemption for a certain period (e.g., 5 to 10 years) limited to the production of compact cars with low production and sales prices could be considered to facilitate purchase by the middle class, increase sales volume, and encourage the economy of scale to be reached. The policy will include, among other things, the imposition of certain annual production volume targets on automobile manufacturers in exchange for the provision of incentives. In addition, a certain level of production would provide an incentive to attract component suppliers. Instead of compact cars, there is a way to favor pickups, which are small trucks that can be used in the agricultural sector and logistics and also serve as passenger cars, as in Thailand in the 1990s. This would be an effective method in Africa, where agriculture is still heavily involved.[46]

In any case, it will be necessary to review the results of the feasibility study by the Ministry of Industry, Small and Medium Enterprises, and to formulate effective attraction strategies as needed, keeping a close eye on the elimination of tariffs under the AfCFTA and the movements of automobile manufacturers and major parts suppliers

- Construction machinery

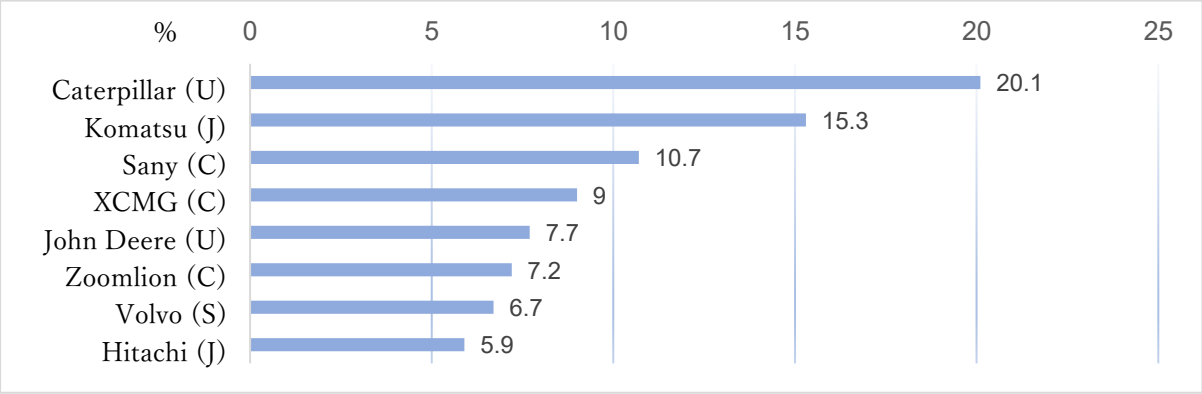
Construction equipment can also be produced locally without industrial accumulations, but only by assembling major components. According to an interview with Komatsu, which has the second largest share of the global construction equipment market and a representative office in Dakar, construction equipment sales in sub-Saharan Africa, excluding South Africa, are approximately 200 million euros in value terms and 10,000 units in number terms, with an average annual growth rate of about 5%. Although the construction equipment market is characterized by sales that rise and fall sharply from

[45]This level is expected to decrease slightly in the case of electric vehicles, which have about one-quarter the number of parts of gasoline-powered vehicles. The following is a summary of the results of the study.
[46]Malaysia's national car policy, which began in the 1980s, and Thailand's low-cost green car policy, which began in 2007, are largely similar schemes.

year to year, the market size is expected to grow at an accelerating pace in the future.

Demand can be broadly categorized in mining and infrastructure such as roads and dams. Performance and quality are important in mining, but in infrastructure, price is more important, and Japanese products with good performance and high prices will suffer.

In Komatsu's case, the company produced in China and India, exported to Africa, and even produced in Turkey in the past. Caterpillar (U.S.), the world leader, has a base in South Africa, where it has a replacement parts center.[47]



Source: deallab, https://deallab.info/construction-machinery/

Figure 3.154 Top Global Construction Machinery Sales Market Share (2021)

Based on its own experience, Komatsu believes that local production in Africa would require a market 10 times the size of the current market. However, this level would be lower if quality were not a concern. For example, unconfirmed information indicates that Caterpillar (U.S.A.) is already assembling on consignment in Cameroon.

At the time of the opening of the N'Dayan PIZ, local production is unlikely, but attracting a replacement parts center like Caterpillar's for West Africa by taking advantage of the deep seaport's capabilities would be possible in the long run, given its proximity to the U.S. home country. In addition, Chinese manufacturers such as SANY Heavy Industry which holds the third largest market share in the world and sells products with lower performance and quality, may also have the possibility of local production and the establishment of replacement parts centers.

- Pharmaceutical industry

The standard of medical care in Senegal is considered relatively good in West Africa. The typical West African medical standard of care is considered to be low, with low levels of physician competence

[47]https://s7d2.scene7.com/is/content/Caterpillar/CM20220516-d2d20-3c30f?_ga=2.125273986.922062552.1685586775-37403857.1685586775https://s7d2.scene7.com/is/content/Caterpillar/CM20220516-d2d20-3c30f?_ga=2.125273986.922062552.1685586775-

and inability to make accurate diagnoses in the hospital. In Senegal, on the other hand, the diagnosis of disease appears to be relatively accurate. When compared to the former French colonies in West Africa, it has the highest expected life expectancy while having the lowest infant mortality rate and a large private pharmaceutical market.

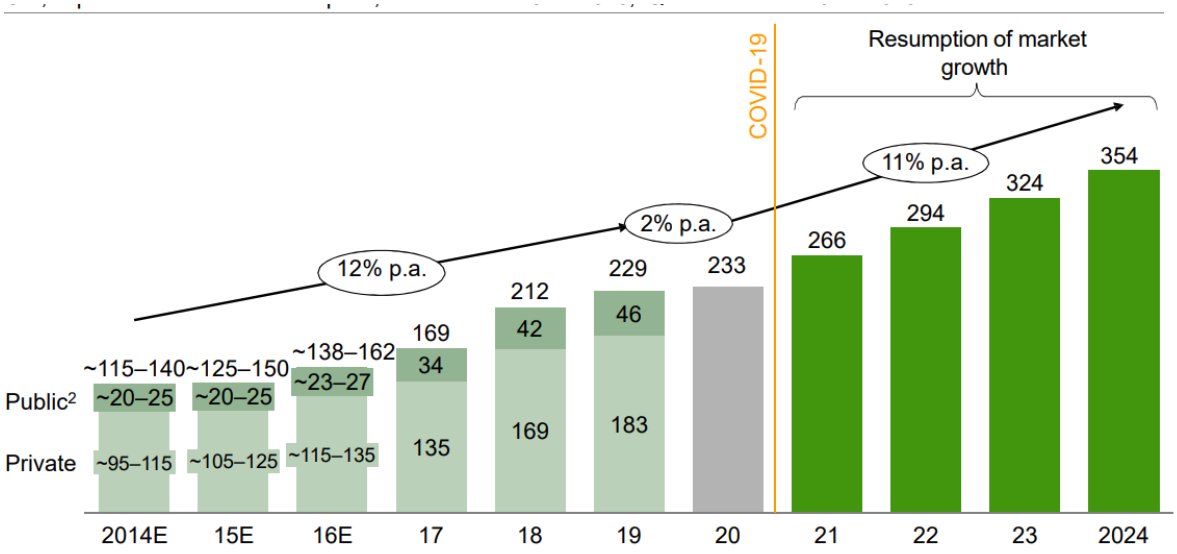
In the wake of COVID-19 pandemic, the Senegalese government aims to focus on developing the pharmaceutical industry. Rather than conducting R&D and drug discovery within the pharmaceutical value chain, the company aims to import raw materials from global manufacturers in Europe and the U.S., etc., and take on the role of distribution (sales), with a focus on packaging (dispensing). [48] In the dispensing sector, some processes are labor-intensive, and Senegal's relatively low labor costs are seen as potentially competitive.

To achieve this goal, the Senegalese government has included the pharmaceutical industry as a priority sector in the SI. In October 2021, a decree was drafted to encourage the pharmaceutical industry, but it has yet to be passed as a law, and the goal is to have it passed by October of this year (2023). In terms of content, it introduces preferential investment policies for the pharmaceutical industry and import restrictions, and stipulates that domestic pharmaceutical manufacturers become subcontractors of major pharmaceutical companies. However, according to domestic pharmaceutical manufacturers, the content is merely an effort target, and is not accompanied by any enforceability as a law or regulation.

Support is also provided by international and foreign aid agencies. The United Nations Industrial Organization (UNIDO) supported the Economic Community of West African States (ECOWAS) in setting standards for the production of medicines to promote the pharmaceutical sector, and in the aftermath of COVID-19 pandemic, the EU and GIZ, together with AFD, agreed with Senegalese President Macky Sall to establish a manufacturing base for infectious disease vaccines, including COVID-19 vaccines, in Senegal. The EU and GIZ, together with AFD have reached an agreement with Senegalese President Macky Sall to establish a manufacturing base in Senegal for vaccines against infectious diseases including coronavirus. AFD has also been constructing a yellow fever vaccine production facility in Diamniajo, outside of Dakar, since 2016.[49,50]

According to data prepared by APIX, the size of the domestic market for pharmaceutical sector in 2019 is €229 million, of which €46 million comes from public subsidies and €183 million from the private market. The average growth rate for the five-year period 2014-2019 is 12%, and 11% is projected for 2021-2024, although the growth rate for the single year 2020 slows to 2% due to the economic downturn in the Corona Vortex.

[48]https://zaidan.pasteur.jp/institut/20181211_01.pdf
[49]EU Website https://ec.europa.eu/commission/presscorner/detail/en/ip_21_3562
[50]same as above



Source: Investment Opportunity to develop pharmaceutical plant in Senegal, February 2021、APIX S.A., p25

https://www.unido.or.jp/files/SENEGALS-PHARMACEUTICAL-INDUSTRY-SECTORAL-OPPORTUNITY-PITCH-BOOK_FEBRUARY-2021.pdf

Figure 3.155 Senegal's Pharmaceutical Market Size (million €)

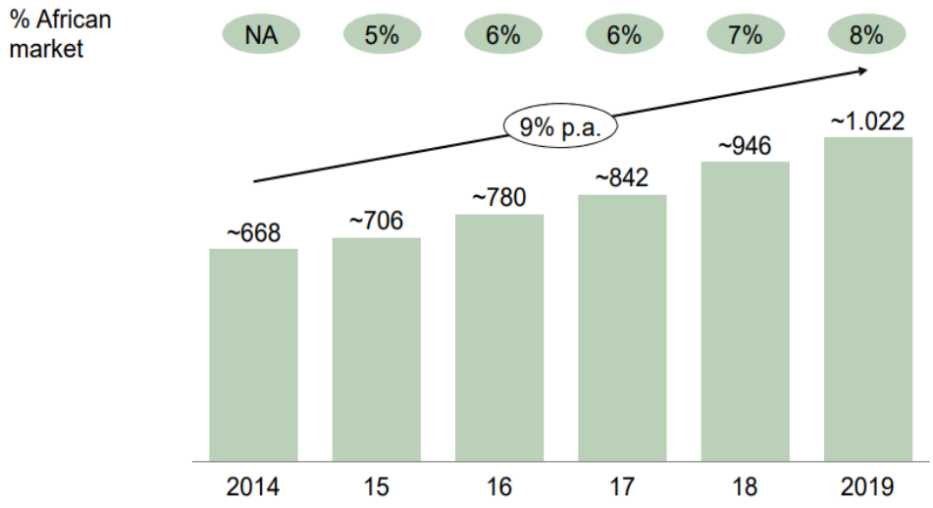
The pharmaceutical market in the five-year period 2014-2019 in the member countries of the West Africa Economic and Monetary Union (WAEMU), [51]which consists of eight of the 12 colonial countries of the former French West Africa, which are also assumed to be export destinations, growing at an average annual rate of 9%, similar to that of Senegal, and the overall African market share has increased from 5% in 2015 to 8% in 2019. WAEMU member countries have adopted a common currency, the CFA franc (Communauté financière africaine = CFA), which has the advantage of avoiding exchange rate risk when exporting.

[51] Benin, Burkina Faso, Cote d'Ivoire, Guinea-Bissau, Mali, Niger, Senegal, Togo z

Table 3.147 Pharmaceutical Markets in West African Economic and Monetary Union (WAEMU) Countries

A : Private pharmaceuticals market in 2019	A / Populati in 2017	Expenditure on pharmaceuticals per capita household in 2017 (After price adjustment)	Expected life expectancy in 2017 (Age)	Infant mortality (Per one thousand)
Senegal ~182M	12	66	68	32
ICôte d'Ivoire ~212M	8	61	57	59
Togo ~62M	8	54	61	47
Benin ~82M	7	34	61	61
Mali ~115M	6	26	59	62
Burkina Faso ~70M	4	36	36	49
Niger ~30M	1	33	33	48

Source: Investment Opportunity to develop pharmaceutical plants in Senegal, February 2021, APIX S.A., p24, based on manufacturer shipments.
https://www.unido.or.jp/files/SENEGALS-PHARMACEUTICAL-INDUSTRY-SECTORAL-OPPORTUNITY-PITCH-BOOK_FEBRUARY-2021.pdfhttps://www.unido.or.jp/files/SENEGALS-PHARMACEUTICAL-INDUSTRY-SECTORAL-OPPORTUNITY-PITCH-



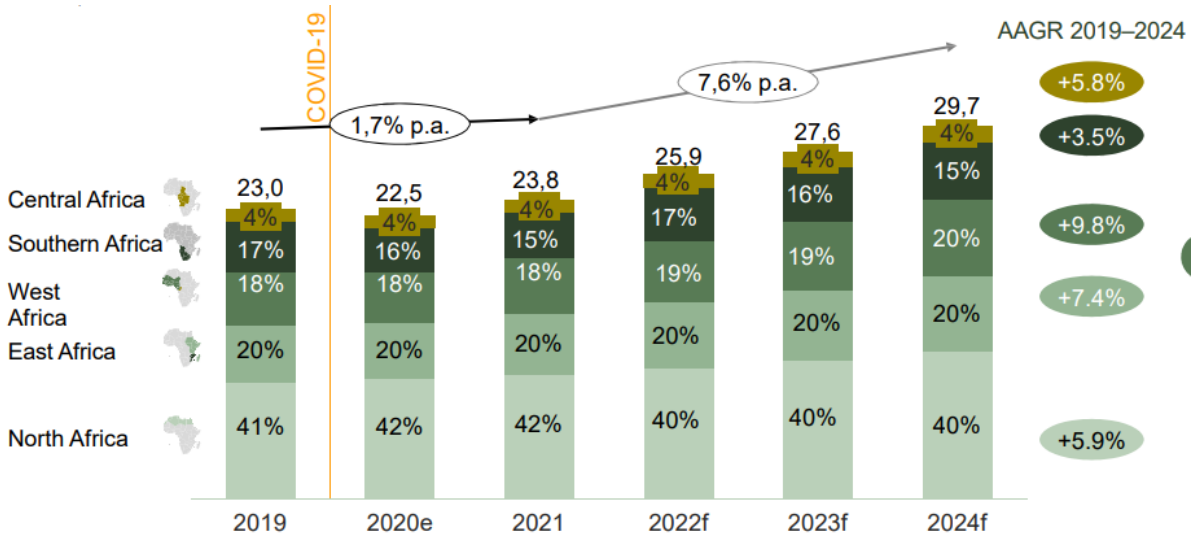
Source: Investment Opportunity to develop pharmaceutical plant in Senegal, February 2021、APIX S.A., p25

https://www.unido.or.jp/files/SENEGALS-PHARMACEUTICAL-INDUSTRY-SECTORAL-OPPORTUNITY-PITCH-BOOK_FEBRUARY-2021.pdf

Unit：100 millions EUR

Figure 3.156 Size of the pharmaceuticals market in West African Economic and Monetary Union (WAEMU) countries

Regarding the future outlook for the size of the intra-African export market for pharmaceutical sector by region (2019-2024), West Africa has the highest growth rate of 9.8% and is promising as the closest market from the perspective of Senegal.



Source: Investment Opportunity to develop pharmaceutical plants in Senegal, February 2021, APIX S.A., p24, based on manufacturer shipments

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Unit: billion EUR

Figure 3.157 Africa Pharmaceutical Market Size Forecast by Region (2019-2024) (CAGR in right-hand side)

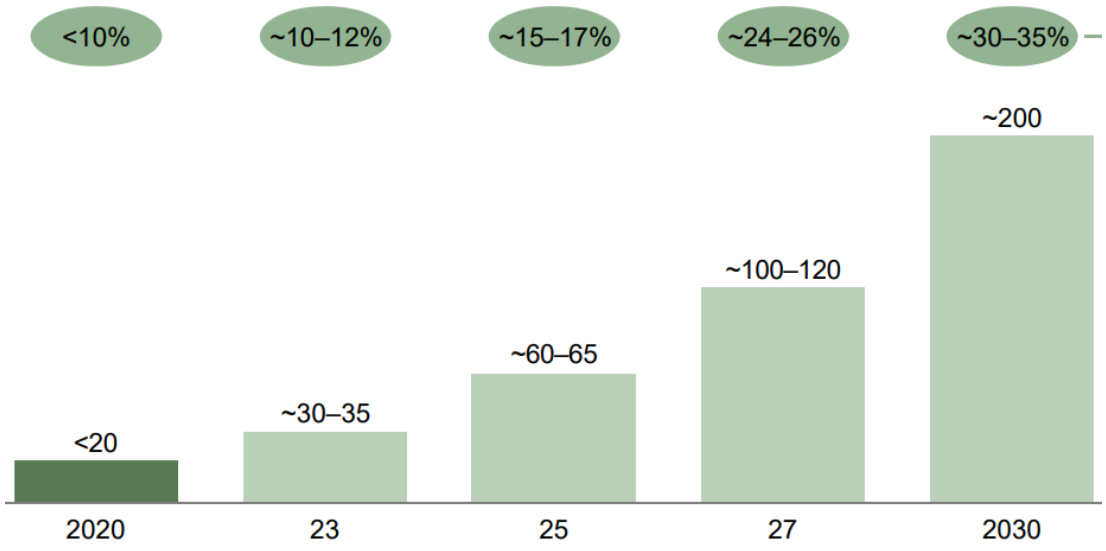
However, many ECOWAS countries are trying to promote the pharmaceutical industry, and competition in the region is expected to intensify. In addition, in order to obtain exemption from import duties within the ECOWAS region, a minimum of 60% of the value added in the exporting country is required as certificate of origin, but this condition cannot be met if the content of production is only the preparation of drugs. In addition, the elimination of intra-African tariffs under the AfCFTA has not yet been implemented, and its future remains uncertain. Although pharmaceutical manufacturers tend to produce a wide variety of products in small quantities, they are required to quickly mass-produce hot-selling products in the ECOWAS region to lower costs and ensure price competitiveness.

APIX estimates that the share of manufacturers producing domestically in the domestic market will be less than 10% in 2020, 10-12% in 2023, and 30-35% in 2030.[52] However, it will be difficult to

[52] Investment Opportunity to develop pharmaceutical plant in Senegal, February 2021、APIX S.A., p25 https://www.unido.or.jp/files/SENEGALS-PHARMACEUTICAL-INDUSTRY-SECTORAL-OPPORTUNITY-PITCH-　BOOK_FEBRUARY-2021.pdf

achieve the share as of 2023, and further efforts will be needed to attract investment to achieve the 2030 figure.

Senegal's pharmaceutical market is small, with an estimated 250-270 billion CFA (about $400 million).[53] An estimated 3% of these sales, or 7 billion CFA ($10 million), come from domestic manufacturers, with the remaining 97% coming from imports. Domestic manufacturers' sales are currently expected to grow at 10-12% per year, in line with APIX estimates (11%).



Source: Investment Opportunity to develop pharmaceutical plant in Senegal, February 2021, APIX S.A., p30

https://www.unido.or.jp/files/SENEGALS-PHARMACEUTICAL-INDUSTRY-SECTORAL-OPPORTUNITY-PITCH-BOOK_FEBRUARY-2021.pdf

Figure 3.158 Senegal's domestic pharmaceutical manufacturers' projected sales and domestic market share through 2030 (billion euros)

Domestic manufacturers, in descending order of sales, are MEDIS (Tunisia), Ouest Africa pharma (Morocco), and Teranga Pharma (Senegal). Laborex Senegal is a company specializing in pharmaceutical logistics, which is a subsidiary of CFAO of France, a wholly owned subsidiary of Toyota Tsusho, and upon interview, they have expressed interest in Ndayane PIZ as a future relocation site, since all of their products are imported (95% from the US and Europe).

Currently, domestic manufacturers do little exporting, but Teranga Pharma is also looking to export to West African countries.

b) Resource utilization (existing)

➢ Fisheries processing industry (general)

Senegal is blessed with abundant fisheries resources, with processed seafood products accounting for

[53] APIX's estimate for 2020 is 230 million euros (about $250 million), which is greater than it

10.8% of Senegal's exports in 2021 and the fisheries industry accounting for 3.2% of GDP. [54] It also ranks second[55] in West Africa in terms of landings, after Nigeria, with an increase of approximately 20% from 410,000 tons in 2010 to 513,000 tons in 2019, despite a decrease in 2020 due to COVID-19 pandemic. On the other hand, in Senegal, small-scale fisheries account for about 80% of the total landings, and only about 20% is landed by modern fishing vessels operated by corporations, making the expansion of landings by corporations a challenge.[56]

Because of the fragile but secure cold chain in logistics, 90.8% of exports by weight are refrigerated packs of fish or fillets. 79.2% of this classification is for intra-Africa. On the other hand, 72.8% of canned products are exported to the U.S. and 12.2% to Europe, South Korea, China, etc. Depending on the species of fish, sanitary standards, shipping costs, and competition with other countries, there may be room to further develop the Asian market, including the U.S. and Europe, where distances are closer, and China, where consumption and imports are increasing rapidly, as discussed below.

Table 3.148 Breakdown of processed seafood exports (by weight, 2020)

Processed marine products	Composition ratio (weight basis)
Refrigerated packs of fish or fillets	90.8% (%)
canning	4.3% (4.3%)
fish meal	2.6% (2.6%)
fish oil	1.0

Source: "Fisheries and Aquaculture in Senegal", Global Agricultural Information Network, US Department of Agriculture November 22,2022, p8, https://apps.fas.usda.gov/newgainapi/api/Report/DownloadReportByFileName?fileName=Fisheries%20and%20Aquaculture %20in%20Senegal_Dakar_Senegal_SG2022-0015.pdf

Globally, per capita consumption of edible seafood has nearly doubled over the past half century, and the pace has not slowed in recent years. [57] According to the OECD-FAO Agricultural Outlook 2022-2031, consumption (demand) is expected to increase by an average of 1.4% per year between 2022 and 2031 due to the growing awareness of seafood as a nutritious food. In response, internationally traded prices for edible marine products have been on the rise against the backdrop of rising global demand, and the Organization for Economic Cooperation and Development (OECD) and the Food and Agriculture Organization of the United Nations (FAO) have forecast generally high prices for marine products over the next decade.[58]

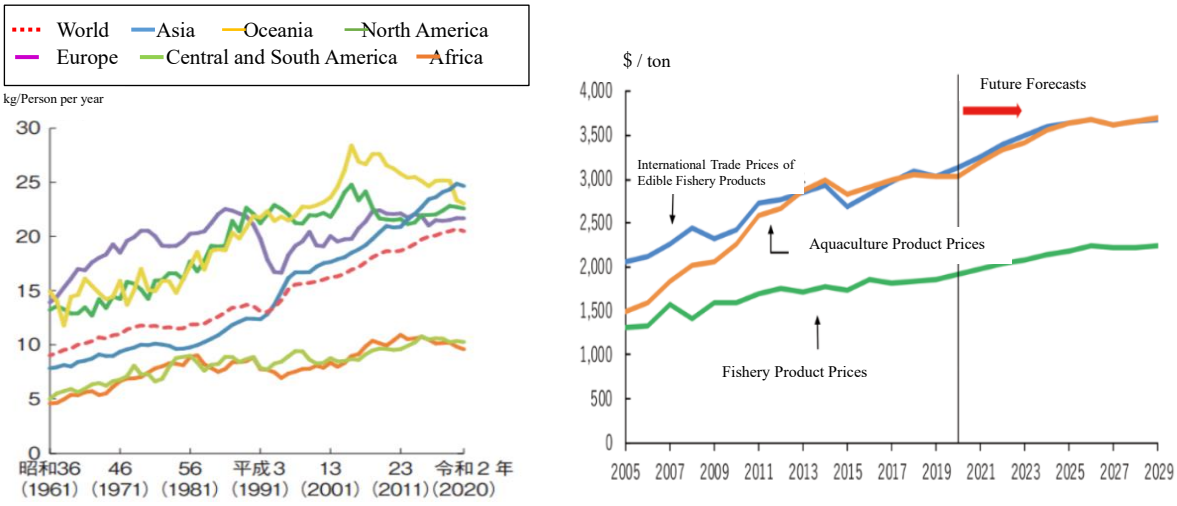
[54]"Fisheries and Aquaculture in Senegal", Global Agricultural Information Network, US Department of Agriculture, November 22,2022, pp18-19https://apps.fas.usda.gov/newgainapi/api/Report/DownloadReportByFileName?fileName=Fisheries%20and%20Aquaculture%20 in%20Senegal_Dakar_Senegal_SG2022-0015.pdf

[55]"Fisheries and Aquaculture in Senegal", Global Agricultural Information Network, US Department of Agriculture, November 22,2022, pp18-19https://apps.fas.usda.gov/newgainapi/api/Report/DownloadReportByFileName?fileName=Fisheries%20and%20Aquaculture%20 in%20Senegal_Dakar_Senegal_SG2022-0015.pdf

[56] US Department of Agriculture, above, p2

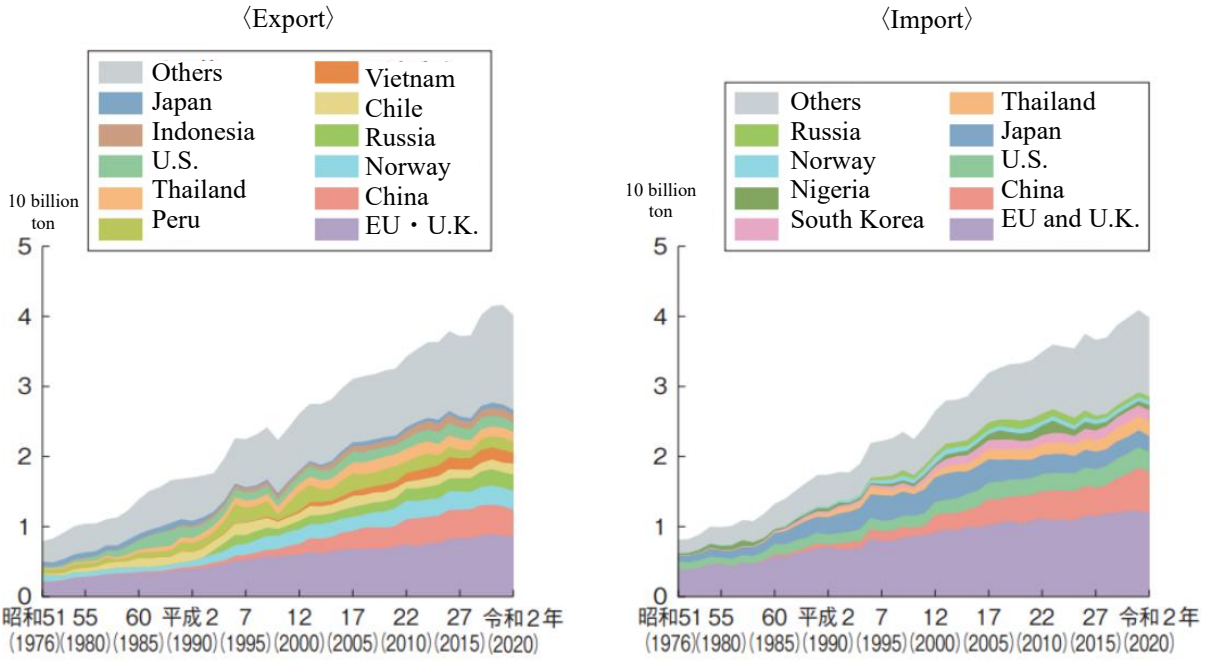
[57] Fisheries White Paper, 2022 edition, p. 149

[58] Fisheries White Paper, 2022 edition, p. 149



Source: Fisheries White Paper 2022 (left), Fisheries Agency, 2020 (right)

Figure 3.159 World per capita annual consumption of edible seafood (left) and international prices of marine products (right)



Source: Fisheries White Paper, 2022 edition, Fisheries Agency, p. 151

Figure 3.160 Trends in World Marine Products Imports and Exports

Fisheries products are a highly traded international commodity, with more than 30% of the world's fisheries and aquaculture production destined for export. In addition, the volume of marine product imports and exports has generally been on the rise due to the improved distribution technology, the relocation of processing plants to countries with lower labor costs, and progress in trade liberalization. The EU/UK, China, Norway, and Russia are the top exporters of marine products, while the EU/UK, China, the U.S., and Japan are the top importers. In particular, China's imports and exports of marine products have increased significantly, and since the mid-2000s it has become the world's largest single country exporter and importer of marine products. In addition, the EU/UK, the U.S., Japan, and other

countries/regions are net importers.[59]

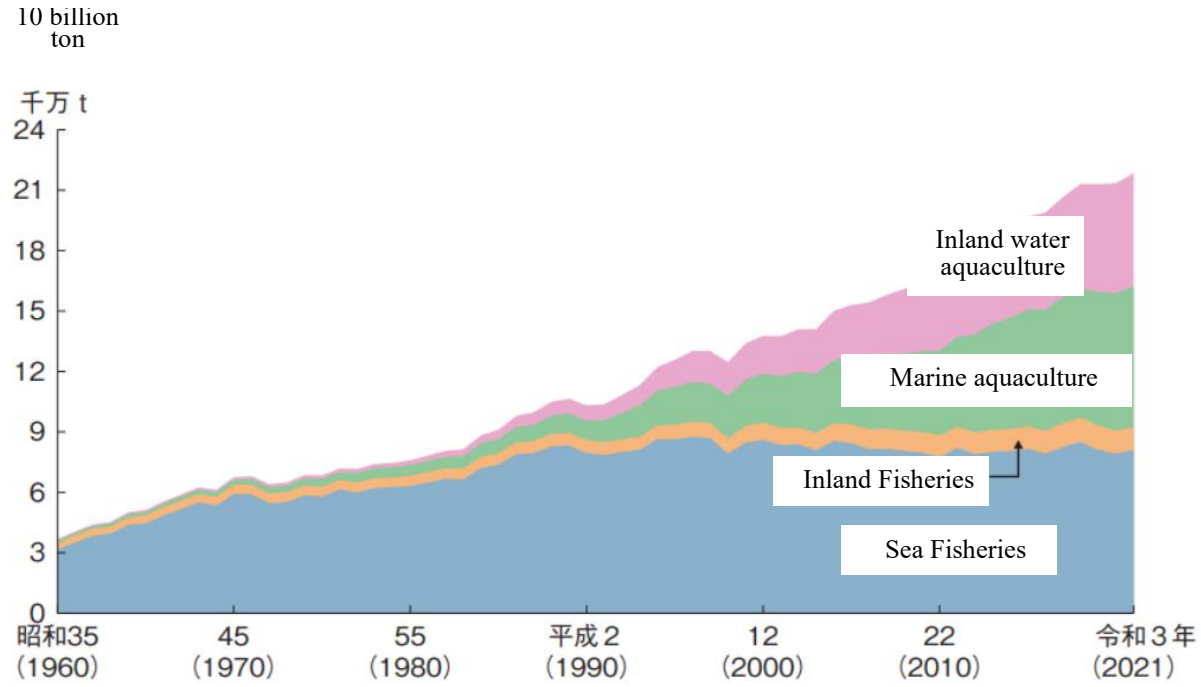
For the marine product processing industry, it may be possible to attract investment from Thai companies. Specifically, it is necessary to strengthen relationships through the Board of Investment, Thailand.

Thailand's exports of processed marine products, mainly canned tuna and other fish products, accounted for about 10% of its total exports in the early 1990s. Canning is labor-intensive, and the fish processing companies took advantage of the low cost of labor to export almost all of its canned goods to Europe. However, seafood processors are struggling with rising labor costs and labor shortages, and their share of total exports has dropped by almost half. The fish used as raw materials are already secured from pelagic fisheries and processed in Thailand, rather than from inshore waters, and logistics costs from the pelagic waters to Thailand are high. If the fishery is closer to Europe and can be processed at a lower labor cost than in Thailand, it can restore export competitiveness. In addition, Senegal is rich in fish species, and its products can be accessed to Europe, a major export market, by shipping from the Mediterranean and Atlantic Oceans, which shortens the distance and reduces costs.

- Aquaculture fishery

The promotion of aquaculture fisheries has become an essential issue in the world. Correspondingly, world catches landed by "aquaculture" and "aquaculture plants" have exceeded those landed by capture fisheries (sea and inland fisheries). While capture fisheries are in gradual decline, aquaculture fisheries are increasing substantially, which is financing the increase in global fish consumption.

[59] see above, Fisheries Agency, p150



Source: Fisheries White Paper, 2022 edition, Fisheries Agency, p. 151

Figure 3.161 Trends in World Fishery and Aquaculture Production

PAP2 also points out that fishery resources are finite.[60] However, while the PSE has expressed the promotion of aquaculture fisheries since 2014, Senegal's aquaculture fisheries landed only 1,000 tons in 2019.

The Senegalese government has enacted an aquaculture and fisheries law, which includes mandatory operational permits, quarantine certificates, and sanitary and environmental protection. In addition, several government agencies subsidize fishmeal.[61] For domestically produced fishmeal, the subsidy is half of that amount (standard price 300 CFA/kg), and for imports, two-thirds (standard price 1,500 CFA/kg). This subsidy underpins domestic demand for compound feed and fishmeal for aquaculture fisheries.

Attracting aquaculture fisheries to the Ndayane PIZ will require land-based aquaculture facilities, and cost is an issue, such as drawing seawater. On the other hand, the risk of disease can be easily controlled, and production costs are more stable than in offshore aquaculture. The Ndayane PIZ will not be completed until 2029 or later, and technological advances during this period are expected to increase the number of fish species that can be farmed and, in the long run, lower electricity prices due to offshore natural gas supply. In addition, aquaculture technology has made remarkable progress, and Japan has advanced aquaculture technologies such as complete tuna farming and land-based salmon farming. With a view to introducing Japanese aquaculture technology, this M/P will position the Ndayane PIZ as a future hub for aquaculture and fisheries development in West Africa. In addition,

[60] PLAN SÉNÉGAL ÉMERGENT PLAN D'ACTIONS PRIORITAIRES 2 AJUSTÉ ET ACCÉLÉRÉ (PAP 2A)POUR LA RELANCE DE L'ÉCONOMIE 2019 – 2023, p64
[61] PLAN SÉNÉGAL ÉMERGENT PLAN D'ACTIONS PRIORITAIRES 2 AJUSTÉ ET ACCÉLÉRÉ (PAP 2A) POUR LA RELANCE DE L'ÉCONOMIE 2019 – 2023, December 2020, p44

although there are cost issues, attracting aquaculture fisheries would also benefit the fishmeal and fish oil sector, which uses aquaculture as a raw material, as described below, as well as the compound feed sector, which uses fishmeal as a raw material.

- Fish meal

Fish meal is made from a wide variety of fish, including horse mackerel, mackerel, Pacific saury, sardines (anchovies, etc.), cod (Alaska pollack, etc.), and the inedible parts of fish (leftovers) from fish processing plants).[62] These raw materials are dried and crushed into a powder. More than one-third of the fish caught or landed by aquaculture fisheries in the world is used to produce fishmeal.[63]

Its use has traditionally been as a fertilizer (organic), but in 2017, it was mostly used for compound feed (for poultry, swine, and fish farming), with 70% for fish farming, 22% for pig farming, 5% for poultry farming, and 3% for other uses.[64]

Fish oil is produced as a byproduct, and similarly its uses are 69% for fish farming, 23% for human consumption, and 8% for other purposes. In recent years, eicosatetraenoic acid (EPA) and docosahexaenoic acid (DHA), which are fatty acids abundant in fish oil, have been reported to inhibit the increase of cholesterol in the blood, prevent cancer, and prevent aging, and are increasingly used in health foods. .[65] The number of cases of their use in health food products is increasing

Table 3.149 Fish Meal and Fish Oil Applications (by weight, 2017)

	Use	Ratio
Fishmeal	For aquaculture fish	70%
	For swine	23%
	For poultry farming	5%
	Other	3%
Fish oil	For aquaculture fish	69%
	For the use of others	23%
	Other	8%

Source: European Market Observatory for Fisheries and Aquaculture Products, MONTHLY HIGHLIGHTS | NO.4/2019, pp24-25

https://effop.org/wp-content/uploads/2019/06/EUMOFA-Monthly-Highlights-April-2019-Fishmeal-and-Fish-Oil.pdf

Looking at the world's major producers of fishmeal, Peru, which traditionally uses anchovy as its raw material, leads the pack with 1.1 million metric tons[66] of production, while Chile is fourth in South America as well. The EU27 ranks third, but the total for Norway (8th) and other European countries is more than 800,000 tons. In Asia, Vietnam (2nd), Thailand (6th), Malaysia (16th), and other Asian

[62] Ishinomaki Fish Feed Industry Website https://gyoryo.com

[63] https://www.gii.co.jp/report/dmin1018782-global-fish-meal-market.html

[64] European Market Observatory for Fisheries and Aquaculture Products, MONTHLY HIGHLIGHTS | NO.4/2019, p24 https://effop.org/wp-content/uploads/2019/06/EUMOFA-Monthly-Highlights-April-2019-Fishmeal-and- Fish-Oil.pdf

[65] （Japan Seafood Oil Association Website, http://www.suisan.or.jp/html/kisochishiki.html#:~:text=%E9%AD%9A%E6%B2%B9%E3%81%AE%E7%94%A8%E9%80%94%E3%81%AF%E3%80%81%E5%8F%A4%E3%81%8F,%E3%81%8C%E5%A0%B1%E5%91%8A%E3%81%95%E3%82%8C%E3%81%A6%E3%81%84%E3%82%8B%E3%80%82

[66] The "metric ton" is written primarily in the United States and is synonymous with "ton."

countries total more than 800,000 tons as well. Senegal is also ranked 24th (21st in exports) and includes foreign direct investment. Fish oil, byproduct of fishmeal, is almost identical, ranks about the same. Within Senegal, there are five state-owned and four private fishmeal and fish oil manufacturing companies, two of which are foreign companies.

Source: Index Mundi, original data from United States Department of Agriculture

(https://www.indexmundi.com/agriculture/?commodity=fish-meal)

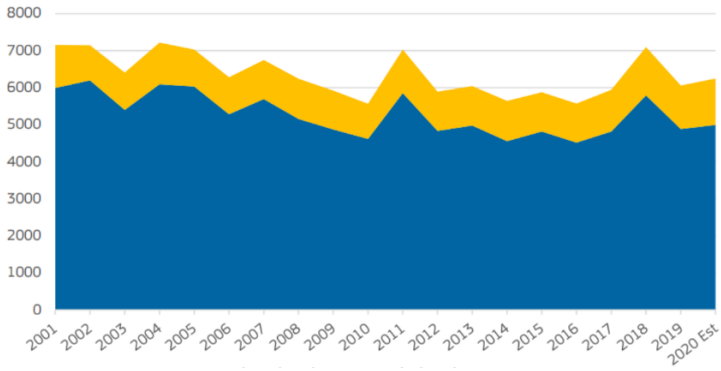
Figure 3.162 Fishmeal production (left) and exports (right) by country (1,000 metric tons, 2022)

Each country's fish meal production is basically dependent on its own catch. While some production processes are labor-intensive, such as sorting raw materials, others, such as drying, are capital-intensive, and both developed and developing countries are among the top producers. Major exporting countries also tend to be almost similar to the producing countries.

It should be noted that Senegal's neighbor Morocco ranks 10th in production and 5th in exports. In the case of Morocco, Senegal produces less than one-tenth of Morocco's fishmeal, although it has the advantage of having its fishing area facing both the Mediterranean Sea and the Atlantic Ocean. Despite differences in terms of coastline length and size of fishing area, Morocco's capture fishery landings are about three times those of Senegal. As mentioned above, there may be room to increase fishmeal production in Senegal in terms of securing raw materials if the number of fish landed by corporate fishing vessels expands and there is no fear of overfishing due to the fish species for fishmeal.

Global fish meal production is estimated to be 5 million tons of fishmeal and 1.25 million tons of fish oil in 2020. [67] Although the catch of Peruvian anchovy may increase or decrease in the order of million tons, the long-term declining trend due to the adverse effects of the El Niño phenomenon has led to a gradual decline in fishmeal production from the 6 million tons produced in 2001-2002.

[67]European Market Observatory for Fisheries and Aquaculture Products, Production and Trade Flow in the EU, Last Update: September 2021, European Commision, p4, https://www.eumofa.eu/documents/20178/432372/Fishmeal+and+fish+oil.pdf



(Unit: 1,000 tons)

Source: European Market Observatory for Fisheries and Aquaculture Products, Production and Trade Flow in the EU, Last Update: September 2021, European Commission, p5, https://www.eumofa.eu/documents/20178/432372/Fishmeal+and+fish+oil.pdf

Figure 3.163 Fishmeal (blue) and fish oil (yellow) production (1,000 tons)

The global market size (demand) for fish meal is estimated to be about $8.5 billion in 2022, according to market research estimates, and is expected to increase by an average of 5.6% per year through 2027.[68] Other market research firms' forecasts also expect an increase of 4-8% over a similar period.

For fish meal and fish oil, in terms of both demand and imports by country, China is by far the largest importer, followed by the EU27. Regionally, demand is largest in Asia, including Japan. Norway, which is a major salmon producer and the 8th largest producer of fishmeal, also ranks 5th in terms of both demand and imports.

Senegal ranks 29th in demand at 3,000 metric tons, with production of 13,000 metric tons, the majority of which is exported. For 2020, when regional statistics are available, 77% of the 7,521 metric tons of total exports (up 29% from the previous year) are destined for Asia, with exports likely to China, Vietnam, and other countries with high import volumes. On the other hand, most fish oil is destined for the United States.

[68] https://www.thebusinessresearchcompany.com/report/fishmeal-global-market-report

Source: Index Mundi, original data from United States Department of Agriculture

(https://www.indexmundi.com/agriculture/?commodity=fish-meal&graph=domestic- consumption)

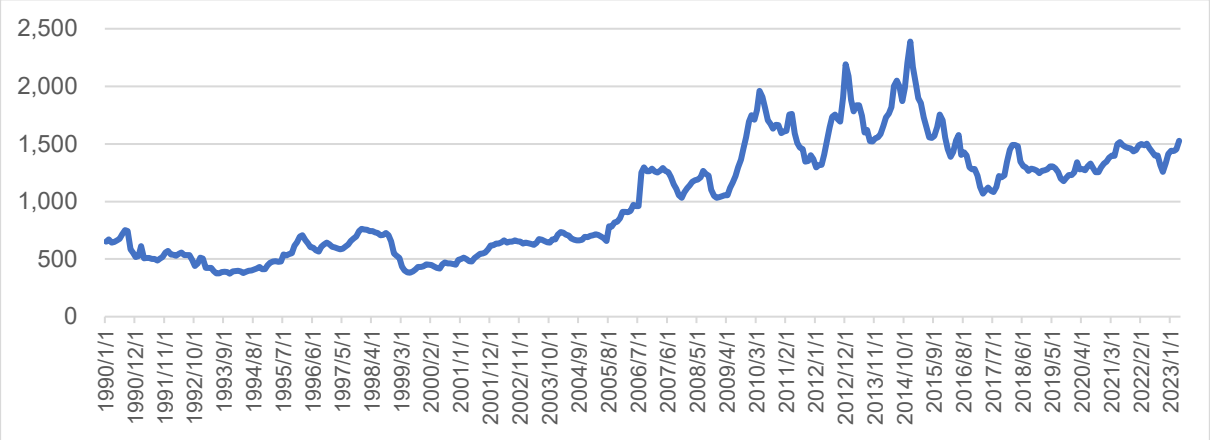
Figure 3.164 Fish Meal Demand (left) and Imports (right) by Country (1,000 metric tons, 2022)

The international price of fish meal began rising from around $400/metric ton in 1999 and temporarily rose about sixfold to about $2,400 in January 2015, before hovering around $1,500 in April 2023. The reasons for this are: the ban on meat and bone meal recommended by the WHO in April 1996 due to bovine spongiform encephalopathy (BSE), which led to the replacement of meat and bone meal used in animal feeds with fishmeal; growing demand for fish meal in China and other emerging countries[69]; and a decrease in the catch of anchovy (anchovy), the raw material for fishmeal, in Peru, the largest fishmeal producer.[70] The Food and Agriculture Organization of the United Nations (FAO) predicts that fish meal prices will continue to rise as demand remains strong worldwide.[71]

[69]There is also awareness of the possibility that the fishing season for anchovy, the raw material, may be interrupted to protect the resource. Nihon Keizai Shimbun, ibid.

[70]Fisheries Agency Website: https://www.jfa.maff.go.jp/j/kikaku/wpaper/r02_h/trend/1/t1_2_2.htmlhttps://www.jfa.maff.go.jp/j/kikaku/wpaper/r02_h/trend/1/t1_2_2.html

[71] Fisheries Agency Website https://www.jfa.maff.go.jp/j/kikaku/wpaper/r02_h/trend/1/t1_2_2.html



Source: JICA research team, from International Monetary Fund (IMF) and Federal Reserve Bank of St. Louis website.

https://fred.stlouisfed.org/series/PFISHUSDA

Figure 3.165 International Price of Fish Meal ($/metric ton)

Long-term potential for fishmeal and fish oil production in Senegal is regarded to be promising. Currently, fishmeal and fish oil have one the highest degree of processing and added value among seafood processing exports. Increased international production of fishmeal and fish oil is consistent with the goal of increasing the level of processing in the fisheries industry in the PSE.

Looking at global market conditions, aquaculture fisheries will have no choice but to expand in the future, and demand for human use is also on the rise due to increasing health consciousness. Meanwhile, the catch of anchovy on the Pacific coast of South America has declined somewhat due to the El Niño phenomenon, and the output of fishmeal and fish oil in Peru has also decreased. Therefore, prices are also expected to follow an upward trend, as noted by FAO.

On the other hand, there are two risks. The first is that if fishmeal and fish oil prices continue to rise, it could spur the development of alternative feed ingredients such as insects. The second point is that fishmeal and fish oil manufacturers already operating in the country are experiencing problems[72]with residents near their plants due to sewage, air pollution, and odors, and some Spanish companies have been brought before the courts[73]. It is essential that this point be fully considered in the Ndayane PIZ.

In order to realistically increase the production of fishmeal and fish oil in Senegal, it will be necessary to increase the proportion of full-scale fishing by corporates, not only traditional fishing by rowing boats. Therefore, we propose that feed production, including animal feed made from fishmeal, be positioned as an important sector in Ndayane PIZ, and that the PAD, in cooperation with the government, support the development of an aquaculture fishery in Ndayane PIZ that is also linked to fishmeal production.

[72] https://earthjournalism.net/stories/a-foreign-owned-fishmeal-factory-causes-a-stink-in-senegal
[73]https://www.seafoodsource.com/news/supply-trade/senegal-court-case-could-impact-fishmeal-industry-expansion-in-west africahttps://www.seafoodsource.com/news/supply-trade/senegal-court-case-could-impact-fishmeal-industry-expansion-in-west

Major fishmeal producing companies in Europe, the U.S., and elsewhere are listed below. Relatively little investment by Western manufacturers outside their own countries is expected to be attracted to Ndayane PIZ.

Table 3.150 Major Manufacturers of Fishmeal and Fish Oil Worldwide

Manufacturer Name	country name
ADM Animal Nutrition	United States of America
Omega Protein Corporation	United States of America
Calysta, Inc.	United States of America
The Scoular Company	United States of America
Animalfeeds International Corporation	United States of America
Austevoll Seafood ASA	Norway
AKER BIOMARINE	Norway
Biomega AS	Norway
Pelagia A.S.	Norway
Pesquera Diamante S.A. (Diamond Fishing)	Peru
Pesquera Exalmar S.A.A.	Peru
Pesquera Hayduk S.A.	Peru
Copeinca S.A.C.	Peru
Corporation Pesquera Inca S.A.C.	Peru
Oceania Group Limited	South Africa
Pioneer Fishing (Pty) Ltd.	South Africa
Sarma Fish S.A.R.L.	Morocco
Sardina D.O.O.	Croatia

Source: JPT

- Agro-processing

In agro-processing, Senegal is in a semi-arid region and has an advantage in processed vegetable and fruit products. In this field, an example of a Japanese company entering the Senegalese market is Kagome Co. Ltd. In December 2017, the company established Kagome Senegal Sarl, a farming company responsible for growing, purchasing, and selling tomatoes for processing in Senegal.[74]

In the ECOWAS region, tomato paste is deeply rooted in the food culture as a basic seasoning and an essential ingredient. On the other hand, tomatoes for processing are not cultivated sufficiently in terms of both quality and quantity due to immature cultivation techniques and high disease and insect stress, and most processed tomato products consumed in the region are now dependent on imports from overseas. Therefore, the company aims to establish a new tomato production area in Senegal using the agricultural technology resources of its group companies, such as seeds and cultivation technology, and to expand its business domain to the production of processed tomato products in Senegal in the future. Kagome also aims to enter the market for processed tomato products in Senegal and the ECOWAS region.

[74] News Release, October 27, 2017, Kagome Corporation Website, https://www.kagome.co.jp/company/news/2017/2017102501.html

Prior to establishing the local subsidiary, the company was selected for JICA's "Preparatory Survey for Cooperation (Promotion of BOP Business Partnerships)" and conducted a survey from 2014 to 2017 on the potential for tomato cultivation and processing business in Senegal. As a result, Senegal was determined to be a suitable location for the development of the tomato business in ECOWAS because of its suitable areas for tomato cultivation compared to other ECOWAS member countries. Additionally, with its stable political situation and low security risk, and the existence of promising markets for processed tomato products in Senegal as well as in neighboring countries such as Nigeria and Ghana are the important factors. If the company's business development and timing are right, the company's tomato paste, and other processed tomato production facilities would have the potential to be in the Ndayane PIZ.

- Manufacture of compound (animal) feed

Among the agro-processing sectors, compound (animal) feed manufacturing is the one with the highest degree of processing and is expected to grow steadily in the future. The global market for compound feed is expected to grow at a CAGR of 3.8% between 2021 and 2028 to reach $767.6 billion.[75] In Africa, it is expected to increase by an average of 4.3% per year through 2028 at $21 billion in 2023.[76]

Standard main ingredients are 50-55% corn, 25-30% soybean meal, and 5% fishmeal for chickens and pigs, and 35% sweet potato, 30% corn, 15% soybean meal, and 5% fishmeal for cattle.[77] In the Sahel region around the Sahara Desert in West Africa, such as Senegal, most of the compound feed is used for poultry farming, 80% in the case of Senegal.[78] Because of the large Muslim population (about 90% of the population in Senegal), the demand for compound feed for pigs is limited, and most cattle and goats are grazed. In recent years, demand for compound feed for aquaculture fisheries has also increased.

In Senegal, most of the raw materials for compound feed are to be imported. Of these, self-sufficiency in major food grains such as corn is low and heavily dependent on imports, so the Senegalese government has made increasing domestic production a high priority issue.[79] If the domestic supply of formula feed can be kept logistics costs low, domestic production of compounded feed will become internationally competitive. As mentioned above, fishmeal is already being produced domestically from local fish, and there may be room to increase the domestic supply of fishmeal as a compound feed ingredient.

In Africa, compound feed manufacturers had 77 compound feed production facilities in South Africa,

[75] https://www.mordorintelligence.com/industry-reports/african-compound-feed-market-industry
[76] https://www.mordorintelligence.com/industry-reports/african-compound-feed-market-industry
[77] Market Focus: West Africa Market Profile, January 17, 2023, US Grains Council https://grains.org/market-focus-west-africa-market-profile/
[78] https://informa-mea-res.cloudinary.com/image/upload/conferences/agra-innovate-west-africa/resources/nl-06-2022-animal-feed- industry.pdf
[79] https://apps.fas.usda.gov/newgainapi/api/report/downloadreportbyfilename?filename=Nigeria%20Animal%20Feed%20Sector%20Snapshot_ Lagos_Nigeria_5-20-2019.pdf

producing a total of 250 million tons (2021).[80] Nigeria produced a total of 5.5 million tons in 2016.[81] In addition, conglomerate Olam (Olam)[82] was planning a compound feed plant with a capacity of 720,000 tons as of late 2016. According to the U.S. Grains Council, in Senegal, the total production of the five major compound feed manufacturers alone is stable at 500,000 tons per year and is expected to increase in the future[83]. In addition, domestic peanuts are used as ingredients. Some of the domestic manufacturers and Olam are assumed to be attracted to the Ndayane PIZ when increasing production.

The largest Asian player in this field is Thailand's Charoen Pokphapand (CP) Group. The company began as a family business selling animal feed, then expanded into manufacturing, upstream chicken and pig breeding, processing and sales of chicken meat, eggs, pork, and other food products, and is now a conglomerate that is also involved in telecommunications and retailing. In addition to being the first foreign investor in China, CF Foods (CPF) has operations in 16 countries, including Japan, Europe, the United States, Southeast Asia, and South Africa. Since CFP does not yet have a production facility in West Africa,[84] CPF is a candidate for the Ndayane PIZ.

c) Resource-based (new)

- Fertilizers in general

Senegal aims to increase agricultural productivity to improve food self-sufficiency. Regarding agricultural fertilizers, which are essential for this purpose, fertilizer use per hectare of farmland is only 22 kg/year compared to the global average of 122 kg/year (2019, Food and Agriculture Organization of the United Nations).

Senegal is the world's 15th largest producer of phosphate ore, the main raw material for chemical fertilizers, and some phosphate fertilizers are produced using its own phosphate ore. In sub-Saharan region phosphate is produced in South Africa (14th), Togo (20th), Tanzania (30th), and Zimbabwe (31st).[85] Senegal also began producing natural gas, which is also a raw material for fertilizer. Over the past two decades, oil and gas fields have been discovered offshore Senegal and Mauritania, including the state-owned PETROSEN, whose Sangomar project, in which the company holds a concession, is expected to begin producing oil and associated gas in 2023.

West African fertilizer producers are Nigeria and, in neighboring countries, Morocco. Morocco's strength is that it is the world's second largest producer of phosphate ore, but Morocco does not produce crude gas, and the other hand, Nigeria does not produce phosphate ore.

Currently, ICS, a joint venture between Indonesia's Indorama and the Senegalese government,

[80] https://www.mordorintelligence.com/industry-reports/african-compound-feed-market-industry
[81] https://informa-mea-res.cloudinary.com/image/upload/conferences/agra-innovate-west-africa/resources/nl-06-2022-animal-feed-industry.pdf.
[80] https://apps.fas.usda.gov/newgainapi/api/report/downloadreportbyfilename?filename=Nigeria%20Animal%20Feed%20Sector%20Snapshot_Lagos_Nigeria_5-20-2019.pdf
[83] See above US Grains Council
[84] https://www.cp-foods.com/
[85] https://www.globalnote.jp/post-3137.html

produces phosphate fertilizer but exports almost all of it to India. Other chemical fertilizers are dependent on imports. There are about 10 fertilizer import companies in the country.

- Urea fertilizer

As mentioned above, meeting domestic demand for fertilizer by manufacturing it domestically is a challenge for Senegal. For this reason, strong requests for fertilizer plant development have been coming to Japan for some time. PETROSEN, the Senegalese Petroleum Corporation, aims to build a urea fertilizer plant in Senegal by using associated gas produced offshore.

In response, the Ministry of Economy, Trade and Industry of Japan (METI) conducted a feasibility study in FY2022 for an ammonia/urea fertilizer/methanol co-production plant project that is environmentally friendly and uses digital technology in a low-carbon society in the Republic of Senegal. After a comparative study of various gas fields and locations in Senegal, the Ndayane PIZ, which has port functions, was selected as a suitable site. The construction of a urea fertilizer plant here would satisfy the urgent domestic demand and would also enable the company to take advantage of its geographical location to export its products. It also does not compete with government-owned ICS because of the different types of chemical fertilizers.

The following table summarizes the results of the analysis of market trends and future demand forecasts for urea fertilizers conducted in the above METI study. In the African region, demand for urea fertilizer increased 121% over the 10-year period 2011-2020 and is expected to continue to increase significantly. In addition, the international market price of urea fertilizer reached 900 USD/ton in 2022. It is expected to fall to 850 USD/ton in 2024, but is expected to remain at a high level in the future. Overall, market conditions are favorable for the construction of urea fertilizer plants.

However, Nigeria is currently the only producer in the region and is increasing its production capacity and exports. Depending on the production capacity to be built, Nigeria will be a future competitor if the company aims to export to West Africa. The main import partners of urea fertilizer for West African countries are Russia and Nigeria. Nigeria should be closely monitored when selecting export destinations and determining production capacity.

Table 3.151 Analysis of Urea Fertilizer Market Trends and Future Demand Projections

(data) item		Analysis Results
Market Trend	Price	The international market price of urea fertilizer reached 900 USD/ton in 2022. It is expected to fall to 850 USD/ton in 2024, but is expected to remain at a certain high level in the future.
	production	The major producers of urea fertilizer are China, Russia, the United States, and India. Urea fertilizer production in the African region in 2020 is about 6% of the global total, but increased by 121% in the 10 years from 2011 to 2020. India, the U.S., and Brazil, the major consumer countries, have set out to intensify their own production of urea fertilizers. Urea fertilizer production in Nigeria is on the rise. Further production growth is expected as a new large-scale plant will be completed in 2021.
	consumption	The major urea fertilizer consuming countries are China, India, the United States, and Brazil. Urea fertilizer consumption in the African region in 2020 is about 3% of the global total, but has increased 59% in the 10 years from 2011 to 2020.In Senegal and seven neighboring countries (Benin, Burkina Faso, Cote d'Ivoire, Ghana, Mali, Niger, and Togo), urea fertilizer consumption is increasing.
	export and import	The West Asian region and the Eastern European and Central Asian region are the main urea fertilizer export regions, while the South Asian and Latin American regions are the main import regions. Nigeria's urea fertilizer exports are on the rise, with Brazil and neighboring West African countries being important markets. The main urea fertilizer import partners in Senegal and West African countries (Benin, Burkina Faso, Cote d'Ivoire, Ghana, Mali, Niger, and Togo) are Russia and Nigeria.
Demand Forecast	whole world	Demand for urea fertilizer is projected to increase in almost all regions, except for the East Asia region. A significant increase in demand for urea fertilizer is projected in the Latin American and African regions.
	Senegal and neighboring countries	If the annual growth rate of nitrogen consumption per capita per year remains above 1.5%, urea fertilizer demand will exceed 1,000,000 tons in 2040. the annual growth rate of nitrogen consumption per capita remains at 3% and that nitrogen consumption per unit population reaches the Indian level, if the demand will reach 2,000,000 tons in 2045.

Source: Feasibility Study on Ammonia/Urea Fertilizer/Methanol Co-production Plant Project with Environmental Consideration and Digital Technology in Low Carbon Society in the Republic of Senegal, Study Report

d) Support Sector

In the Ndayane PIZ, logistics, business processing outsourcing (BPO), IT software, and data centers are to be attracted. Those sectors provide the tenant firms with support functions. Additionally, tenant companies of these sectors can aim to export their services by taking advantage of their competitive labor costs. PSE aims to be one of the top three French-speaking service outsourcing centers in Africa. Regarding logistics, logistics generated in each sector will be handled within PIZ.

As an example, Laborex Senegal, a French CFAO affiliate specializing in pharmaceutical market logistics, has expressed interest in entering Ndayane PIZ, in this case it would open a logistics warehouse adjacent to a pharmaceutical manufacturer within the manufacturing and assembly zone. In addition, Moroccan OCP, a chemical fertilizer manufacturer, has been waiting at a temporary storage facility in the Diamniadio SEZ for bulk product imported at the port of Dakar, which is then transferred to a distribution center in the Sandiara SEZ for re-export to inland countries such as Mali and Gambia. The company intends to use the Ndayane port to move its bulk storage to Ndayane PIZ,

and depending on the rent, also intends to move its distribution center to the Ndayane PIZ..[86]

Currently, the Port of Dakar is assumed to be responsible for the distribution of grains and other commodities to landlocked countries such as neighboring Mali, since the logistics warehouse in Mali is located at the wharf of the Port of Dakar.

3.13.4 Vison and Strategy Plan for PIZ Development

3.13.4.1 Vision

Creation of a PIZ that is attractive as a trade hub in the ECOWAS - Atlantic region.

3.13.4.2 Strategy

(1) Leverage strengths as a deep sea port

The most important aspect of the Ndayane PIZ development strategy is that this PIZ is adjacent to the Ndayane Multipurpose Port, which will be the main alternative line to the Port of Dakar of Senegal. Ndayane Port is to be developed as a deep-sea port with a draft of 15-20 m, and a port M/P is being formulated assuming the berthing of large-capacity ships. Because Ndayane port will be the new water transportation hub of Senegal, the primary strategy of the Ndayane PIZ to maximize the advantages of the trend and attract industries that are capable of mass production and export (both import substitution and export processing).

(2) Leverage strategic location

Senegal is located on the western edge of the African continent. This location is of strategic importance because it is the gateway to the Atlantic Ocean for the ECOWAS countries, as well as the proximity in distance on shipping routes with Europe and the Americas. Therefore, it is essential to formulate a development policy that appropriately takes into account market trends and needs for port facilities in the above regions. The second strategy is to take advantage of this geographical advantage and attract industries that make use of water and land transportation.

(3) Optimization of local industries and identification of companies to attract

As already mentioned in 3.13.3.3 Consideration of attracting industries, we examined the local industries. Based on this, how to place each industry within the PIZ based on the resources owned by Senegal, domestic and overseas market trends, synergies between industries, etc.

(4) External cooperation in PIZ operation

The main one (owner) of PIZ development (owner) is PAD who owns the land and has a desire to develop SEZ. However, this is the first time for PAD to develop and operate an SEZ, and naturally there is no organization in charge of PIZ within the organization. In order to actually develop a PIZ, attract private companies and operate it sustainably, we need to work together with PIZ personnel and PIZ organizations, and essentially to strengthen know-how related to PIZ operation.

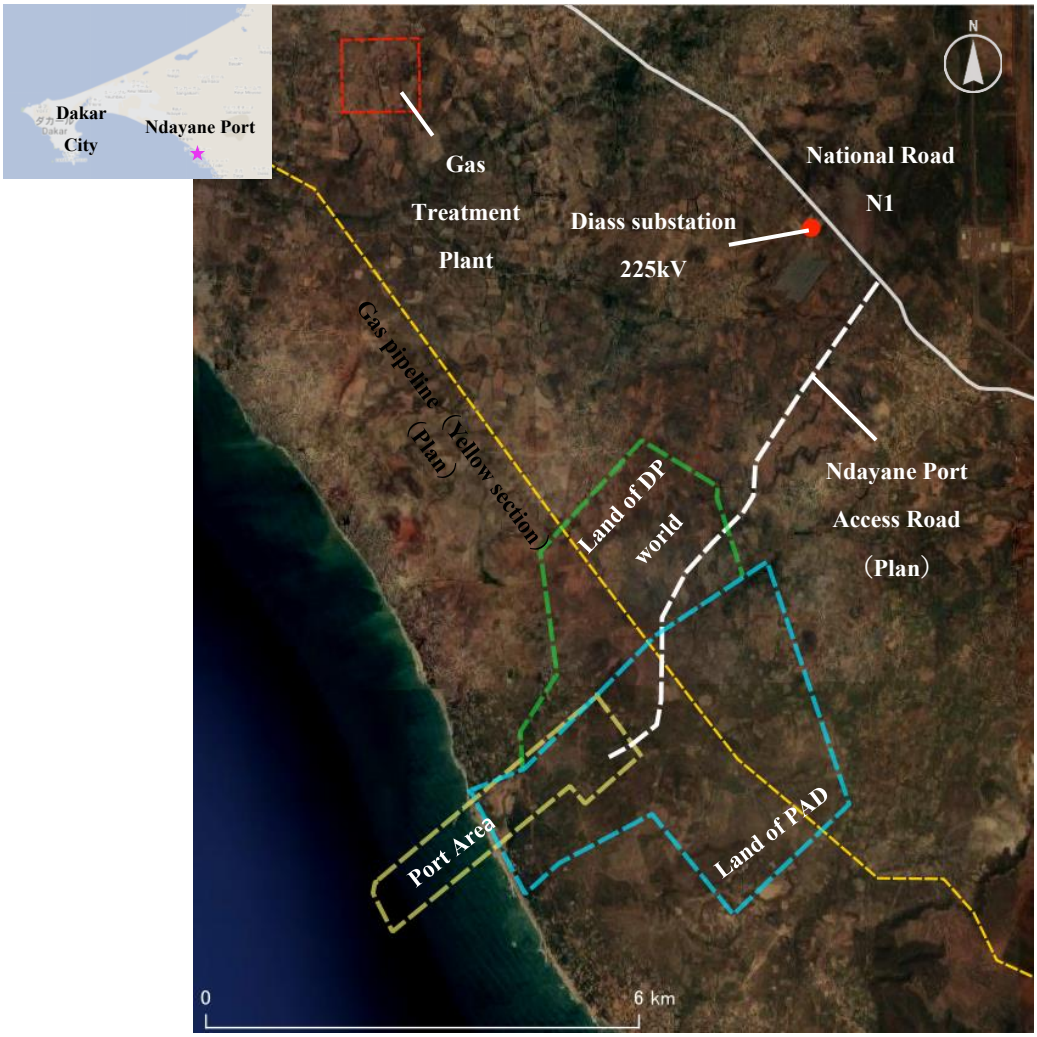
In the short to medium term, we will build a system of cooperation with external organizations with

[86]These are the results of interviews conducted by the JICA survey team.

experiences in SEZ development, such as JICA, APIX and Tanger Med, and externally procure know-how. In the meantime, we will accumulate experience and capabilities within PAD; and in the very long term, we will establish a PIZ specialized organization within PAD, it is necessary to be able to operate PIZ autonomously by developing human resources in-house. It is needed to discuss with PAD to determinate this period, but we suppose 20 to 25 years that is a standard PPP contract period in Senegal. For this reason, when receiving external assistance, it is necessary to respect the independence of PAD and strengthen their capacity. In the case of a private company, once a PPP contract is concluded with a private company, the PPP will last for about 20 to 25 years, so there will be no opportunity to operate the PAD independently. Therefore, it is necessary to fully consider the operation system during the preparation period.

3.13.5 PIZ Development Plan

3.13.5.1 Current situation of infrastructure



Source: Feasibility Study on Ammonia/Urea Fertilizer/Methanol Co-production Plant Project with Environmental Consideration and Digital Technology in Low Carbon Society in the Republic of Senegal, Study Report

Figure 3.166 Current situation of infrastructure around Ndayane Port

(1) Road

When the SEZ development is completed at the start of plant operation, which is a major arterial road, can be used, but the SEZ development plan is currently expected to be delayed, so it is necessary for the operator to secure an access road to the National Road N1. In addition, as National Route N1 is a single-lane road with limited traffic capacity, further congestion will occur due to the expected increase in traffic volume accompanying port development.

(2) Rainwater drainage

Rainwater drainage is described in the section on rainwater drainage planning and design.

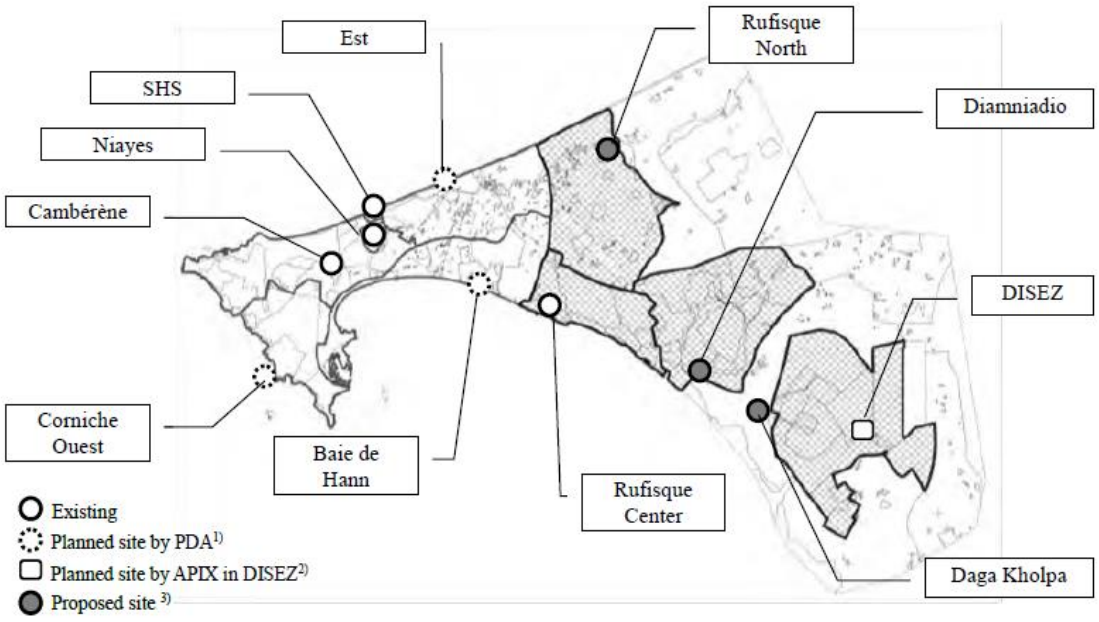
(3) Water supply

Although there is an existing domestic water supply through deep wells in the vicinity of Ndayane Port, Senegal does not recommend the use of well water due to the fact that there is not enough capacity to begin with, and that well water has decreased due to overpumping in recent years. In fact, SONES, which is in charge of water supply, also wants to reduce the percentage of well water in the water supply in the future. Therefore, this PIZ will be planned based on the policy of using seawater desalination as the main source of clean water.

(4) Sewage

Sewerage planning areas have been established in urban areas, and phased development is planned based on the investment program of Dakar Sewerage M/P (Plan Directeur d'Assainissement Liquide de Dakar: PDA), with a target penetration rate of 63% in 2035. The development plan for the sewage treatment plant is shown in Figure 1-49. Specifically, sewage treatment plants are planned in the Diass Special Economic Zone (hereinafter referred to as “DISEZ”), Diamniadio and other areas where the development is being promoted as sub-centers.

However, the water treatment plant around Ndayane Port has not been completed yet, and the completion date is unclear, so it is necessary to plan a water treatment plant within the PIZ area.

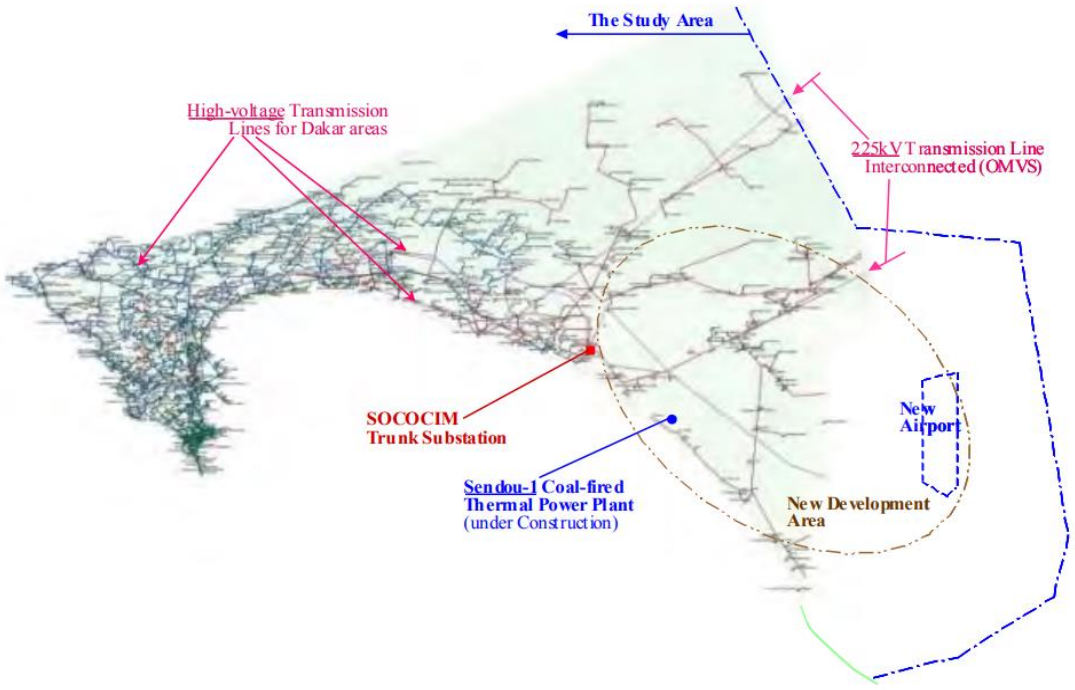


Source: JICA "Master Plan for the Development of the Dakar Metropolitan Area in Senegal project"

Figure 3.167 Location of sewage treatment plants in the Dakar Metropolitan area (existing and planning)

(5) Electricity

The development strategy includes expansion of domestic power transmission lines, reduction of electricity prices and the development of power supply facilities in newly developed areas. In particular, in areas such as Diamniadio and DISEZ where the new city center is envisioned, the development of the Sococim substation which is the starting point of the high-voltage transmission line, and the Sendou coal-fired power plant are positioned as important facilities. Of these, the Sendou coal-fired power plant was completed in 2019, but it is not expected to start operating due to opposition from residents.



Source: JICA "Master Plan for the Development of the Dakar Metropolitan Area in Senegal project"

Figure 3.168 Electricity Distribution Plan for the Dakar Metropolitan Area

In the case of Ndayane Port, it is possible to connect to Diass sub-station which is located 5km northeast of the planned construction site and has a 225kV line.

(6) Telecommunication

In 2019, the percentage of internet users in Senegal is 55%, the mobile phone network in 2019 covered 98.0% of the population with 2G or higher, 92.1% with 3G or higher and 66.8% with 4G or higher. Coverage for 4G and above expanded rapidly from 36.5% to 62.0% from 2017 to 2018. ICT bases such as data centers, IXPs (Internet Exchange Points) and SOC/CSIRTs (Security Operation Centers/Computer Security Incident Response Teams) are being developed.

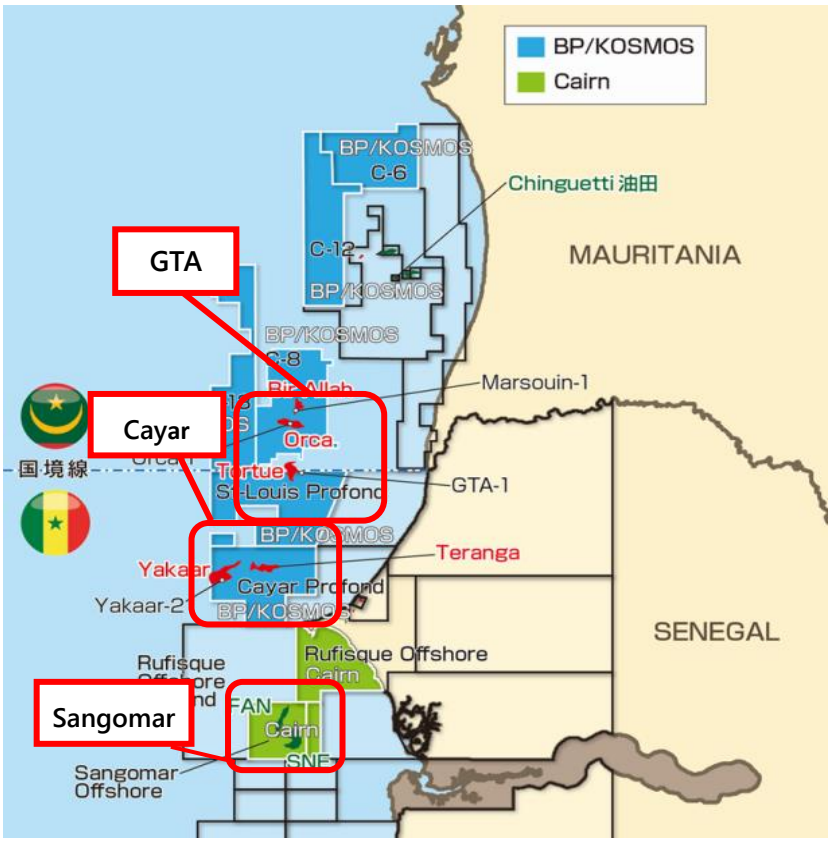
Orange (alliance with the national telephone company - SONATEL) is the largest provider of fixed broadband. Fiber-optic connections are also provided, but only for large companies, most individual users use ADSL. There are three main mobile operators, with the largest - Orange (SONATEL), holding a 53% share. This is followed by Free with 24.6% and Expresso (Sudanese capital) with 22.4%.

Source: Performances Group

Figure 3.169 Telecommunications network 3of Senegal

(7) Gas

Oil and gas fields were discovered one after another off the coast of Senegal and Mauritania in the 2000s, and final investment decisions (hereinafter referred to as "FID") were made for Phase 1 of Greater Tortue Ahmeyim (hereinafter referred to as "GTA") in 2018 and Sangomar oil field (hereinafter referred to as "Sangomar") in 2020. Both projects are under development and construction with production expected to begin in 2023, and FID for Phase 2 of GTA is also expected in 2022-2023.



Source: Feasibility Study on Ammonia/Urea Fertilizer/Methanol Co-production Plant Project with Environmental Consideration and Digital Technology in Low Carbon Society in the Republic of Senegal, Study Report

Figure 3.170 Locations of oil and gas fields around Senegal

Table 3.152 Summary of Gas Development in Senegal

	Gas Development Project Name				
	GTA			Sangomar	Cayar
	Phase 1	Phase 2	Phase 3		
Investor	BP 61%) Kosmos (29%) PETROSEN (5%) SMHPM (5%)			Woodside (82%) PETROSEN (18%)	BP (60%) Kosmos (30%) PETROSEN (10%)
Year of Final Investment Decision (FID)	December 2018	2022	Undecided	January 2020	Undecided
Year of Starting Production	2023	Undecided	Undecided	2023	Undecided
Output	35mmscfd	Undecided	Undecided	100mmscfd	150mmscfd
Usage	LNG: Export Gas: Power generation	Undecided	Undecided	LNG: Power generation/ plant LPG: Domestic distribution of household propane gas, etc.	LNG: Power generation/ plant
Note	Not available for this plant as it is intended for export	Same as on the left	Same as on the left	Use of associated gas. In that case, only the creation of the FID annex is required. Only PETROSEN is an off-taker, therefore easily to adjust	BP developer doubts the creditworthiness of gas off-taker SENELEC, no prospects for FID

Source: Ministry of Economy, Trade and Industry

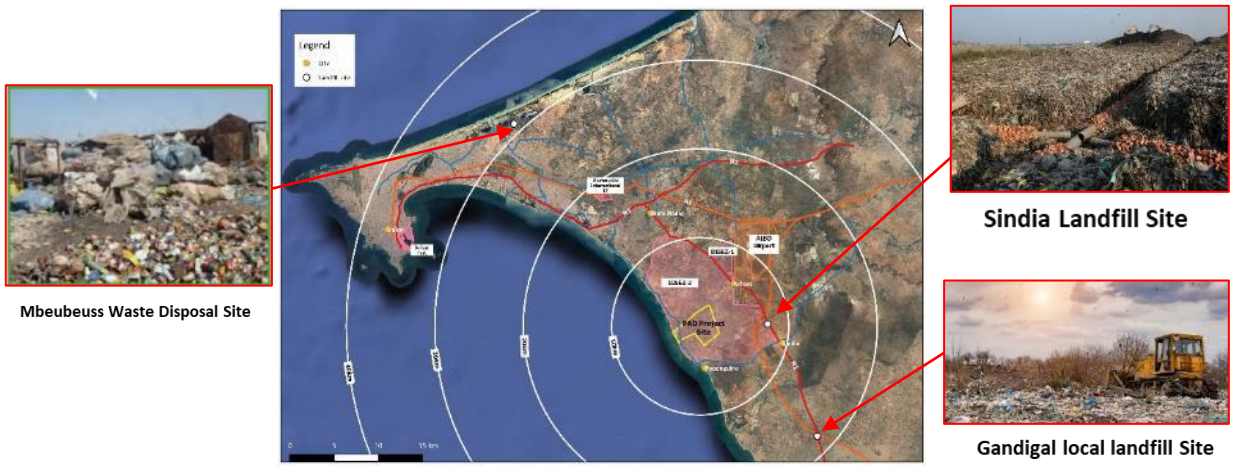
In Sangomar, the Senegal National Petroleum Corporation (PETROSEN) is planning to utilize the associated gas for a urea fertilizer plant because oil production is expected to start in 2023 and because of the low degree of difficulty in coordinating among the parties involved in the gas utilization. Furthermore, the location of the urea fertilizer plant is assumed to be within this PIZ and should be considered in the PIZ development plan, as the PAD has signed an MOU with the PAD as of 2023 regarding the consideration of the location.

(8) Waste treatment

There are many waste treatment facilities in Dakar Region and its surroundings (including the Ndayane Port area). Waste discharged from both households and industries is processed at treatment facilities in each region and then transported to three landfill sites. Among them, in the area where Ndayane port is located, it is transported to the landfill site of Sindia or Gandigal.

Source: SONAGED

Figure 3.171 Location of Waste Treatment Facilities in Dakar and Surrounding Areas



Source: JPT

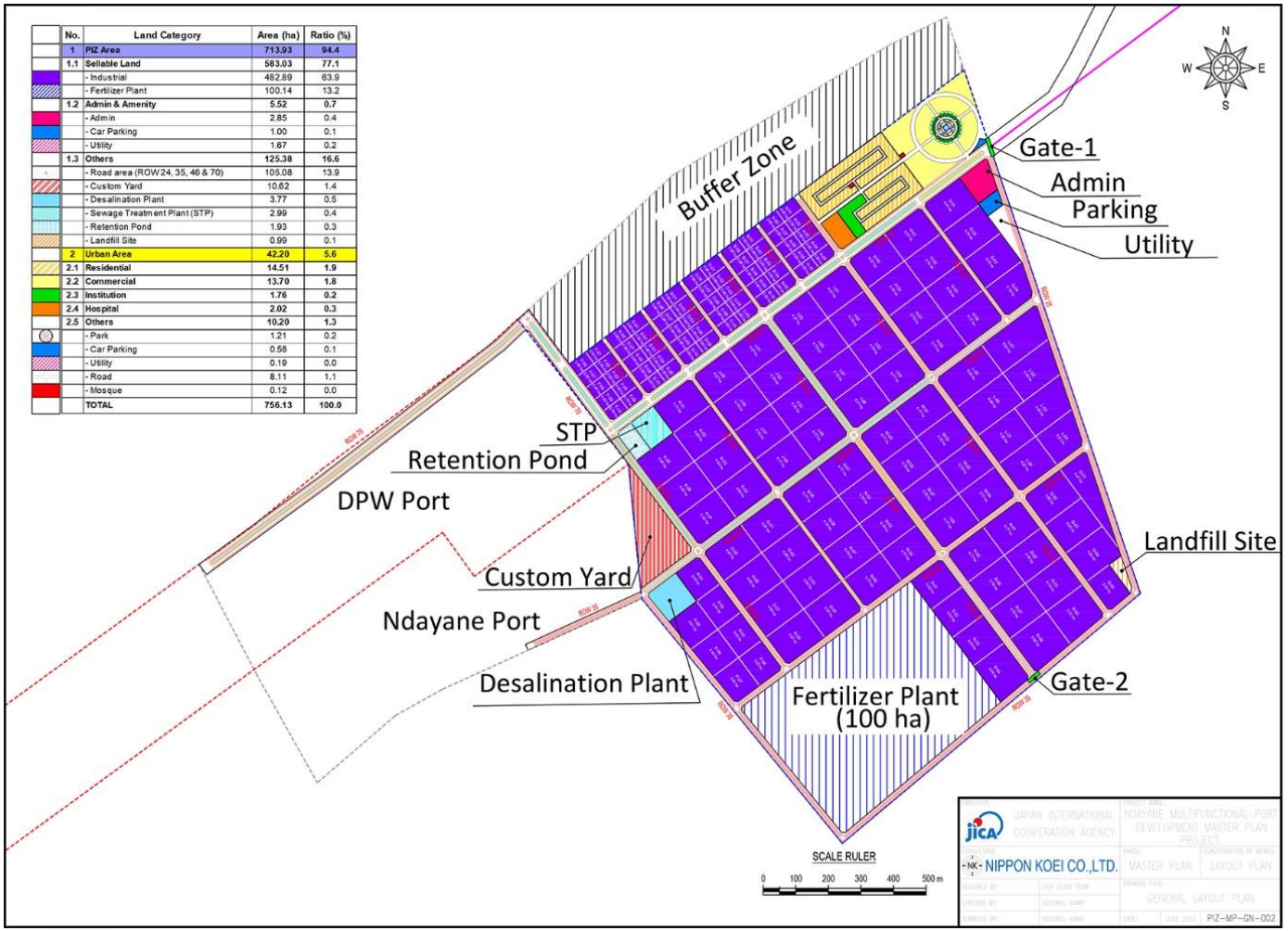
Figure 3.172 Location of landfill sites

3.13.5.2 Land Use Plan

In Phase 1 of PIZ, the industrial land area is 245 ha and 102 lots, and in Phase 2, 238 ha and 49 lots, which are expected to bring about 12,000 direct jobs. Both areas assume a long-term lease of 25 years.

The land use of the PIZ is proposed as shown in Figure 3.173. The saleable industrial land including industrial land area is 612 ha, which represents about 80% of the total site area. It consists of an industrial zone (heavy, medium, and light industry), a logistics zone (including customs), an administrative area (including administrative buildings, residential areas for workers, and vocational training) urban zone, and an infrastructure zone.

The urban area (42.20 ha) will be located at the entrance of the PIZ in accordance with the Dakar Metropolitan Master Plan. The fertilizer plant, which PETROSEN plans to build, will be located in the southeast corner of the PIZ, considering the impact of pollution on the urban function area. In addition, a desalination plant, a sewage treatment plant, an electrical substation, and a waste treatment plant will be planned as shown in the figure below. These facilities are planned to be shared with the port.



No.	Land Category	Area (ha)	Ratio (%)
1	PIZ Area	713.93	94.4
1.1	Sellable Land	583.03	77.1
	- Industrial	482.89	63.9
	- Fertilizer Plant	100.14	13.2
1.2	Admin & Amenity	5.52	0.7
	- Admin	2.85	0.4
	- Car Parking	1.00	0.1
	- Utility	1.67	0.2
1.3	Others	125.38	16.6
	- Road area (ROW24, 35, 46 & 70)	105.08	13.9
	- Custom Yard	10.62	1.4
	- Desalination Plant	3.77	0.5
	- Sewage Treatment Plant (STP)	2.99	0.4
	- Retention Pond	1.93	0.3
	- Landfill Site	0.99	0.1
2	Urban Area	42.20	5.6
2.1	Residential	14.51	1.9
2.2	Commercial	13.70	1.8
2.3	Institution	1.76	0.2
2.4	Hospital	2.02	0.3
2.5	Others	10.20	1.3
	- Park	1.21	0.2
	- Car Parking	0.58	0.1
	- Utility	0.19	0.0
	- Road	8.11	1.1
	- Mosque	0.12	0.0
	TOTAL	756.13	100.0

Source: JPT

Figure 3.173 Land Use Plan in PIZ

3.13.5.3 Demand Forecast of Infrastructure

In PIZ, the following intensity per day was used as a reference for infrastructure demand forecasting, based on similar cases.

Table 3.153 Intensity per day used for infrastructure demand forecast

Item	Intensity	Note
1． Population		
Industrial	10 m2/Capita	From similar case
Commercial	20 m2/Capita	From similar case
Residential (High rise)	20 m2/Capita	From similar case
Residential (Middle)	38 m2/Capita	From similar case
2． Water Supply		
Industrial	80 m3/ha	From similar case
Commercial	200 L/Capita	From similar case
Residential	100 L/Capita	From similar case
3． Wastewater	Amount of water consumption × 80%	From similar case
4． Power Supply		
Industrial	0.35 MVA/ha	From similar case
Commercial	60 W/m2	From similar case
Residential	20 W/m2	From similar case
5． Gas Supply		
Industrial	282 Nm3/ha	From similar case
Commercial	20 Nm3/ha	From similar case
Residential	20 Nm3/ha	From similar case
6． Telecom		
Industrial	0.002 Mbps/Capita	From similar case
Commercial	0.04 Mbps/Capita	From similar case
Residential	0.1 Mbps/Capita	From similar case
7． Solid Waste		
Industrial	3100 kg/ha	From similar case
Commercial	0.5 kg/Capita	From similar case
Residential	0.6 kg/Capita	From similar case

Source: JPT

The results of the infrastructure demand forecasts are shown below. The scale of various infrastructures was assumed based on the forecast results.

Table 3.154 Results of Infrastructure Demand Forecast

Sector	Area	Area (ha)	Population *	Demand
Water Supply (m3/day)	Phase 1	502.59	37492	24,750
	Phase 2	253.53	11877	19,004
	Port area	(410.00)		2,600
	Total	**756.13**	**49370**	**46,354**
Wastewater (m3/day)	Phase 1	502.59	37492	15,456
	Phase 2	253.53	11877	11,402
	Total	**756.13**	**49370**	**26,858**
Power Supply (MW)	Phase 1	502.59	37492	105
	Phase 2	253.53	11877	83
	Port area	(410.00)		120
	Street Light	150 Nos.		0.2
	Total	**756.13**	**49370**	**309**
Gas (Nm3/day)	Phase 1	502.59	37492	69,894
	Phase 2	253.53	11877	66,988
	Total	**756.13**	**49370**	**136,882**
ICT (Mbps)	Phase 1	502.59	37492	6,761
	Phase 2	253.53	11877	4,751
	Total	**756.13**	**49370**	**11,512**
Solid Waste (ton/day)	Phase 1	502.59	37492	774
	Phase 2	253.53	11877	736
	Total	**756.13**	**49370**	**1,510**

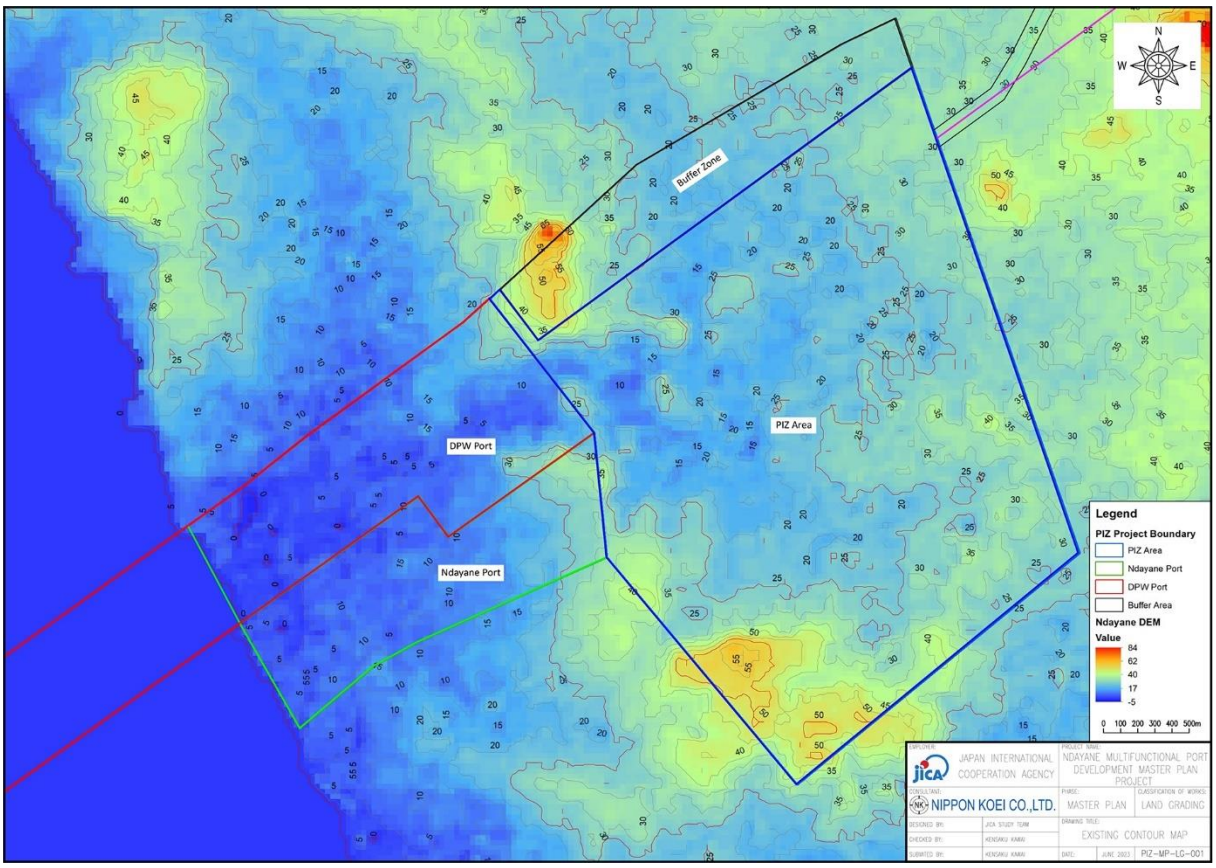
* Population = Resident + Employee

Source: JPT

3.13.5.4 On-Site Infrastructure Plan

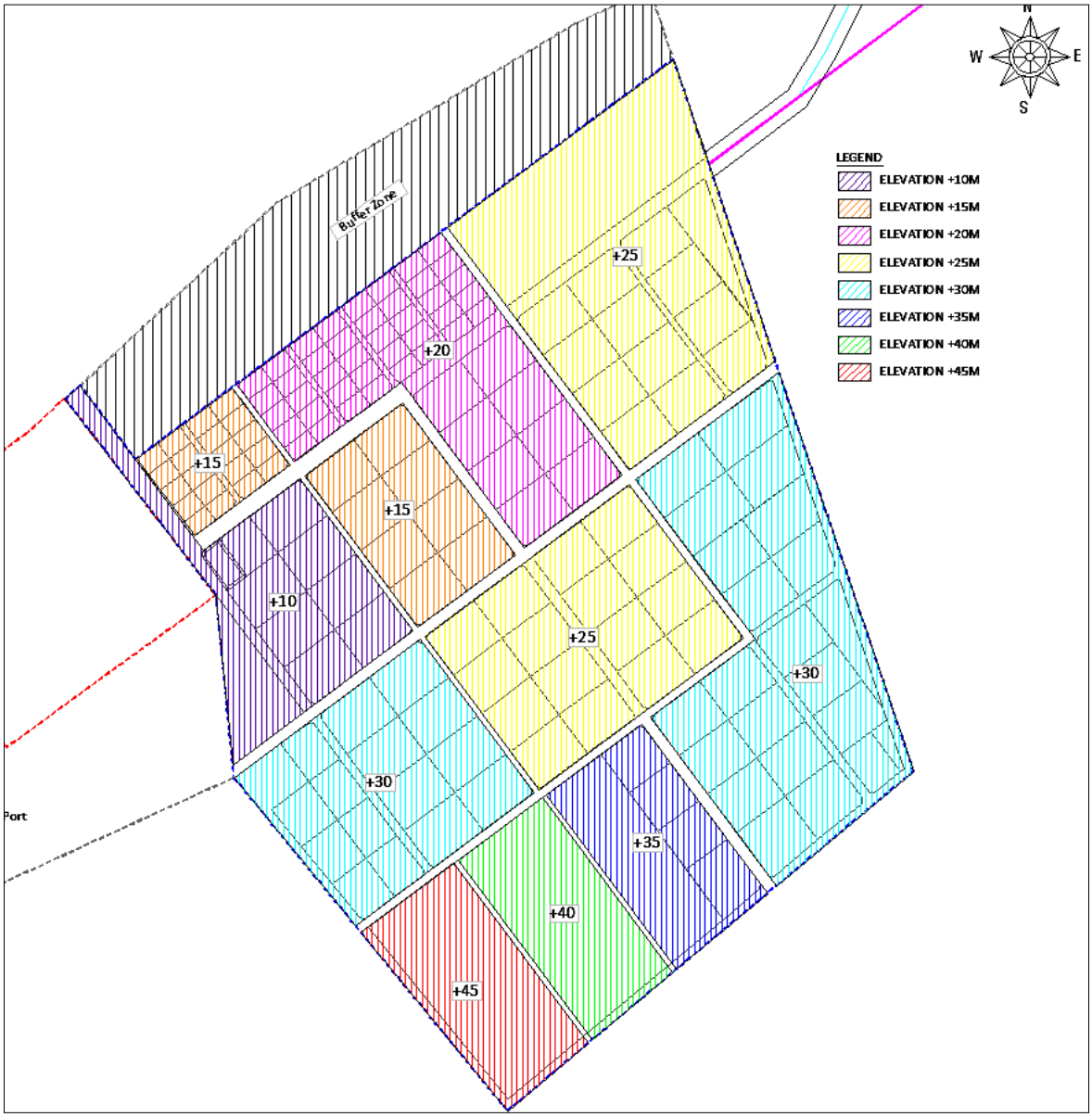
(1) Land Preparation

The existing elevation on the site is EL+5m to EL+55m. Considering the drainage plan, the landscaping slope is planned to be in the direction of the port. The land preparation plan is shown in Figure 3.174. The area of EL+85m between the DPW site and the Project site in the northwestern part of the site is proposed as a buffer zone to reduce development costs. The maximum difference in elevation of 5m between the land development elevation and the adjacent road elevation will be adjusted by using a slope (1:1.5). The plan is to balance the difference in the amount of cut and fill as much as possible to create an economical land preparation plan. The excavated soil is being disposed of in the nearest solid waste area.



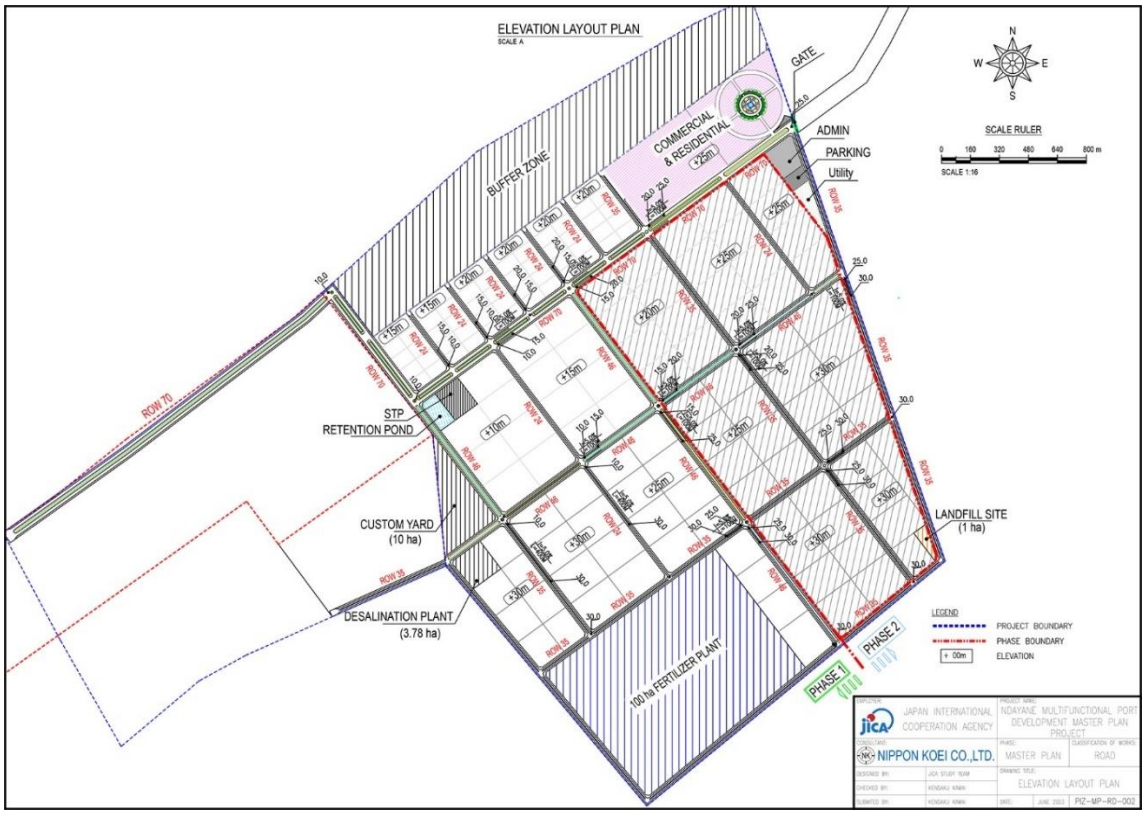
Source: JPT

Figure 3.174 Elevation mesh data



Source: JPT

Figure 3.175 Planned Elevation of Plot



Source: JPT

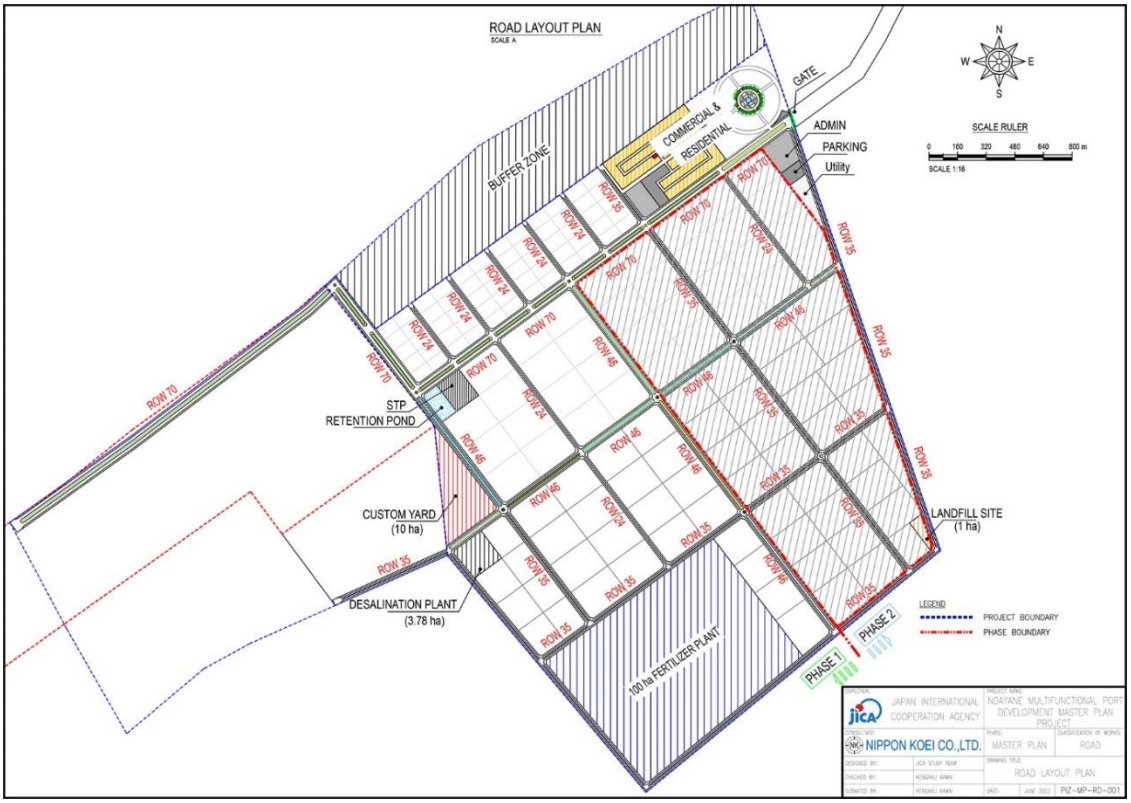
Figure 3.176 Land preparation plan

(2) Road

Four types of roads are planned: ROW70 (8 lanes), ROW46 (4 lanes), and ROW35 (2 lanes) and ROW24 (2 lanes), as shown in the figure below ROW70 (8 lanes) will also serve as an access road to port facilities. Asphalt concrete pavement will be applied to the road. A buffer zone of 8 m will be provided on both sides of the road, and utilities are planned to be buried under the buffer zone.

The existing ground elevation in PIZ varies throughout the area, which could lead to high land grading costs on construction. To address this issue, the elevation of all roads was designed based on existing ground elevation. Ramps were installed in areas where there are variations in elevation to ensure smooth transitions between different sections of the road.

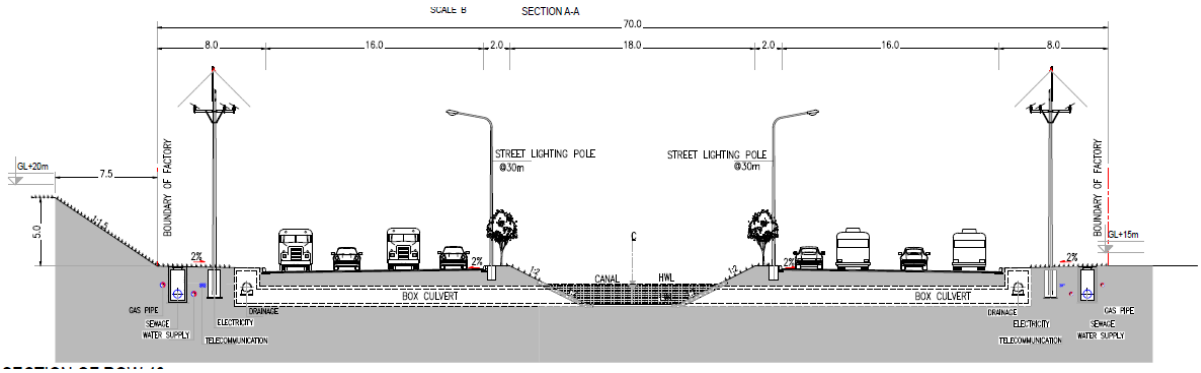
Note that the road plan will need to be modified according to DPW's development plan and port plan in the future.



Source: JPT

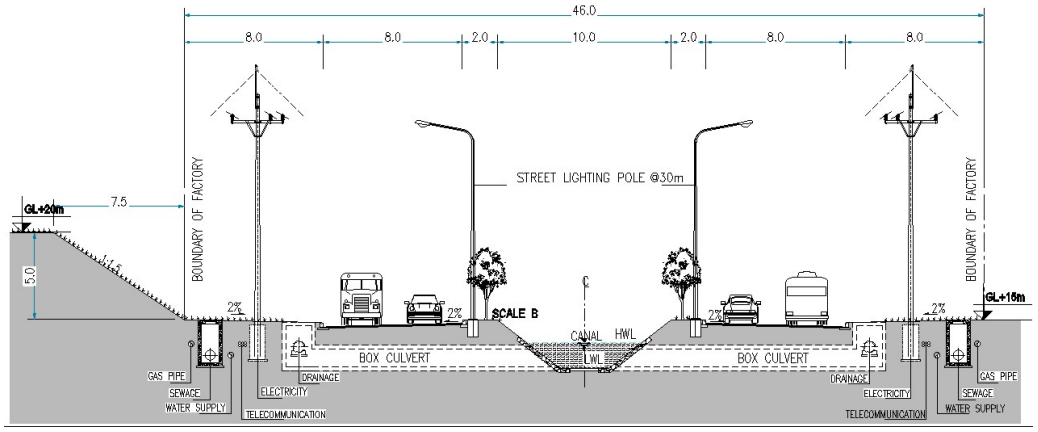
Figure 3.177 Road layout plan

There are four rights-of-way in total, with the main ROW measuring 70 m and the sub-roads measuring 46 m, 35 m, and 24 m respectively. The sub-roads are intended to provide access to smaller areas. The retention canal will be situated at the center of both ROW 70 and ROW 46.



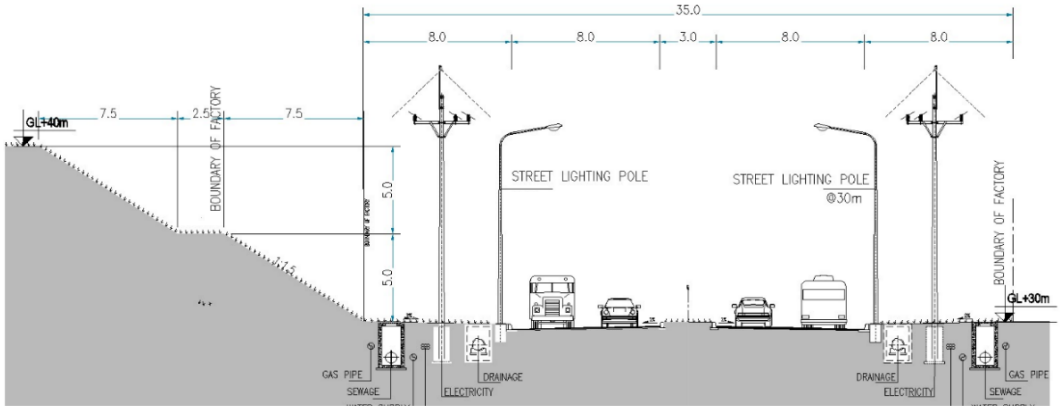
Source: JPT

Figure 3.178 Typical Section for ROW 70



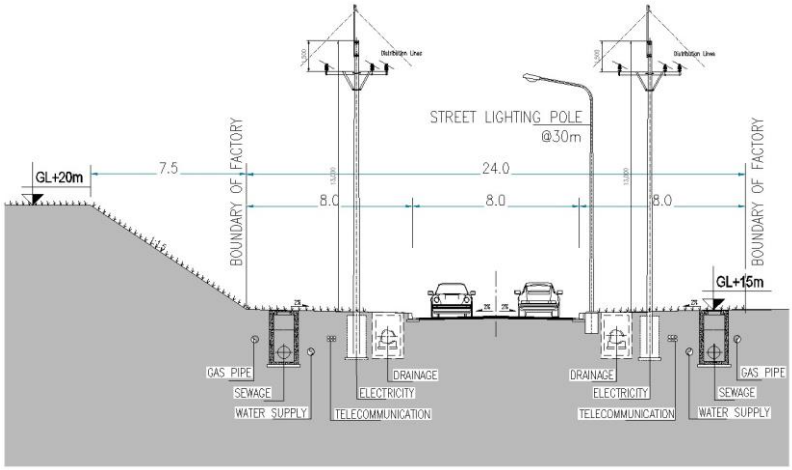
Source: JPT

Figure 3.179 Typical Section for ROW 46



Source: JPT

Figure 3.180 Typical Section for ROW 35



Source: JPT

Figure 3.181 Typical Section for ROW 24

(3) Drainage

A drainage channel with a catchment area around PIZ will be planned to cross PIZ.

In ROW70 and ROW46, the main trunk drainage channel (18 m wide and 10 m wide) will be placed in the center of the road section; in ROW35 and ROW24, storm drainage culverts will be placed within the buffer zone.

The planning conditions shall be set as follows.

The following are applied for rainfall intensity and 10 years for probable rainfall.

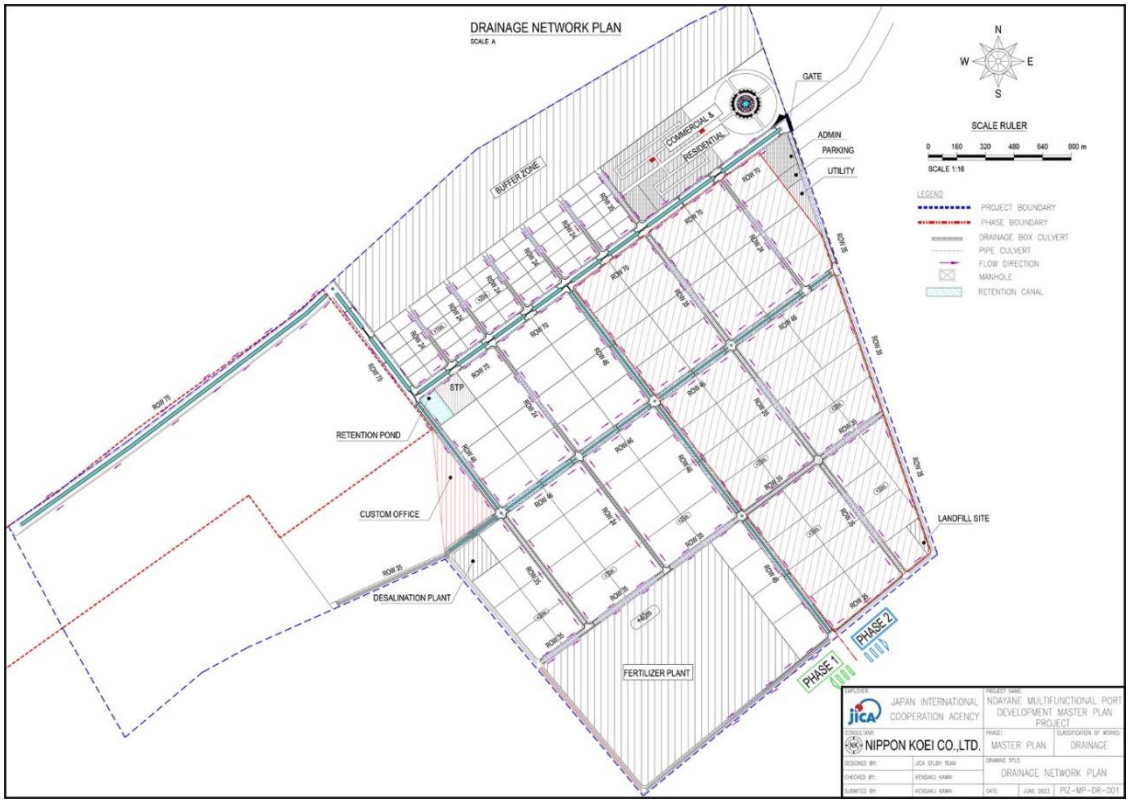
$$Q=\frac{1}{360} C \cdot I \cdot A \ (Rational\ Formula)$$

Where, Q: Design Storm Water Flow ($m^3/second$)

C : Runoff Coefficient

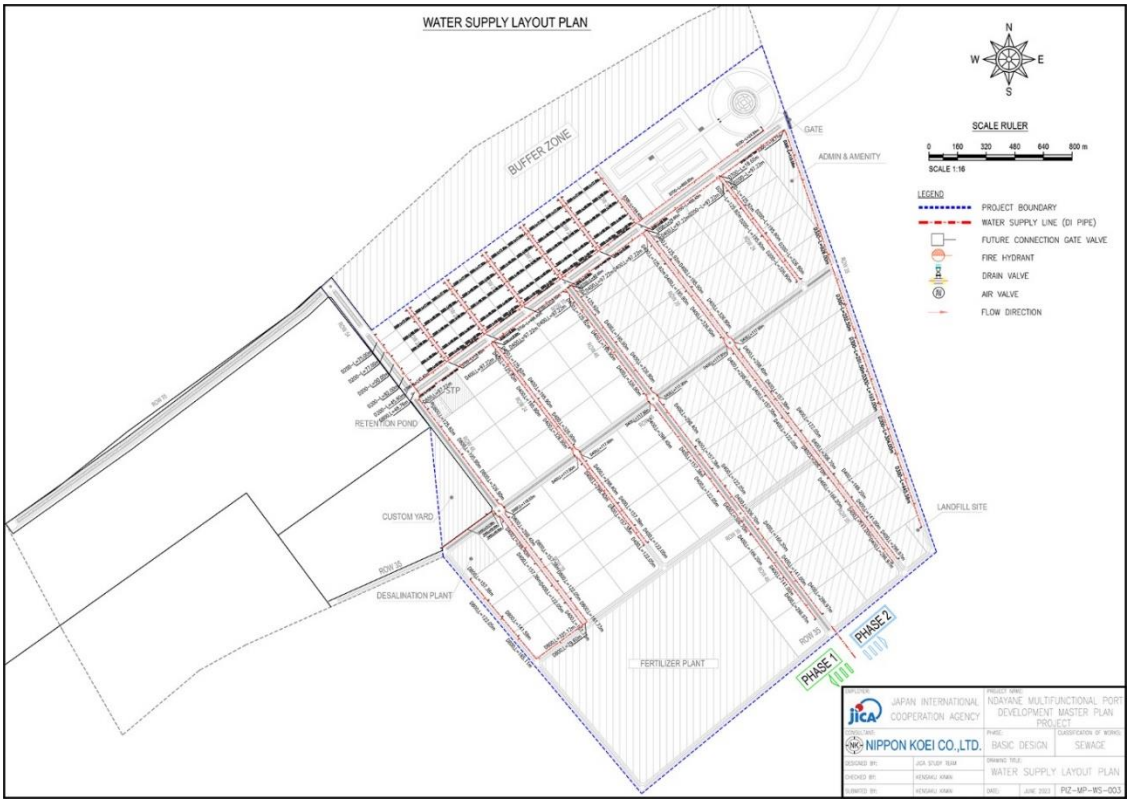
I : Rainfall Intensity (mm /second)

A : Drainage Area (ha)



Source: JPT

Figure 3.182 Water distribution network plan

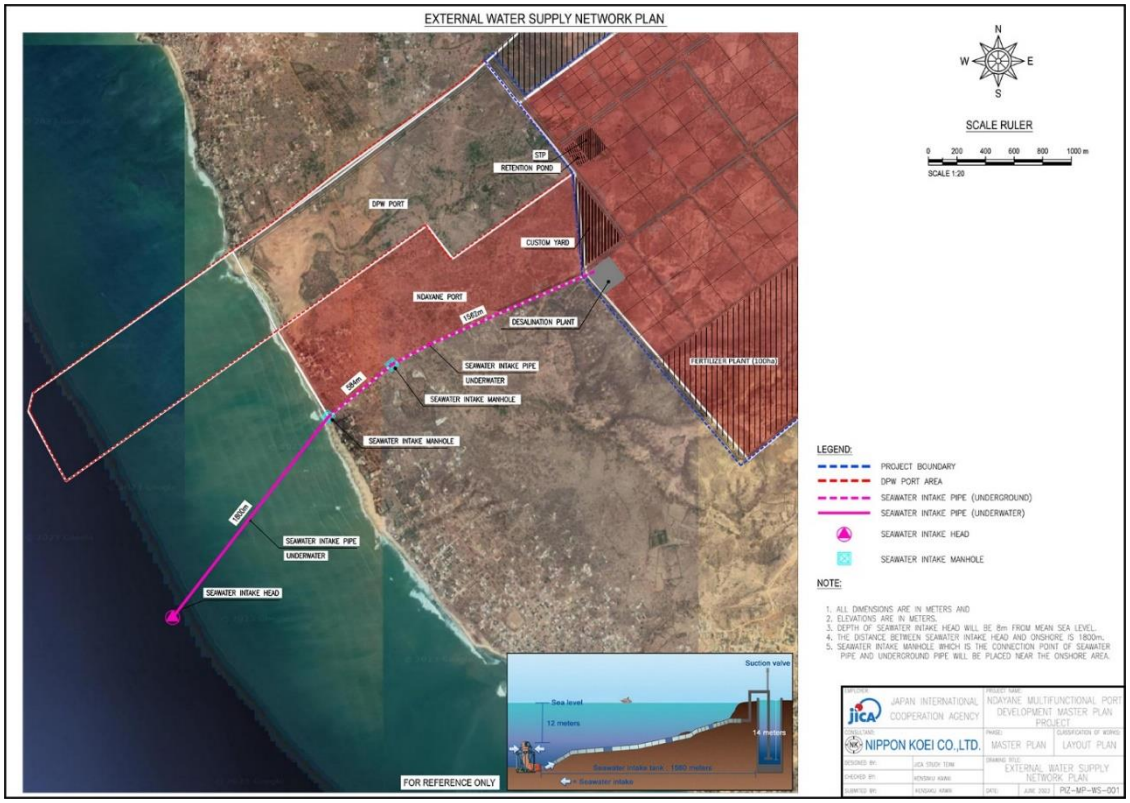


Source: JPT

Figure 3.183 Water distribution layout plan

(4) Water supply

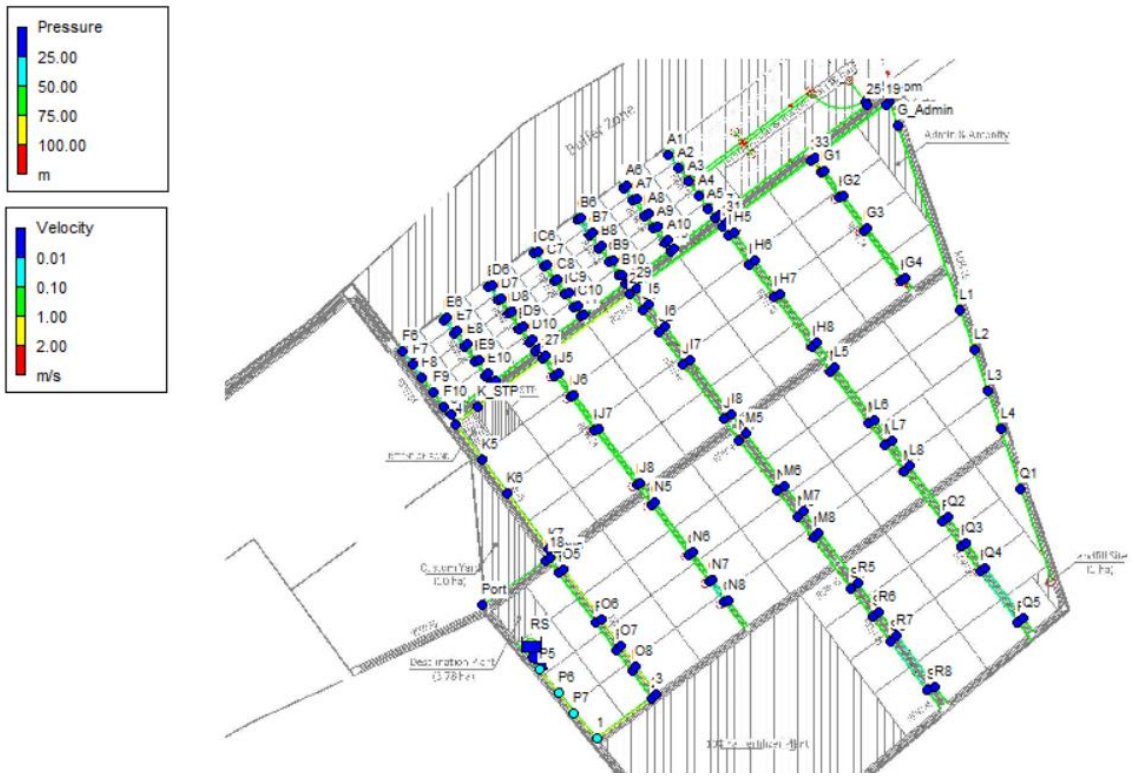
Intensity of water consumption are 80 m3/ha/day for industrial use, 200 L/Capita/day for residential use, and 100 m3/ha/day for commercial use. As for the port, approximately 400 m3/plot/day is required when water supply to ships is taken into account. As a water source, seawater is considered since the use of well water is regulated in the vicinity of Ndayane Port. A seawater desalination plant (50,000 m3/day) will be planned based on the results of the above demand forecast for water supply. Seawater intake is assumed to be 1,800 m from the coast.



Source: JPT

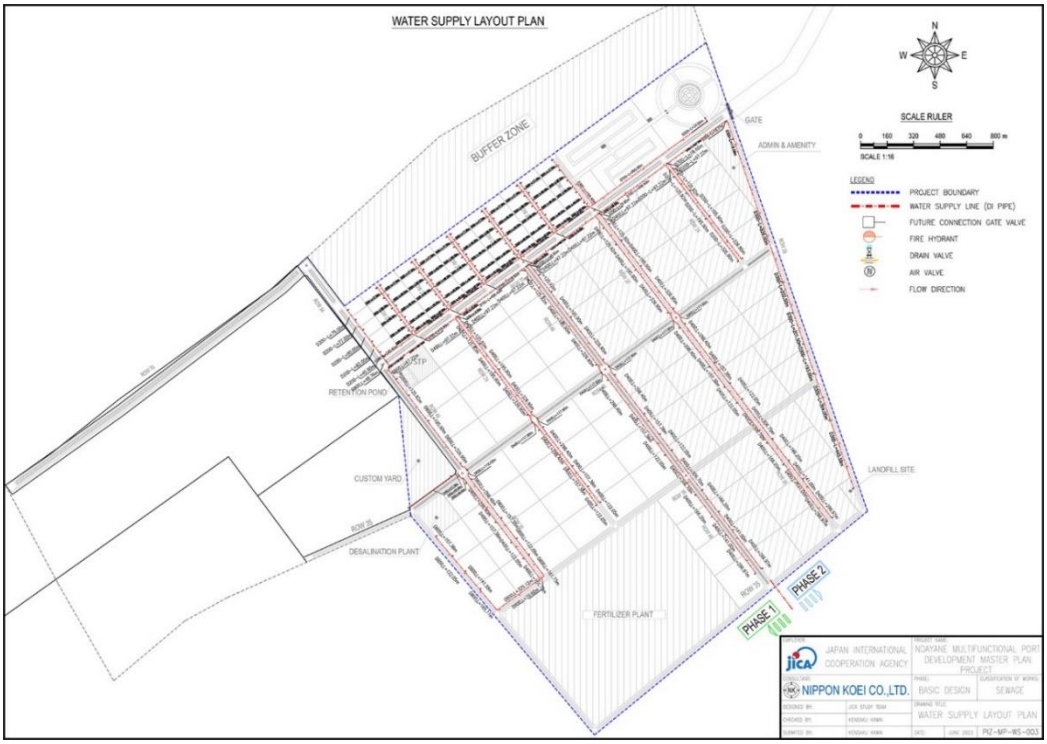
Figure 3.184 Water supply network plan (external connection)

Water desalination plant is located 2.2 km from the sea line. Pipe size within PIZ area varies from Ø200~800 based on pressure needed. The total length of water distribution pipe is over 30,000 m. Concrete above-ground storage tank in 6 nos. with a capacity of 50,000 m3 is designed to store water for distribution. The result of the hydraulic simulation of water supply in PIZ is in below based on Epanet.



Source: JPT

Figure 3.185 Results of hydraulic power simulation



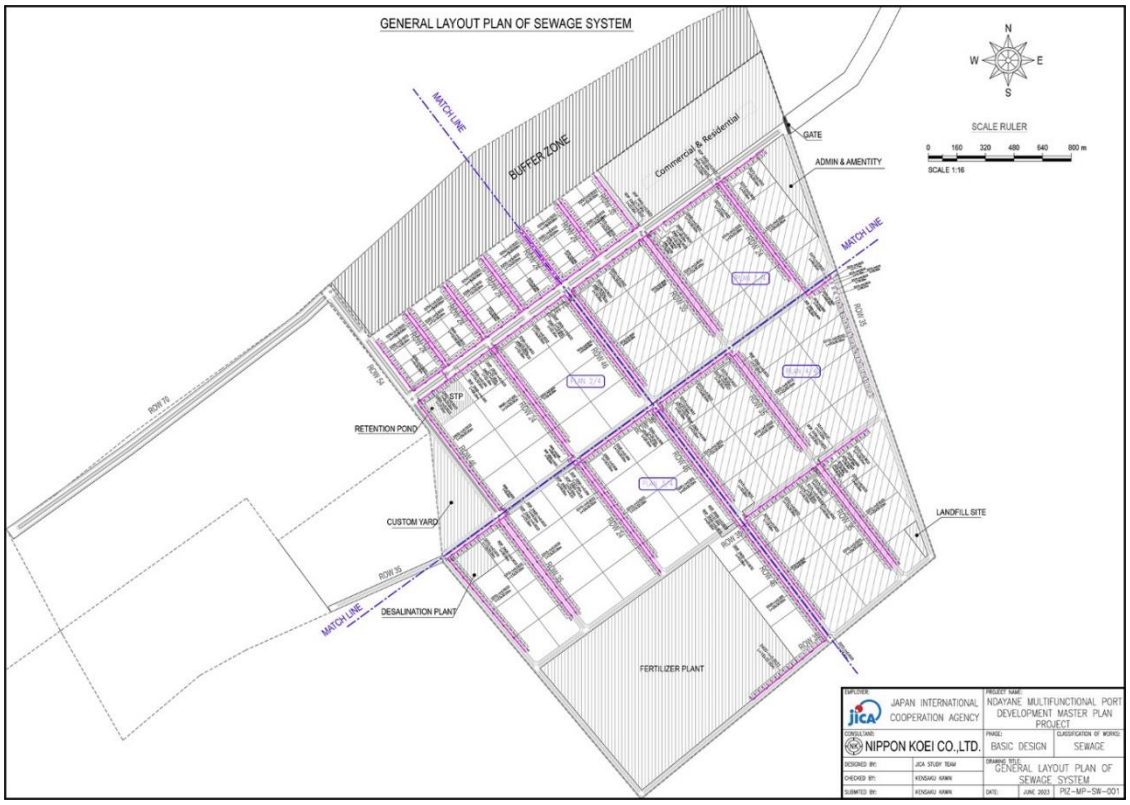
Source: JPT

Figure 3.186 Water supply layout plan

(5) Sewage

The volume of treated sewage is assumed to be 80% of the water consumption to be discharged to the sewage facilities. A sewage treatment plant (40,000 m3/day) will be located in the southern part of PIZ.

A diversion system (collecting sewage and rainwater separately) will be used as the sewage system. As a general rule, the sewage pipelines will be of the natural flow type, with relay pumps applied as necessary to discharge the sewage to the sewage treatment plant downstream. The sewage pipeline is located in a utility area on both sides of the road, running 8 meters typically using pipe sizes ranging from D315 to D500, and it includes a slope. HDPE pipe is predominantly used for the sewage pipeline, while DCIP pipe is used for road crossing areas. However, due to the variance of land grading, certain sections of the wastewater pipeline experience a drop in elevation. In such cases, manholes with backdrops are installed to accommodate the elevation changes. The pipeline's slope is adequate to handle the reduction in elevation length, making it unnecessary to install a lift pump. Sewage Network layout plan is shown in the following



Source: JPT

Figure 3.187 Sewer system layout plan

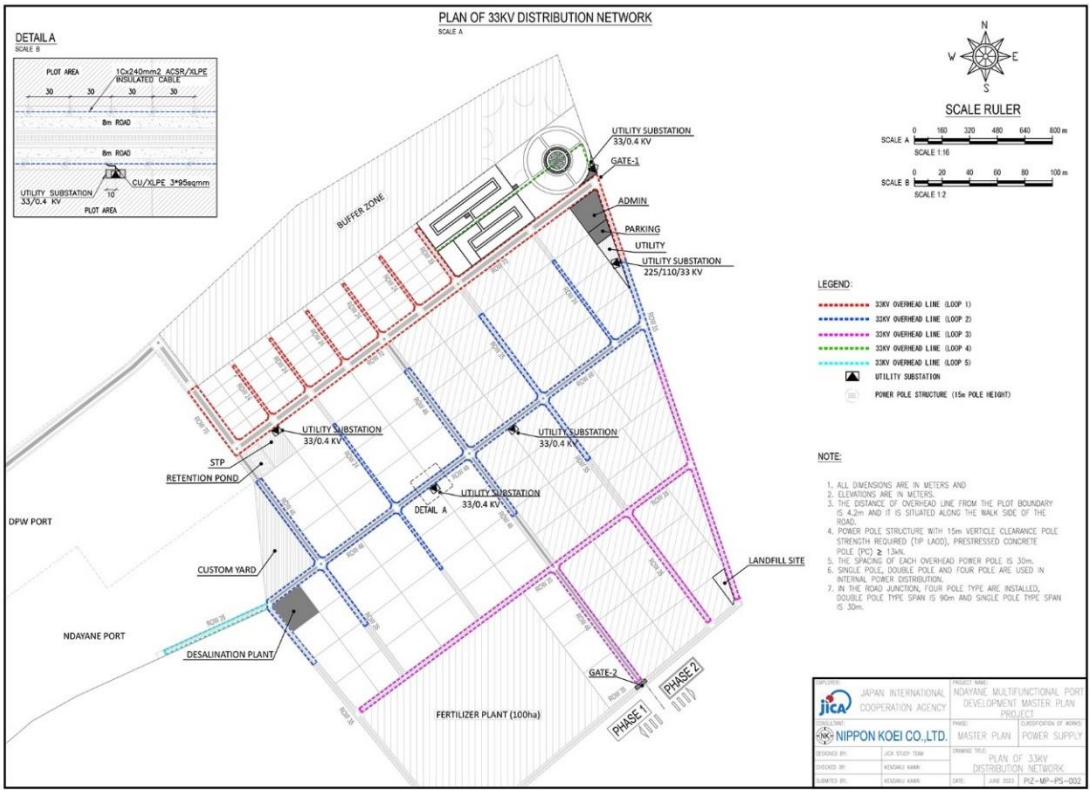
(6) Power supply

A transmission line (225 kV) will be placed from the nearest (2.30 km distant) DIASS substation (225 V) to the substation (225 kV/100/kV/33 kV) planned on PIZ. The power will be transformed to 33kV

at the substation (225kV/100/kV/33kV) on the site and distributed within PIZ.

The concept of power system for PIZ area should provide under construction feeder from main receiving substation cable trench to on the north side of main substation and after roadside area it will rise up and be connected to new overhead 33kV transmission line going through PIZ area. This new transmission line should be installed within the outer side of the existing double circuit overhead line along PIZ road.

Besides, it should be noted that distribution system for PIZ should be by phrases; the first loop with two feeder cables (2 x 240 mm2) overhead distribution lines should be provided for Phase 1 and for Phase 2 should be provided in the future in order to minimize space and to give time for the relocation of the existing overhead transmission lines. Power distribution system in PIZ area shall be by phases with looping system as shown in Figure.

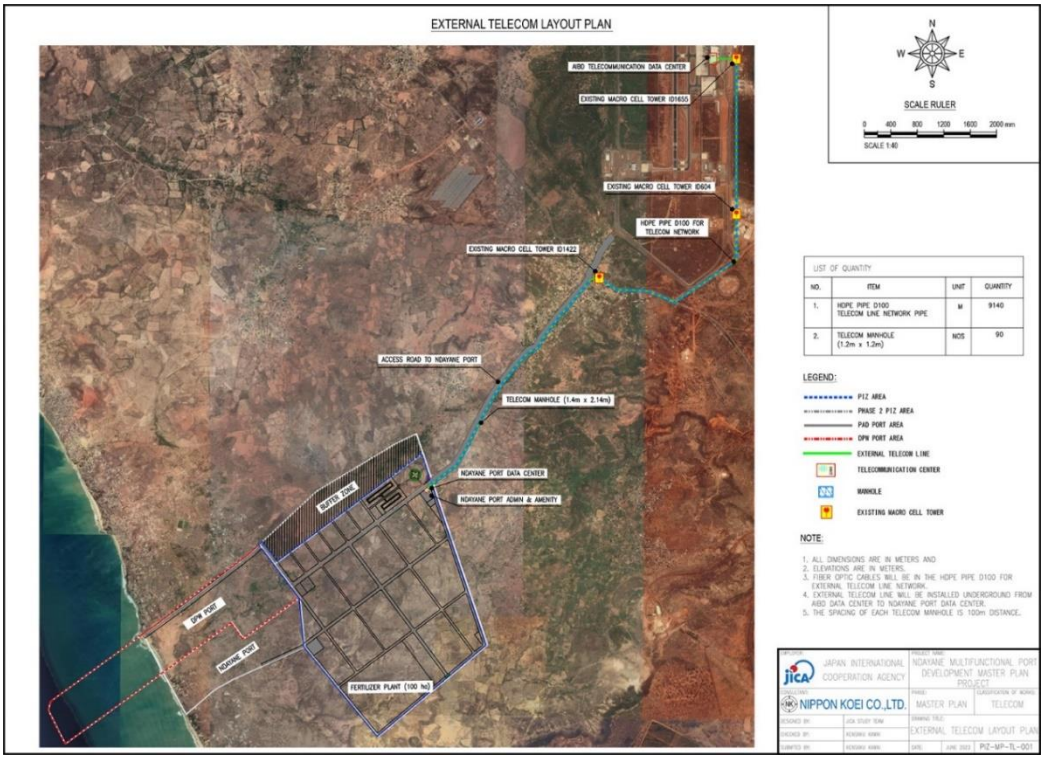


Source: JPT

Figure 3.188 33kV distribution network plan

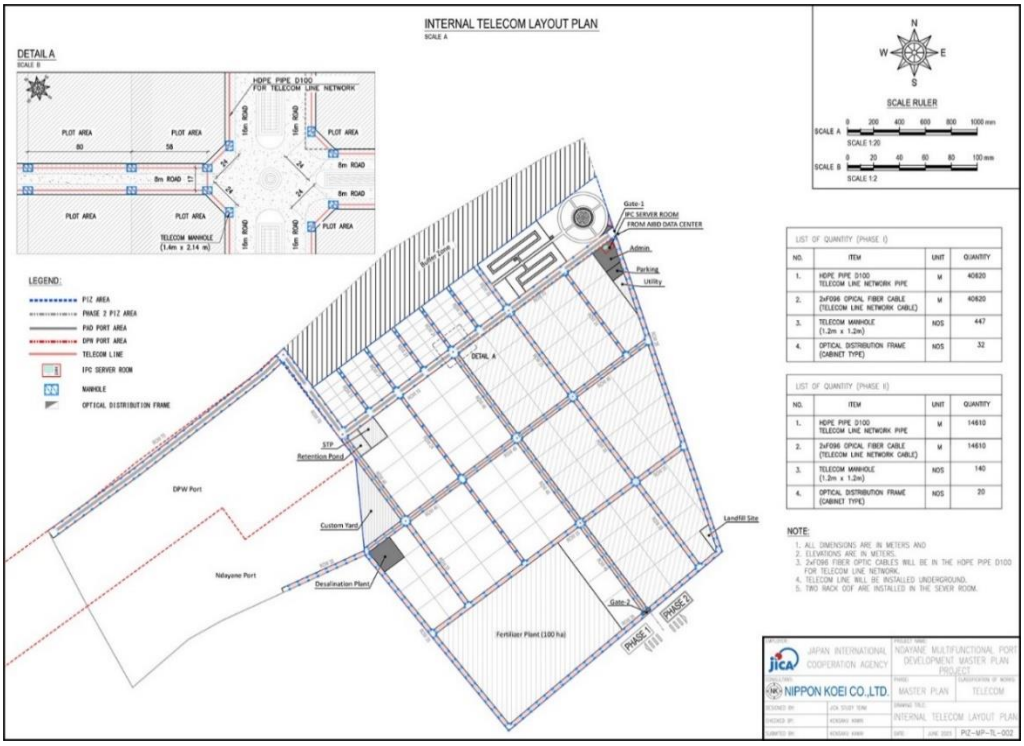
(7) Telecommunication

As for the telecommunication network, it is assumed that it will be connected from the AIBD's telecommunication center located in the northeastern part of PIZ; the same assumption is made in the DPW M/P. In addition, when tenants move in, telecommunication lines (optical fiber) will be laid from the server room in the administration building to each tenant.



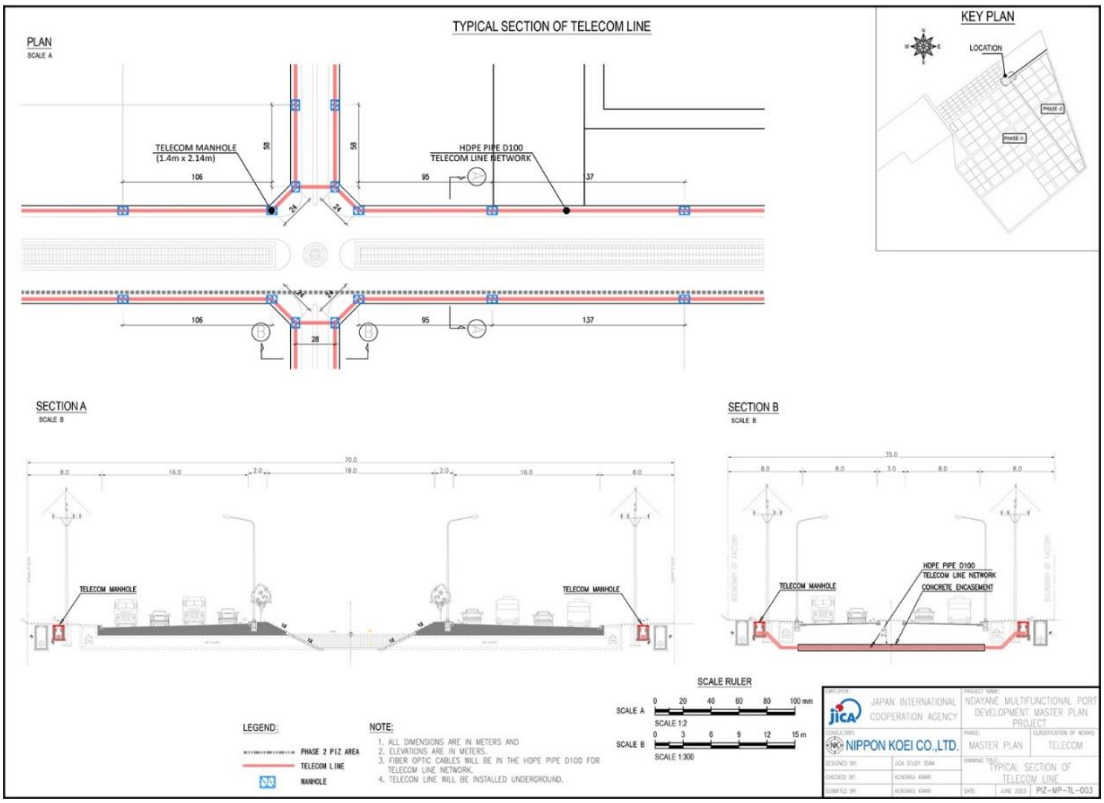
Source: JPT

Figure 3.189 Telecommunication layout plan (external connection)



Source: JPT

Figure 3.190 Telecommunication layout plan

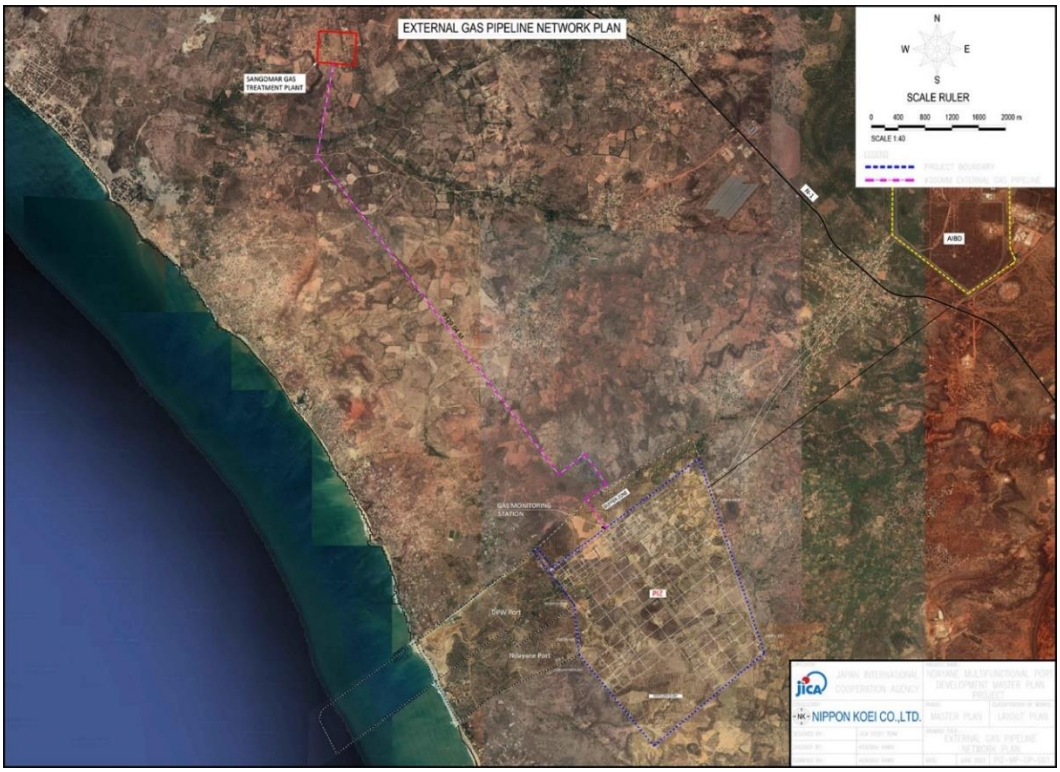


Source: JPT

Figure 3.191 Cross-section of telecommunication line

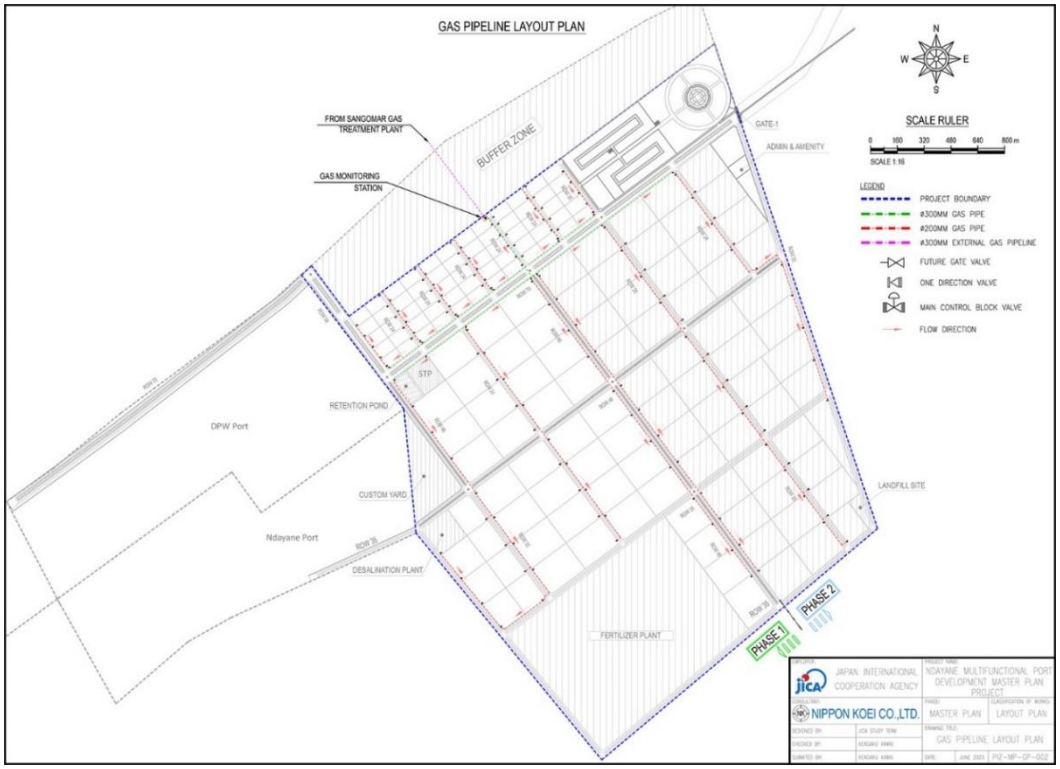
(8) Gas

Gas pipes will be laid from the Sangomar gas refined plant, which will be drawn from the Sangomar gas field, to the PIZ site boundary, about 10 km. The piping system of gas supply withing the site area is applied in two different pipe diameters including: Ø300mm for the main transmission and distribution, Ø 200mm for the secondary distribution to the tenants. In this study, the unit demand was set as 282 Nm3/ha/day for industrial area and 20 Nm3/ha/day for residential area. As a result, the demand for gas in the PIZ area is forecasted at around 136,882 Nm3/day.



Source: JPT

Figure 3.192 Gas pipeline network plan (external connections)



Source: JPT

Figure 3.193 Gas pipeline layout plan

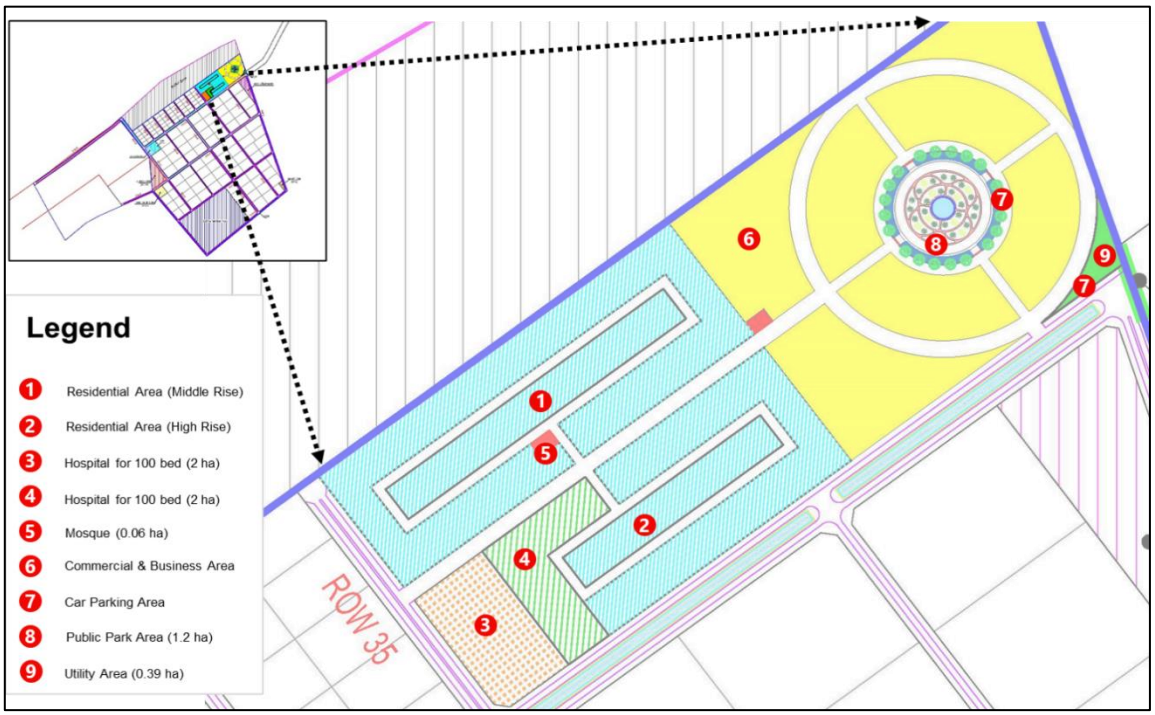
3.13.5.5 New Urban Area Development Plan

The total land area for industrial development in PIZ is calculated to be approximately 543ha, including 100ha of fertilizer plant. Moreover, a 42.2 ha urban area (6% of PIZ) is planned for new urban area development.

The new urban area in PIZ has a significant potential due to its proximity to the newly developed airport and adjacent to future Ndayane Multifunction Port Development which will accommodate city dwellers and workers projected in the year, 2035. In such a context, the new urban area is strategically placed to attract airport-related activities, business agglomeration and development of housings for labor.

Considering, the increase in density of residents and workers, the population demand forecast in PIZ area for the target year, 2035 is calculated based on the population census data of Thies, Senegal projection rate.

The facilities to be developed in the New Urban Area are shown in the figure below.



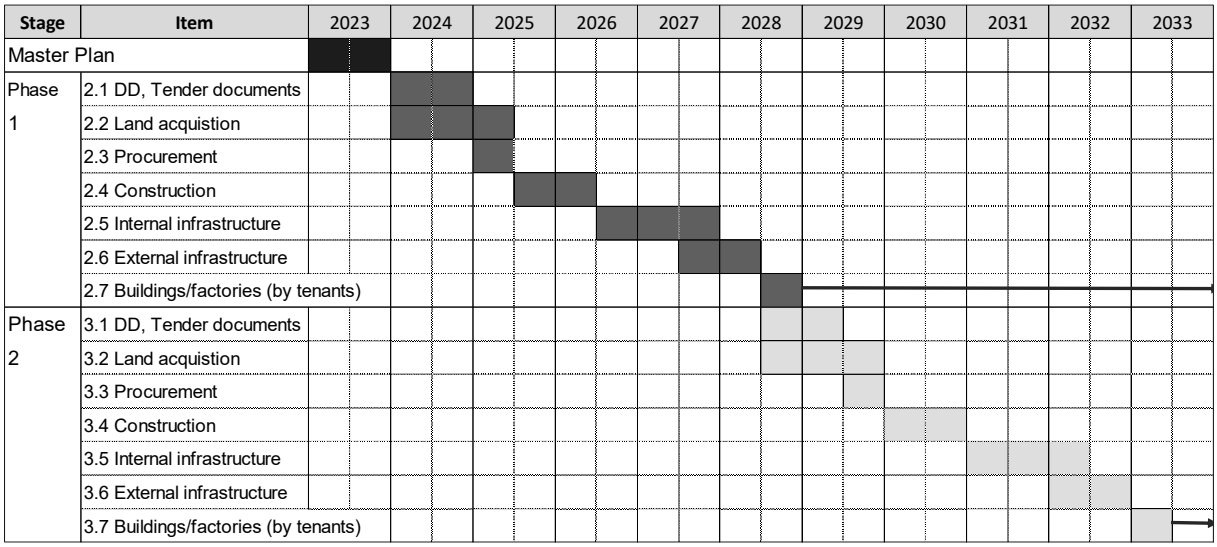
Source: JPT

Figure 3.194 City-Life Elements

3.13.5.6 Schedule and Cost Estimation

(1) Development Schedule

The development of PIZ will be conducted in phases (Phase 1 and Phase 2) based on the estimated sales schedule. The main infrastructure will be located in Phase 1. Assuming site acquisition and resettlement, the following schedule is proposed.



Source: JPT

Figure 3.195 PIZ development schedule

(2) Infrastructure cost estimation

a) Conditions of cost estimation

Basic policy for estimation: Estimate with reference to the unit cost in Senegal and the SEZ actual unit cost in other countries.

Tax treatment: VAT 18%.

Inflation rate: 2%.

Contingency: 10%.

Point of time of cost estimation: June 2023

b) Result of cost estimation

As shown in the Table 3.155, it is assumed that the development cost will be approximately 442 million USD for Phase 1 and 57 million USD for Phase 2.

Among them, the cost items to be borne by parties other than PAD are assumed to be the desalination plant (250 million USD), the trunk road ROW 70 (12 million USD), and the rainwater drainage system (50%, 5.3 million USD). Excluding these costs, the development cost per land area sold would be USD 49.

Table 3.155 Result of cost estimation

Cost Estimation for Master Plan Development Project of Multifunction Port of Ndayane in the Republic of Senegal

Item		Total (Equivalent Million USD)
A.	**Phase I**	
I.	**Offsite Infrastructure**	
1	**Power Supply System**	1.81
2	**Water Supply System**	250.00
3	**Telecommunication**	0.56
4	**Gas Pipe Line System**	2.33
II	**Onsite Infrastructure**	
1	**Major Infrastructure (Public)**	17.30
2	**Land Grading**	89.86
3	**Road**	24.71
4	**Storm Water Drainage System**	21.22
5	**Water Supply System**	12.85
6	**Sewage System**	8.01
7	**Power Supply System**	3.98
8	**Gas Pipe Line System**	4.73
9	**Telecommunication System**	2.56
10	**Streetlight**	1.29
11	**Landscaping**	0.84
	Total Construction Cost for Phase I	**442.07**
B.	**Phase II**	
I	**Onsite Infrastructure**	
1	**Major Infrastructure (Public)**	10.98
2	**Land Grading**	23.92
3	**Road**	7.42
4	**Storm Water Drainage System**	3.45
5	**Water Supply System**	2.31
6	**Sewage System**	3.83
7	**Power Supply System**	1.87
8	**Gas Pipe Line System**	1.19
9	**Telecommunication System**	0.91
10	**Streetlight**	0.68
11	**Landscaping**	0.31
	Total Construction Cost for Phase II	**56.87**
	Total Construction Cost for Phase I and II	**498.94**
	General (10%)	**49.89**
	VAT (18%)	**89.81**
	Contingency(10%)	**49.89**
	Detailed Design Cost	**2.00**
	GRAND TOTAL	**690.53**
	Development Area (ha)	756.13
	Saleable Area (ha)	583.00
	construction cost/saleable area (US$/m²), with VAT	118.445
	construction cost/saleable area (US$/m²), without VAT	103.040

Source: JPT

※Note that the above costs do not include eminent domain and construction management costs.

3.13.6 Business Plan

3.13.6.1 Human Resources Management and Establishment of Organizations for PIZ Development and Operation

(1) Prerequisite

The following are prerequisites when considering PIZ development personnel and organization

- The Ndayane Port PIZ will be established to contribute to the economic development of Senegal by taking advantage of its proximity to a multi-purpose deep sea port.
- The PAD, as the landowner, developer, and operator of PIZ, will take ownership of the project through all phases
- Since PAD has no experience in SEZ implementation, a structure will be established to maintain PAD's ownership and build its capacity.
- SDG considerations will also be taken into account.

(2) Examples from other countries

In Southeast Asia, there are many examples of companies taking the lead in developing SEZs. In addition, SEZs at the strategic locations such as ports have received supports from special organizations of PPP and ODA since their planning stage.

Table 3.156 Examples of SEZ Development and Operating Entities

SEZ	Planning Phase	Construction Phase	Operation Phase
Thilawa SEZ (Myanmar)	Myanmar-Japan Thilawa Development (MJTD): Myanmar side 51%, Japan side (trading companies, banking group, JICA) 49%. Thilawa Port and other external infrastructures were developed by Yen Loan JICA Technical Cooperation Project to support livelihood restoration of displaced people	MJTD	MJTD
Sihanoukville Port SEZ (Cambodia)	Sihanoukville Port Authority (PAS) JICA Technical Cooperation	PAS (a Yen Loan project)	PAS JICA technical cooperation "SEZ Operation Advisor Project"
Tangier MED Free Zone (Morocco)	Tanger MED: Subsidiary of Tanger Med Special Agency (TMSA), a government-owned public limited company established for the purpose of developing industrial parks and ports.	Tanger MED	Tanger MED (Sales by Sumitomo Corporation)

Source: JPT

(3) Issues of PAD's Organizational Structure for PIZ Development

In order to develop and manage the Ndayane PIZ as promoter/developer, the following roles must be fulfilled in accordance with the SEZ Law.

- Obtaining approval from the competent minister for the SEZ promoter/developer status, and construction and maintenance of the SEZ

- SEZ management

In the former, experience and knowledge of area development and in the latter, experience and knowledge of business operations are essential.

In order to fulfill these roles and achieve results as a promoter/developer of PIZs. the PAD must have following functions.

Organizational functions required for a PIZ promoter/developer

- Function of business management as the master developer of the entire project. It ensures the integrity of the entire project. Signing of a convention with the Administrator (APIX) to be selected as the promoter/developer of the Ndayane Port PIZ. Note that according to the SEZ Law 2017-06, convention is described as a concession arrangement, which means it is a concession agreement with APIX. Since PAD is a public institution, it is not appropriate for PPP and needs to be confirmed what type of concession format it is.
- Coordination function of the various actors for SEZ development (re-contracting, regulatory authorities, APIX, etc.)

Organizational functions required for PIZ development

- Technical competence in planning, research, design, proposal preparation (including sub-contacting), and financial planning
- Administrative management functions, such as application procedures to APIX, and fundraising functions
- Understanding of environmental and social considerations, ability to conduct environmental monitoring
- Resettlement, if required, and function of coordinating the relocation of existing facilities
- Contracting with construction companies, and construction supervision functions for infrastructure development

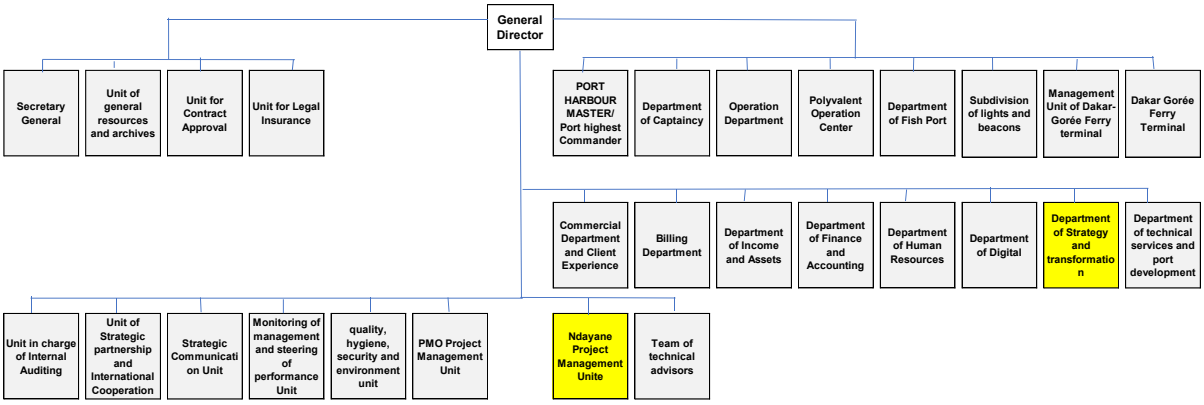
Organizational functions required for PIZ operations and management

- Marketing of SEZ to domestic and foreign investors, promotion of tenant companies, and other sales activities
- Provide services in the SEZ that enhance customer's satisfaction as needed by the tenant companies
- Business management to ensure smooth progress of the PIZ project (leasing of sites, provision of other services and brokerage for tenant companies)

Currently, the existing SEZ development in Senegal is being implemented by promoters/developers who have signed convention (concession contract) with APIX. Promoter/developer attributes vary by SEZ (see Table 2-13). Of these, all but APROSI under the Ministry of Industry, promoter/developer in Diamniadio SEZ are believed to have no experience in SEZ development.

The challenge for PAD in developing PIZ is that PAD is a public agency in charge of port development and management and has no experience in SEZ development, although it has a strong intention to develop it. There is also no department within the organization that is in charge of area development. Although there is a client management department in for port management, there is neither experience nor a department in charge of business management after the establishment of the SEZ.

Below is an organizational chart of the PAD.



Source: JPT, based on the information of PAD

Figure 3.196 Organigram of PAD

(4) Organization for PIZ realization

Under these circumstances, it is fair to say that it is a great challenge for PAD to develop Ndayane PIZ and act as promoter/developer to attract and manage the tenant companies. While self-management is a very long-term goal, it is desirable to establish a PIZ and start its operation with support from other organizations, not only in-house consultants, for a period of about 25 years.

As PAD develops and operates PIZ, the goal is to build a SEZ that is attractive to companies, increase occupancy rate, increase customer satisfaction, generate a profit, and as stated in the PSE, contribute to the development of Senegal. This will require the human resources who have knowledges and experiences in each of the business functions. Organizational structure accompanying this process is also required. SDG perspective is also essential. In addition to this, it is necessary for the PAD to maintain ownership over PIZ development, and to develop and strengthen its capacity in these areas through the development and management process.

PAD has now started work to develop the SEZ, led by the Director of Strategy and Transformation, *Directeur de la stratégie et de la transformation*, and the Head of the Ndayane Project Management Unit, *Chef de l'unité de la gestion du projet Ndayane*, but there are no concrete facts and results yet (the yellow marks in the organigram above are the departments they belong to). In order to begin preparations for the establishment of SEZ at an early stage, it is essential to procure the necessary human resources.

The following options could be considered **as a method of human resource procurement and organization for the development of a PIZ development plan.**

Prerequisite: Formal establishment of a department in charge of PIZ within PAD, responsible for overall management and external relations such as APIX.

Option 1: Hiring in-house consultants

Option 2: Contract with APROSI

Option 3: JICA technical cooperation

Option 4: Business contracts with private companies

Option 5: Partnership with the private sector (PPP)

Note that the option of completing the project exclusively with PAD internal personnel is deemed impossible in view of the current situation. Below is a comparison of the pros and cons of options 1 through 4.

Table 3.157 Comparison of Organizational Options for PIZ Development Planning

Option	1. Hiring in-house consultants	2. Contract with APROSI	3. JICA technical cooperation	4. Business contracts with private companies	5. PPP
Contents	Hire external persons in the relevant field as in-house consultants.	APROSI, which is under the Ministry of Industry and has experience as a promoter/developer of SEZ, provides support.	Conduct a preparatory survey (FS) in the technical cooperation scheme as a precondition for JICA's loan aid.	Order from domestic and foreign companies with experience in SEZ development	Sign a PPP contract (concession) with domestic and/or foreign companies, and outsource operation
Advantage	By making it an in-house consultant, the PAD can retain its independence. The wishes of the PAD can be respected.	APROSI's experience in SEZ development is utilized in the Ndayane PIZ.	JICA's experience in supporting SEZ development in other countries is utilized. Highly specialized personnel can be deployed at no cost to the PAD. Through FS, contributes to PAD's human resource development.	Able to perform SEA development work from a professional perspective. Some vendors can use their experience in SEZ development in other countries.	Concessionaires are responsible for performing development work from a professional perspective. Some concessionaires will benefit from experience in SEZ development in other countries.
Disadvantage	Unknown how many talented experts are in Senegal. Labor costs because of new hiring.	APROSI's own structure is unclear (e.g., whether there is area development engineers). Expenses unknown. Unclear how much respect will be given to PAD's initiative.	It takes time from the submission of the letter of request to the implementation of the work.	Due to lack of experience of PAD, it is unable to maintain their independence. The contract amount could be high. It takes time to procure.	Due to lack of experience of PAD, they are unable to maintain their independence. Also, quality cannot be guaranteed. Transparency cannot be maintained depending on the nature of the contract. Concessionaire's business priorities may become the priority, not Senegal's development.

Source: JPT

Among the above, JICA's financial cooperation is supposed appropriate, because it is implemented by highly specialized and experienced, and does not impose any personnel or outsourcing personnel costs for the PAD. Thus, this option is recommended to be the best option for PADs who currently have few experiences in SEZs, because it has the basic concept to build a partnership with counterparts (CPs) to respect their intention and to provide technology transfers. However, since it takes time from the submission of the letter of request, through its adoption by the Government of Japan, procurement

and up to the contracting of JICA consultant, quick action is required: to have the letter of request submitted as soon as possible if this option is selected; and for JICA to proceed with the procedure as soon as possible in consideration of the local situation. It would be preferable[87] to submit the letter of request after the ITR2 briefing scheduled in September 2023, for example. [88]

The human resource procurement method and organization for PIZ construction should be effectively managed in conjunction with the construction financing method, as well as obtaining technical management support following the development plan formulation. The following options are possibly considered.

- Cooperation with construction supervision consultant within the framework of Japanese financial assistance (yen loan, or, depending on the amount, grant aid)."
- Cooperation with construction supervision consultant in the framework of funding from international organizations or hiring in-house construction supervision consultants.
- In other cases of foreign government funding, hiring in-house consultants to supervise construction (in some cases, this may not be possible due to the structure of the project)
- In the case of investments by domestic and foreign private companies, they may not be involved in construction supervision.

Procurement of human resources and organization for PIZ operation and management, following options could be considered.

Prerequisite: Formal establishment of a department in charge of PIZ within PAD, responsible for overall management and external relations such as with APIX. Collaboration with an external organization experienced in business operations for the PIZ operation and management.
Option 1: Hiring a business consultant
Option 2: JICA technical assistance
Option 3: Cooperation with APROSI
Option 4: Cooperation with Tanger MED
Option 5: Partnership with the Private Sector (PPP)

[87]The possibility of proposal-based ODA will also be considered.

[88] Also, possibility of the proposal type ODA should be considered.

Table 3.158 Comparison of Organizational Options for PIZ Operation

Option		Hiring a Business Consultant	Supported by JICA Technical Assistance	Supported by APROSI	Cooperation with Tanger MED	Partnerships with the Private Sector (PPP)
Contents		Hire outside business experts as in-house consultants.	JICA technical cooperation project to support practical operations	Supported by APROSI (precedent: Sandiara SEZ).	The SEZ division of Tanger MED, who gives PAD technical assistance in port operations.	A PPP contract will be signed with a private company to take charge of the operation.
Advantage		By making it an in-house consultant, the PAD can retain its independence. The wishes of the PAD will be respected.	Japan's experience and knowledge of SEZ support will be utilized. Technology transfer to PAD will take place.	Experience in prior SEZs will be utilized. It is a Senegalese government agency and is familiar with the SEZ system.	The company's experience in supporting SEZ development in Morocco and other countries will be utilized. It is a government-owned company with extensive business experience.	They are business operation professionals
Disadvantage		Unknown how many talented people are in Senegal. Labor costs will be high because of new hiring.	Long-term support is not possible. It is unclear to what extent the ODA framework can support business activities.	APROSI itself is a public institution with unknown business experience. Expenses unknown	Expenses unknown Possible lack of respect for PAD and Senegalese ownership	Possible lack of respect for PAD and Senegalese ownership Possibility of low interest in information disclosure and environmental and social considerations.

Source: JPT

Among the above, JICA's technical cooperation project is the most appropriate in that it respects the ownership of Senegal and PAD, strengthens the capacity of PAD, and has experience in supporting SEZs and industrial parks. However, it may be difficult to provide long-term assistance; and as JICA itself is a government agency, it may be difficult to provide in-depth business support. Therefore, it would be desirable to provide support at the start of SEZ operation to build an operational foundation, and to support contracts with organizations such as Tanger MED that is operating Tanger Free Zone, or to support PPPs with the private sector.

3.13.6.2 Funding Scheme

The following financing options are possible, with an eye toward public and private financing.

(1) Senegalese government's own budget

In view of the present circumstances of the Senegalese government, it is considered to be a con proposal.

(2) ODA

a. Grant aid from foreign governments and international organizations

b. Loan aid from foreign governments and international organizations (Low-interest loans for Least Developed Countries)

* Technical assistance and training for operation and management should be included.

(3) Loans from banks and other private companies

* In the private sector, the interest rate is the market rate and there may be little transparency regarding the loan.

(4) PPP

* PAD initiative is important to manage concessionaires.

3.13.6.3 Developer Selection Process

The PAD's Contract Approval Unit will make the selection in accordance with the PAD's selection process

3.13.7 Economic Effect and Financial Analysis

3.13.7.1 Analytical Conditions

The JPT analyzed economic effect and financial analysis of the Ndayane PIZ proposed in this Master Plan with the following assumptions. Although the proposed PIZ site is reportedly owned by PAD, it is assumed that some of the land is privately owned, as there are houses and farmland scattered throughout the site. The actual area to acquire should be surveyed at the FS phase. Funding is assumed to be provided by Yen loans.

Table 3.159 Assumptions

Item	Contents	Description
Target District	Ndayane Port Industrial Zone *(Zone industrielle portuaire de Ndayane*)	
Total area	756.1 ha	
Phase 1	502.6 ha	
Phase 2	253.5 ha	
Land acquisition area ratio	25%	Assumption due to information not yet received from PAD.
Acquisition area Phase 1	189.0 ha 125.7 ha	
Phase 2	63.4 ha	
Business model	Leasing of sites (factories, office buildings, housing)	
	Infrastructure Provision Services	
Area for rent Phase 1 Phase 2	616.3 ha 378.7 ha 237.6 ha	
Rentable ratio	100% for land, 0% for superstructure	
Discount rate *Taux de remise*	2.75% (2.75%)	Lending rates of Central Bank of West Africa City Bank
Foreign exchange rate	USD 1.0000 = XOF 602.27026	Calculated based on the JICA exchange rate, July 2023

Source: JPT

Regarding the project implementation funds, the following financial plan is assumed.

Table 3.160 Financial Plan

Item	Contents	Description
Percentage of Own Funds	100% of construction costs be borrowed.	Site acquisition costs and Environmental and Social Impact Assessment (ESIA) are self-funded.
Cash Flow Period	30 years	Based on the loan repayment periods below and on the PPP contract terms prevailing in Senegal.
Loan repayment period	25 years	General conditions + fixed interest rate + Option 1, applied to LDCs or poor countries eligible for Yen loans.
Grace period	7 years	
Borrowing rate %/year	1.50%	

Source: JPT

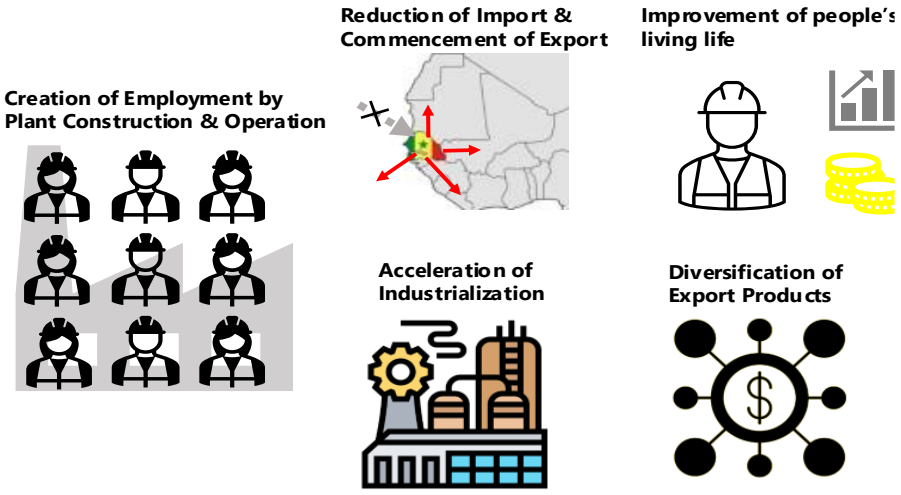
3.13.7.2 Economic Effect Analysis

(1) Expected economic effects

Although PIZ is a project to focus private companies to promote industrial activities, it is considered to be public in nature and to have an economic impact on Senegal, because it is likely to receive bilateral and multilateral financial assistance and it is a national project with a PSE description,

As the main economic impact,

- Job creation (an indicator in the SI)
- Reducing imports of light industrial goods thanks to increase of import substitution production
- Diversification of export products
- Promotion of industrialization of Senegal
- Achievement of PSE through the realization of above
- Improving the living standard of the people through these effects



Source: JPT, based on the feasibility study on the co-production of ammonia/urea fertilizer/methanol using environmentally friendly/digital technology in a low-carbon society in the Republic of Senegal.

Figure 3.197 Expected Economic Benefits

PIZ is expected to generate economic effects as explained below.

(2) Job creation

In 0 Land Use Plan of this PIZ MP, the JPT proposes the land use of PIZ as shown in Figure 3.173. In this plan, the area of residential zone, industrial zone, commercial zone, and land for other facilities, etc. was set, and the number of employees was assumed using the average value in general SEZs. As a result, it is estimated that a total of 37,000 jobs will be created, including those in the industries that will be invited, as well as those working in commercial facilities and facilities of public institutions.

Table 3.161 Estimated Number of Employees in the PIZ

Phase	Land Use	Area (ha)	Employee
Phase 1	Residential	14.57	0
	Commercial (60% of Urban area)	14.18	7,091
	Industrial	245.34	12,266
	Institutions	3.79	1,894
	Open space	1.92	0
	Utility	0.19	0
	Custom Inspection Yard	10.62	531
	Retention Pond	4.71	0
	STP		
	Desalination Plant	3.77	189
	Admin & Amenity	5.52	2,850
	Fertilizer Plant	100.14	0
	Road	97.84	
	Phase 1 total	502.59	24,821
Phase 2	Industrial	237.55	11,878
	Landfill site	0.99	0
	Road	15	
	Phase 2 total	253.53	11,877
Total		**756.13**	**36,698**

Source: JPT

(3) Reduction of import and expansion of export, and diversification of export products/goods

Economic effects of the sectors that are proposed as the target industries to invite to the PIZ in 3.13.3.3. "Industries to be attracted" are assumed as follows.

Table 3.162 Estimation of Economic Effects from the viewpoint of Invited Industries

Item	Sector	Breakdown	Market	Fund	Estimate of economic effects
Manufacturing and assembly	(i) Electric appliance	Air conditioner	Africa including Senegal	Foreign capital	Export creation
		Printer	Africa including Senegal, emerging countries	Foreign capital	Export creation
	(ii) Automobiles		Africa including Senegal, global market	Foreign capital (e.g., Korea)	Export creation
	Construction machinery		Africa including Senegal	Foreign capital	Export creation
	(iv) Pharmaceuticals		Senegal, West African countries	Foreign capital, Senegal	Import substitution, export creation
b) Resource-based industry (existing)	(i) Fishery processing		Senegal, global market	Domestic, (plan of foreign capital invitation)	Export, satisfaction of domestic demand
	Aquaculture		Senegal, global market	Domestic, (plan of foreign capital invitation)	Export, satisfaction of domestic demand
	(iii) Fishmeal		Senegal, global market	Domestic, foreign capital	Export, satisfaction of domestic demand
	(iv) Agricultural processing		Senegal, global market	Domestic, foreign capital	Export, satisfaction of domestic demand
	(v) Compound feed production		Senegal	Domestic, foreign capital	Import substitution, satisfaction of domestic demand, export
c) Resource-based industry (new)	(i) Urea fertilizer		Senegal, West African countries	Domestic, foreign capital	Import substitution, satisfaction of domestic demand, export
d) Support sector	(i) Service export		Francophone countries	Foreign capital	Service export

Source: JPT

If these sectors are successfully invited, it is expected that the following economic effects will increase.

a) The manufacturing and assembly processing sector is a business that attracts foreign capital to process products and exports them to African countries, mainly West Africa. Attracting investment in this sector will have the economic effect of expanding exports and diversifying export products. Especially in this sector, since there is no base in Senegal, new entry of foreign companies can be expected.

b) Resource-based industry (existing) and c) resource-based industry (new) sectors aim to target the Senegal market and the world market by investing domestic and foreign capitals and are expected to have multifaceted effects such as export processing and import reduction, diversification of export products, and fulfillment of domestic demand.

d) Support sector provides economic effects of export diversification in terms of service exports.

e) Each sector, especially a), will be realized by foreign investment. Therefore, much of the jobs mentioned in the previous section will be created through foreign investment. In other words, the expansion of foreign direct investment can be expected to have the effect of activating Senegalese economy.

(4) Effect on National Economy

b) resource-based industry (existing) and c) resource-based industry (new) sectors are projected to meet domestic demand for food and fertilizers. Import substitution production lowers the price of basic commodities and also allows the Government to reduce fertilizer subsidies to farmers, which will reduce overall state expenditure. It is possible to use the reduced expenditure to contribute to the improvement of people's living lives and further contributes to achievement of the PSE and the SDG 2 “End hunger, achieve food security and improved nutrition and promote sustainable agriculture”.

(5) Economic effect analysis

Regarding the specific economic effect analysis according to EIRR calculation, it is necessary to proceed with the analysis by confirming the specific investment sector, investment volume, and business scale, in the course of formulating the PIZ implementation plan in the future.

As a reference, the case of Sandiara SEZ, which started business in 2015, is shown[89]. By the end of 2022, this SEZ has got the following results.

- 500 jobs created (expecting 20,000 in the end)
- 42 billion FCFA (XOF) of investment realized (expecting to eventually reach 200 billion FCFA)
- Sixteen of the 20 tenant companies (including those under construction) are foreign ones, which can be said to have attracted foreign direct investment. Many are also export-oriented production companies.
- Sales are unknown at this time but expect final sales of 2 trillion FCFA (XOF).

3.13.7.3 Financial Analysis

(1) Business Model

The business model of the Ndayane PIZ to be operated by PAD is set up as follows.

- PAD signs SEZ Promoter/Developer Convention with APIX for approximately 756 ha hinterland of Ndayane Multifunction Port.
- It develops the area as SEZ (Ndayane PIZ) in compliance with Senegalese laws and regulations.

[89]Source: Présentation du Plan Sandiara Emergent, Sandiara City Hall, 2022.

- It attracts private companies, lease the land and collect their rental fees.
- In addition, it collects administrative fees for utilization of infrastructures inside PIZ.
- It receives Yen loans or other public assistance for construction.
- For the PIZ operation and management, it is assumed that PAD, receiving technical support in organizational establishment and capacity strengthening by the JICA technical cooperation or other form, enter with a PPP contract with private companies who have experience in developing SEA or industrial park, such as APROSI, Tanger MED, and other companies. with experience in SEZ and industrial park development for the PIZ operation.

(2) Preconditions

a) Expenditure

Expenditures include land acquisition, construction, and operation and maintenance costs. Since the JPT does not conduct a price survey for this M/P, the relevant information is used for price estimate. In the detailed planning study, prices should be revised based on a careful review of real estate value studies and information on the operation of the existing SEZs.

i. Land acquisition cost

In the plan site of PIZ, a signboard is set saying that the Decree declares public utilization of 1,200 ha as Ndayane Multifunction Port, designated it as the state land, and registered it in the name of the state. However, it is not clear whether the register was accompanied by payment of acquisition cost or compensation, and detailed area of the state land instead of approximate figure of 1,200. As the JPT observed houses and orchard there, it is set for financial analysis that PAD has to acquire 25% of PIZ development area fin future. It needs to survey the real land area at the FS stage.

The JPT checks the prices of several properties for sale near Diass on CoinAfrique, a real estate sales website targeting West Africa, and extracted a roughly intermediate value.

Source: JPT

Figure 3.198 Signboard Showing that the Land is set to be Expropriated as State Land

ii. Construction cost

An average value was set based on the cost of SEZ construction in several countries.

Financial analysis applies the result of the cost estimate (Table 3.155). However, it partly excludes some facilities which will be used exclusively by PIZ but by the wide range of area including Ndayane Port, communities, trunk road and the airport from the PIZ construction cost. They are fifty percent both of eight lane trunk road of ROW 70 and rainwater drainage system. Moreover, the desalination plant is a facility to provide water service inside PIZ, but financial analysis excludes it as well because construction cost and O&M cost are expensive and suppose it would be constructed by a PPP contract. As the result, unit construction price is USD 51/$m^{2/}$. It is Alternative 1 of alternative comparison.

For reference, the construction cost of Sandiara SEZ is 30 billion FCFA for 100 ha. When applying the present foreign currency exchange rate, it is approximately USD 50/m^2 and seems almost same as the Alternative 1.

Then, the JPT sets Alternative 2, Alternative 3, and Alternative 4 by changing the cost coverage facilities.

Alternative 2: Exclusion of the desalination plant and ROW 70 road, and 50 % of the rainwater drainage system.

Alternative 3: Construction of all facilities by the PIZ construction cost. The promoter/developer will

supply the water produced by the desalination plant and collect water charge using the SONES water tariff rate.

Alternative 4: Construction of the desalination plan by the PIZ construction cost and provision of water supply service and water charge collection as same as Alternative 3. On the other hand, exclusion of entire ROW 70 road and rainwater drainage system from the construction cost

iii. Maintenance costs

Maintenance costs are set to 4% of construction costs per year. This includes labor costs, promotional expenses, and major infrastructure repairs in the PAD management portion of the project.

Table 3.163 Expenditure Items

No.	Item	Unit price	Unit	Phase	Amount	Unit
1	Land purchase	6.64	USD/m^2	Phase 1	125.65	ha
				Phase 2	63.38	ha
2	Construction (building cost)	51	USD/m^2	Phase 1	502.59	ha
				Phase 2	253.53	ha
3	Operation and maintenance	2.0	USD/m^2/年	Phase 1 Phase 2	For the PAD managing area (non-lease contract area)	

Source: JPT

Table 3.164 Comparison of Construction Cost Alternatives

Alternative	Desalination plant	ROW 70	Other roads	Rainwater drainage system	Unit price USD/m^2	Construction Cost million USD		
						Phase 1	Phase 2	Total
Alt. 1	-	50%	50%	50%	**51**	234.4	79,5	313.8
Alt. 2	-	-	+	50%	**49**	220.1	79.5	299.6
Alt. 3	+ water charge	+	+	+	**113**	611.1	79.5	690.
Alt. 4	+ water charge	-	+	50%	**105**	565.1	79.5	643.6

Source: JPT

Note: + included in the construction cost,-excluded in the construction cost

b) Revenue

In terms of revenues, there are site rental fee, occupancy fees when companies move in, and management fees for the provision of infrastructure and other services. Examples from existing SEZs are as follows.

i. Site rental fee

Dimniadio SEZ XOF 960（USD1.59） /m^2/year

Diass SEZ XOF 3,000（USD4.98） /m^2/year

Bargny-Sendou SEZ XOF 1,530（USD2.50） /m^2/year

In the financial analysis, the JPT takes the median of the three SEZ and sets it at 2.50 USD/m^2/year. In implementing the project, it is necessary to grasp the prices of SEZs not only in Senegal but also in West African countries, and to set appropriate price.

ii. Move-in fee

Sandiara SEZ XOF 2,000 /m^2 (approx. 3.32USD/m^2),

one-time payment upon move-in. Financial analysis applies this price.

iii. Management fee (infrastructure supply fee, etc.)

Sandiara SEZ XOF 1,000 (USD 1.67) /m^2 per year

Financial analysis applies this price.

Table 3.165 Revenue Items

No.	Item	Unit price	Unit	Phase	Amount	Unit	Price	Unit
1	Site rental fee	2.50	USD/m^2/y	Phase 1	378.7	ha	9.5	Million USD/y
				Phase 2	237.5	ha	5.9	Million USD/y
2	Move-in fee	3.32	USD/m^2	Phase 1	378.7	ha	12.6	Million USD
				Phase 2	237.5	ha	7.9	Million USD
3	Management fee	1.66	USD/m^2/y	Phase 1	378.7	ha	6.3	Million USD/y
				Phase 2	237.5	ha	3.9	Million USD/y

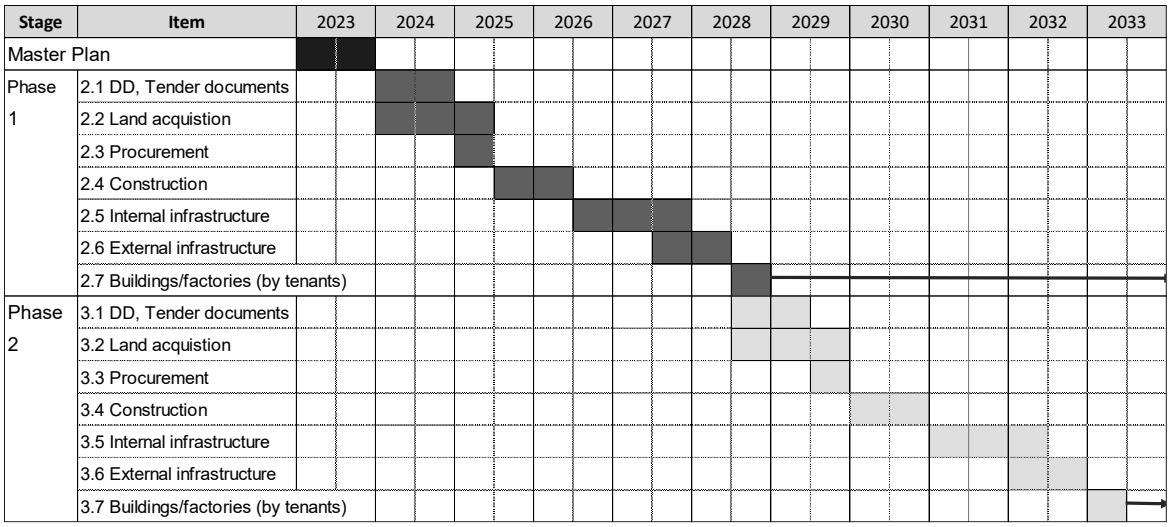
Source: JPT

c) Other conditions

- The overall cash flow period shall be 30 years.
- Site acquisition is conducted in parallel with detailed design and preparation of bidding documents.
- The construction cost will be spent in 3.5 years for land development, inside and outside infrastructures of the PIZ. It is set to be distributed in the cashflow equally for each year on an area ratio basis.
- Land rental income is subject to corporate occupancy rate. In the case of Sandiara SEZ, while the original plan is for 60 companies to occupy the SEZ, as of the end of 2022, seven years after the start of the project in 2015, 42 companies had entered the project in some forms. Of these, 14 companies have already started operations or are building plants with authorized installation. After being authorized, they contract with the promoter/developer (Sandiara City Hall in the case of Sandiara SEZ). It is assumed that the occupancy fee is paid at the time of signing the contract and that the land rental fee begins to be paid from that point on. Six companies were in process at end of 2022, and six new companies are expected to sign

contracts in 2023[90]. The occupancy rate for analysis was set by applying this occupancy trend and assuming that PETROSEN's fertilizer plant will be occupied immediately after the development in the Phase 1.

- Realistically, the JPT set the maximum occupancy rate at 95% for Phase 1 and 90% for Phase 2.
- Phase 1 construction financing will be borrowed in 2025, with a seven-year grace period, and repayment with 18 installments will begin in 2032. Phase 2 construction financing will be borrowed in 2029 and repayment with 18 installments will begin in 2036, also after a seven-year grace period. These will be paid off in 2053and interest rate is 1.5% per annum.



Source: JPT

Figure 3.199 PIZ Development Schedule (reiterated)

Phase	Explanation	2028	2029	2030	2031	2032	2033	2034		2050	2051	2052	2053
Phase 1	Occupation rate (area %)	20%	23%	27%	32%	37%	47%	57%		95%	95%	95%	95%
Phase 2	Occupation rate (area %)						3%	6%		90%	90%	90%	90%

Source: JPT

Figure 3.200 Tenant Move-in Trend (cumulative area, estimated)

(3) Results of Financial Analysis

The JPT performed a financial analysis using the revenues and expenditures, the PIZ development schedule and conditions described above. This resulted in minus both for NPV and FIRR.

Table 3.166 Summary of Financial Analysis

Unit: million USD

[90]Présentation du Plan Sandiara Emergent, 2022, Sandiara City Hall

Alternative	Explanation	Revenue	Expenditure	Balance	NPV	FIRR %
1	Exclusion of 100% of the desalination plant, 50% of roads and stormwater drainage system	458.8	548.0	-89.1	-186.0	-1.34%
2	Exclusion of 100% of the desalination plants and ROW 70 road, 50% of stormwater drainage system	458.8	524.5	-65.6	-166.6	-1.01%
3	Including all infrastructures and facilities	834.0	1,190.6	-356.6	-500.6	-2.63%
4	Exclusion of 100% of ROW 70 road and 50% of rainwater drainage system	834.0	1,037.2	-203.2	-386.7	-1.55%

Source: JPT

Next, sensitivity analysis was conducted on alternative 2, which has the highest FIRR among the 4 alternatives, to explore the direction of the project implementation. Sensitivity analysis of four cases, i.e., reduction of land acquisition area, improvement of move-in speed, reduction of construction cost, and combination of all these three cases, shows a negative NPV, and it has become clear that PIZ cannot be profitable under current prices and conditions. Therefore, in the feasibility study, it is necessary to conduct more detailed cost survey and examine revenue expansion measures.

Table 3.167 Summary of Sensitivity Analysis Results

Unit: million USD

Case	Explanation	Revenue	Expenditure	Balances	NPV	FIRR %
Case 0	-	458.8	524.5	-65.6	-166.6	-1.01%
Case 1	Reduction of land acquisition by 50% of case 0 (12.5% of the total land to acquire)	458.8	518.2	-59.4	-160.8	-0.92%
Case 2	5% faster occupancy in the first decade	477.9	513.8	-36.0	-146.6	-0.55%
Case 3	Reduction of construction cost by 20%	458.8	422.1	36.7	-81.9	0.64%
Case 4	All of above (reduction of land acquisition by 50%, faster occupancy rate, reduction of construction cost by 20%)	477.9	407.3	70.6	-57.6	1.24%

Source: JPT

It is obvious that if the occupancy fee, land rent, and management fees, all collected from occupying companies, increase, it will improve FIRR. However, Ndayane PIZ needs to proceed with its SEZ business while competing with the neighboring Diass SEZ and Bargny-Sendou SEZ which is also a

port SEZ, an easy increase in prices may lead to a reduction in competitiveness.

In the F/S following this M/P, a marketing analysis (including 3C analysis and 4P analysis[91]) should be conducted to develop a marketing strategy that will increase the FIRR and competitiveness of the Ndayane PIZ, by closely examining the business and market trends of the other 4 SEZs. It is also essential to formulate a business plan for PIZ while keeping in mind the development of SEZs such as Abidjan (Côte d'Ivoire) and Tema (Ghana), which have the large ports in West Africa, as competitors. In addition, an economic analysis should be conducted with specific projections of economic benefits to understand the effects of this PIZ on the Senegalese society and economy, and to propose a business plan that will also contribute to the achievement of the PSE.

3.14 Natural and Environmental Condition Survey

3.14.1 Data Analysis of Existing Field Natural Condition Survey

(1) General

JPT received and collected previous observations and surveys which have been conducted around Ndayane Port. The summary of the information is shown in the sub-sections below.

(2) Weather Data

There are two tropical seasons in Senegal: a rainy season and a dry season. Rainy season runs from May to November and dry season runs from December to April.

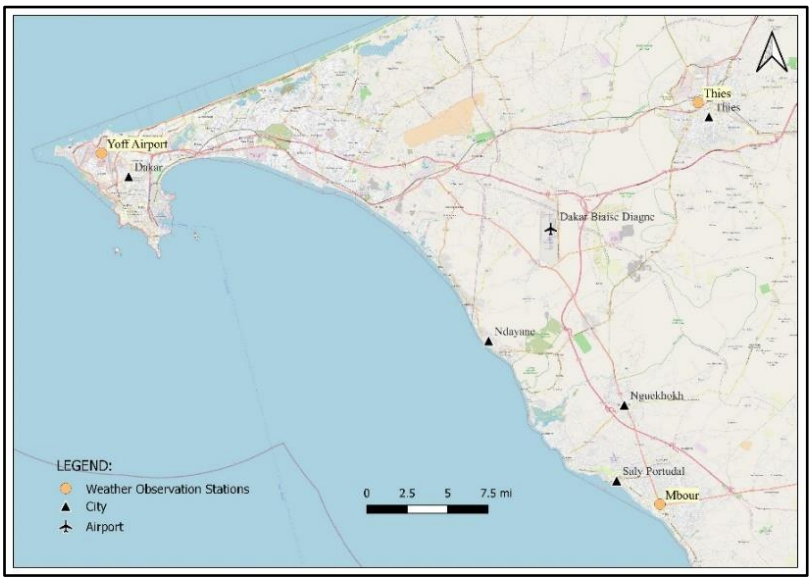
According to National Agency for Civil Aviation and Meteorology (ANACIM) in Senegal, the following data are available and can be purchased from ANACIM.

Table 3.168 Weather Data from Nearest Station to Ndayane Area

Type of Weather Data	Station	Period
Temperature	MBOUR	1960–2022
Rainfall	MBOUR	1941–2022
Wind	MBOUR	1960–2022
Humidity	MBOUR	1960–2022

Source: ANACIM

[91] 3C = customer, company, competitor, 4P = place, price, product, promotion



Source: JPT based on QGIS

Figure 3.201 Weather Observation Stations

(3) Temperature

The average ambient temperatures at Dakar are summarized in the table below.

Table 3.169 Average Ambient Temperatures at Dakar

Month	Jan	Feb	Mar	Apr	May	June	July	Aug	Sep	Oct	Nov	Dec
Average high (°C)	25.3	25.2	25.4	25.0	26.0	28.6	30.0	30.3	30.7	31.0	29.8	27.4
Average low (°C)	18.3	18.0	18.5	19.2	20.7	23.5	25.1	25.3	25.2	25.3	23.3	21.0

Source: ESIA Report (January 2020)

(4) Rainfall

According to the meteorological data from three stations situated in Yoff Airport, Thiès and Mbour, the average monthly rainfall is between 200 to 300 mm with a peak period in August. The rainfall in August ranges from 112 to 344 mm and 114 to 494 mm respectively, while the annual average is 41 and 55 mm/month respectively. At Dakar, the rainfall between 2007 and 2016 in August ranges from 86 to 380 mm/month.

The following table gives the average monthly rainfall data for Dakar (Yoff) for the period 2007 to 2016 as obtained from ANACMS.

Table 3.170 Average Monthly Rainfall Data in Dakar (Yoff).

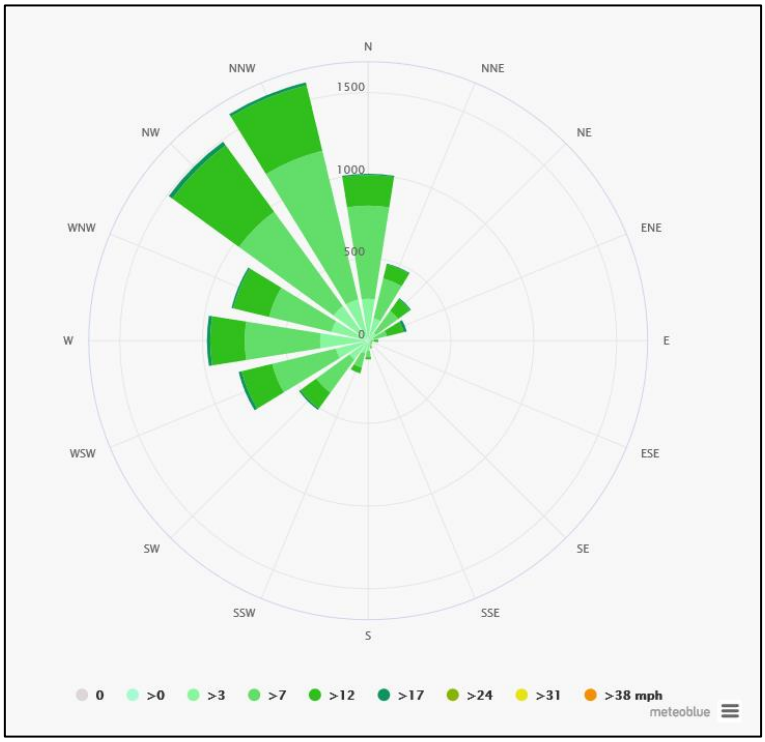
Month	Jan	Feb	Mar	Apr	May	June	July	Aug	Sep	Oct	Nov	Dec
Rainfall (mm)	0	0	0	0	0	7	50	221	167	22	1	1

Source: Agence Nationale de l'Aviation Civile et de la Météorologie du Sénégal

(5) Wind

During the rainy season (May to November), the prevailing wind is from the west to the northwest, from the Atlantic Ocean, and changes to the east and northeast, from the Sahara, during the dry season (December to April).

From Dakar, Senegal (N 14°41′37″, W 17°26′39″) which is the nearest station to the site, wind data are reported below:



Source: ESIA Report (January 2020)

Figure 3.202 Wind Data

The prevailing winds are from NW-NNW-N (about 40% of the total on hourly basis) and WSW-W-WNW (more than 20%). The wind rose shows that the wind rarely blows from the southeast. The observed speed for high winds from NW is more than 17 mph (27 km/h). The average range is between 7.0-12.0 mph with total occurrence of more than 50% of the annual data. The calm winds, with speed less than 3 mph (5 km/h), are recorded for approximately 5% of the total.

(6) Previous Survey Data

Table 3.171 shows the location and elevation to Chart Datum which is approximately the level of Lowest Astronomical Tide. The range of MHWS and MLWS in Dakar is 1.2 m and it is 1.3 m in Mbour. Since Ndayane is located between Dakar and Mbour, the tide level will be similar to two locations.

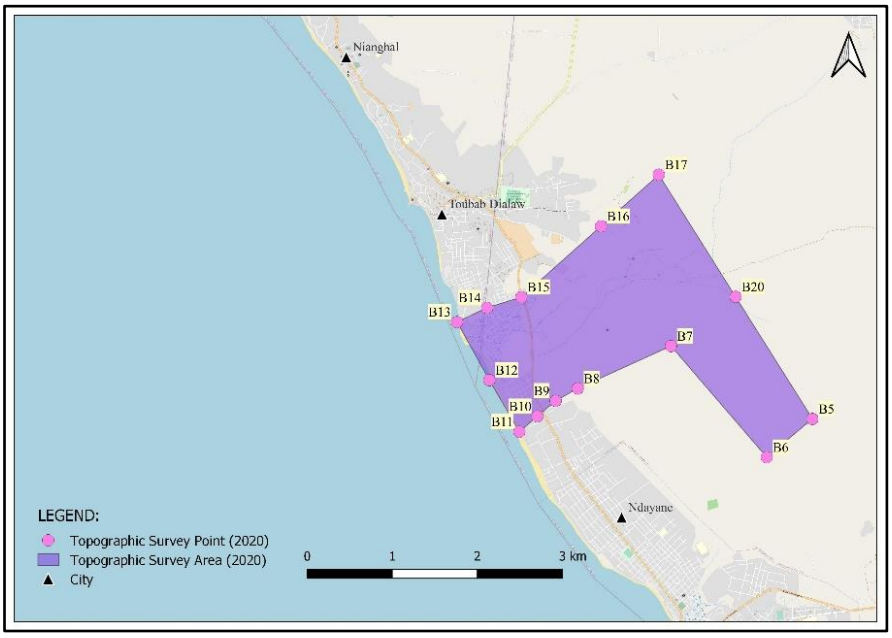
Table 3.171 Tidal Levels referred to Datum of Soundings

Place	Lat	Long	Heights in meters above Chart Datum			
	N	W	MHWS	MHWN	MLWN	MLWS
S. Louis	16°01′	16°30′	1.6	1.3	0.8	0.5
Dakar	14°40′	17°25′	1.6	1.3	0.7	0.4
Mbour	14°25′	16°58′	1.7	1.4	0.7	0.4
Pointe de Sangomar	13°50′	16°45′	1.5	1.3	0.7	0.6

Source: French Government chart 7388 of 1997

a) Topography

In 2020, Topographic survey (level control survey) was carried out by China Harbour Engineering Company Ltd. (CHEC) who had been designated by the Port Authority of Dakar (PORT AUTONOME DE DAKAR) to meet the design requirements and to provide the essential survey data needed for the design.

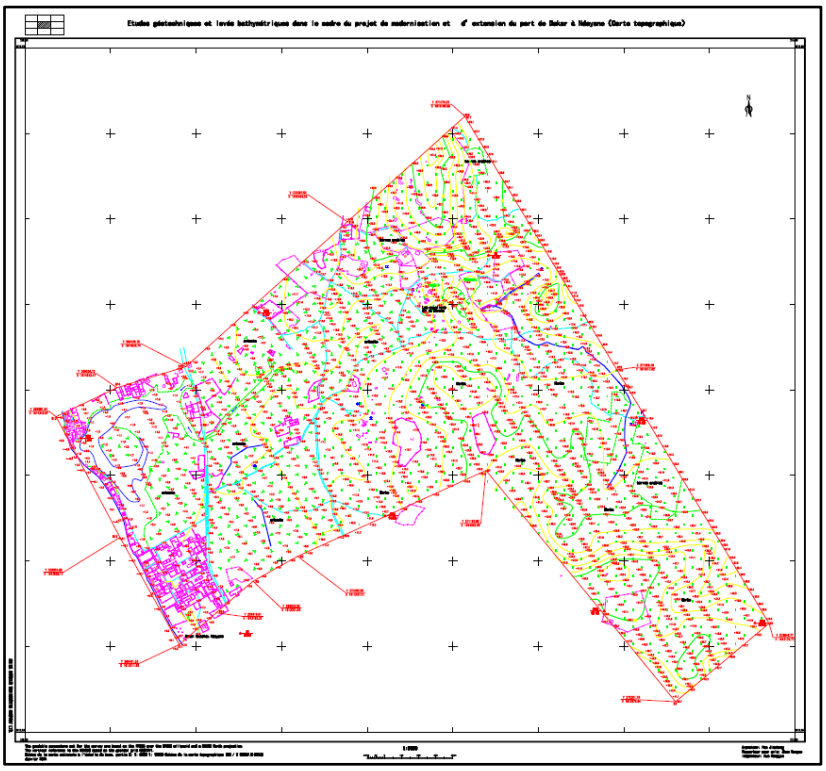


Source: JPT based on QGIS and CHEC report

Figure 3.203 Topographic Survey Area (2020)

Following features are mapped in this Survey:

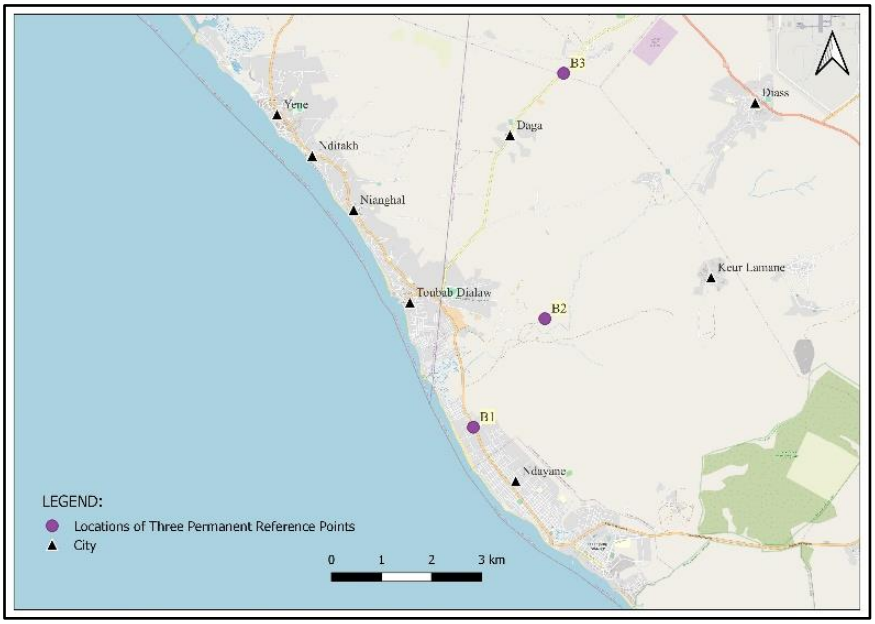
- The coastline is surveyed and mapped according to the actual traces formed by the average surface of the high tides and drawn on the topographic map with the corresponding symbols.
- Rivers and dry natural ravines are mapped according to topographical features. The water network and ancillary facilities are mapped according to the actual shapes.
- The outer contours of homes and ancillary facilities are measured, and the contour boundaries of the house are the footings of the walls or the skin of the outer walls.
- The main roads of the survey area are mapped in the actual forms and are represented by corresponding slopes according to the diagram.
- The power lines mapped rod by rod and expressed by the corresponding linear connections.
- The vegetation in the survey area consists mainly of shrubs.



Source: Topographic Report by CHEC (February 2021)

Figure 3.204 Topographic Survey Contour Map (2020)

In 2017, DPW assigned SHAFA Construction West Africa Sarl to perform the topographic survey and the establishment of the three permanent reference points and the realization of (temporary) markers for the aerial survey.



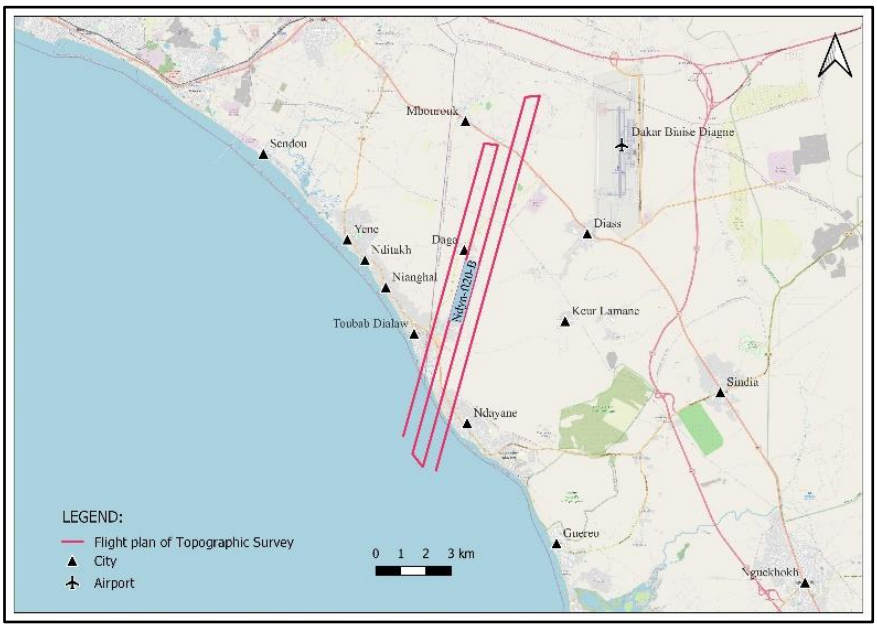
Source: JPT based on QGIS

Figure 3.205 Locations of Three Permanent Reference Points

Table 3.172 Coordinates in UTM 28N and WGS84 system

	Mean values			
Ref points	**East**	**North**	**Altitude**	**Ellipsoid**
B1	269758,179	1613075,845	7,951	38,548
B2	271208,436	1615287,367	19,594	50,181
B3	271629,737	1620311,624	29,498	60,087

Source: Report (Topographic Survey: Establishment of reference points) 2017



Source: JPT based on QGIS and Topographic Survey by Aerial Photogrammetry

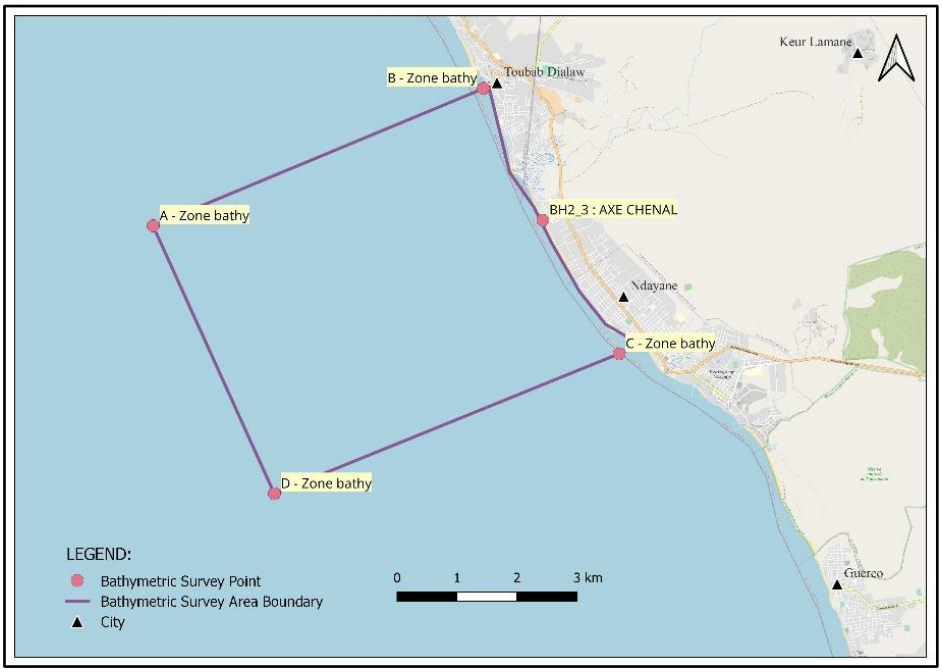
Figure 3.206 Flight Plan of Topographic Survey by Aerial Photogrammetry

The flight was planned to make an angle of 15° to the North in order to take into account both the shape of the site and the direction of the northeast trade winds prevailing in this region. The acquisition was made in the opposite direction: one band going up to the North, the next going down and so on (see the above figure). At 10 cm resolution, the site was completely covered by 400 images.

b) Bathymetry

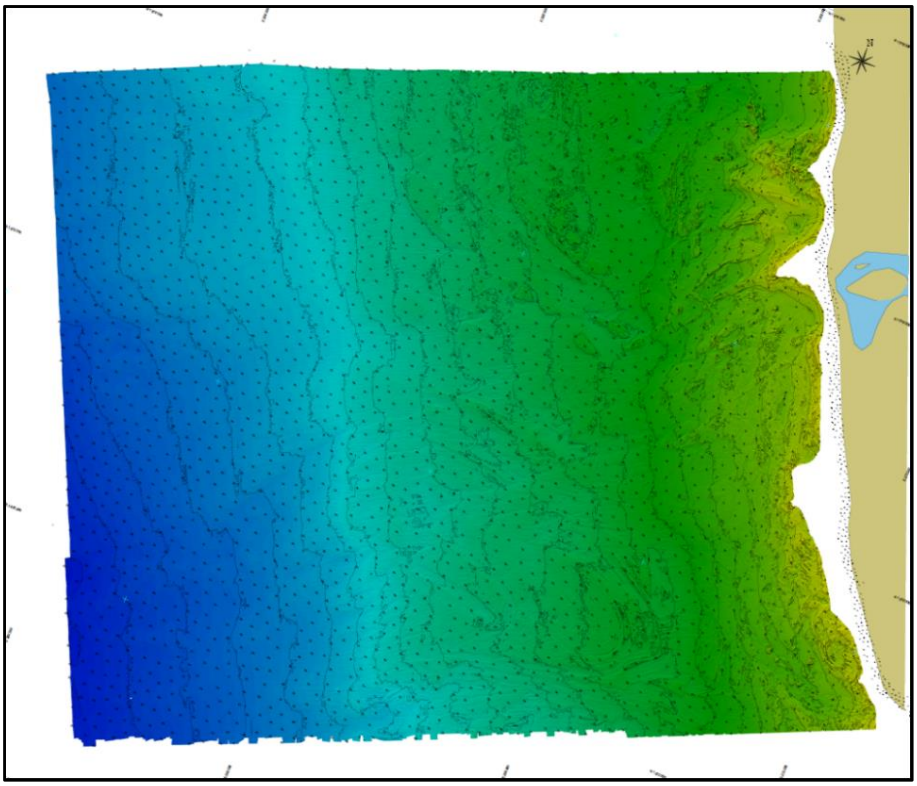
In 2017, Tous Travaux Sous Marins (TTSM) carried out the bathymetric survey in the figure below under SHAFA CONSTRUCTIONS WA as Main Contractor, acting on behalf of DPW as Client, in response to Invitation to Tender for Bathymetric and Geophysical survey services in Toubab Dialow, Senegal.

The bathymetry in the survey area shows a water depth from 2.5 m at the coastline and up to 23.5 m on the deepest part (6 km from the coast). A lot of rocky areas are present near the shore. A general slope of 0.3% is observed from the coastline toward the offshore.



Source: JPT based on QGIS and SHAFA CONSTRUCTIONS WA - PROJECT TOUBAB DIALAW

Figure 3.207 Bathymetric Survey Area (2017)

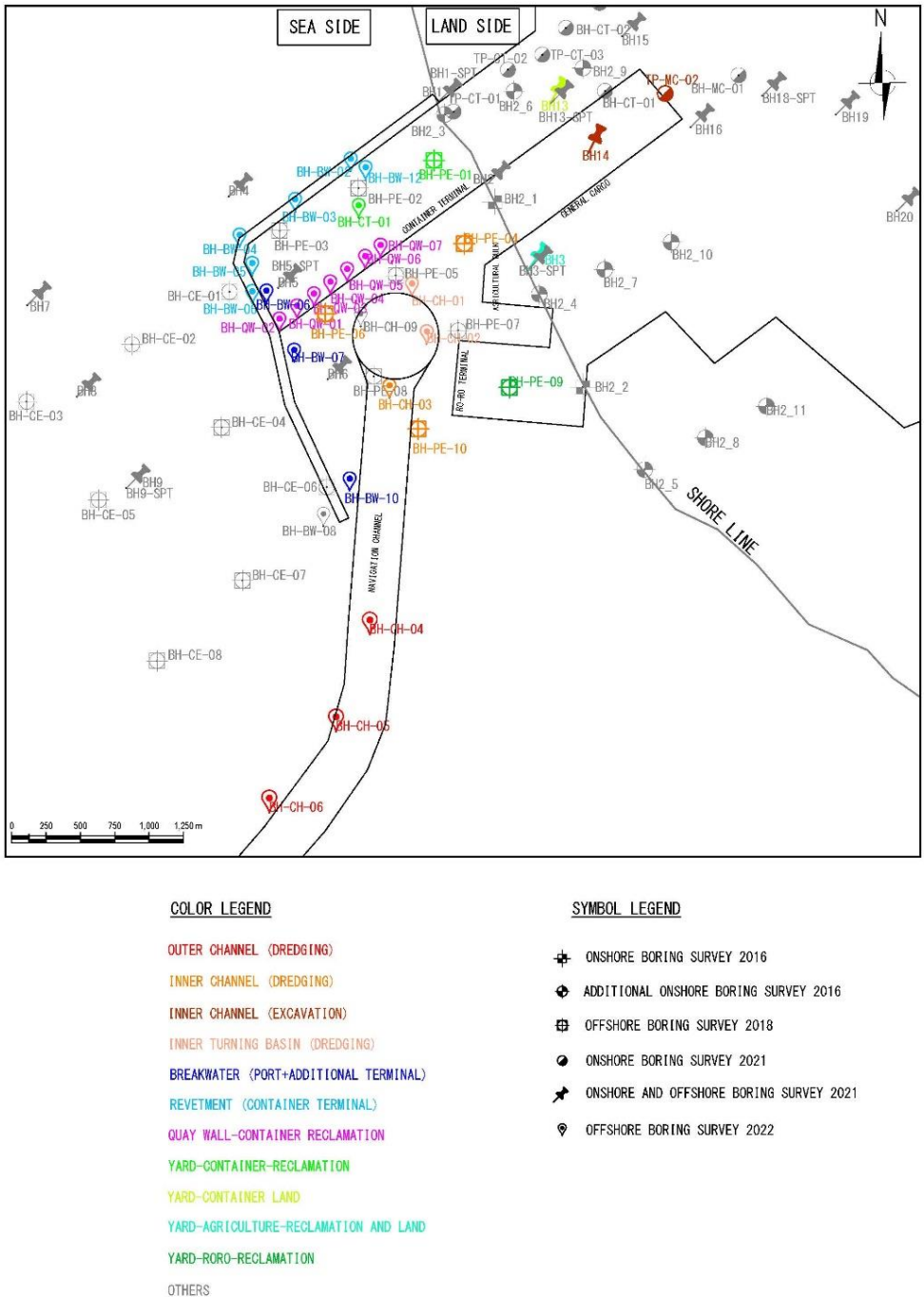


Source: Charting of SHAFA CONSTRUCTIONS WA - PROJECT TOUBAB DIALOW –

Figure 3.208 Bathymetric Survey Counter Map (2017)

c) Geology

The followings boring surveys were carried out in the past.



Source: JPT

Figure 3.209 Locations of Previous Boring Surveys

Table 3.173 Summary of Soil Conditions at Ndayane Port Area by Previous Boring Surveys

Port Facility	Borehole Number	Survey	Major Characteristic
Channel			
Outer Channel (Dredging)	BH-CH-04 to CH-CH 06	Offshore Boring Survey (2022)	The soils at this area are mostly composed of Limestones and Sandstones. UCS found above the plan depths of CH4 and CH5 are 47.3 MPA (with about 50% RQD) and 2.08 MPA respectively (no UCS testing for CH6). Therefore, hard rock dredging type will be needed as Grab Dredger or Cutter Suction Dredger. (Before construction, further investigation such as seismic survey to avoid UCS 50 rock is recommended.)
Inner Channel (Dredging)	BH-CH-03	Offshore Boring Survey (2022)	The soils at this area are mostly composed of Limestones and Sandstones. UCS found around the plan depths of CH-03, PE-10, PE-04 are not more than 29.3 MPA which is acceptable to be dredged with Cutter Suction Dredger. But 60.43 MPA UCS with high RQD was found -16.19 m which is above the plan depth at PE-06 which may need drilling and blasting. (Before construction, further investigation such as seismic survey to avoid UCS 50 rock is recommended.)
	BH-PE-04, BH-PE-06 and BH-PE-10	Offshore Boring Survey (2018)	
Inner Channel (Excavation)	BH14	Onshore and Offshore Boring Survey (2021)	BH14: boring is just until to -14.34 m. Results could not read properly. However, that borehole includes rocks. TP-MC-02: that investigation (maybe digging) is just 4.5 m long which is composed of gravel and limestone. Before the construction, further investigation until the plan depth is recommended.
	TP-MC-02	Onshore Boring Survey (2021)	
Inner Turning Basin (Dredging)	BH-CH-01 and BH-CH-02	Offshore Boring Survey (2022)	The soils at this area are mostly composed of Limestones. UCS found around the plan depths of CH-01 and CH-02 are about 10 MPA (with low RQD) and 45 MPA respectively (with over 55% of RQD). Therefore, hard rock dredging type will be needed as Grab Dredger or Cutter Suction Dredger. (Before construction, further investigation such as seismic survey to avoid UCS 50 rock is recommended.)
Breakwater and Rock Revetment			
Breakwater	BH-BW-06, BH-BW-07 and BH-BW-10	Offshore Boring Survey (2022)	The soils at this area are mostly composed of Limestones. Limestone layer which has RQD 50% and over is found from 1 m to 7 m from seabed level. Therefore, deep excavation for foundation and soil replacement may not be needed for rock type structure.
Revetment	BH-BW-02 to BH-BW-06 and BH-BW-12		The soils at this area are mostly composed of Limestones. Limestone layer which has RQD 50% and over is found from 2 m to 7 m from seabed level except at BW-03 which hold low RQD. Therefore, deep excavation for foundation and soil replacement may not be needed for rock type structure.
Quay Wall			
Container Terminal	BH-QW-01 to BH-QW-07	Offshore Boring Survey (2022)	The soils at this area are mostly composed of Limestones and sandstones. Gravity type maybe favorable than pile type due to rocky seabed. All the rock excavation till to plan depth of berth pocket will be needed. At plan depth which is same as berth pocket hold more than 50% RQD, except at QW-07 which has low RQD at plan depth.

Port Facility	Borehole Number	Survey	Major Characteristic
Yard			
Container - Reclamation Area	BH-CT-01	Offshore Boring Survey (2022)	CT-01: limestone from surface till depth 9m bottom of BH, RQD is very high all over 70%. PE-01: top 1.45m is sand with gravels and below layers are Marls, Limestone etc. So that, soil improvement will not be required.
	BH-PE-01	Offshore Boring Survey (2018)	
Container - Land Area	BH13	Onshore and Offshore Boring Survey (2021)	Top 1.9 m is backfill mixed with clay and below layers are sandstone by -17.94 m. So that, soil improvement will not be required.
General Cargo Terminal – Reclamation & Land Area	BH3	Onshore and Offshore Boring Survey (2021)	Sand, gravel and silty clay are alternatively found with some portions of very fractured sandstone until -21.52 m. So that, excavation for the foundation will not be difficult and further investigation maybe required to determine necessity of soil improvement.
RoRo Terminal - Reclamation Area	BH-PE-09	Offshore Boring Survey (2018)	Top 2 m is sand and clay, and below layers are Sandstone and Limestones. So that, soil improvement will not be required.

UCS=Uniaxial Compressive Strength, RQD=Rock Quality Designation

Source: JPT based on related reports received from PAD

The soil natures found in the previous offshore boring survey in 2022 are summarized as follows:

Table 3.174 Soil Nature with its Qualification of Offshore Boring Survey (2022)

Borehole No.	Soil Nature	Depth (m)	Carbonate (%)	Soil Qualification
BH-CH-01	Green to yellowish marly limestone, moderately fractured	4.00-5.00	29	Highly calcareous soil
BH-CH-02	Grey to blackish limestone, weakly fractured	11.00-12.00	36	Highly calcareous soil
BH-CH-03	Whitish shell limestone with intervals if shell clayey sand	4.00-5.00	5	None calcareous soil
BH-CH-04	Grey to greenish Sandstone limestone	8.00-9.00	48.47	Highly calcareous soil
BH-CH-05	Greenish to Yellowish Marly limestone	3.03-4.00	55.07	Very Highly calcareous soil
BH-CH-06	Yellowish Sandstone	4.50-7.00	44.3	Highly calcareous soil

Source: JPT

Source: JPT based on related reports received from PAD

Figure 3.210 Photos of Samples from the Previous Boring Surveys

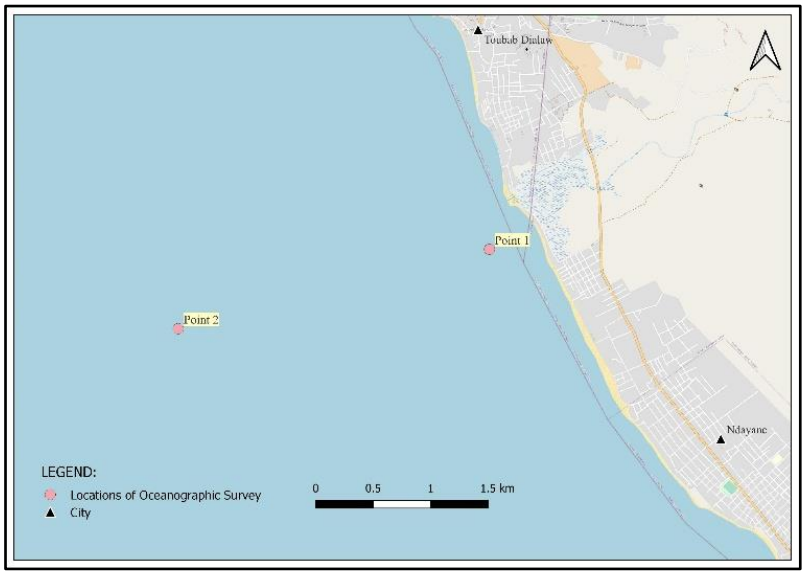
d) Hydrography

This survey was instigated by NortekMed on September 20, 2017 and the Client was DPW. The oceanographic survey includes collection of current profile, directional wave, and water level at two locations (detailed in the figure below) during the course of one year.

Table 3.175 Coordinates of Oceanographic Monitoring Points

	Latitude WFS84	Longitude WGS84	Water Depth (MSL)
Point1	14° 35′ 11.3″ N	17° 08′ 52.6″ N	6 m
Point2	14° 34′ 48.2″ N	17° 10′ 23.1″ N	15 m

Source: ESIA Report (January 2020)



Source: JPT based on QGIS

Figure 3.211 Locations of Oceanographic Survey

Point 1 was monitored with a signature 1000 advanced five-beam current profiling system, deployed on a concrete frame which is positioned on the seabed. Point 2 was monitored with an AWAC 1 MHz, which is a current profiler and a wave directional system in a single unit. A maintenance visit is scheduled every 3 months to retrieve the data, change the battery and clean the sensors.

Period 1: September 20, 2017 to December 13, 2017

Period 2: December 15, 2017 to March 11, 2018

Period 3: March 16, 2018 to June 26, 2018

Period 4: June 28, 2018 to October 3, 2018

According to the reports, the sensors have been recovered in a perfect state and all data have been downloaded for all the above periods.

Current speeds measured at Point1 (closest to the shore) were low and demonstrated little variation between depth and period. Minor changes in current direction were observed between deployments at the surface and mid water column, these changes may reflect local wind and tidal conditions.

The current speeds measured at Point 2 (furthest from the shore) were low most of the time but did increase to a more moderate speed. No significant change in current directions were observed between the 1 and 2 deployment period.

Table 3.176 Measured Current Speeds

Sampling Location	Surface Current Speeds (m/s)	Seabed Current Speed (m/s)	Surface Direction	Seabed Direction
Point 1 – Deployment 1	0.06	0.03	SE-SSE	NNW
Point 1 – Deployment 2	0.05	0.04	S	E
Point 1 Maximum Speeds	0.68	0.41	-	-
Point 2 – Deployment 1	0.18	0.09	SSE	SSE

Source: ESIA Report (January 2020)

The elevations of tides are reasonably consistent and in line with the UK Admiralty tidal predictions for the primary port at Dakar.

The tide is semi-diurnal. The tidal ranges go from 0.35 m during neap tides to 1.7 m during spring tides on the study area.

The fluctuations of water level recorded on Point 1 and Point 2 are very similar and.

Water level with respect to Chart Datum are calculated by subtracting the lowest astronomical tide measured during the period (CD = LAT = 4.967 m for Period 1 and 13.65 m for Period 2).

Table 3.177 UK Admiralty Tidal Levels (m CD)

Tidal Condition	Tidal Level (m CD)
Highest Astronomical Tide	+1.9
Mean High Water Spring	+1.7
Mean High Water Neap	+1.3
Mean Sea Level	+1.1
Mean Low Water Neap	+0.7
Mean Low Water Spring	+0.4
Lowest Astronomical Tide	0.0

Source: ESIA Report (January 2020)

3.14.2 Summary of Field Natural Condition Survey

(1) General

Topographic, bathymetric and seabed sampling surveys (hereinafter called “line survey”), and drone survey are proposed to conduct as new field surveys in order to know the shoreline changes and to supplement the existing results for Multifunction Port of Ndayane. During the first time line survey, JPT planned to conduct Suspended Sediment (SS) Sampling Survey as an additional scope in order to know the concentration of SS.

Table 3.178 New Natural Condition Surveys

Survey	Area	Survey Period
Topographic	12 lines	Two (2) times (one time in the dry season and one time in the rainy season)
Bathymetric	12 lines	
Seabed Sampling	120 points	
UAV [Drone]	Between 12 lines	One (1) time (in the dry season)
Suspended Sediment (SS) Sampling Survey	2 locations	One (1) time (in the rainy season)

Source: JPT

(2) Selection of the Subcontractor for Line Survey

Tender Invitation for Tender Documents for line survey and drone survey were issued in September 2022 to three survey companies Deparentis, AGTS Senegal and TTSM. Tender Proposals of three survey companies were received and evaluated in October 2022. Since the price for conducting the Drone Survey was high and beyond the budget, it was decided to cancel the drone survey.

According to the Tender Evaluation Result, Contract Negotiation Meeting with TTSM (1st rank Tenderer) only for line survey was held in the second week of November 2022. Then, the Contract was signed with TTSM and mobilization was begun in November 30, 2022.

Table 3.179 Tender Process for Line Survey

No.	Description	Date
1.	Tender Issuance	September 22, 2022
2.	Tender Deadline	October 10, 2022
3.	Tender Evaluation	October 25, 2022
4.	Contract Negotiation Meeting	November 11, 2022
5.	Contract Signing	November 30, 2022

Source: JPT

(3) Cancellation of Drone Survey

According to the explanation in the above sub-section, Drone Survey was cancelled to conduct by subcontracting. After that, JPT planned to carry out the drone survey by their own. JPT's plan is to bring the drone(s) to Senegal, and fly the drone and collect the data. Therefore, JPT asked PAD for the necessary permission(s) to fly the drone(s) in Senegal. PAD replied that the permission from ANACIM will be required and it will take more than three months (roughly estimation) to get the approval from ANACIM. Due to the long waiting time for the approval, JPT decided not to carry out the Drone Survey by their own.

(4) Additional Scope of Works

JPT requested TTSM to submit the quotation, methodology, work schedule, and mobilization for Suspended Sediment (SS) Sampling Survey which will be the additional scope. TTSM submitted the requested documents. JPT was reviewing the documents and confirmed to JICA.

The scope of SS Sampling Survey is as follows:

- No. of sampling = 36 samples, analyzing concentration of SS (mg/l)

  2 locations (at offshore area of Ndayane) x 1 seasons (Rainy season) x 3 days during spring tide of a month x 4 times (at flood, high, ebb and low tide) x 3 depth (0.50 m from the surface, mid-depth and 0.50 m above bottom).

Table 3.180 Coordinate of the SS Sampling Point

	Latitude WGS84	Longitude WGS84
SS Sampling Points	14° 34′ 11.3″ N	17° 00′ 23.1″ W
	14° 29′ 27.6″ N	17° 05′ 52.8″ W

Source: JPT

(5) Selection of the Subcontractor for Suspended Sediment (SS) Sampling Survey

JPT called for a Tender on "Suspended Sediment (SS) Sampling Survey" and issued a Tender Invitation on June 27, 2023 to three local survey companies Deparentis, AGTS Senegal and TTSM. The deadline of the Tender Submission was July 5, 2023, and the tender evaluation was done in July 2023.

According to the Tender Evaluation Result, Contract Negotiation Meeting with Deparentis (1st rank Tenderer) was held in the fourth week of July 2023. Then, the Contract was signed with Deparentis and mobilization was begun in August 2023.

Table 3.181 Tender Process for Suspended Sediment (SS) Sampling Survey

No.	Description	Date
1.	Tender Issuance	June 27, 2023
2.	Tender Deadline	July 5, 2023
3.	Tender Evaluation	July 19, 2023
4.	Contract Negotiation Meeting	July 25, 2023
5.	Contract Signing	August 2, 2023

Source: JPT

(6) Topographic and Bathymetric Surveys

a) Equipment

The following equipment were used for Topographic and Bathymetric Surveys in both dry and rainy seasons.

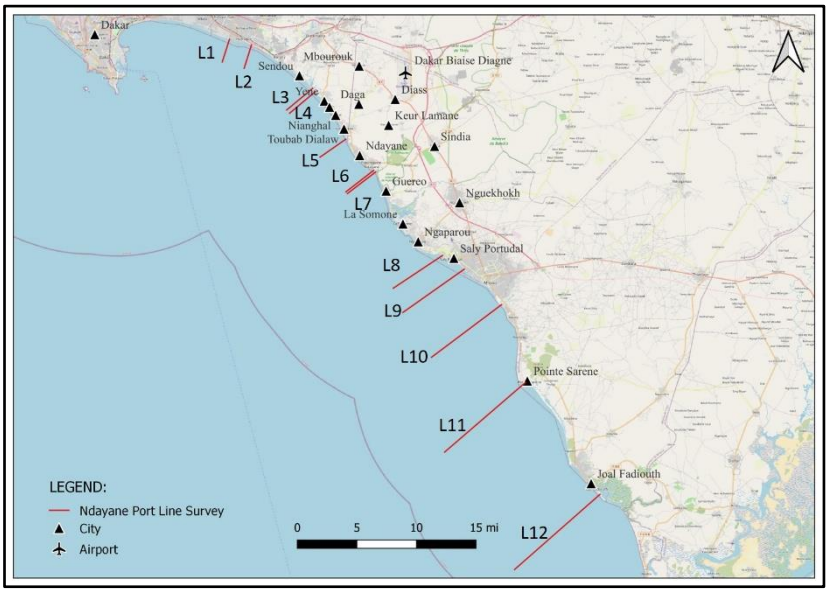
Jet-ski Yamaha for Survey Nautical Support	Chartered Fishing Boat for Safety boat
RTK Base Station (Trimble SPS 855) for Positioning	CEESCOPE BI-FREQUENCY (33/200 KHz) for Echo-sounder
Trimble SPS986 for Topographic Rover	Trimble TSC 7 for Topographic Controller

Source: JPT

Figure 3.212 Equipment Photos for Topographic and Bathymetric Surveys

b) Survey Locations

The survey locations of Topographic and Bathymetric are as follows:



Source: JPT based on QGIS

Figure 3.213 Locations of Line Survey

Table 3.182 Coordinates of Line Survey

	Beginning (Beachside)		End (Seaside)		Length (km)
	X	Y	X	Y	
Line 1	253207	1628165	252204	1625052	3.27
Line 2	256160	16273742	255145	1624138	3.36
Line 3	264352	1621272	260828	168317	4.48
Line 4	264709	1620823	261208	1617859	4.49
Line 5	268751	1614200	265251	1611752	4.27
Line 6	272460	1609855	268701	1606921	4.77
Line 7	272723	1609627	268892	1606677	4.83
Line 8	281633	1598005	274956	1593517	8
Line 9	284538	1596076	276220	1590181	10
Line 10	289533	1591143	280040	1583926	12
Line 11	292647	1580343	281706	1570830	14.5
Line 12	302595	1564799	290992	1554526	15.5

Source: JPT

c) Base Station

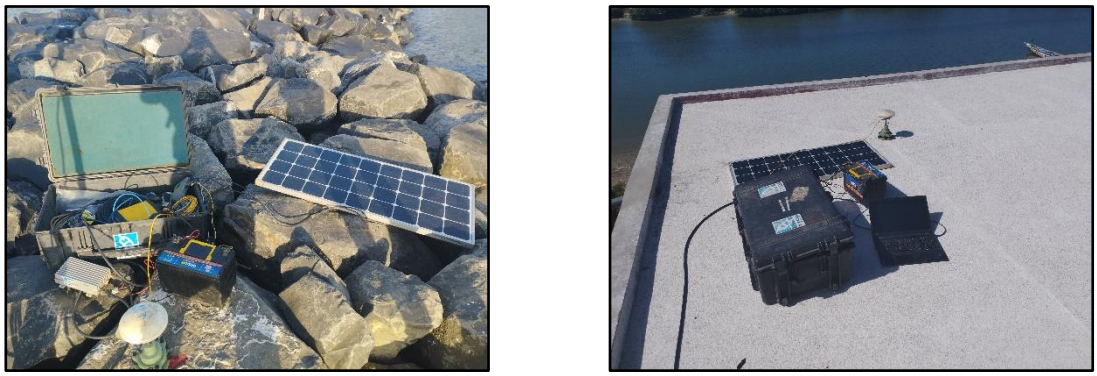
The survey was performed with a base station providing Real-Time Kinematic (RTK) correction in order to get positioning and depth as accurate possible as well as tide compensation.

In case of loss of RTK reception, the quality of the data will be recovered during the Kinematic Post-processing (PPK). The base stations were mobilized at five locations during the first-time survey in the dry season:

Table 3.183 Geodetic References Coordinates for the first time survey in the dry season

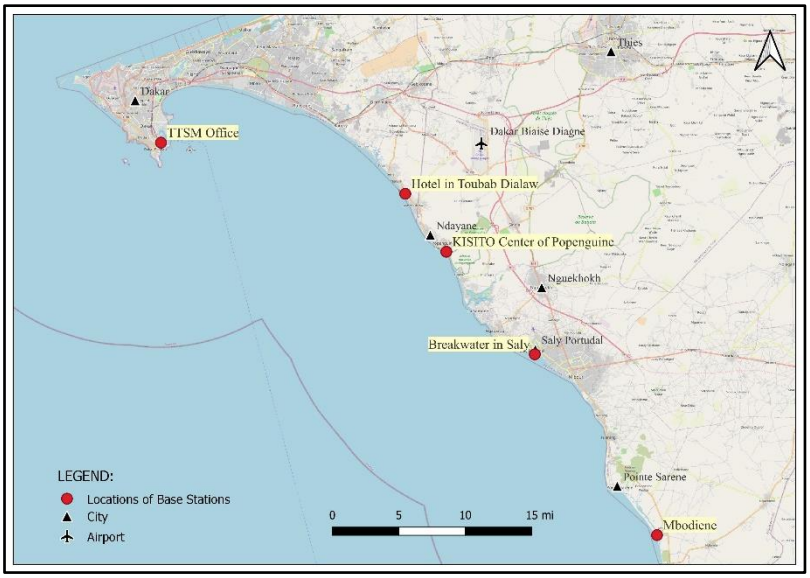
System: WGS84, Ellipsoid: WGS84, ITRF 2014/ Epoch 2022.92					
City	**Location**	**Line**	**Latitude (N)**	**Longitude (W)**	**Ellipsoidal Height (m)**
Dakar	TTSM Office	Bathy and Topo: L1 and L2	14° 40′ 29.03239″	17° 25′ 53.20719″	37.300
Toubab Dialow	Hotel in Toubab Dialow	Bathy and Topo: L3, L4 and L5	14° 37′ 2.67102″	17° 09′ 26.45913″	54.665
Popenguine	KISITO Center of Popenguine	Bathy and Topo: L6 and L7	14° 33′ 8.52093″	17° 06′ 40.77319″	41.172
Saly	Breakwater in Saly	Bathy and Topo: L8, L9 and L10	14° 26′ 14.25163″	17° 00′ 43.49125″	32.256
Mbodiene	Mbodiene	Bathy and Topo: L11 and L12	14° 14′ 4.15612″	16° 52′ 29.74765″	38.497

Source: Draft Report by TTSM for Topographic and Bathymetric Surveys (December 2022)



Source: JPT

Figure 3.214 Base Station in Saly (Left) and Mbodiene (Right)



Source: JPT based on QGIS

Figure 3.215 Location of Base Stations

The following locations were used to set and transfer the base stations during the second time survey in the rainy season:

Table 3.184 Geodetic References Coordinates for the second time survey in the rainy season

System: WGS84, Ellipsoid: WGS84, ITRF 2014/ Epoch 2022.92					
City	**Location**	**Line**	**Latitude (N)**	**Longitude (W)**	**Ellipsoidal Height (m)**
Dakar	TTSM Office	Bathy and Topo: L1 and L2	14° 40′ 29.03219″	17° 25′ 53.20649″	37.370
Toubab Dialow	Accomodation	Bathy and Topo: L3, L4 and L5	14° 36′ 40.72662″	17° 09′ 13.79706″	50.892
Popenguine	KISITO Center	Bathy and Topo: L6 and L7	14° 33′ 8.19297″	17° 06′ 40.84082″	41.140
Saly	Breakwater	Bathy and Topo: L8, L9 and L10	14° 26′ 14.25240″	17° 00′ 43.49031″	32.270
Mbodiene	Mbodiene	Bathy and Topo: L11 and L12	14° 14′ 3.82195″	16° 52′ 29.60361″	38.394

Source: Final Report by TTSM for Topographic and Bathymetric Surveys (October 2023)

Source: JPT

Figure 3.216 Base Station in Toubab Dialow (Left) and Saly (Right)

d) Methodology of Topographic Survey

The topographic survey was carried out with a Trimble TSC7 field notebook and a Trimble TSC7 mobile.

During acquisition, position corrections were obtained in real time (RTK) with the use of a reference station which ensures centimetric precision in planimetry and altimetry. The raw topography data are the ellipsoidal heights associated with WGS84.

After post-processing, the final data will be attached to Mean Sea Level (MSL), the same reference as the bathymetric data.

The survey geodetics points were created by the team following the survey plan after a long time of recording.

Topographical and bathymetric surveys have been started with the creation of an initial point. The acquired data corrected once the final coordinates obtained after post-processing of the raw data of the base.

The data logging was started before any survey and stopped at the end of the day.

e) Methodology of Bathymetric Survey

The single-beam bathymetric was led with Ceescope hi-frequency echo-sounder (33/200 KHz) with centimeter precision. It was mobilized on a jet-ski to do the survey.

It was installed using a pole behind of the jet ski. The GPS antenna was installed above the pole to minimize the offsets between the sounder and the antenna.

Acquisition and processing are done with Hypack hydrographic software and Qinertia or equivalent software for bathymetric and positioning processing.

During the survey, a Trimble SPS855 reference station was installed. It continuously transmitted real-time differential and kinematic corrections (RTK) under maritime standardized formats CMR+ or RTCM. The survey was carried out on each line to ensure quality assessment and quality check of the data in postprocessing.

To correct the raw data, tide corrections was applied in real time with the RTK and PPK in post processing to achieve millimetric precision of sounding vertical and horizontal Datum.

Simultaneously, sound speed measurements were carried out using an AML SVP fitted with sensors every day before, during and after the measurements well distributed in space and time apart from the integrated SVS that is compensating the ray tracing of the SBES in real time in the thermocline strata of the water column. After acquisition, the raw data will be post-processed. The soundings will be referenced relative to Mean Sea Level (MSL).

During the survey, the jet-ski speed was maintained around 3 knots. As per the HSE plan, a safety boat accompanied the jet ski during bathymetry operations to intervene in case of emergency.

The survey line was improved in high tide period for nearshore.

f) Positioning

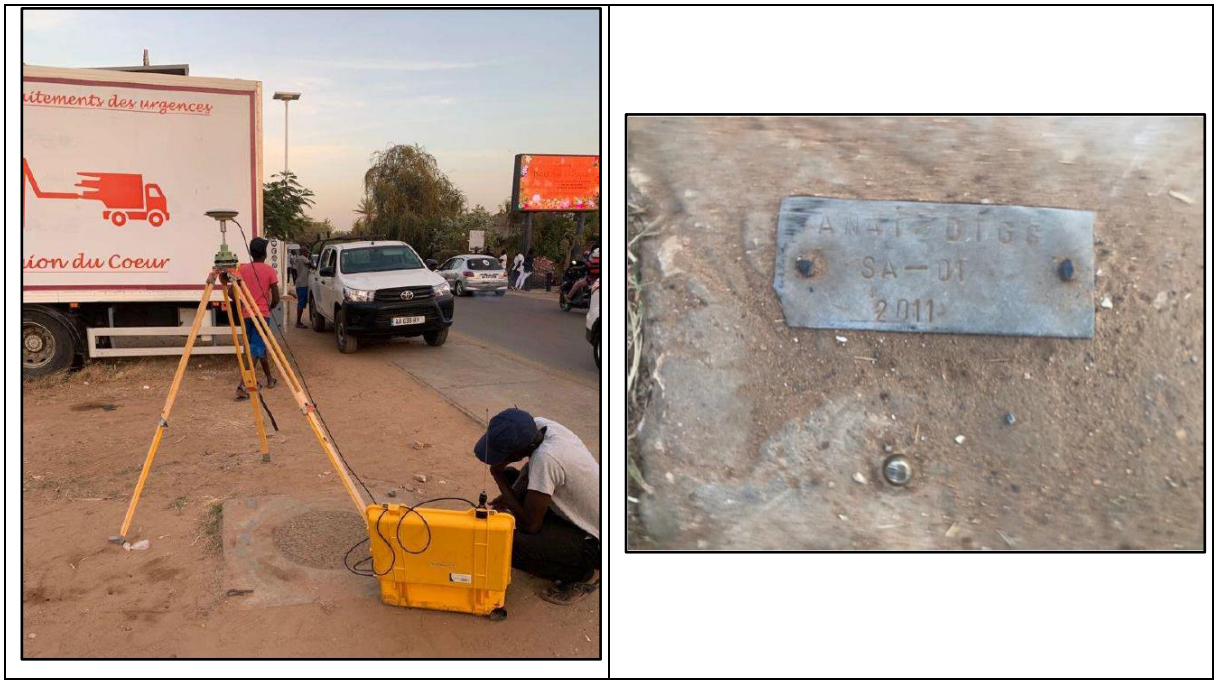
The following three control points are carried out during the first and second time surveys in dry and rainy seasons.

Saly in front of Lamantin Beach Resort & Spa (SA-01 geodetic point)

Mbour High School (MB-03 geodetic point)

Joal (V039 geodetic point)

In Saly, the first geodetic point considered (SA-03), was located on a roundabout but seems to have been destroyed during its rehabilitation. Therefore, a control check was done on geodetic point SA-01.



Source: JPT

Figure 3.217 Control Check on SA-01 (in the dry season)

Source: JPT

Figure 3.218 Control Check on MB-03 (in the dry season)

Source: JPT

Figure 3.219 Control Check on V039 (in the dry season)

Source: JPT

Figure 3.220 Control Check on MB-03 (left) and V039 (right)
(in the rainy season)

g) Survey Period

Topographic survey was carried out in December 2022 for the first time in the dry season and in September 2023 for the second time in the rainy season.

The actual schedule of topographic and bathymetric surveys is summarized in the table below.

Table 3.185 Actual Schedule of First Time Survey

Date	Activity
November 30, 2022	Mobilization from TTSM, Bathy on L1 and L2
December 1, 2022	Topo on L1 and L2, Transit to Toubab Dialow
December 2, 2022	Bathy and Topo on L3, L4 and L5, Bathy on L6 and L7
December 3, 2022	Base station transfers to Popenguine, Topo on L6 and L7, Transit to Saly
December 4, 2022	Topo on L8, L9 and L10, Bathy on L9
December 5, 2022	Bathy on L8 and L10, Geodetic control point in Saly
December 6, 2022	Transit to Mbodiene, Topo and Bathy on L11 and L12
December 7, 2022	Geodetic control point in Joal Fadiout, Transit to TTSM
December 8, 2022	Demobilization, Start post-processing and report

Source: Draft Report by TTSM for Topographic and Bathymetric Surveys (December 2022)

Table 3.186 Actual Schedule of Second Time Survey

Date	Activity
September 5, 2023	Mobilization from TTSM, Topo on L1 and L2
September 14, 2023	Bathy on L1 and L2, Transit to Toubab Dialow
September 15, 2023	Bathy and Topo on L8, L9 and L10, Measuring Control Point SA-01
September 16, 2023	Bathy on L8, L9 and L10, Transit from Saly to Mbodiene
September 17, 2023	Topo and Bathy on L11 and L12, Transit from Joal to Mbodiene
September 18, 2023	Bathy on L3, L4, L5, L6 and L7, Topo on L3 and L4
September 19, 2023	Topo on L5, L6 and L7

Source: Final Report by TTSM for Topographic and Bathymetric Surveys (October 2023)

(7) Seabed Sampling Survey

a) Equipment

This core sampler is used for marine, aquatic, or nonaquatic soil sampling.

This comes complete with SS core tube (20” L x 2” D), “tee” handle with valve, two plastic liner tubes with caps, three eggshell core catchers, two Lexan nose pieces, and carrying case.

Source: JPT

Figure 3.221 Sampling Kit: WILDCO 2424-B20

The original plan is to use the sampling kit in the above figure. Later, the Subcontractor proposed that the survey cannot be accomplished with the sampling kit (WILDCO) because of the type of soil in Ndayane area. If the sampling kit (WILDCO) is used for the survey, the divers will have to take the sample 4 to 5 times to get enough sample mass to carry out the analysis. This will make the divers to come back each time to the surface, which is inefficient and dangerous.

Therefore, the Subcontractor proposed to change the equipment from WILDCO to vibrocorer which can carry out both moisture content analysis and granulometry on the samples. The sampling tube (vibrocorer) is 130 cm long.

Source: JPT

Figure 3.222 Vibrocorer

b) Survey Locations

Based on the result of bathymetric survey, the following locations were chosen for the seabed sampling survey and delivered to TTSM via mail in December 2022.

Table 3.187 Locations of Seabed Sampling Survey

UTM 28N		1	2	3	4	5	6	7
L1	X	253202.75	253196.10	253190.00	253183.00	253174.67	253169.00	253157.08
	Y	1628150.15	1628130.22	1628110.00	1628085.00	1628069.03	1628053.21	1628016.64
L3	X	264321.13	264263.20	264232.00	264200.00	264180.00	264155.70	264131.06
	Y	1621247.17	1621198.44	1621173.00	1621144.00	1621130.00	1621104.22	1621083.16
L5 (Dry/Rainy)	X	268750.67	268729.58	268706.31	268676.05	268588.77	268403.40	268354.84
	Y	1614199.42	1614185.77	1614169.52	1614148.89	1614071.19	1613947.51	1613916.87
L7	X	272714.67	272708.09	272698.30	272683.23	272634.55	272626.96	272580.18
	Y	1609624.20	1609617.59	1609609.24	1609597.03	1609563.86	1609555.24	1609513.96
L8' (Dry/Rainy)	X	273869.00	274267.00	274592.00	274758.00	275154.00	275825.00	276404.00
	Y	1607215.00	1606007.00	1604828.00	1603708.00	1603070.00	1602594.00	1601437.00
L10	X	289526.15	289514.27	289505.00	289435.61	289327.74	288961.85	288472.78
	Y	1591129.07	1591120.78	1591113.00	1591064.59	1590982.08	1590704.13	1590333.02

UTM 28N		8	9	10	11	12	13	14	15
L1	X	253127.74	253052.81	252954.98	252871.91	252828.98	252790.04	252747.73	252724.05
	Y	1627919.72	1627679.73	1627384.84	1627121.73	1626990.18	1626867.42	1626735.30	1626662.32
L3	X	264079.24	264021.67	263868.43	263641.47	263437.07	263364.30	262981.50	262576.42
	Y	1621033.13	1620988.51	1620856.36	1620668.61	1620502.10	1620433.63	1620115.04	1619776.20
L5 (Dry/Rainy)	X	268282.00	268233.15	268176.02	267871.31	267724.62	267513.54	267297.42	266835.38
	Y	1613859.70	1613831.35	1613799.16	1613579.55	1613474.71	1613328.21	1613177.68	1612852.10
L7	X	272559.18	272461.42	272139.51	271708.75	271481.20	271017.31	270632.82	270239.19
	Y	1609504.12	1609429.14	1609186.21	1608847.33	1608675.25	1608316.62	1608019.48	1607716.50
L8' (Dry/Rainy)	X	274645.00	274480.00	274187.00	273876.00	273491.00	273016.00	272503.00	271991.00
	Y	1603603.00	1603487.00	1603271.00	1603029.00	1602708.00	1602338.00	1601972.00	1601569.00
L10	X	287989.06	287526.74	286743.26	284237.48	282981.86	282397.68	281629.94	281392.87
	Y	1589966.48	1589616.48	1589025.85	1587129.18	1586179.90	1585736.22	1585155.17	1584974.02

Source: JPT

c) Methodology

The following steps will be carried out for each sampling:

- Position the boat at sampling point location and anchor the boat.
- Lower the vibrocorer into the water.
- Switch ON the vibrating head's power supply.
- Lift the vibrocorer outside the water and secured on the pontoon. The handlers are careful not to spill the contents (the contents are blocked by a core catcher).
- The contents of the corer are poured into a plastic bag that is then labeled with a sample number identifying the bathy line and point position.

As soon as the team returns to shore, the samples are stored in a dry area.

d) Survey Period

The first time Seabed Sampling Survey was carried out in the dry season in January 2023. The second time was conducted in the rainy season in July 2023.

(8) Suspended Sediment (SS) Sampling Survey

a) Equipment

Water samples are taken using a Niskin type bottle.

The Niskin bottle works by keeping both ends open, so water can enter the bottle. The bottle is tripped as it rapidly closes and traps water for samples to be taken. The water collected in this way is brought back on board and packaged in sampling bottles.

Source: JPT

Figure 3.223 NISKIN bottle

b) Survey Locations

The Survey was carried out at the locations described below:

- Location 1 (WGS84)
  Latitude : 14° 34′ 11.3″ N
  Longitude : 17° 10′ 23.1″ W
- Location 2 (WGS84)
  Latitude : 14° 29′ 27.6″ N
  Longitude : 17° 05′ 52.8″ W

c) Methodology

The surveyors will travel to the site from the Port of Dakar by sea, using the survey boat, perfectly suitable for this kind of coastal work.

The distance is approximatively 30 km (location 1) and 40 km (location 2). Location between the two locations is approximatively 12 km.

On board of the survey boat, the surveyors will be equipped with a 5 liters NISKIN sampling bottle,

and the other equipment (such as radar, GPS, echo-sounder, etc.). They will have containers for storing the samples, which will be supplied by the CERES LOCUTOX laboratory, responsible for analyzing suspended solids. Samples volume will be 250 ml minimum.

To guarantee the mission, they will have a spare NISKIN bottle on board.

The water samples are packaged in bottles supplied by the analysis laboratory, identified by a numbered label. A photo with GPS location will be taken on site at the time of bottling.

Each label corresponds to a date and time, a location and the depth of the sample.

The laboratory results report will then be attached to this number in order to determine the

statistical distribution of suspended sediment material.

The water samples will be transported to the laboratory at the end of the field campaign.

Analyses to determine the concentration of suspended sediments will be carried out by the CERES LOCUTOX laboratory in accordance with standard ISO 11923.

The process is membrane filtration on a glass filter, drying at 105°C and weighing of the residue retained. The result obtained is reported in mg/l.

d) Survey Period

The Survey was conducted on August 31, 2023, and on September 1 & 2, 2023.

3.14.3 Result of Field Natural Condition Survey

(1) Result of Topographic and Bathymetric Survey

The following depths are summarized and extracted by referring to the map of topographic and bathymetric surveys.

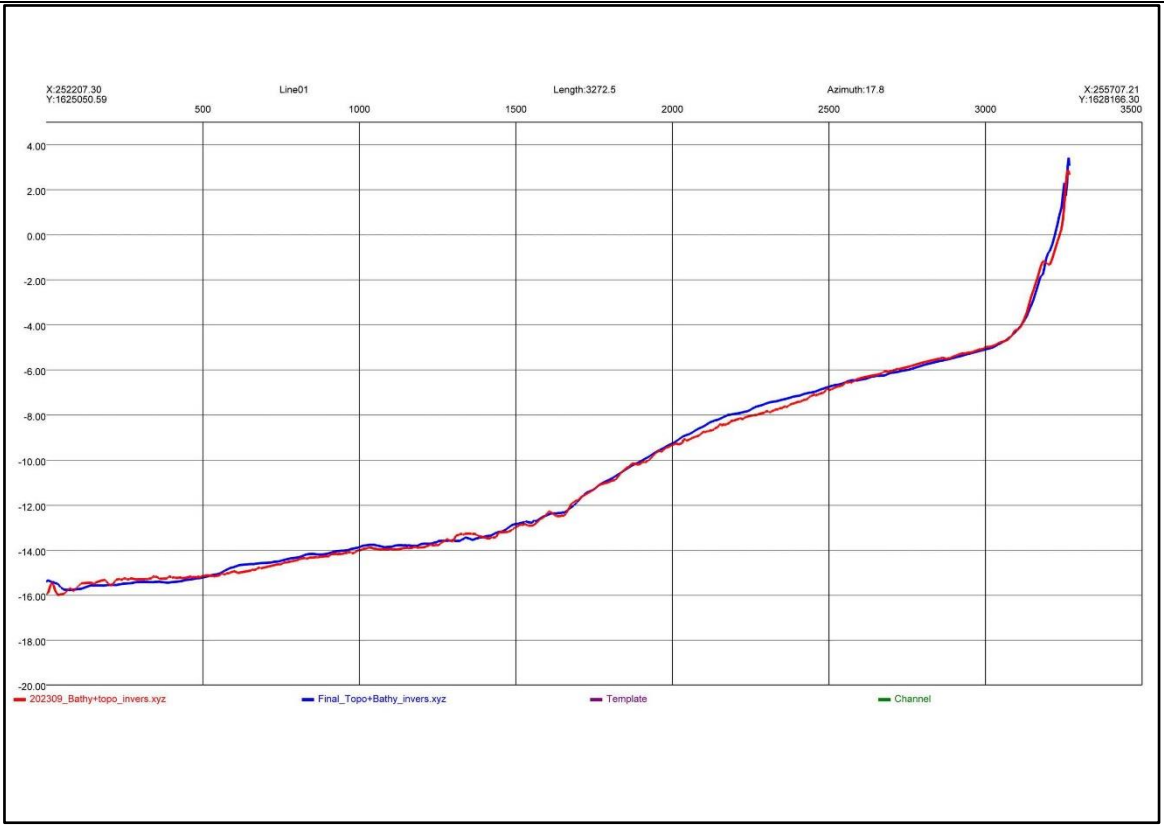
Table 3.188 Depths of Beginning Point and Ending Point for Each Line

	Beginning (Beachside)				End (Seaside)			
	X	Y	Depth (m) (MSL)		X	Y	Depth (m) (MSL)	
			Dry	Rainy			Dry	Rainy
Line 1	253207	1628165	1.6	1.2	252204	1625052	-15.3	-15.5
Line 2	256160	1627342	2.3	1.6	255145	1624138	-17.1	-19.4
Line 3	264352	1621272	0.5	-	260828	168317	-18.6	-18.5
Line 4	264709	1620823	1.6	-	261208	1617859	-19.2	-19.0
Line 5	268751	1614200	1.9	2.6	265251	1611752	-18.2	-18.8
Line 6	272460	1609855	6.4	4.8	268701	1606921	-16.0	-16.6
Line 7	272723	1609627	2.2	2.0	268892	1606677	-16.4	-16.8
Line 8	281633	1598005	2.6	2.3	274956	1593517	-12.9	-13.6
Line 9	284538	1596076	2.1	2.2	276220	1590181	-11.7	-12.4
Line 10	289533	1591143	2.8	-	280040	1583926	-11.4	-12.2
Line 11	292647	1580343	1.3	0.9	281706	1570830	-12.8	-12.6
Line 12	302595	1564799	2.3	2.2	290992	1554526	-12.4	-12.5

Source: JPT

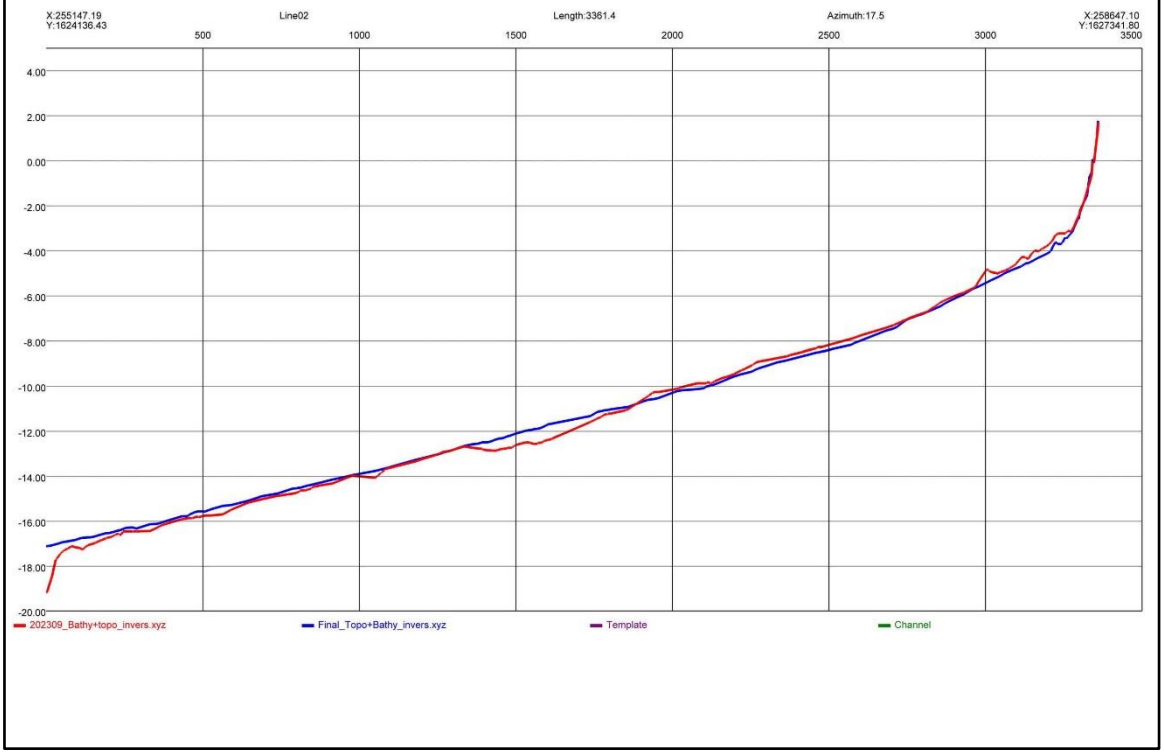
The followings are the comparison of the profiles of bathymetric survey in dry (which is in blue color)

and rainy seasons (which is in red color), and the observations. Since Topography and Bathymetric surveys are conducted two times in a year, seasonal seabed changes in the onshore–offshore is observed. According to the results and comparison of the profiles, it is found that the depths in the rainy season are deeper than those in the dry season especially on the Line 5, 6, 7, 8, 9, & 10.



Profile of Line 1

Local fishing boat mooring on the line.
Local fishing boat and fishnet on the beach.
Uneven terrain on the beach.
Gentle slope into the sea.
Sandy bottom.
Rocky area north of the line 600m from the beach.

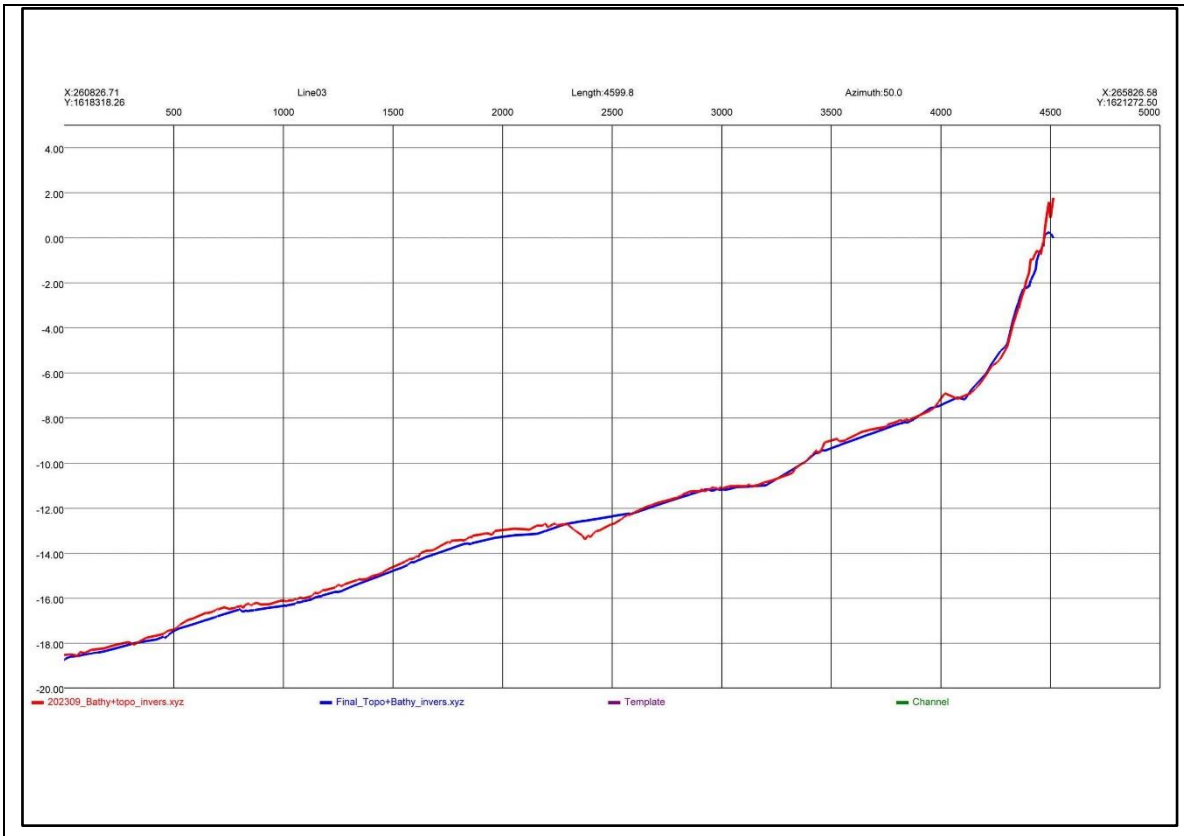


Profile of Line 2

Steep slope.

Pile of rocks on the beach.

Elementary school at the top of the beach.

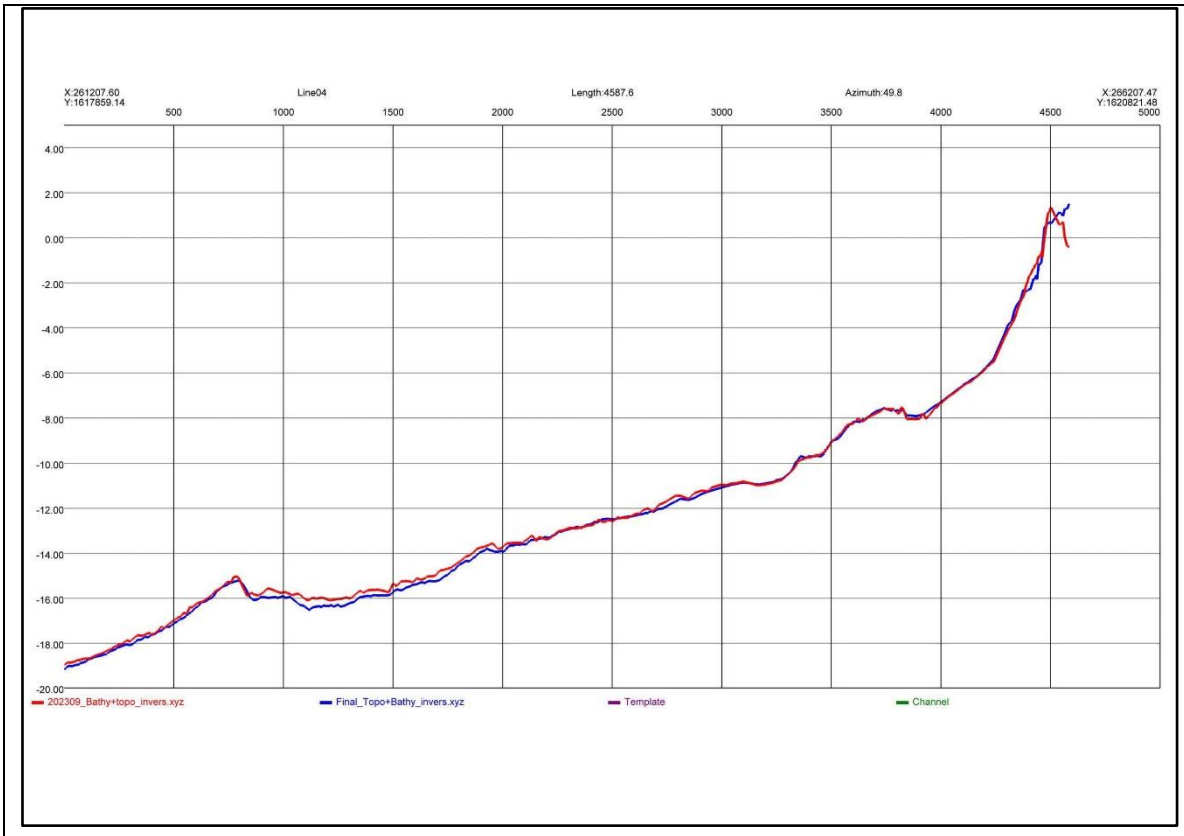


Profile of Line 3

Rocky shore.

Gentle slope.

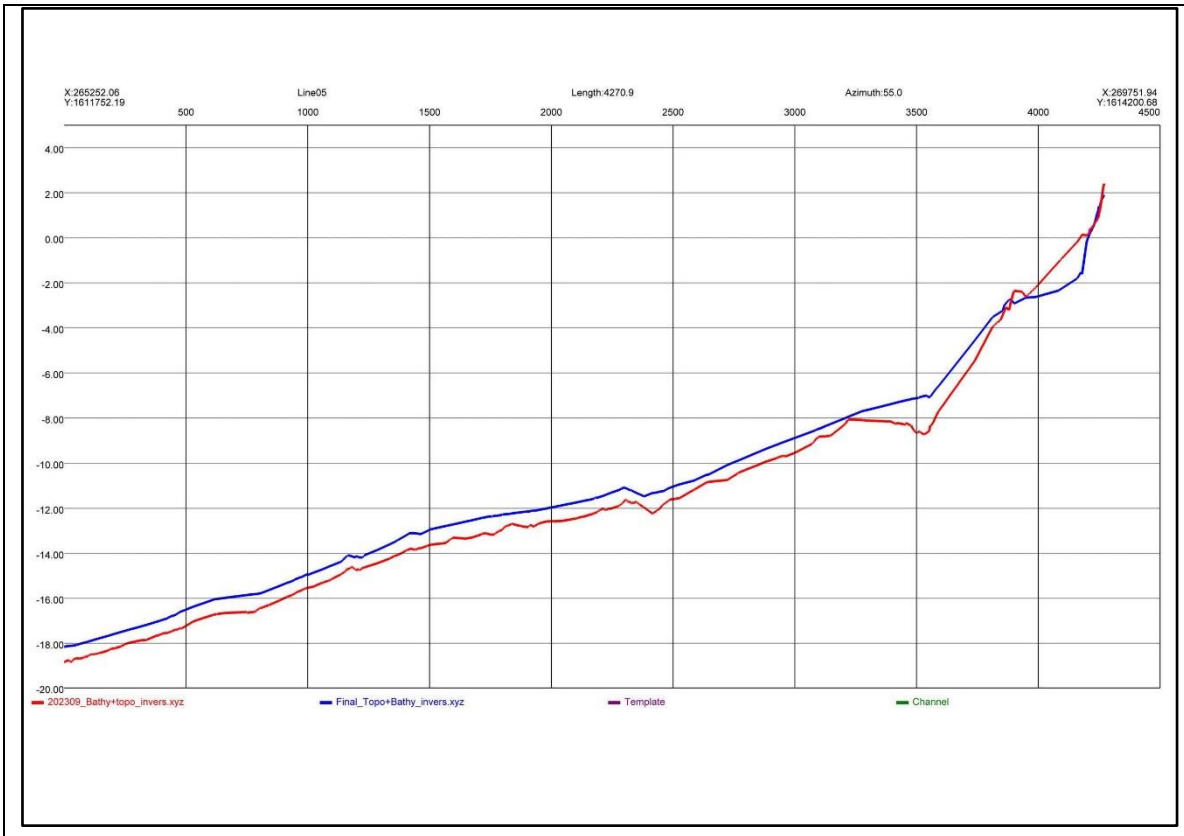
Presence of shell on the bottom.



Profile of Line 4

Presence of rocks before the beach area.

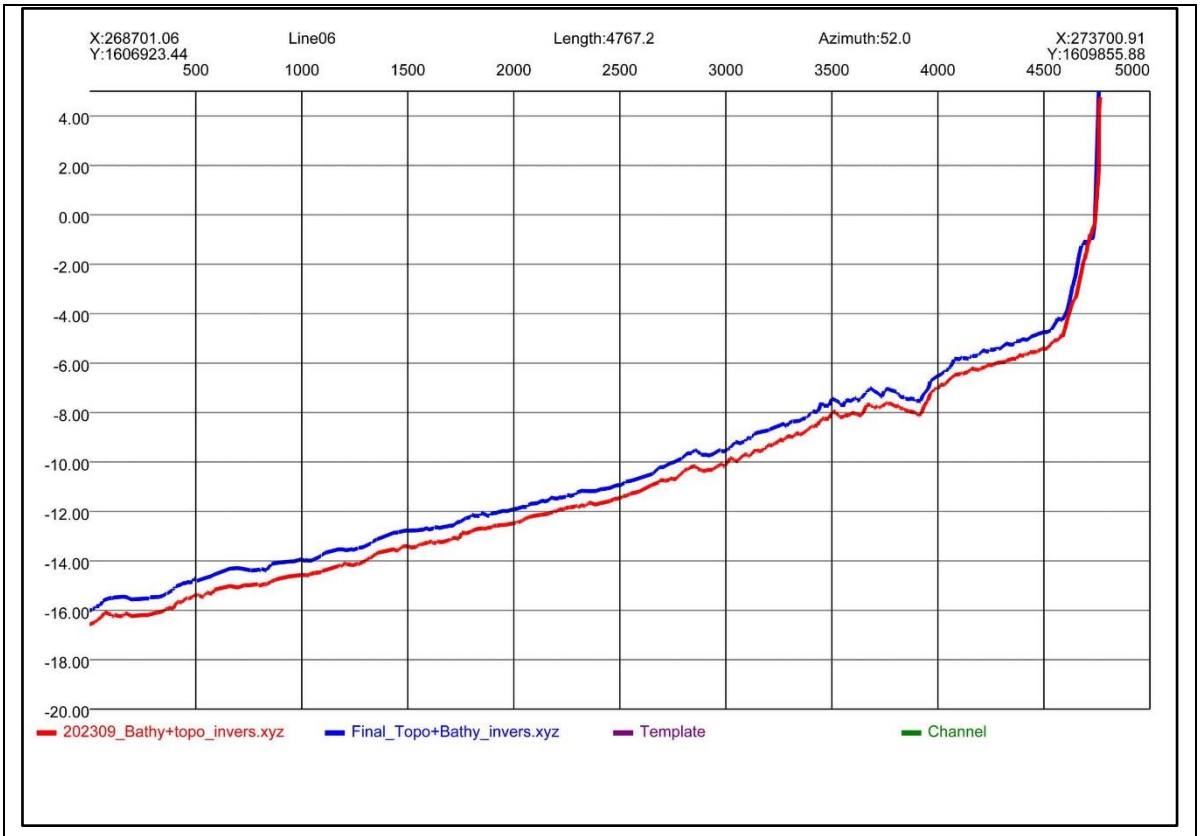
Mooring area for local fishing boat.



Profile of Line 5

Gentle slope.

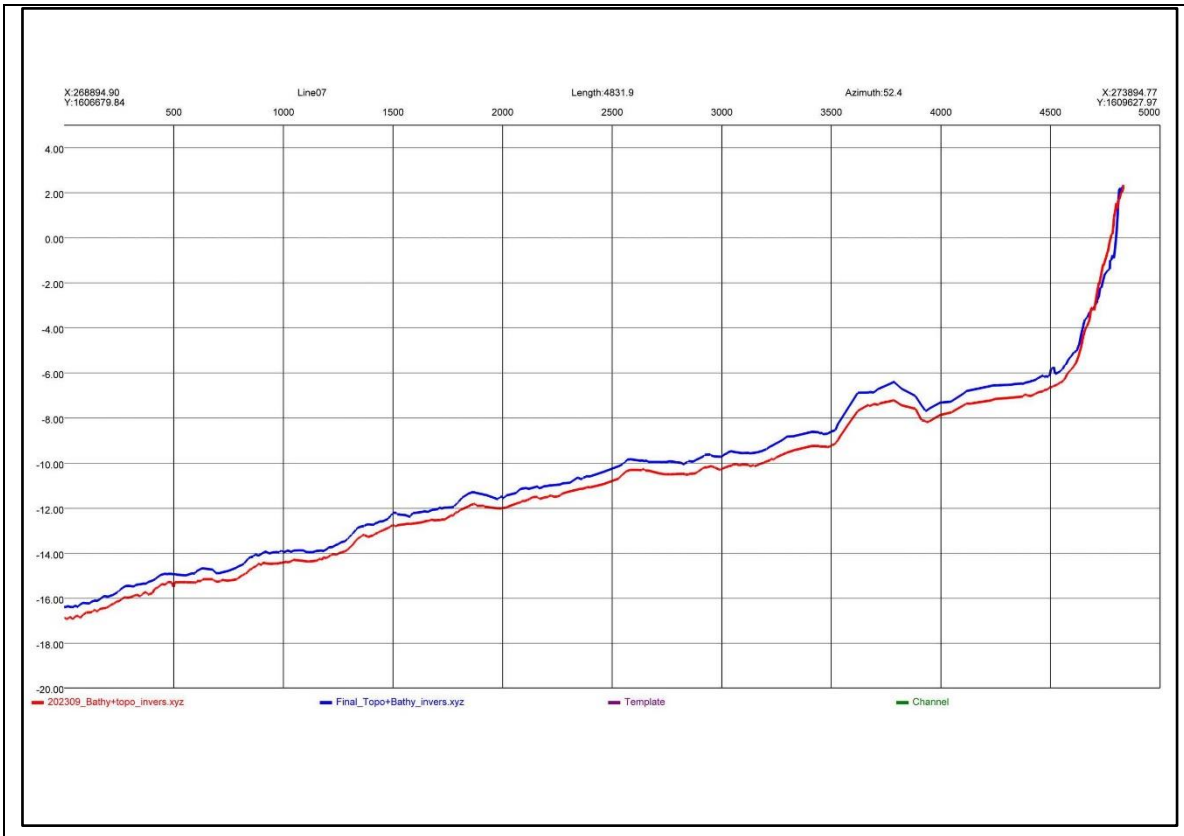
Sandbar and rocks around the line.



Profile of Line 6

Very rough terrain.

Uninhabited House in front of the line (land side).

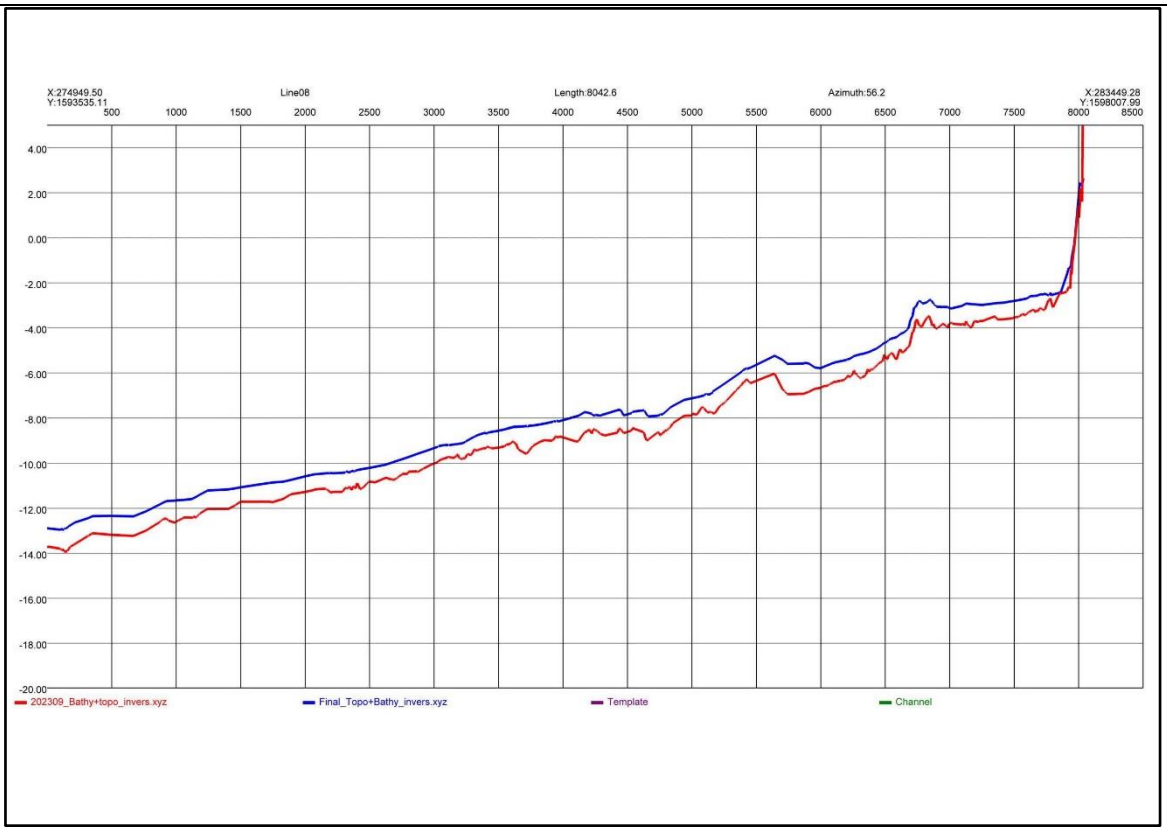


Profile of Line 7

Sandy beach

Steep slope

Line is located in front of a hotel

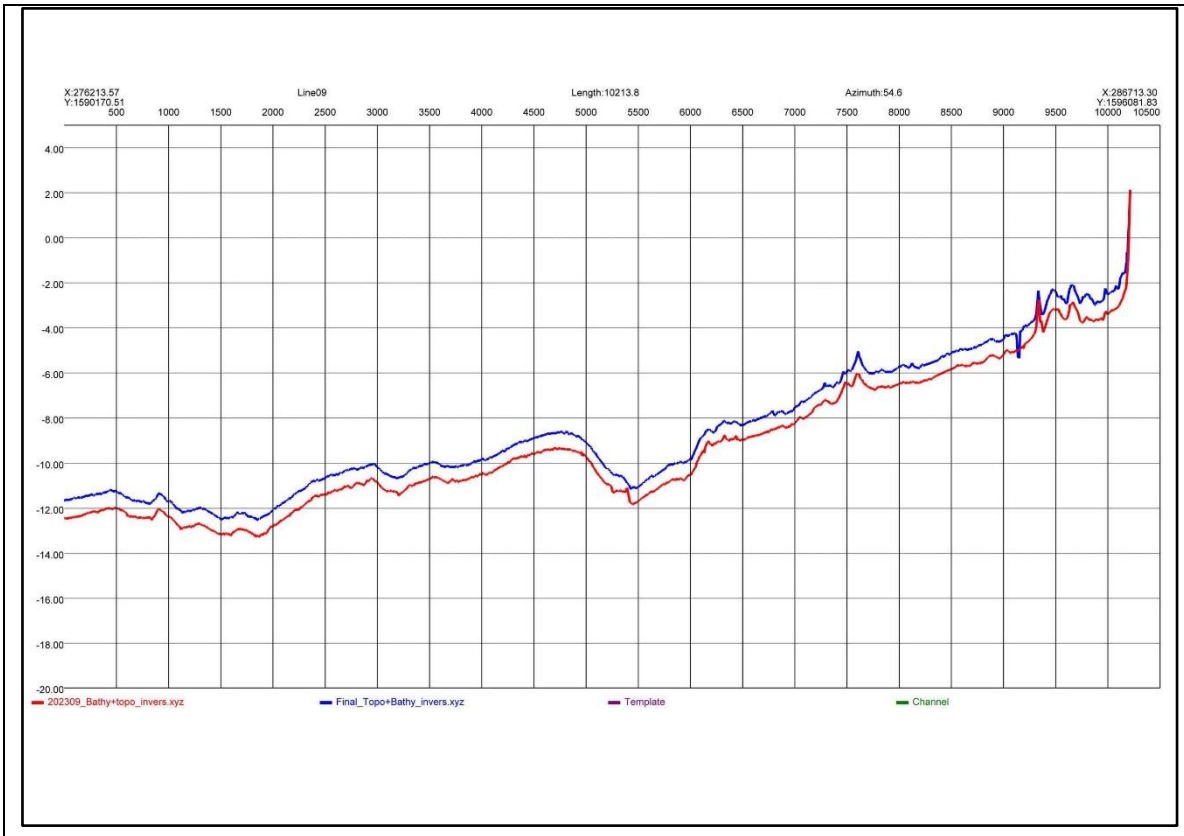


Profile of Line 8

Steep slope.

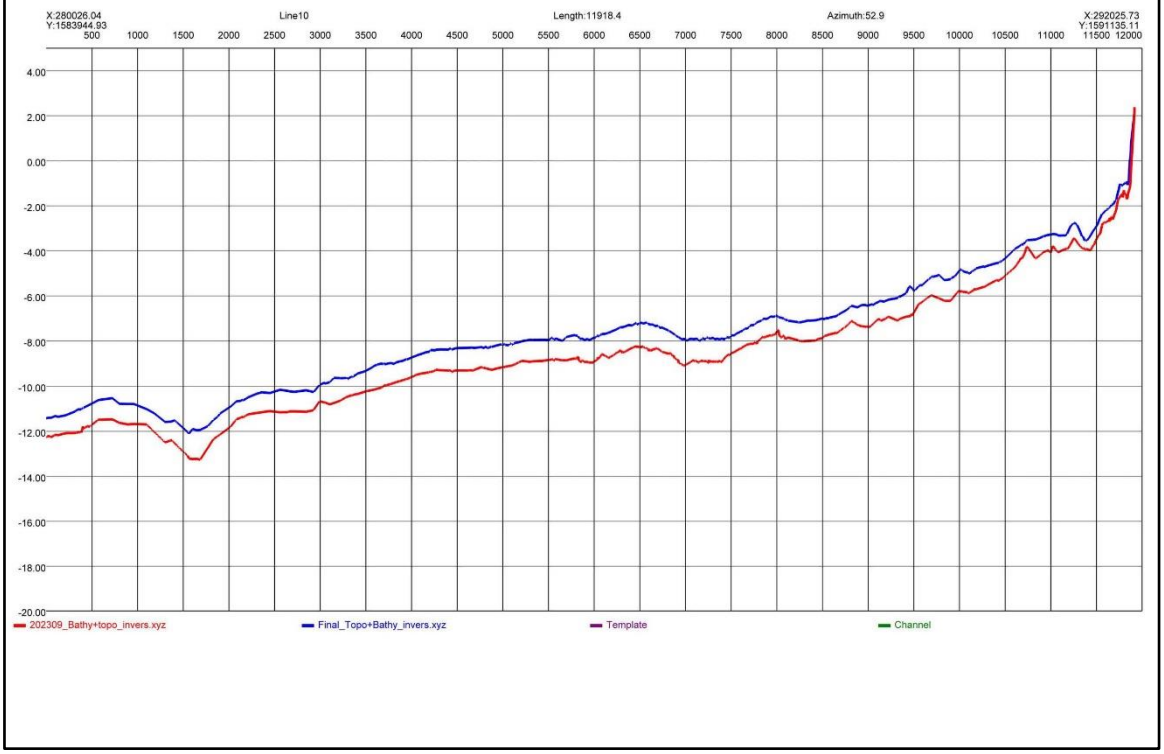
Very sandy beach.

Presence of algae in the water.



Profile of Line 9

Rock protection at the edge of the beach.

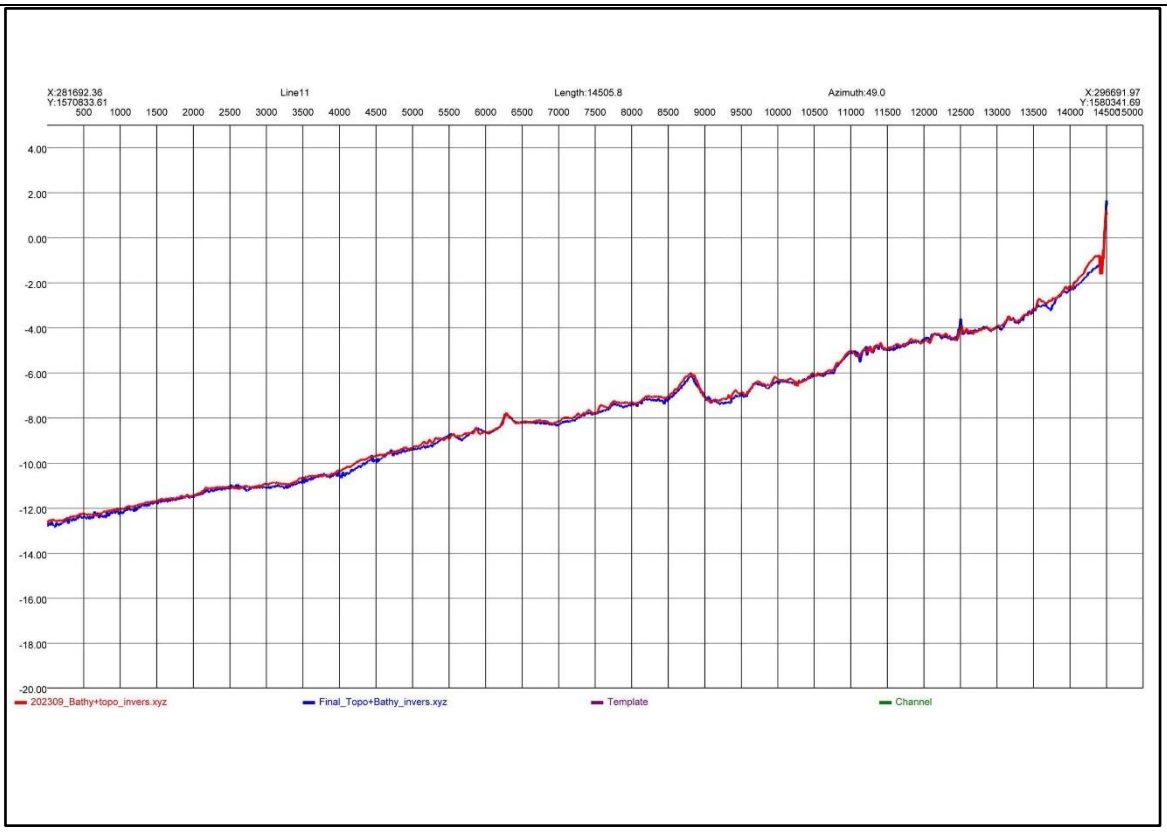


Profile of Line 10

Steep slope.

Sandy beach.

In front of the industrial zone of Ouarang.

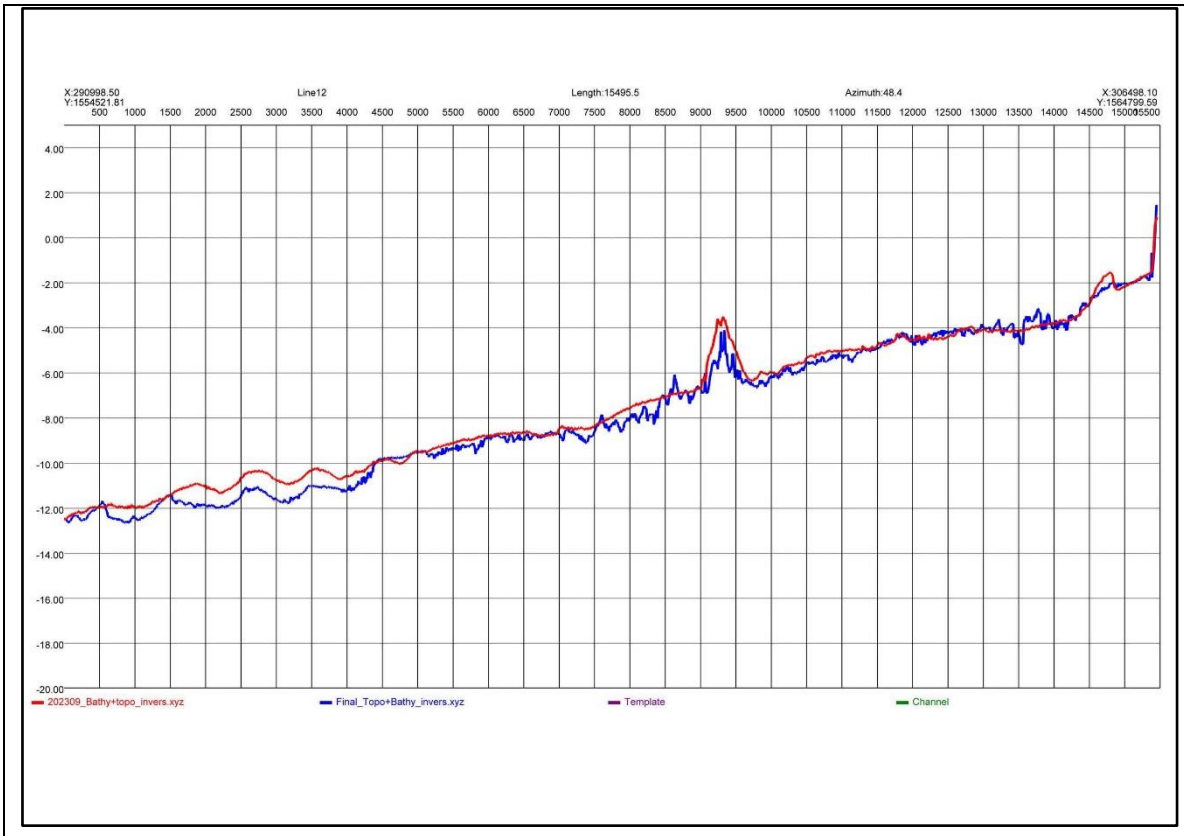


Profile of Line 11

Steep slope

Sandy beach

The line crosses a local fishing boats mooring area



Profile of Line 12

Steep slope.

Sandy beach.

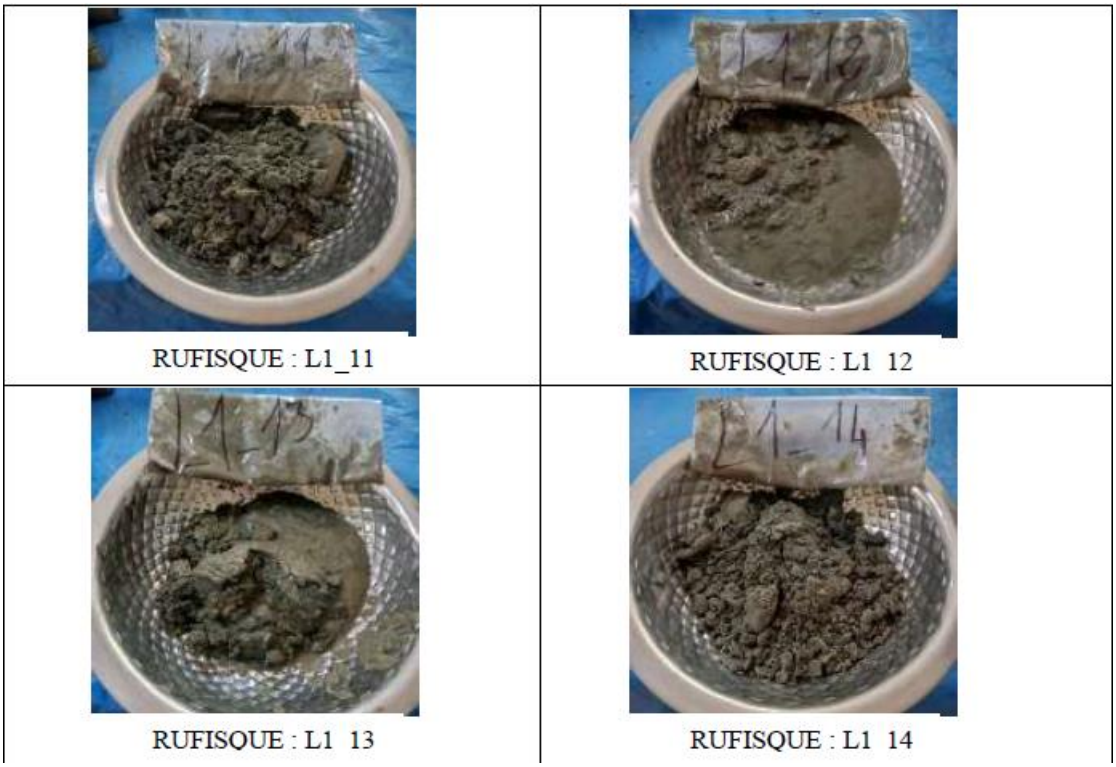
The line crosses a local fishing boats mooring area.

Source: JPT

Figure 3.224 Bathy Profiles from Line 1 to 12

(2) Result of Seabed Sampling Survey

The visual description of the samples shows sandy, silt and in places clayey soils.



Source: JPT

Figure 3.225 Photo of Seabed Samples

The following table gives the main results for the laboratory analysis.

Table 3.189 Laboratory Analysis

Line	Soil Nature	Water Content (%)	Particle Size D_{max} (mm)
L1_7	Fine shell sand with organic debris	33.3	10
L3_12	Low gravelly shell sand with organic debris	34.3	31.5
L5_14	Gravelly shell sand (dry season)	33.7	31.5
	Shelly sand (rainy season)	27.3	31.5
L7_14	Gravelly shell sand	34.4	25
L8'_12	Fine gravelly shell sand (dry season)	41.7	20
	Shell sand + Organic Sand (rainy season)	35.3	20
L10_13	Fine gravelly shell sand	33.9	31.5

Source: JPT

(3) Result of Suspended Sediment (SS) Sampling Survey

The following table shows the result of each sample, and tested by glass filtration method. Comparing the two locations, it is found that the concentration of suspended sediments at location 2 are higher

than location 1 because of some factors such as location, human activities, river runoff, etc.

Table 3.190 Result of SS Sampling Survey

Tide	Position	Result of Day 1 (August 31, 2023) (mg/L)		Result of Day 2 (September 1, 2023) (mg/L)		Result of Day 3 (September 2, 2023) (mg/L)	
		Location 1	Location 2	Location 1	Location 2	Location 1	Location 2
High	0.5 m above bottom	114.72	121.67	138.00	188.58	187.20	161.41
	Mid-depth	113.07	178.75	164.00	243.81	120.59	105.41
	0.5 m from surface	143.83	68.33	161.88	184.23	94.38	82.47
Ebb	0.5 m above bottom	132.92	173.56	139.86	173.00	113.21	168.39
	Mid-depth	98.00	43.75	164.51	142.85	114.15	269.46
	0.5 m from surface	264.56	55.66	106.04	118.98	117.87	72.10
Low	0.5 m above bottom	94.91	72.00	42.08	104.57	165.71	175.92
	Mid-depth	191.11	149.06	138.67	64.50	98.33	146.97
	0.5 m from surface	90.48	93.80	122.86	53.88	94.34	56.73
Flood	0.5 m above bottom	115.67	115.44	127.57	74.15	131.38	73.55
	Mid-depth	67.32	131.25	176.25	147.50	143.39	154.23
	0.5 m from surface	90.72	80.98	104.83	57.28	101.00	30.30

Source: JPT

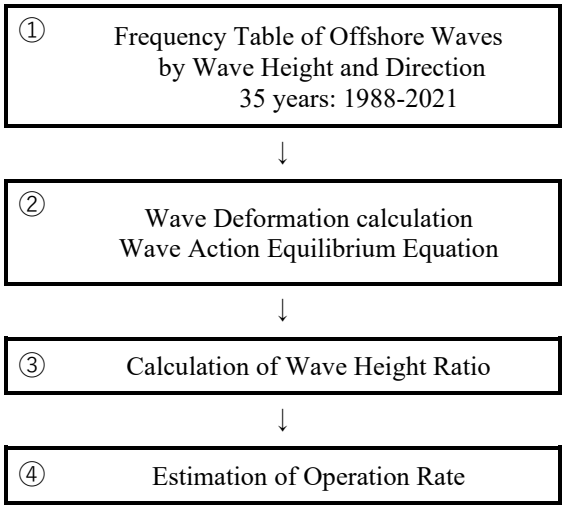
3.15 Calmness Analysis for Waves

3.15.1 General of Calmness Analysis

The Project site is located at 14.34°N, 17.08°W in the Republic of Senegal. The northern part of the country is divided into Desert climate, the central part into Semi-arid climate with many dry seasons, and the southern part into Tropical savanna climate. In general, the climate is divided into a rainy season from June to September, and a dry season from October to May.

The waves that come to the Project site are mainly wind waves and swells caused by the seasonally changing climate like monsoon.

Calmness in the Port is evaluated by the operation rate of the quay. The operation rate is calculated by following procedure.



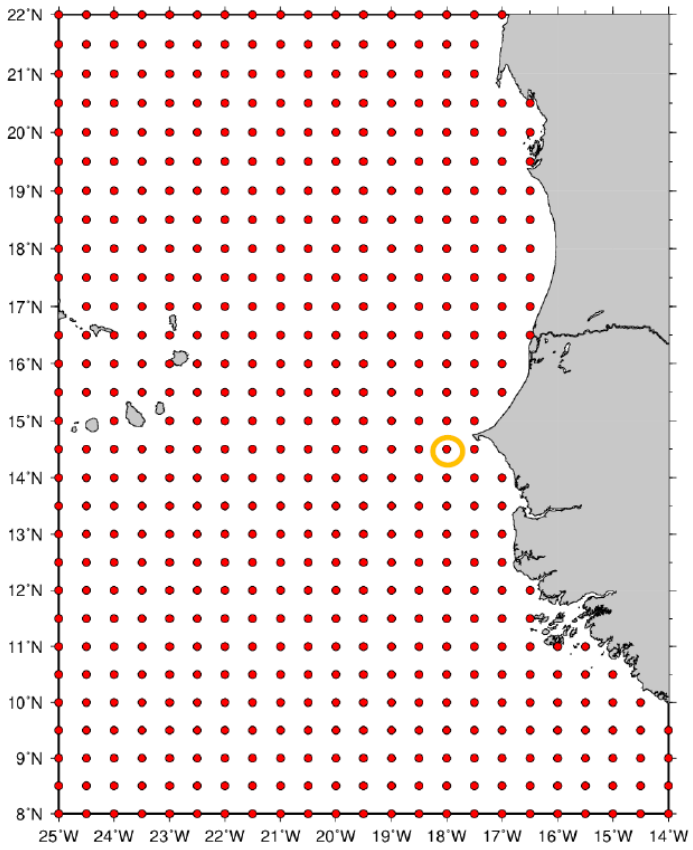
Source: JPT

Figure 3.226 Calculation Flow of Operation Rate

In this study, a frequency table of offshore waves by wave height and direction is created based on the wave estimation data at offshore area of Senegal. A wave deformation calculation is performed through the point of offshore wave and the points where the operation rate is calculated (in front of the quay wall), using the wave data for each wave direction as input data. The deformation calculation uses a model which can handle refraction, diffraction, shallow-water deformation, and wave breaking. The ratio of the offshore wave height to the wave height at the location where the operation rate is calculated (herein after called as "wave height ratio") is obtained for each wave direction by wave deformation calculations mentioned above. The offshore wave frequency table is converted to a frequency table of wave heights at the points where the operation rate is calculated by the wave height ratio, and the wave height occurrence rate below the target wave height required for cargo handling operation (herein after called as limit wave height for operation) is calculated. The wave height occurrence rate calculated above can be the operation rate at each point. In this study, the values used for middle and large size vessels in the Japanese Port Design Standard are quoted, and the critical wave height for operation is set at 0.50 m and the target utilization rate at the quay is set at 97.5%.

3.15.2 Offshore Wave Frequency Table

Long-term offshore wave data is necessary to study the operation rate. However, since long-term offshore wave observation data is not available around the Project site, wave estimation data is used as the offshore wave data in this survey. The wave estimation data used in this survey is a database of global areas with a latitude-longitude grid of 0.5 degrees (about 50 km) and hourly intervals, estimated using the "JWA3G", a third-generation global wave estimation model developed by Japan Weather Association (JWA), with ocean winds from the National Centers for Environmental Prediction (NCEP) objective analysis values as input conditions. The JWA3G model is an analytical model based on the spectral method and is the latest practical model for estimating irregular waves. The offshore wave data used in this study is acquired at the sea near Dakar as shown in Figure 3.227 (14.5°N, 18.0°W).



Source: JPT based on JWA

Figure 3.227 Location of Offshore Wave Data

The most recent 35 years of data (from 1988 to 2022) are used for the offshore wave date using the calmness analysis. The wave estimation data records wave heights, wave directions, and periods of offshore waves at one-hour intervals. Table 3.191 shows the frequency table of offshore waves at offshore area of Senegal by wave height and direction, which is prepared based on this offshore wave data.

Table 3.191 Offshore Wave Frequency Table at the Offshore area of Senegal

1988-2022	SSW	SW	WSW	W	WNW	NW	NNW	N	NNE	NE	ENE	E	ESE	SE	SSE	S	Sum	Total
0.0 ~ 0.5 m																		
0.5 ~ 1.0 m	23 (0.0)	44 (0.0)	14 (0.0)	70 (0.0)	26 (0.0)	48 (0.0)	91 (0.0)	16 (0.0)	14 (0.0)	3 (0.0)	5 (0.0)	9 (0.0)	5 (0.0)	1 (0.0)		9 (0.0)	378 (0.1)	378 (0.1)
1.0 ~ 1.5 m	5205 (1.7)	6873 (2.2)	5071 (1.7)	5010 (1.6)	6387 (2.1)	11092 (3.6)	17361 (5.7)	4902 (1.6)	952 (0.3)	200 (0.1)	56 (0.0)	9 (0.0)	13 (0.0)	12 (0.0)	33 (0.0)	772 (0.3)	63948 (20.9)	64326 (21.0)
1.5 ~ 2.0 m	7334 (2.4)	7051 (2.3)	5371 (1.8)	5502 (1.8)	8209 (2.7)	19920 (6.5)	55972 (18.3)	24765 (8.1)	2254 (0.7)	429 (0.1)	47 (0.0)	27 (0.0)	20 (0.0)	10 (0.0)	97 (0.0)	1113 (0.4)	138121 (45.1)	202447 (66.1)
2.0 ~ 2.5 m	1586 (0.5)	1226 (0.4)	709 (0.2)	791 (0.3)	1285 (0.4)	7076 (2.3)	35101 (11.5)	22942 (7.5)	1621 (0.5)	298 (0.1)	26 (0.0)	11 (0.0)	10 (0.0)	8 (0.0)	44 (0.0)	306 (0.1)	73040 (23.9)	275487 (90.0)
2.5 ~ 3.0 m	208 (0.1)	68 (0.0)	80 (0.0)	38 (0.0)	145 (0.0)	1524 (0.5)	11988 (3.9)	8827 (2.9)	476 (0.2)	42 (0.0)					16 (0.0)	86 (0.0)	23498 (7.7)	298985 (97.7)
3.0 ~ 3.5 m	15 (0.0)	23 (0.0)	35 (0.0)	10 (0.0)	3 (0.0)	296 (0.1)	2945 (1.0)	1922 (0.6)	122 (0.0)							11 (0.0)	5382 (1.8)	304367 (99.4)
3.5 ~ 4.0 m	2 (0.0)	7 (0.0)	4 (0.0)			57 (0.0)	739 (0.2)	488 (0.2)	2 (0.0)							4 (0.0)	1303 (0.4)	305670 (99.9)
4.0 ~ 4.5 m							175 (0.1)	119 (0.0)									294 (0.1)	305964 (100.0)
4.5 ~ 5.0 m							66 (0.0)	27 (0.0)									93 (0.0)	306057 (100.0)
5.0 ~ 5.5 m							11 (0.0)	4 (0.0)									15 (0.0)	306072 (100.0)
Sum	14373 (4.7)	15292 (5.0)	11284 (3.7)	11421 (3.7)	16055 (5.2)	40013 (13.1)	124449 (40.7)	64012 (20.9)	5441 (1.8)	972 (0.3)	134 (0.0)	56 (0.0)	48 (0.0)	31 (0.0)	190 (0.1)	2301 (0.8)	306072 (100.0)	

Source: JPT based on JWA

Table 3.191 shows that offshore waves from NW to N directions are dominant at the offshore of Senegal, and that extreme waves with wave height of 4.0 m or higher are found in NNW and N direction. Since the mouth of Ndayane Port faces to the southwest, offshore waves affecting the operation rate of the Ndayane port site are considered to be limited from SW to W directions.

In the following, the offshore waves are organized with a focus on seasonal changes. The seasonal classification of wave direction is divided into two periods: the period of a rainy season from June to September and the period of a dry season from October to May. Table 3.192 and Table 3.193 show the frequency tables of offshore waves by wave height and direction from October to May and June to September, respectively. Figure 3.228 also shows the Wave Rose for each period. Especially in the October-May period, 90% of the offshore waves are north to northwest direction.

Table 3.192 Offshore Wave Frequency Table at the Offshore Area of Senegal

(Dry Season: October to May)

1988-2022	SSW	SW	WSW	W	WNW	NW	NNW	N	NNE	NE	ENE	E	ESE	SE	SSE	S	Sum	Total
0.0 ～ 0.5 m																		
0.5 ～ 1.0 m	6 (0.0)	24 (0.0)	2 (0.0)	8 (0.0)	5 (0.0)	8 (0.0)	55 (0.0)	16 (0.0)	14 (0.0)	3 (0.0)	5 (0.0)	9 (0.0)	5 (0.0)	1 (0.0)		9 (0.0)	170 (0.1)	170 (0.1)
1.0 ～ 1.5 m	235 (0.1)	404 (0.2)	387 (0.2)	682 (0.3)	1670 (0.8)	4257 (2.1)	9902 (4.9)	4593 (2.3)	950 (0.5)	198 (0.1)	54 (0.0)	7 (0.0)	8 (0.0)	2 (0.0)	1 (0.0)	125 (0.1)	23475 (11.5)	23645 (11.6)
1.5 ～ 2.0 m	360 (0.2)	635 (0.3)	708 (0.3)	1029 (0.5)	2355 (1.2)	10595 (5.2)	43550 (21.4)	23802 (11.7)	2236 (1.1)	427 (0.2)	45 (0.0)	21 (0.0)	18 (0.0)	2 (0.0)	6 (0.0)	71 (0.0)	85860 (42.2)	109505 (53.8)
2.0 ～ 2.5 m	119 (0.1)	153 (0.1)	105 (0.1)	205 (0.1)	573 (0.3)	5653 (2.8)	32844 (16.1)	22671 (11.1)	1620 (0.8)	295 (0.1)	24 (0.0)	6 (0.0)	8 (0.0)			4 (0.0)	64280 (31.6)	173785 (85.4)
2.5 ～ 3.0 m	17 (0.0)	10 (0.0)	23 (0.0)	23 (0.0)	112 (0.1)	1455 (0.7)	11807 (5.8)	8790 (4.3)	476 (0.2)	42 (0.0)						4 (0.0)	22759 (11.2)	196544 (96.5)
3.0 ～ 3.5 m	7 (0.0)	19 (0.0)	30 (0.0)	7 (0.0)		293 (0.1)	2944 (1.4)	1922 (0.9)	122 (0.1)							7 (0.0)	5351 (2.6)	201895 (99.2)
3.5 ～ 4.0 m		5 (0.0)	4 (0.0)			57 (0.0)	739 (0.4)	488 (0.2)	2 (0.0)								1295 (0.6)	203190 (99.8)
4.0 ～ 4.5 m							175 (0.1)	119 (0.1)									294 (0.1)	203484 (99.9)
4.5 ～ 5.0 m							66 (0.0)	27 (0.0)									93 (0.0)	203577 (100.0)
5.0 ～ 5.5 m							11 (0.0)	4 (0.0)									15 (0.0)	203592 (100.0)
Sum	744 (0.4)	1250 (0.6)	1259 (0.6)	1954 (1.0)	4715 (2.3)	22318 (11.0)	102093 (50.1)	62432 (30.7)	5420 (2.7)	965 (0.5)	128 (0.1)	43 (0.0)	39 (0.0)	5 (0.0)	7 (0.0)	220 (0.1)	203592 (100.0)	

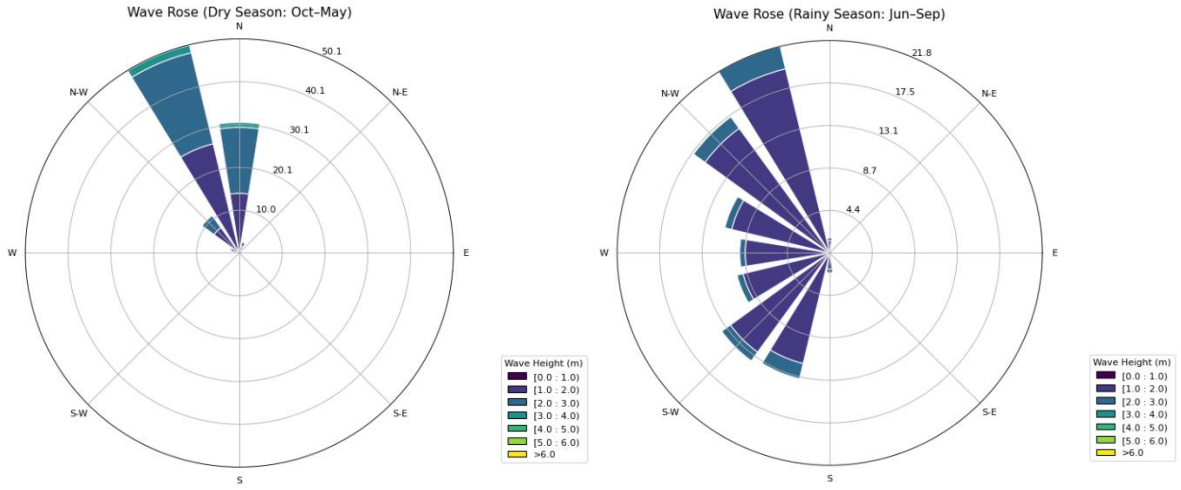
Source: JPT based on JWA

Table 3.193 Offshore Wave Frequency Table at the Offshore Area of Senegal

(Rainy Season: June to September)

1988-2022	SSW	SW	WSW	W	WNW	NW	NNW	N	NNE	NE	ENE	E	ESE	SE	SSE	S	Sum	Total
0.0 ～ 0.5 m																		
0.5 ～ 1.0 m	17 (0.0)	20 (0.0)	12 (0.0)	62 (0.1)	21 (0.0)	40 (0.0)	36 (0.0)										208 (0.2)	208 (0.2)
1.0 ～ 1.5 m	4970 (4.8)	6469 (6.3)	4684 (4.6)	4328 (4.2)	4717 (4.6)	6835 (6.7)	7459 (7.3)	309 (0.3)	2 (0.0)	2 (0.0)	2 (0.0)	2 (0.0)	5 (0.0)	10 (0.0)	32 (0.0)	647 (0.6)	40473 (39.5)	40681 (39.7)
1.5 ～ 2.0 m	6974 (6.8)	6416 (6.3)	4663 (4.6)	4473 (4.4)	5854 (5.7)	9325 (9.1)	12422 (12.1)	963 (0.9)	18 (0.0)	2 (0.0)	2 (0.0)	6 (0.0)	2 (0.0)	8 (0.0)	91 (0.1)	1042 (1.0)	52261 (51.0)	92942 (90.7)
2.0 ～ 2.5 m	1467 (1.4)	1073 (1.0)	604 (0.6)	586 (0.6)	712 (0.7)	1423 (1.4)	2257 (2.2)	271 (0.3)	1 (0.0)	3 (0.0)	2 (0.0)	5 (0.0)	2 (0.0)	8 (0.0)	44 (0.0)	302 (0.3)	8760 (8.5)	101702 (99.2)
2.5 ～ 3.0 m	191 (0.2)	58 (0.1)	57 (0.1)	15 (0.0)	33 (0.0)	69 (0.1)	181 (0.2)	37 (0.0)							16 (0.0)	82 (0.1)	739 (0.7)	102441 (100.0)
3.0 ～ 3.5 m	8 (0.0)	4 (0.0)	5 (0.0)	3 (0.0)	3 (0.0)	3 (0.0)	1 (0.0)									4 (0.0)	31 (0.0)	102472 (100.0)
3.5 ～ 4.0 m	2 (0.0)	2 (0.0)														4 (0.0)	8 (0.0)	102480 (100.0)
4.0 ～ 4.5 m																		102480 (100.0)
4.5 ～ 5.0 m																		102480 (100.0)
5.0 ～ 5.5 m																		102480 (100.0)
Sum	13629 (13.3)	14042 (13.7)	10025 (9.8)	9467 (9.2)	11340 (11.1)	17695 (17.3)	22356 (21.8)	1580 (1.5)	21 (0.0)	7 (0.0)	6 (0.0)	13 (0.0)	9 (0.0)	26 (0.0)	183 (0.2)	2081 (2.0)	102480 (100.0)	

Source: JPT based on JWA



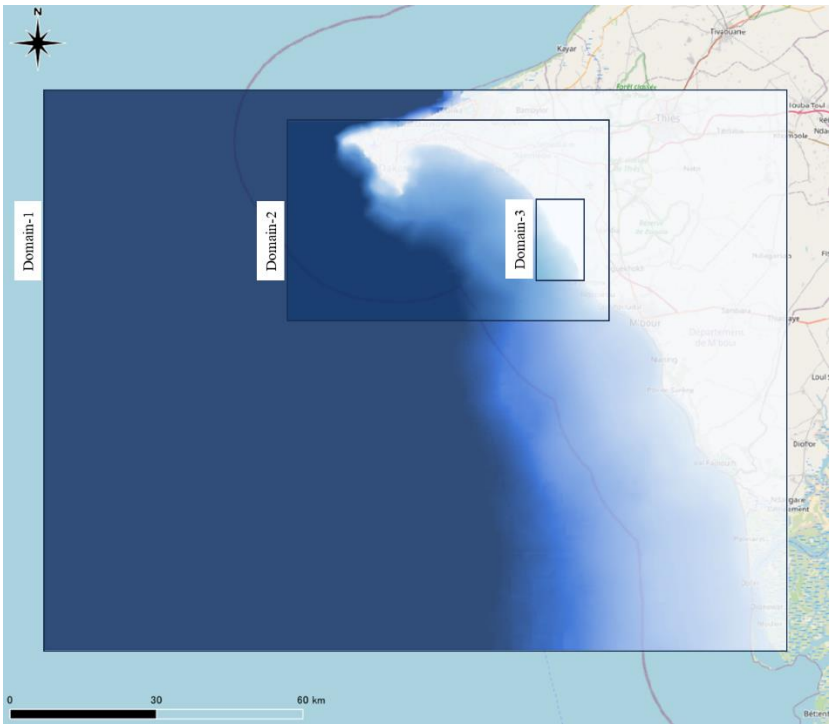
Source: JWA

Figure 3.228 Wave Rose at the Offshore Area of Senegal (By Season)

3.15.3 Wave Deformation Calculation

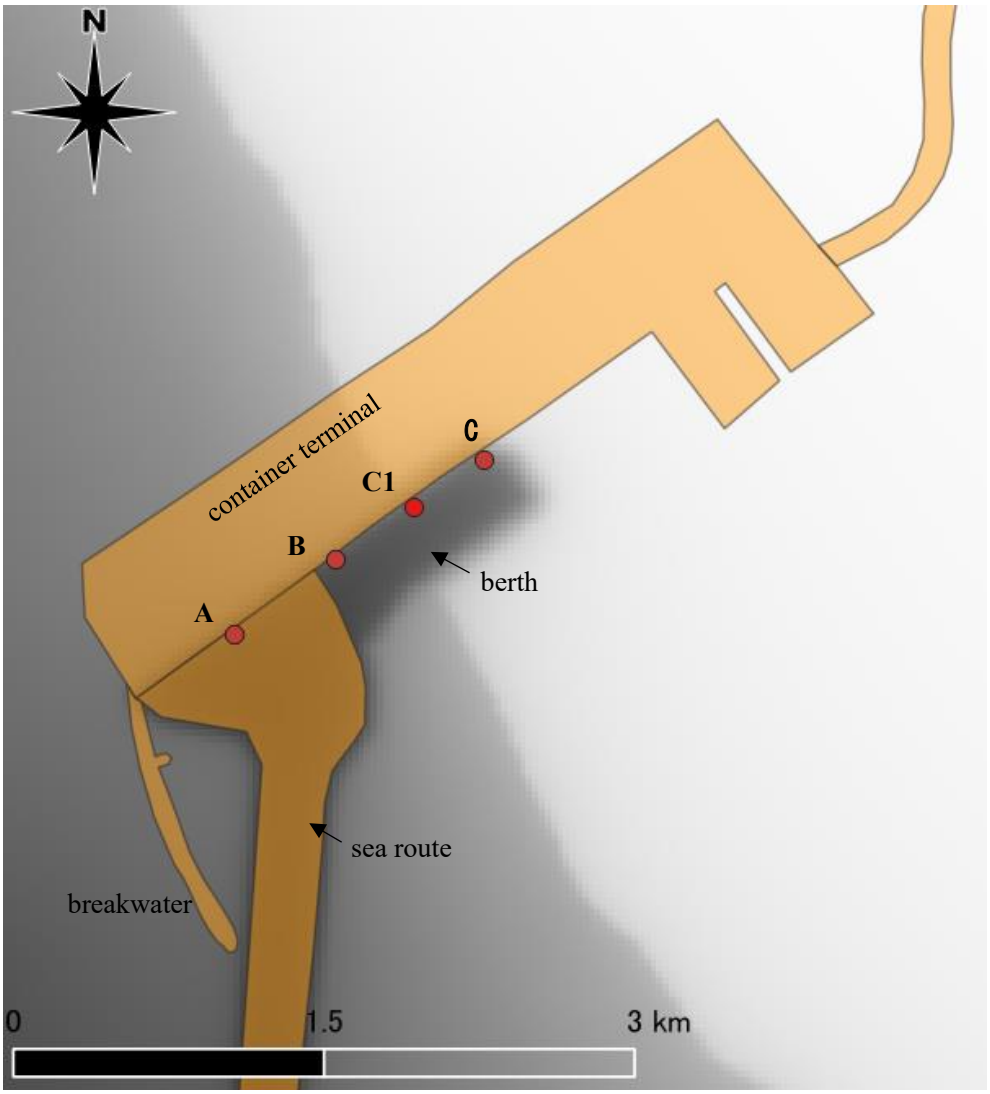
The wave deformation analysis is performed using the wave action equilibrium equations by SWAN, a third-generation wave estimation model that improves on the wave estimation model WAM, which mainly targets deep-water waves, to account for wave refraction, diffraction, shallow-water deformation, and wave deformation due to breaking waves in shallow to extremely shallow water areas.

Figure 3.229 shows the computational domain of shallow water deformation calculations. In consideration of calculation time, the mesh spacing is increased for the calculation domain over a wide area. The smallest computational domain (Domain-3) covered Ndayane port site. In Domain-3, two cases were considered after the construction of the terminal, shown in Figure 3.230 and Figure 3.231, and the output points of the calculations were all at the points where vessels would be moored. Case 1 assumes the layout of Ndayane Port in 2027, when the DPW container terminal and breakwater are constructed. Cases 2 assume the future layout plan in 2047 proposed by this project.



Source: JPT based on QGIS

Figure 3.229 Domain of Wave Deformation Calculation



Source: JPT based on QGIS

Figure 3.230 Case1: After Construction of Container Terminal and Breakwater

Source: JPT based on QGIS

Figure 3.231 Case2: Future Terminal Plan (2047)

The offshore wave conditions used for wave deformation calculations is determined as follows, respectively. For the offshore wave height H_0, a wave height (3.0 m) is selected as the representative wave height with an exceedance probability of 97.5% or less in all offshore wave directions. The offshore wave period T_0 is determined by extracting the period of the offshore wave with representative wave height H_0 = 3.0 m from the frequency table of offshore waves organized by the wave height and period. In general, the larger the period, the greater the effect of diffraction and the relatively larger the wave height in the port, so a value on the safe side is adopted in this study. Therefore, T_0 = 13.0s, the maximum value of the period for offshore waves with a wave height of 3.0 m, is adopted. The offshore wave wavelength L_0 is obtained by substituting the period T_0=13.0s for the period $L_0=1.56\times T_0^2$ of deep-sea waves. The directional concentration parameter of offshore waves, S_{max}, is set to S_{max}=25 (swell with short decay distance) because the waves reaching the project site are mainly wind waves and swell. The tide level is set to MSL.

Table 3.194 Offshore Wave Frequency Table at the Offshore Area of Senegal
(Wave Height and Wave Period)

1988-2022	～4	4～5	5～6	6～7	7～8	8～9	9～10	10～11	11～12	12～13	13～14	14～15	15～	Sum	Total
0.0～0.5 m															
0.5～1.0 m			20 (0.0)	248 (0.1)	110 (0.0)									378 (0.1)	378 (0.1)
1.0～1.5 m		3 (0.0)	1,390 (0.5)	19,643 (6.4)	33,458 (10.9)	8,432 (2.8)	898 (0.3)	107 (0.0)	15 (0.0)	2 (0.0)				63948 (20.9)	64326 (21.0)
1.5～2.0 m			2,005 (0.7)	26,823 (8.8)	54,318 (17.7)	40,438 (13.2)	12,004 (3.9)	2,139 (0.7)	320 (0.1)	67 (0.0)	6 (0.0)	1 (0.0)		138121 (45.1)	202447 (66.1)
2.0～2.5 m			322 (0.1)	12,798 (4.2)	22,851 (7.5)	18,900 (6.2)	12,055 (3.9)	4,670 (1.5)	1,132 (0.4)	236 (0.1)	60 (0.0)	16 (0.0)		73040 (23.9)	275487 (90.0)
2.5～3.0 m			1 (0.0)	2,052 (0.7)	5,885 (1.9)	5,746 (1.9)	4,312 (1.4)	3,155 (1.0)	1,803 (0.6)	407 (0.1)	122 (0.0)	10 (0.0)	5 (0.0)	23498 (7.7)	298985 (97.7)
3.0～3.5 m				220 (0.1)	763 (0.2)	993 (0.3)	1,140 (0.4)	933 (0.3)	779 (0.3)	360 (0.1)	129 (0.0)	41 (0.0)	24 (0.0)	5382 (1.8)	304367 (99.4)
3.5～4.0 m					63 (0.0)	204 (0.1)	365 (0.1)	180 (0.1)	236 (0.1)	144 (0.0)	47 (0.0)	24 (0.0)	40 (0.0)	1303 (0.4)	305670 (99.9)
4.0～4.5 m					4 (0.0)	17 (0.0)	54 (0.0)	49 (0.0)	83 (0.0)	45 (0.0)	35 (0.0)		7 (0.0)	294 (0.1)	305964 (100.0)
4.5～5.0 m						11 (0.0)	6 (0.0)	9 (0.0)	29 (0.0)	30 (0.0)	8 (0.0)			93 (0.0)	306057 (100.0)
5.0～5.5 m									14 (0.0)	1 (0.0)				15 (0.0)	306072 (100.0)
Sum		3 (0.0)	3738 (1.2)	61784 (20.2)	117452 (38.4)	74741 (24.4)	30834 (10.1)	11242 (3.7)	4411 (1.4)	1292 (0.4)	407 (0.1)	92 (0.0)	76 (0.0)	306072 (100.0)	
Total		3 (0.0)	3741 (1.2)	65525 (21.4)	182977 (59.8)	257718 (84.2)	288552 (94.3)	299794 (97.9)	304205 (99.4)	305497 (99.8)	305904 (99.9)	305996 (100.0)	306072 (100.0)		

Source: JPT

Table 3.195 shows the conditions for the wave deformation calculation.

Table 3.195 Wave Deformation Calculation Conditions

Item		Adopted value
Offshore Wave condition	Wave height H_0(m)	3.0
	Wave Period T_o(s)	13.0
	Wavelength L_0(m)	263.6
	S_{max}	25
	Wave Direction	N、NNE、S、SSW、SW、WSW、W、NW NNW、N、NNE
	Tide level (m)	MSL+0.00 m
Calculation Domain (m) (longitude×latitude)	Domain-1	152280×114480
	Domain-2	65340×40500
	Domain-3	9450×16500
Number of calculation grid (longitude×latitude)	Domain-1	564×424
	Domain-2	726×450
	Domain-3	315×550
Calculation gird Sapcing (m) (ΔX×ΔY)	Domain-1	270×270
	Domain-2	90×90
	Domain-3	30×30

Source: JPT

3.15.4 Wave Height at the Mouth of the Port

(1) Wave Height Ratio

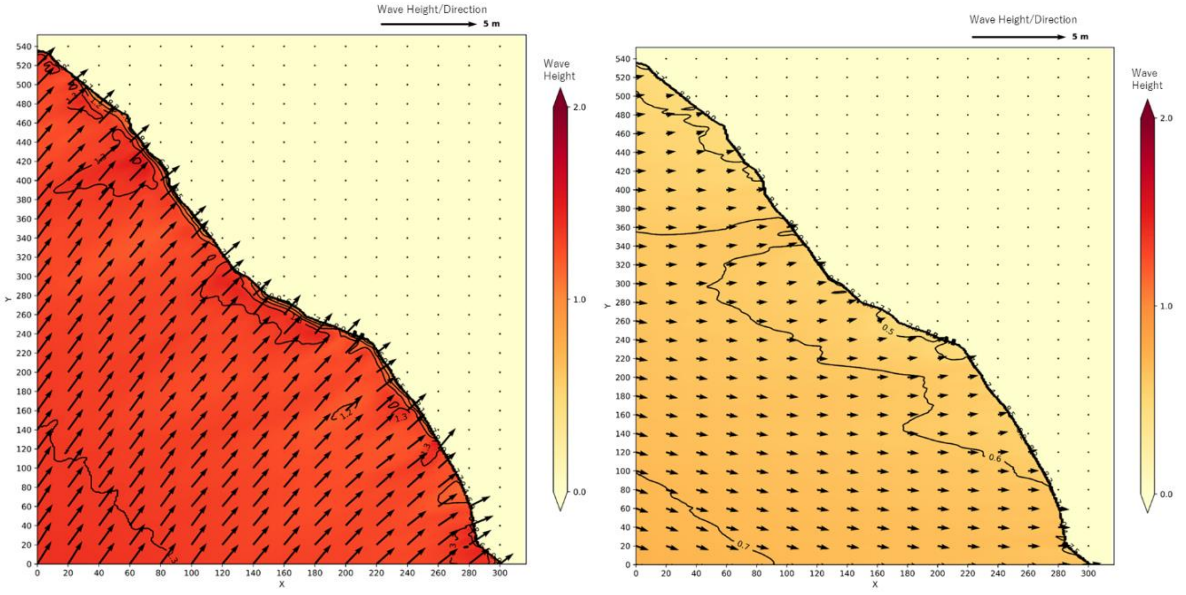
Table 3.196 shows the wave height ratios for each offshore wave direction based on the offshore wave incident point at the points where the operation rate is calculated. For wave directions for which no calculations, the wave height ratios are interpolated from the results of calculation for wave directions on both sides (gray hatched areas in Table 3.196).

Table 3.196 Wave Height Ratio and Wave Direction Ratio at Ndayane

	S	SSW	SW	WSW	W	WNW	NW	NNW	N	N	NNE	NE	E	ESE	SE	SSE
Wave Height	1.18	1.32	1.33	1.32	1.19	1.02	0.84	0.63	0.49	0.49	0.43	0.56	0.68	0.81	0.93	1.05
Wave Height Ratio	0.67	0.78	0.82	0.82	0.74	0.62	0.46	0.30	0.23	0.23	0.22	0.28	0.36	0.43	0.51	0.59
Wave Direction	66.00	54.00	42.00	22.00	6.00	2.00	358.00	354.00	350.00	350.00	346.00					
Wave Direction Difference	24.00	13.50	3.00	0.50	-6.00	-24.50	-43.00	-61.50	-80.00	-80.00	-98.50	-138.08	-177.67	142.75	103.17	63.58

Source: JPT

Figure 3.232 shows the results of wave deformation calculations with typical wave directions SSW and NNW for the rainy season and the dry season, respectively. The contours in the figure indicate wave heights, and the arrows indicate wave directions and heights. The wave height ratios for the other wave directions shown in Table 3.195 were calculated in the same way.



Source: JPT

Figure 3.232 Typical Image of Calculation Results (Left: SSW, Right: NNW)

(2) Frequency Table

The frequency table of wave heights at the mouth of the port is created by multiplying the wave height ratios for each wave direction shown in the previous section by the wave height rank values in the offshore wave frequency table. The probability that the wave height would be less than the target wave height of 0.50 m required for the operation is calculated as the operation rate from that table. Table 3.197 shows the frequency tables of wave heights for the entire year at the mouth of the port. The same process

was done for the dry season and the rainy season. (Table 3.198 & Table 3.199) Table 3.200 shows the operation rate at each location calculated from the frequency table of wave heights.

Table 3.197 Frequency Table of Wave Heights at Ndayane (Full Year)

Ndayane	SSW	SW	WSW	W	WNW	NW	NNW	N	NNE	NE	ENE	E	ESE	SE	SSE	S	Total	Total(%)	Accu.(%)
0.00 ～ 0.50 m	0	5	81	59969	19129	0	0	0	0	0	0	0	0	0	0	0	79184	25.87	25.87
0.50 ～ 1.00 m	1037	2256	2514	118790	41305	0	0	0	0	0	0	0	0	0	0	1	165903	54.20	80.07
1.00 ～ 1.50 m	3765	18519	12165	17019	1583	0	0	0	0	0	0	0	0	0	0	2	53053	17.33	97.41
1.50 ～ 2.00 m	915	3619	2049	848	44	0	0	0	0	0	0	0	0	0	0	1	7476	2.44	99.85
2.00 ～ 2.50 m	106	143	131	12	0	0	0	0	0	0	0	0	0	0	0	0	392	0.13	99.98
2.50 ～ 3.00 m	4	21	35	0	0	0	0	0	0	0	0	0	0	0	0	0	60	0.02	100.00
3.00 ～ 3.50 m	0	3	1	0	0	0	0	0	0	0	0	0	0	0	0	0	4	0.00	100.00
Total	5827	24566	16976	196638	62061	0	0	0	0	0	0	0	0	0	0	4	306072	100.00	
Total(%)	1.90	8.03	5.55	64.25	20.28	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	100.00		
wave height ratio	1.252	1.272	1.230	0.649	0.595	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000			

Source: JPT

Table 3.198 Frequency Table of Wave Heights at Ndayane (Dry Season: Oct-May)

Ndayane/Dry	SSW	SW	WSW	W	WNW	NW	NNW	N	NNE	NE	ENE	E	ESE	SE	SSE	S	Total	Total(%)	Accu.(%)
0.00 ～ 0.50 m	0	5	79	48499	16518	0	0	0	0	0	0	0	0	0	0	0	65101	31.98	31.98
0.50 ～ 1.00 m	145	123	388	87726	37226	0	0	0	0	0	0	0	0	0	0	0	125608	61.70	93.67
1.00 ～ 1.50 m	273	1113	1354	7337	1507	0	0	0	0	0	0	0	0	0	0	0	11584	5.69	99.36
1.50 ～ 2.00 m	51	292	392	381	44	0	0	0	0	0	0	0	0	0	0	0	1160	0.57	99.93
2.00 ～ 2.50 m	11	33	37	8	0	0	0	0	0	0	0	0	0	0	0	0	89	0.04	99.98
2.50 ～ 3.00 m	0	14	32	0	0	0	0	0	0	0	0	0	0	0	0	0	46	0.02	100.00
3.00 ～ 3.50 m	0	3	1	0	0	0	0	0	0	0	0	0	0	0	0	0	4	0.00	100.00
Total	480	1583	2283	143951	55295	0	0	0	0	0	0	0	0	0	0	0	203592	100.00	
Total(%)	0.24	0.78	1.12	70.71	27.16	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	100.00		
wave height ratio	1.156	1.324	1.245	0.612	0.599	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000			

Source: JPT

Table 3.199 Frequency Table of Wave Heights at Ndayane (Rainy Season: June-September)

Ndayane/Rainy	SSW	SW	WSW	W	WNW	NW	NNW	N	NNE	NE	ENE	E	ESE	SE	SSE	S	Total	Total(%)	Accu.(%)
0.00 ～ 0.50 m	0	0	2	11470	2611	0	0	0	0	0	0	0	0	0	0	0	14083	13.74	13.74
0.50 ～ 1.00 m	892	2133	2126	31064	4079	0	0	0	0	0	0	0	0	0	0	1	40295	39.32	53.06
1.00 ～ 1.50 m	3492	17406	10811	9682	76	0	0	0	0	0	0	0	0	0	0	2	41469	40.47	93.53
1.50 ～ 2.00 m	864	3327	1657	467	0	0	0	0	0	0	0	0	0	0	0	1	6316	6.16	99.69
2.00 ～ 2.50 m	95	110	94	4	0	0	0	0	0	0	0	0	0	0	0	0	303	0.30	99.99
2.50 ～ 3.00 m	4	7	3	0	0	0	0	0	0	0	0	0	0	0	0	0	14	0.01	100.00
3.00 ～ 3.50 m	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	100.00
Total	5347	22983	14693	52687	6766	0	0	0	0	0	0	0	0	0	0	4	102480	100.00	
Total(%)	5.22	22.43	14.34	51.41	6.60	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	100.00		
wave height ratio	1.261	1.269	1.227	0.749	0.562	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000			

Source: JPT

Table 3.200 Operation Rate (Probability of Wave Height not Exceeding 0.5m) at Calculation Point

Full Year	Dry Season	Rainy Season
25.87 %	31.98 %	13.74 %

Source: JPT

3.15.5 Wave Height inside the Port

(1) Wave Height Ratio

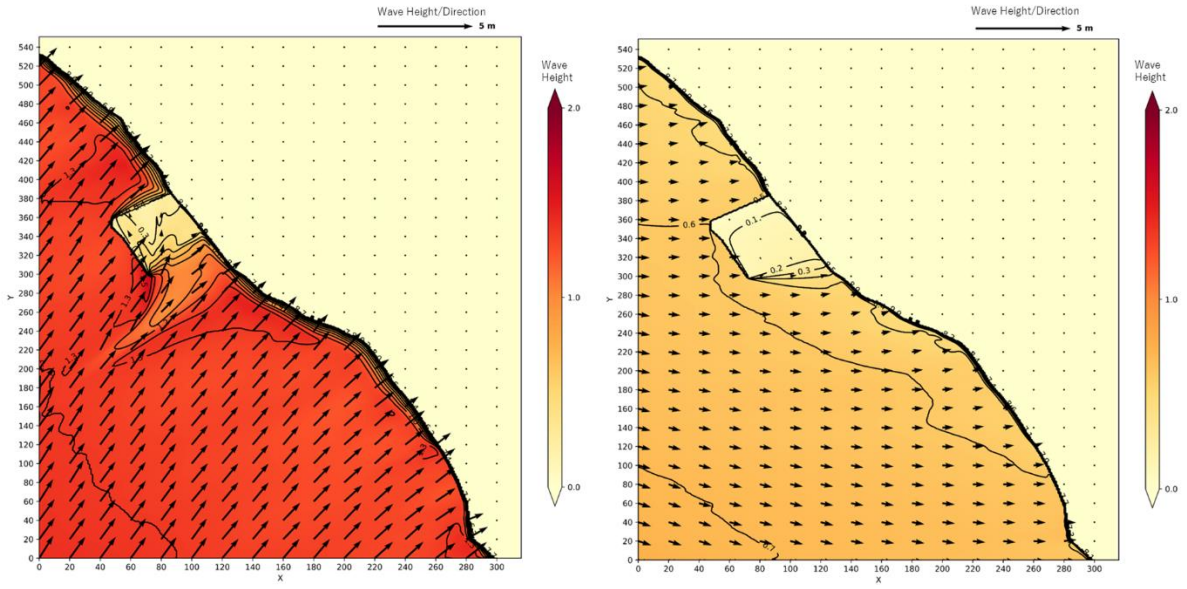
Table 3.201 shows the wave height ratios in the same way as above for points A, B, C1 and C2 in front of the container terminal shown in Case 1 (Figure 3.230). For wave directions for which no calculations, wave height ratios are interpolated from the results of calculation for wave directions on both sides (gray hatched areas in Table 3.201).

Table 3.201 Wave Height Ratio and Wave Direction Ratio inside Ndayane port (Case 1)

		S	SSW	SW	WSW	W	WNW	NW	NNW	N	N	NNE	NE	ENE	E	ESE	SE	SSE
Ndayane/A	Wave Height	0.184	0.194	0.157	0.094	0.039	0.033	0.032	0.032	0.032	0.032	0.032	0.053	0.075	0.097	0.119	0.140	0.162
	Wave Height Ratio	0.11	0.11	0.10	0.06	0.02	0.02	0.02	0.02	0.01	0.01	0.02	0.03	0.04	0.05	0.06	0.08	0.09
	Wave Direction	98	102	98	102	102	318	318	318	318	318	318						
	Wave Direction Difference	-8	-35	-53	-80	-102	20	-3	-26	-48	-48	-71	-113	-156	162	120	77	35
Ndayane/B	Wave Height	0.279	0.321	0.288	0.189	0.057	0.036	0.032	0.031	0.031	0.031	0.030	0.066	0.101	0.137	0.172	0.208	0.243
	Wave Height Ratio	0.16	0.19	0.18	0.12	0.03	0.02	0.02	0.02	0.01	0.01	0.02	0.03	0.05	0.07	0.09	0.11	0.14
	Wave Direction	78	78	78	78	78	78	318	318	318	318	318						
	Wave Direction Difference	12	-11	-33	-56	-78	-101	-3	-26	-48	-48	-71	-110	-150	171	131	91	52
Ndayane/C1	Wave Height	0.090	0.105	0.098	0.075	0.040	0.037	0.036	0.036	0.035	0.035	0.034	0.042	0.050	0.058	0.066	0.074	0.082
	Wave Height Ratio	0.05	0.06	0.06	0.05	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.03	0.03	0.04	0.04	0.05
	Wave Direction	62	62	62	62	62	62	322	66	322	322	322						
	Wave Direction Difference	28	6	-17	-40	-62	-85	-7	-134	-52	-52	-75	-111	-148	175	138	102	65
Ndayane/C2	Wave Height	0.164	0.192	0.180	0.131	0.046	0.036	0.035	0.036	0.034	0.034	0.033	0.051	0.070	0.089	0.107	0.126	0.145
	Wave Height Ratio	0.09	0.11	0.11	0.08	0.03	0.02	0.02	0.02	0.02	0.02	0.02	0.03	0.04	0.05	0.06	0.07	0.08
	Wave Direction	70	70	70	70	66	66	70	70	318	318	318						
	Wave Direction Difference	20	-3	-25	-48	-66	-89	-115	-138	-48	-48	-71	-109	-148	174	136	97	59

Source: JPT

Figure 3.233 shows the results of wave deformation calculations with typical wave directions SSW and NNW for the rainy season and the dry season. The contours in the figure indicate wave heights, and the arrows indicate wave directions and heights. The wave height ratios for the other wave directions shown in Table 3.195 were calculated in the same way.



Source: JPT

Figure 3.233 Typical Image of Calculation Results (Case 1, Left: SSW, Right: NNW)

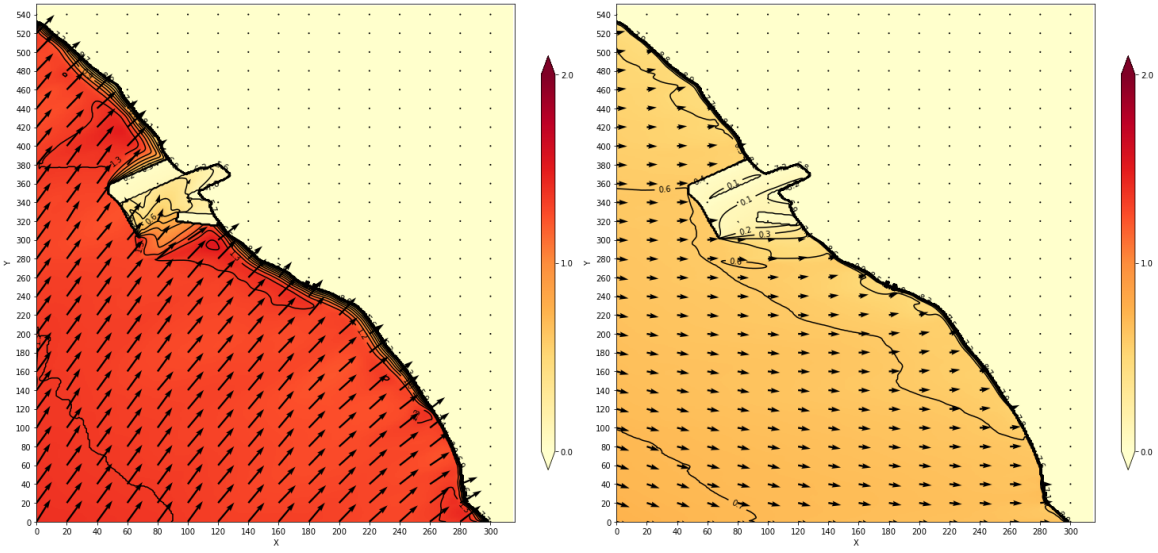
Table 3.202 shows the wave height ratios in the same way as above for Case 2 (Figure 3.231). For wave directions for which no calculations, wave height ratios are interpolated from the results of calculation for wave directions on both sides (gray hatched areas in Table 3.202).

Table 3.202 Wave Height Ratio and Wave Direction Ratio inside Ndayane Port (Case 2)

		S	SSW	SW	WSW	W	WNW	NW	NNW	N	N	NNE	NE	ENE	E	ESE	SE	SSE
Ndayane/D	出力波高	0.160	0.173	0.159	0.133	0.108	0.110	0.112	0.108	0.114	0.114	0.116	0.122	0.128	0.135	0.141	0.147	0.153
	波高比	0.091	0.102	0.098	0.082	0.067	0.067	0.061	0.052	0.052	0.052	0.058	0.062	0.066	0.071	0.076	0.081	0.086
	出力波向	26	26	26	26	326	322	318	322	318	318	318						
	波向差分	64	42	19	-4	34	16	-3	-30	-48	-48	-71	-103	-135	-167	161	128	96
Ndayane/E	出力波高	0.226	0.250	0.224	0.175	0.104	0.086	0.077	0.077	0.074	0.074	0.073	0.095	0.117	0.139	0.161	0.183	0.204
	波高比	0.129	0.148	0.138	0.108	0.064	0.052	0.042	0.037	0.034	0.034	0.036	0.048	0.060	0.073	0.086	0.100	0.115
	出力波向	38	38	38	38	38	358	358	358	358	358	358						
	波向差分	52	30	7	-16	-38	-21	-43	-66	-88	-88	-111	-139	-167	165	137	108	80
Ndayane/F	出力波高	0.144	0.160	0.151	0.134	0.126	0.124	0.119	0.118	0.117	0.117	0.116	0.120	0.124	0.128	0.132	0.136	0.140
	波高比	0.083	0.095	0.093	0.083	0.078	0.075	0.065	0.057	0.054	0.054	0.058	0.061	0.064	0.068	0.071	0.075	0.079
	出力波向	338	338	338	338	322	314	318	314	318	318	318						
	波向差分	112	90	67	45	38	24	-3	-22	-48	-48	-71	-96	-121	-147	-172	163	137

Source: JPT

Figure 3.234 shows the results of wave deformation calculations with typical wave directions SSW and NNW for the rainy season and the dry season. The contours in the figure indicate wave heights, and the arrows indicate wave directions and heights. The wave height ratios for the other wave directions shown in Table 3.195 were calculated in the same way.



Source: JPT

Figure 3.234 Typical Image of Calculation Results (Case 2, Left: SSW, Right: NNW)

(2) Operation Rate

Frequency tables of wave heights at each location in Case 1 are shown in Table 3.203 to Table 3.214.

Table 3.203 Frequency Table of Wave Heights at point A inside Ndayane Port (Case1, Full Year)

Ndayane/A	SSW	SW	WSW	W	WNW	NW	NNW	N	NNE	NE	ENE	E	ESE	SE	SSE	S	Total	Total(%)	Accu.(%)
0.00 ～ 0.10 m	0	0	0	0	14811	87985	0	0	0	50	137	23	6	0	420	399	103831	33.92	33.92
0.10 ～ 0.20 m	0	0	0	0	20259	137356	0	0	0	172	580	55	57	91	13077	16570	188217	61.49	95.42
0.20 ～ 0.30 m	0	0	0	0	171	960	0	0	0	0	0	1	13	58	5053	7137	13393	4.38	99.79
0.30 ～ 0.40 m	0	0	0	0	0	0	0	0	0	0	0	0	0	2	347	258	607	0.20	99.99
0.40 ～ 0.50 m	0	0	0	0	0	0	0	0	0	0	0	0	0	0	9	15	24	0.01	100.00
0.50 ～ 0.60 m	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	100.00
0.60 ～ 0.70 m	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	100.00
0.70 ～ 0.80 m	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	100.00
Total	0	0	0	0	35241	226301	0	0	0	222	717	79	76	151	18906	24379	306072	100.00	
Total(%)	0.00	0.00	0.00	0.00	11.51	73.94	0.00	0.00	0.00	0.07	0.23	0.03	0.02	0.05	6.18	7.97	100.00		
wave height ratio	0.000	0.000	0.000	0.000	0.108	0.110	0.000	0.000	0.000	0.120	0.124	0.130	0.164	0.199	0.176	0.180			

Source: JPT

Table 3.204 Frequency Table of Wave Heights at point A inside Ndayane Port (Case1, Dry Season)

Ndayane/A/Dry	SSW	SW	WSW	W	WNW	NW	NNW	N	NNE	NE	ENE	E	ESE	SE	SSE	S	Total	Total(%)	Accu.(%)
0.00 ～ 0.10 m	0	0	0	0	10021	58074	0	0	0	50	134	21	5	0	33	30	68368	33.58	33.58
0.10 ～ 0.20 m	0	0	0	0	16960	112907	0	0	0	171	573	41	34	3	1090	1390	133169	65.41	98.99
0.20 ～ 0.30 m	0	0	0	0	169	952	0	0	0	0	0	0	0	3	347	516	1987	0.98	99.97
0.30 ～ 0.40 m	0	0	0	0	0	0	0	0	0	0	0	0	0	0	24	34	58	0.03	100.00
0.40 ～ 0.50 m	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	10	10	0.00	100.00
0.50 ～ 0.60 m	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	100.00
0.60 ～ 0.70 m	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	100.00
0.70 ～ 0.80 m	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	100.00
Total	0	0	0	0	27150	171933	0	0	0	221	707	62	39	6	1494	1980	203592	100.00	
Total(%)	0.00	0.00	0.00	0.00	13.34	84.45	0.00	0.00	0.00	0.11	0.35	0.03	0.02	0.00	0.73	0.97	100.00		
wave height ratio	0.000	0.000	0.000	0.000	0.111	0.113	0.000	0.000	0.000	0.120	0.124	0.125	0.149	0.187	0.174	0.177			

Source: JPT

Table 3.205 Frequency Table of Wave Heights at point A inside Ndayane Port (Case1, Rainy Season)

Ndayane/A/Rainy	SSW	SW	WSW	W	WNW	NW	NNW	N	NNE	NE	ENE	E	ESE	SE	SSE	S	Total	Total(%)	Accu.(%)
0.00 ～ 0.10 m	0	0	0	0	4790	29911	0	0	0	0	3	2	1	0	387	369	35463	34.60	34.60
0.10 ～ 0.20 m	0	0	0	0	3299	24449	0	0	0	1	7	14	23	88	11987	15180	55048	53.72	88.32
0.20 ～ 0.30 m	0	0	0	0	2	8	0	0	0	0	0	1	13	55	4706	6621	11406	11.13	99.45
0.30 ～ 0.40 m	0	0	0	0	0	0	0	0	0	0	0	0	0	2	323	224	549	0.54	99.99
0.40 ～ 0.50 m	0	0	0	0	0	0	0	0	0	0	0	0	0	0	9	5	14	0.01	100.00
0.50 ～ 0.60 m	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	100.00
0.60 ～ 0.70 m	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	100.00
0.70 ～ 0.80 m	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	100.00
Total	0	0	0	0	8091	54368	0	0	0	1	10	17	37	145	17412	22399	102480	100.00	
Total(%)	0.00	0.00	0.00	0.00	7.90	53.05	0.00	0.00	0.00	0.00	0.01	0.02	0.04	0.14	16.99	21.86	100.00		
wave height ratio	0.000	0.000	0.000	0.000	0.098	0.100	0.000	0.000	0.000	0.136	0.124	0.147	0.179	0.199	0.176	0.181			

Source: JPT

Table 3.206 Frequency Table of Wave Heights at point B inside Ndayane Port (Case1, Full Year)

Ndayane/B	SSW	SW	WSW	W	WNW	NW	NNW	N	NNE	NE	ENE	E	ESE	SE	SSE	S	Total	Total(%)	Accu.(%)
0.00 ～ 0.10 m	0	0	4	36	41522	55735	0	0	0	0	0	0	0	0	0	0	97297	31.79	31.79
0.10 ～ 0.20 m	5761	1666	22	249	63988	99721	0	0	0	0	0	0	0	0	0	0	171407	56.00	87.79
0.20 ～ 0.30 m	14602	5637	43	33	503	772	0	0	0	0	0	0	0	0	0	0	21590	7.05	94.85
0.30 ～ 0.40 m	9542	3562	7	0	0	0	0	0	0	0	0	0	0	0	0	0	13111	4.28	99.13
0.40 ～ 0.50 m	1695	665	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2360	0.77	99.90
0.50 ～ 0.60 m	232	41	0	0	0	0	0	0	0	0	0	0	0	0	0	0	273	0.09	99.99
0.60 ～ 0.70 m	26	6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	32	0.01	100.00
0.70 ～ 0.80 m	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0.00	100.00
Total	31859	11578	76	318	106013	156228	0	0	0	0	0	0	0	0	0	0	306072	100.00	
Total(%)	10.41	3.78	0.02	0.10	34.64	51.04	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	100.00		
wave height ratio	0.276	0.281	0.221	0.144	0.110	0.112	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000			

Source: JPT

Table 3.207 Frequency Table of Wave Heights at point B inside Ndayane Port (Case1, Dry Season)

Ndayane/B/Dry	SSW	SW	WSW	W	WNW	NW	NNW	N	NNE	NE	ENE	E	ESE	SE	SSE	S	Total	Total(%)	Accu.(%)
0.00 ～ 0.10 m	0	0	4	36	27255	37730	0	0	0	0	0	0	0	0	0	0	65025	31.94	31.94
0.10 ～ 0.20 m	484	209	11	240	51654	81867	0	0	0	0	0	0	0	0	0	0	134465	66.05	97.99
0.20 ～ 0.30 m	1164	447	19	31	498	763	0	0	0	0	0	0	0	0	0	0	2922	1.44	99.42
0.30 ～ 0.40 m	657	258	0	0	0	0	0	0	0	0	0	0	0	0	0	0	915	0.45	99.87
0.40 ～ 0.50 m	132	69	0	0	0	0	0	0	0	0	0	0	0	0	0	0	201	0.10	99.97
0.50 ～ 0.60 m	33	16	0	0	0	0	0	0	0	0	0	0	0	0	0	0	49	0.02	99.99
0.60 ～ 0.70 m	10	5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	15	0.01	100.00
0.70 ～ 0.80 m	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	100.00
Total	2480	1004	34	307	79407	120360	0	0	0	0	0	0	0	0	0	0	203592	100.00	
Total(%)	1.22	0.49	0.02	0.15	39.00	59.12	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	100.00		
wave height ratio	0.273	0.273	0.191	0.143	0.113	0.114	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000			

Source: JPT

Table 3.208 Frequency Table of Wave Heights at point B inside Ndayane Port (Case1, Rainy Season)

Ndayane/B/Rainy	SSW	SW	WSW	W	WNW	NW	NNW	N	NNE	NE	ENE	E	ESE	SE	SSE	S	Total	Total(%)	Accu.(%)
0.00 ～ 0.10 m	0	0	0	0	14267	18005	0	0	0	0	0	0	0	0	0	0	32272	31.49	31.49
0.10 ～ 0.20 m	5277	1457	11	9	12334	17854	0	0	0	0	0	0	0	0	0	0	36942	36.05	67.54
0.20 ～ 0.30 m	13438	5190	24	2	5	9	0	0	0	0	0	0	0	0	0	0	18668	18.22	85.76
0.30 ～ 0.40 m	8885	3304	7	0	0	0	0	0	0	0	0	0	0	0	0	0	12196	11.90	97.66
0.40 ～ 0.50 m	1563	596	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2159	2.11	99.76
0.50 ～ 0.60 m	199	25	0	0	0	0	0	0	0	0	0	0	0	0	0	0	224	0.22	99.98
0.60 ～ 0.70 m	16	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	17	0.02	100.00
0.70 ～ 0.80 m	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0.00	100.00
Total	29379	10574	42	11	26606	35868	0	0	0	0	0	0	0	0	0	0	102480	100.00	
Total(%)	28.67	10.32	0.04	0.01	25.96	35.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	100.00		
wave height ratio	0.276	0.282	0.245	0.160	0.101	0.102	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000			

Source: JPT

Table 3.209 Frequency Table of Wave Heights at point C1 inside Ndayane Port (Case1, Full Year)

Ndayane/C1	SSW	SW	WSW	W	WNW	NW	NNW	N	NNE	NE	ENE	E	ESE	SE	SSE	S	Total	Total(%)	Accu.(%)
0.00 ～ 0.10 m	156921	25723	70	173	46829	63623	0	0	0	0	0	0	0	0	0	0	293339	95.84	95.84
0.10 ～ 0.20 m	9447	3269	1	0	0	0	0	0	0	0	0	0	0	0	0	0	12717	4.15	99.99
0.20 ～ 0.30 m	12	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	16	0.01	100.00
0.30 ～ 0.40 m	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	100.00
0.40 ～ 0.50 m	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	100.00
0.50 ～ 0.60 m	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	100.00
0.60 ～ 0.70 m	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	100.00
0.70 ～ 0.80 m	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	100.00
Total	166380	28996	71	173	46829	63623	0	0	0	0	0	0	0	0	0	0	306072	100.00	
Total(%)	54.36	9.47	0.02	0.06	15.30	20.79	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	100.00		
wave height ratio	0.000	0.058	0.060	0.046	0.033	0.034	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000			

Source: JPT

Table 3.210 Frequency Table of Wave Heights at point C1 inside Ndayane Port (Case1, Dry Season)

Ndayane/C1/Dry	SSW	SW	WSW	W	WNW	NW	NNW	N	NNE	NE	ENE	E	ESE	SE	SSE	S	Total	Total(%)	Accu.(%)
0.00 ～ 0.10 m	99514	11740	45	156	41059	50088	0	0	0	0	0	0	0	0	0	0	202602	99.51	99.51
0.10 ～ 0.20 m	720	263	0	0	0	0	0	0	0	0	0	0	0	0	0	0	983	0.48	100.00
0.20 ～ 0.30 m	4	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	7	0.00	100.00
0.30 ～ 0.40 m	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	100.00
0.40 ～ 0.50 m	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	100.00
0.50 ～ 0.60 m	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	100.00
0.60 ～ 0.70 m	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	100.00
0.70 ～ 0.80 m	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	100.00
Total	100238	12006	45	156	41059	50088	0	0	0	0	0	0	0	0	0	0	203592	100.00	
Total(%)	49.23	5.90	0.02	0.08	20.17	24.60	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	100.00		
wave height ratio	0.000	0.041	0.057	0.045	0.034	0.035	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000			

Source: JPT

Table 3.211 Frequency Table of Wave Heights at point C1 inside Ndayane Port (Case1, Rainy Season)

Ndayane/C1/Rainy	SSW	SW	WSW	W	WNW	NW	NNW	N	NNE	NE	ENE	E	ESE	SE	SSE	S	Total	Total(%)	Accu.(%)
0.00 ～ 0.10 m	57407	13983	25	17	5770	13535	0	0	0	0	0	0	0	0	0	0	90737	88.54	88.54
0.10 ～ 0.20 m	8727	3006	1	0	0	0	0	0	0	0	0	0	0	0	0	0	11734	11.45	99.99
0.20 ～ 0.30 m	8	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	9	0.01	100.00
0.30 ～ 0.40 m	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	100.00
0.40 ～ 0.50 m	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	100.00
0.50 ～ 0.60 m	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	100.00
0.60 ～ 0.70 m	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	100.00
0.70 ～ 0.80 m	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	100.00
Total	66142	16990	26	17	5770	13535	0	0	0	0	0	0	0	0	0	0	102480	100.00	
Total(%)	64.54	16.58	0.03	0.02	5.63	13.21	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	100.00		
wave height ratio	0.000	0.070	0.065	0.059	0.030	0.031	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000			

Source: JPT

Table 3.212 Frequency Table of Wave Heights at point C2 inside Ndayane Port (Case1, Full Year)

Ndayane/C2	SSW	SW	WSW	W	WNW	NW	NNW	N	NNE	NE	ENE	E	ESE	SE	SSE	S	Total	Total(%)	Accu.(%)
0.00 ～ 0.10 m	179923	2160	44	160	19796	50643	0	0	0	0	0	0	0	0	0	10893	263619	86.13	86.13
0.10 ～ 0.20 m	31084	146	31	4	0	0	0	0	0	0	0	0	0	0	0	3295	34560	11.29	97.42
0.20 ～ 0.30 m	7071	14	0	0	0	0	0	0	0	0	0	0	0	0	0	649	7734	2.53	99.95
0.30 ～ 0.40 m	137	0	0	0	0	0	0	0	0	0	0	0	0	0	0	15	152	0.05	100.00
0.40 ～ 0.50 m	6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	7	0.00	100.00
0.50 ～ 0.60 m	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	100.00
0.60 ～ 0.70 m	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	100.00
0.70 ～ 0.80 m	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	100.00
Total	218221	2320	75	164	19796	50643	0	0	0	0	0	0	0	0	0	14853	306072	100.00	
Total(%)	71.30	0.76	0.02	0.05	6.47	16.55	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	4.85	100.00		
wave height ratio	0.000	0.047	0.095	0.066	0.033	0.033	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000			

Source: JPT

Table 3.213 Frequency Table of Wave Heights at point C2 inside Ndayane Port (Case1, Dry Season)

Ndayane/C2/Dry	SSW	SW	WSW	W	WNW	NW	NNW	N	NNE	NE	ENE	E	ESE	SE	SSE	S	Total	Total(%)	Accu.(%)
0.00 ～ 0.10 m	123541	608	29	152	18759	50070	0	0	0	0	0	0	0	0	0	7053	200212	98.34	98.34
0.10 ～ 0.20 m	2460	6	18	0	0	0	0	0	0	0	0	0	0	0	0	266	2750	1.35	99.69
0.20 ～ 0.30 m	519	0	0	0	0	0	0	0	0	0	0	0	0	0	0	54	573	0.28	99.97
0.30 ～ 0.40 m	47	0	0	0	0	0	0	0	0	0	0	0	0	0	0	6	53	0.03	100.00
0.40 ～ 0.50 m	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4	0.00	100.00
0.50 ～ 0.60 m	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	100.00
0.60 ～ 0.70 m	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	100.00
0.70 ～ 0.80 m	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	100.00
Total	126571	614	47	152	18759	50070	0	0	0	0	0	0	0	0	0	7379	203592	100.00	
Total(%)	62.17	0.30	0.02	0.07	9.21	24.59	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	3.62	100.00		
wave height ratio	0.000	0.041	0.089	0.064	0.033	0.033	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000			

Source: JPT

Table 3.214 Frequency Table of Wave Heights at point C2 inside Ndayane Port (Case1, Rainy Season)

Ndayane/C2	SSW	SW	WSW	W	WNW	NW	NNW	N	NNE	NE	ENE	E	ESE	SE	SSE	S	Total	Total(%)	Accu.(%)
0.00 ～ 0.10 m	179923	2160	44	160	19796	50643	0	0	0	0	0	0	0	0	0	10893	263619	86.13	86.13
0.10 ～ 0.20 m	31084	146	31	4	0	0	0	0	0	0	0	0	0	0	0	3295	34560	11.29	97.42
0.20 ～ 0.30 m	7071	14	0	0	0	0	0	0	0	0	0	0	0	0	0	649	7734	2.53	99.95
0.30 ～ 0.40 m	137	0	0	0	0	0	0	0	0	0	0	0	0	0	0	15	152	0.05	100.00
0.40 ～ 0.50 m	6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	7	0.00	100.00
0.50 ～ 0.60 m	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	100.00
0.60 ～ 0.70 m	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	100.00
0.70 ～ 0.80 m	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	100.00
Total	218221	2320	75	164	19796	50643	0	0	0	0	0	0	0	0	0	14853	306072	100.00	
Total(%)	71.30	0.76	0.02	0.05	6.47	16.55	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	4.85	100.00		
wave height ratio	0.000	0.047	0.095	0.066	0.033	0.033	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000			

Source: JPT

Table 3.215 to Table 3.217 show the operation rate calculated from the frequency tables at point A, B, C1 and C2. Case 1 is ensured calmness. By constructing the terminal to the south (Case 2), point B, which was less than 100% in Case 1, becomes 99.99%, closer to 100%.

Berths on container terminal side (Points A to C)

Table 3.215 Operation Rate (Probability of Wave Height not Exceeding 0.5m) at Calculation Point (Full Year)

Case	Point A	Point B	Point C1	Point C2
1	100.00 %	99.95 %	100.00 %	100.00 %
2	100.00 %	99.99 %	-	100.00 %

Source: JPT

Table 3.216 Operation Rate (Probability of Wave Height not Exceeding 0.5m) at Calculation Point (Dry Season)

Case	Point A	Point B	Point C1	Point C2
1	100.00 %	99.97 %	100.00 %	100.00 %
2	100.00 %	100.00 %	-	100.00 %

Source: JPT

Table 3.217 Operation Rate (Probability of Wave Height not Exceeding 0.5m) at Calculation Point (Rainy Season)

Case	Point A	Point B	Point C1	Point C2
1	100.00 %	99.90 %	100.00 %	100.00 %
2	100.00 %	99.99 %	-	100.00 %

Source: JPT

Frequency tables of wave heights at each location in Case 2 are shown in Table 3.218 to Table 3.226. Table 3.227 shows the operation rate at each point in front of the terminal, calculated from the frequency table of wave heights at points D to F. The operation rate at all periods resulted as 100.00% at all three locations.

Table 3.218 Frequency Table of Wave Heights at point D inside Ndayane port (Case2, Full Year)

Ndayane/D	SSW	SW	WSW	W	WNW	NW	NNW	N	NNE	NE	ENE	E	ESE	SE	SSE	S	Total	Total(%)	Accu.(%)
0.00 ～ 0.10 m	0	125	881	27	29216	93273	0	0	0	0	0	0	0	0	0	0	123522	40.36	40.36
0.10 ～ 0.20 m	0	5197	33582	143	29591	109695	0	0	0	0	0	0	0	0	0	0	178208	58.22	98.58
0.20 ～ 0.30 m	0	418	3094	14	149	610	0	0	0	0	0	0	0	0	0	0	4285	1.40	99.98
0.30 ～ 0.40 m	0	9	48	0	0	0	0	0	0	0	0	0	0	0	0	0	57	0.02	100.00
0.40 ～ 0.50 m	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	100.00
Total	0	5749	37605	184	58956	203578	0	0	0	0	0	0	0	0	0	0	306072	100.00	
Total(%)	0.00	1.88	12.29	0.06	19.26	66.51	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	100.00		
wave height ratio	0.000	0.149	0.153	0.140	0.104	0.106	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000			

Source: JPT

Table 3.219 Frequency Table of Wave Heights at point D inside Ndayane port (Case2, Dry Season)

Ndayane/D/Dry	SSW	SW	WSW	W	WNW	NW	NNW	N	NNE	NE	ENE	E	ESE	SE	SSE	S	Total	Total(%)	Accu.(%)
0.00 ～ 0.10 m	0	18	123	16	17942	64647	0	0	0	0	0	0	0	0	0	0	82746	40.64	40.64
0.10 ～ 0.20 m	0	410	2529	45	23437	93275	0	0	0	0	0	0	0	0	0	0	119696	58.79	99.44
0.20 ～ 0.30 m	0	46	320	0	148	605	0	0	0	0	0	0	0	0	0	0	1119	0.55	99.98
0.30 ～ 0.40 m	0	4	27	0	0	0	0	0	0	0	0	0	0	0	0	0	31	0.02	100.00
0.40 ～ 0.50 m	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	100.00
Total	0	478	2999	61	41527	158527	0	0	0	0	0	0	0	0	0	0	203592	100.00	
Total(%)	0.00	0.23	1.47	0.03	20.40	77.87	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	100.00		
wave height ratio	0.000	0.153	0.154	0.121	0.107	0.109	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000			

Source: JPT

Table 3.220 Frequency Table of Wave Heights at point D inside Ndayane port (Case2, Rainy Season)

Ndayane/D/Rainy	SSW	SW	WSW	W	WNW	NW	NNW	N	NNE	NE	ENE	E	ESE	SE	SSE	S	Total	Total(%)	Accu.(%)
0.00 ～ 0.10 m	0	107	758	11	11274	28626	0	0	0	0	0	0	0	0	0	0	40776	39.79	39.79
0.10 ～ 0.20 m	0	4787	31053	98	6154	16420	0	0	0	0	0	0	0	0	0	0	58512	57.10	96.89
0.20 ～ 0.30 m	0	372	2774	14	1	5	0	0	0	0	0	0	0	0	0	0	3166	3.09	99.97
0.30 ～ 0.40 m	0	5	21	0	0	0	0	0	0	0	0	0	0	0	0	0	26	0.03	100.00
0.40 ～ 0.50 m	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	100.00
Total	0	5271	34606	123	17429	45051	0	0	0	0	0	0	0	0	0	0	102480	100.00	
Total(%)	0.00	5.14	33.77	0.12	17.01	43.96	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	100.00		
wave height ratio	0.000	0.149	0.152	0.150	0.095	0.095	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000			

Source: JPT

Table 3.221 Frequency Table of Wave Heights at point E inside Ndayane port (Case2, Full Year)

Ndayane/E	SSW	SW	WSW	W	WNW	NW	NNW	N	NNE	NE	ENE	E	ESE	SE	SSE	S	Total	Total(%)	Accu.(%)
0.00 ～ 0.10 m	0	4118	2222	211631	20787	0	0	0	0	0	0	0	0	0	0	0	238758	78.01	78.01
0.10 ～ 0.20 m	0	16226	8255	16298	2000	0	0	0	0	0	0	0	0	0	0	0	42779	13.98	91.98
0.20 ～ 0.30 m	0	14522	7604	0	0	0	0	0	0	0	0	0	0	0	0	0	22126	7.23	99.21
0.30 ～ 0.40 m	0	1491	795	0	0	0	0	0	0	0	0	0	0	0	0	0	2286	0.75	99.96
0.40 ～ 0.50 m	0	87	29	0	0	0	0	0	0	0	0	0	0	0	0	0	116	0.04	100.00
0.50 ～ 0.60 m	0	4	3	0	0	0	0	0	0	0	0	0	0	0	0	0	7	0.00	100.00
Total	0	36448	18908	227929	22787	0	0	0	0	0	0	0	0	0	0	0	306072	100.00	
Total(%)	0.00	11.91	6.18	74.47	7.44	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	100.00		
wave height ratio	0.000	0.189	0.189	0.073	0.076	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000			

Source: JPT

Table 3.222 Frequency Table of Wave Heights at point E inside Ndayane port (Case2, Dry Season)

Ndayane/E/Dry	SSW	SW	WSW	W	WNW	NW	NNW	N	NNE	NE	ENE	E	ESE	SE	SSE	S	Total	Total(%)	Accu.(%)
0.00 ～ 0.10 m	0	539	599	164450	16441	0	0	0	0	0	0	0	0	0	0	0	182029	89.41	89.41
0.10 ～ 0.20 m	0	1636	1197	14936	1880	0	0	0	0	0	0	0	0	0	0	0	19649	9.65	99.06
0.20 ～ 0.30 m	0	1077	527	0	0	0	0	0	0	0	0	0	0	0	0	0	1604	0.79	99.85
0.30 ～ 0.40 m	0	148	108	0	0	0	0	0	0	0	0	0	0	0	0	0	256	0.13	99.97
0.40 ～ 0.50 m	0	26	24	0	0	0	0	0	0	0	0	0	0	0	0	0	50	0.02	100.00
0.50 ～ 0.60 m	0	2	2	0	0	0	0	0	0	0	0	0	0	0	0	0	4	0.00	100.00
Total	0	3428	2457	179386	18321	0	0	0	0	0	0	0	0	0	0	0	203592	100.00	
Total(%)	0.00	1.68	1.21	88.11	9.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	100.00		
wave height ratio	0.000	0.176	0.159	0.075	0.077	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000			

Source: JPT

Table 3.223 Frequency Table of Wave Heights at point E inside Ndayane port (Case2, Rainy Season)

Ndayane/E/Rainy	SSW	SW	WSW	W	WNW	NW	NNW	N	NNE	NE	ENE	E	ESE	SE	SSE	S	Total	Total(%)	Accu.(%)
0.00 ～ 0.10 m	0	3579	1623	47181	4346	0	0	0	0	0	0	0	0	0	0	0	56729	55.36	55.36
0.10 ～ 0.20 m	0	14590	7058	1362	120	0	0	0	0	0	0	0	0	0	0	0	23130	22.57	77.93
0.20 ～ 0.30 m	0	13445	7077	0	0	0	0	0	0	0	0	0	0	0	0	0	20522	20.03	97.95
0.30 ～ 0.40 m	0	1343	687	0	0	0	0	0	0	0	0	0	0	0	0	0	2030	1.98	99.93
0.40 ～ 0.50 m	0	61	5	0	0	0	0	0	0	0	0	0	0	0	0	0	66	0.06	100.00
0.50 ～ 0.60 m	0	2	1	0	0	0	0	0	0	0	0	0	0	0	0	0	3	0.00	100.00
Total	0	33020	16451	48543	4466	0	0	0	0	0	0	0	0	0	0	0	102480	100.00	
Total(%)	0.00	32.22	16.05	47.37	4.36	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	100.00		
wave height ratio	0.000	0.191	0.193	0.068	0.070	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000			

Source: JPT

Table 3.224 Frequency Table of Wave Heights at point F inside Ndayane port (Case2, Full Year)

Ndayane/F	SSW	SW	WSW	W	WNW	NW	NNW	N	NNE	NE	ENE	E	ESE	SE	SSE	S	Total	Total(%)	Accu.(%)
0.00 ～ 0.10 m	0	0	0	19	9879	78823	2301	0	0	0	0	0	0	0	0	0	91022	29.74	29.74
0.10 ～ 0.20 m	0	0	0	725	56189	149517	5047	0	0	0	0	0	0	0	0	0	211478	69.09	98.83
0.20 ～ 0.30 m	0	0	0	30	2063	1386	59	0	0	0	0	0	0	0	0	0	3538	1.16	99.99
0.30 ～ 0.40 m	0	0	0	1	30	3	0	0	0	0	0	0	0	0	0	0	34	0.01	100.00
0.40 ～ 0.50 m	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	100.00
Total	0	0	0	775	68161	229729	7407	0	0	0	0	0	0	0	0	0	306072	100.00	
Total(%)	0.00	0.00	0.00	0.25	22.27	75.06	2.42	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	100.00		
wave height ratio	0.000	0.000	0.000	0.145	0.132	0.113	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000			

Source: JPT

Table 3.225 Frequency Table of Wave Heights at point F inside Ndayane port (Case2, Dry Season)

Ndayane/F/Dry	SSW	SW	WSW	W	WNW	NW	NNW	N	NNE	NE	ENE	E	ESE	SE	SSE	S	Total	Total(%)	Accu.(%)
0.00 ～ 0.10 m	0	0	0	2	6820	52309	1794	0	0	0	0	0	0	0	0	0	60925	29.93	29.93
0.10 ～ 0.20 m	0	0	0	62	16099	120295	4355	0	0	0	0	0	0	0	0	0	140811	69.16	99.09
0.20 ～ 0.30 m	0	0	0	2	423	1352	58	0	0	0	0	0	0	0	0	0	1835	0.90	99.99
0.30 ～ 0.40 m	0	0	0	0	18	3	0	0	0	0	0	0	0	0	0	0	21	0.01	100.00
0.40 ～ 0.50 m	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	100.00
Total	0	0	0	66	23360	173959	6207	0	0	0	0	0	0	0	0	0	203592	100.00	
Total(%)	0.00	0.00	0.00	0.03	11.47	85.44	3.05	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	100.00		
wave height ratio	0.000	0.000	0.000	0.148	0.118	0.116	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000			

Source: JPT

Table 3.226 Frequency Table of Wave Heights at point F inside Ndayane port (Case2, Rainy Season)

Ndayane/F/Rainy	SSW	SW	WSW	W	WNW	NW	NNW	N	NNE	NE	ENE	E	ESE	SE	SSE	S	Total	Total(%)	Accu.(%)
0.00 ～ 0.10 m	0	0	0	17	3059	26514	507	0	0	0	0	0	0	0	0	0	30097	29.37	29.37
0.10 ～ 0.20 m	0	0	0	663	40090	29222	692	0	0	0	0	0	0	0	0	0	70667	68.96	98.33
0.20 ～ 0.30 m	0	0	0	28	1640	34	1	0	0	0	0	0	0	0	0	0	1703	1.66	99.99
0.30 ～ 0.40 m	0	0	0	1	12	0	0	0	0	0	0	0	0	0	0	0	13	0.01	100.00
0.40 ～ 0.50 m	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	100.00
Total	0	0	0	709	44801	55770	1200	0	0	0	0	0	0	0	0	0	102480	100.00	
Total(%)	0.00	0.00	0.00	0.69	43.72	54.42	1.17	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	100.00		
wave height ratio	0.000	0.000	0.000	0.144	0.140	0.104	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000			

Source: JPT

Berths on the south side (Points D to F)

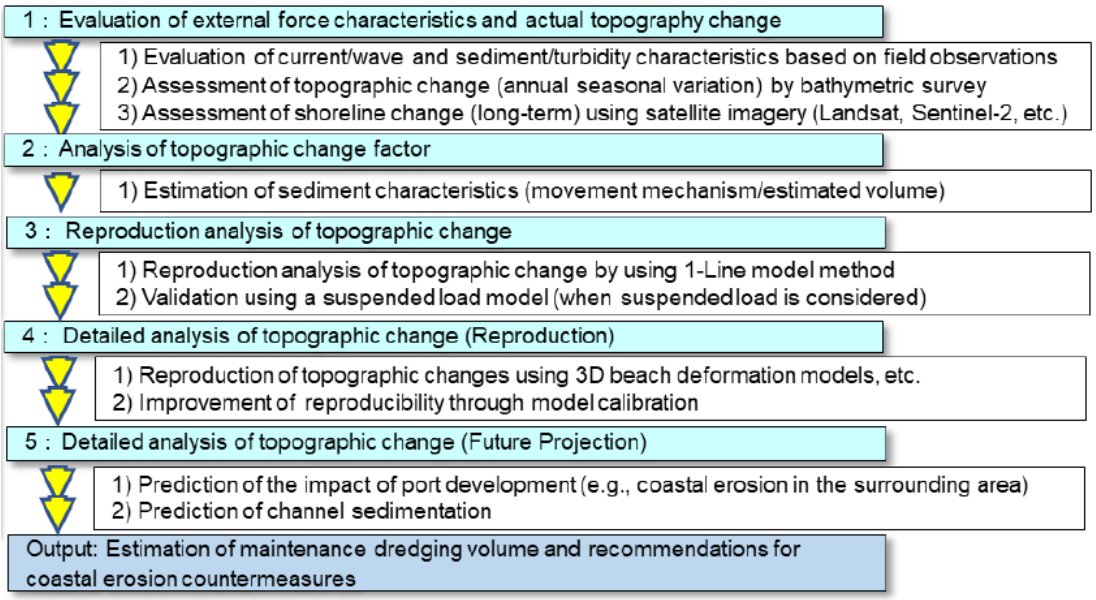
Table 3.227 Operation Rate (Probability of Wave Height not Exceeding 0.5m) at Calculation Point

Case 2	Point D	Point E	Point F
Full Year	100.00 %	100.00 %	100.00 %
Rainy Season	100.00 %	100.00 %	100.00 %
Dry Season	100.00 %	100.00 %	100.0

Source: JPT

3.16 Examination of Maintenance Dredging (including Sediment Transport/Shoreline Analysis)

To evaluate necessity of maintenance dredging, sediment analysis is conducted to estimate amount of annual channel sedimentation. The study flow for the estimation of channel sedimentation is shown in the figure below.



Source: JPT

Figure 3.235 Diagram of Channel Sedimentation and Shoreline Change Study in this Project

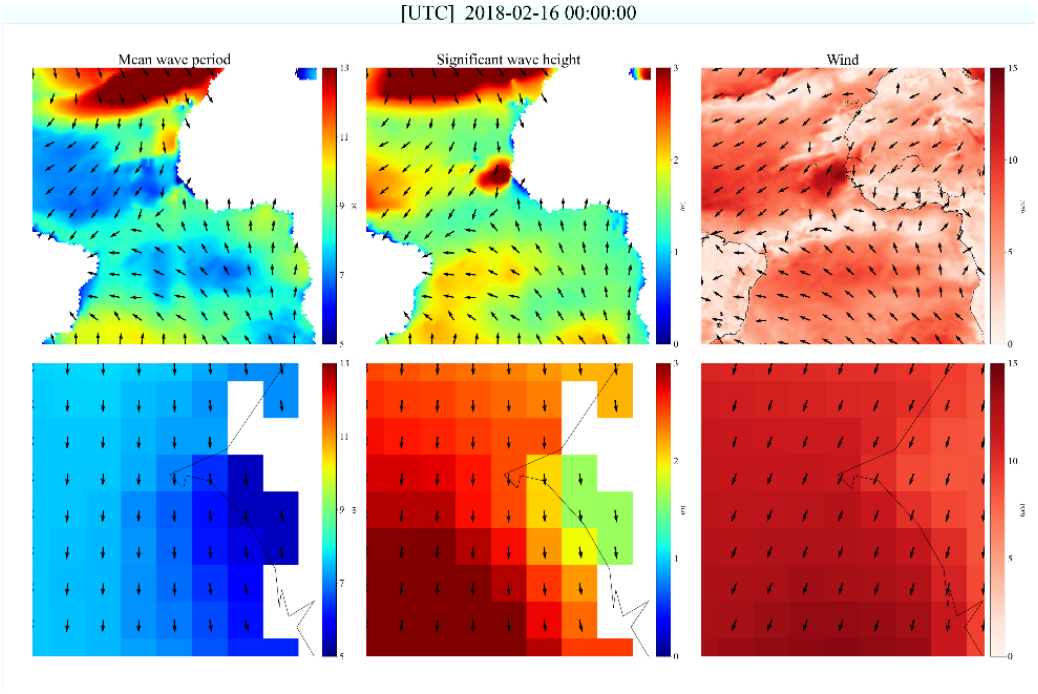
3.16.1 Evaluation of External Force Characteristics and Actual Topographic Change

(1) Current, Wave, Sediment and Turbidity Characteristics

a) Wave and Current Characteristics at Offshore Area of Ndayane

To understand the wave characteristics at the offshore area of Ndayane, wave and current observations conducted by DPW in 2017 and ERA5, the reanalysis data of wave estimation by ECMWF, were analyzed. Although the accuracy of the estimation in the coastal area needs to be confirmed, it is enough to grasp the characteristics of the wave field, mainly in the offshore area.

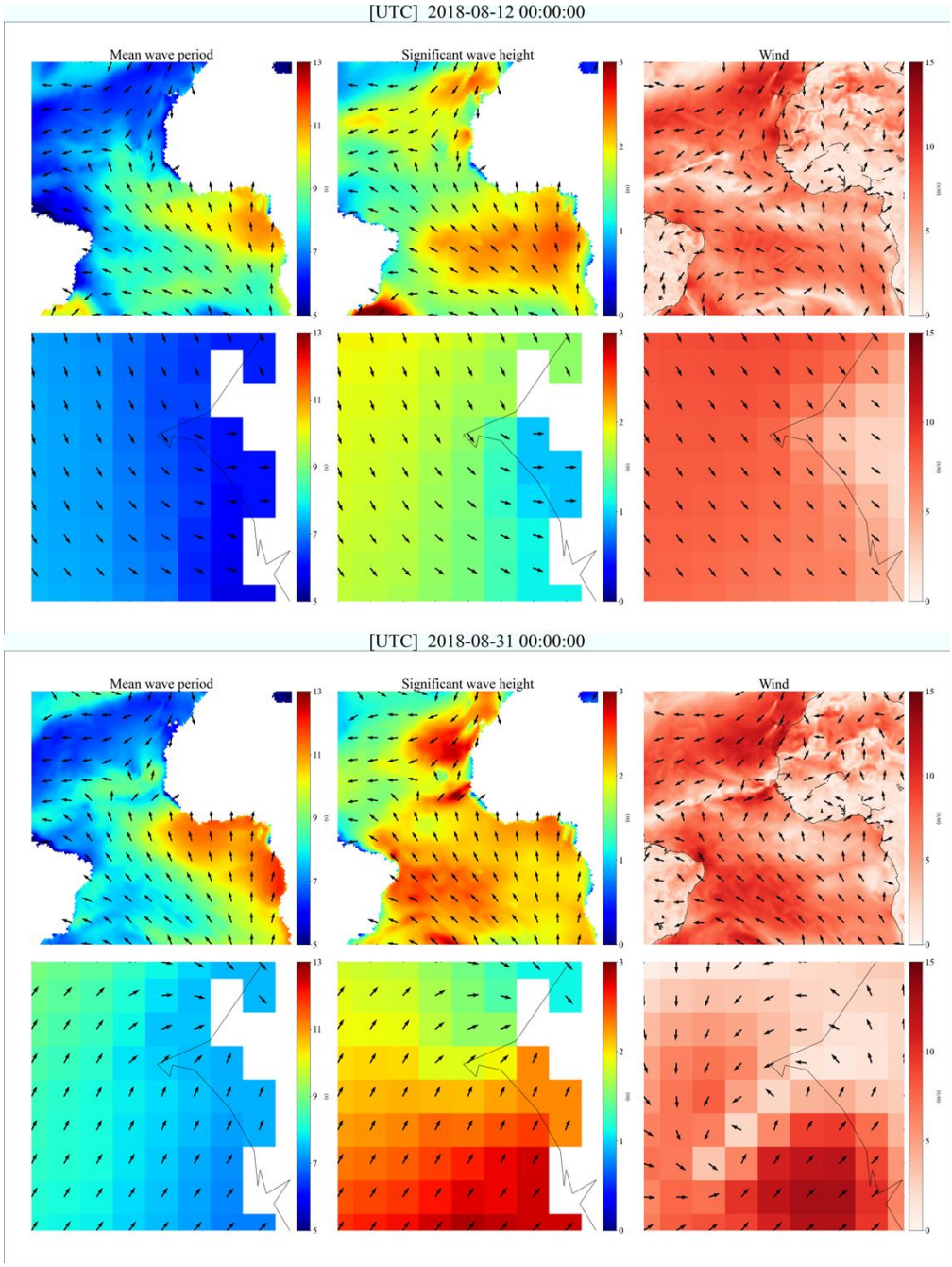
Figure 3.236 shows a distribution of the wave field based on ERA5 at a certain point in the dry season (February 16, 2018). The upper figure shows the sea area over the whole of Africa, while the lower figure focuses on the area around Senegal. During the dry season in February 2018, waves striking from the north are predominant around Senegal. The figure above also shows that waves with a period longer than 13s are pushing toward Senegal, and that these waves are predominant at offshore of Ndayane as well. This pattern also appears frequently during other periods of the dry season.



Source: Prepared by JPT based on ERA5/ECMWF

Figure 3.236 Wave Field in the Dry Season (February 16, 2018)

Figure 3.237 shows a distribution of the wave field based on ERA5 at certain times during the rainy season. The upper figure, shown for August 12, 2018, indicates that waves are coming from north of Senegal and affecting the waves at offshore of Ndayane. On the other hand, in the lower result shown for August 31, 2018, high waves coming from south of Senegal have a significant impact on the waves at offshore of Ndayane. Thus, it is considered that during the rainy season, the waves at offshore of Ndayane are affected by waves coming from both the north and the south.

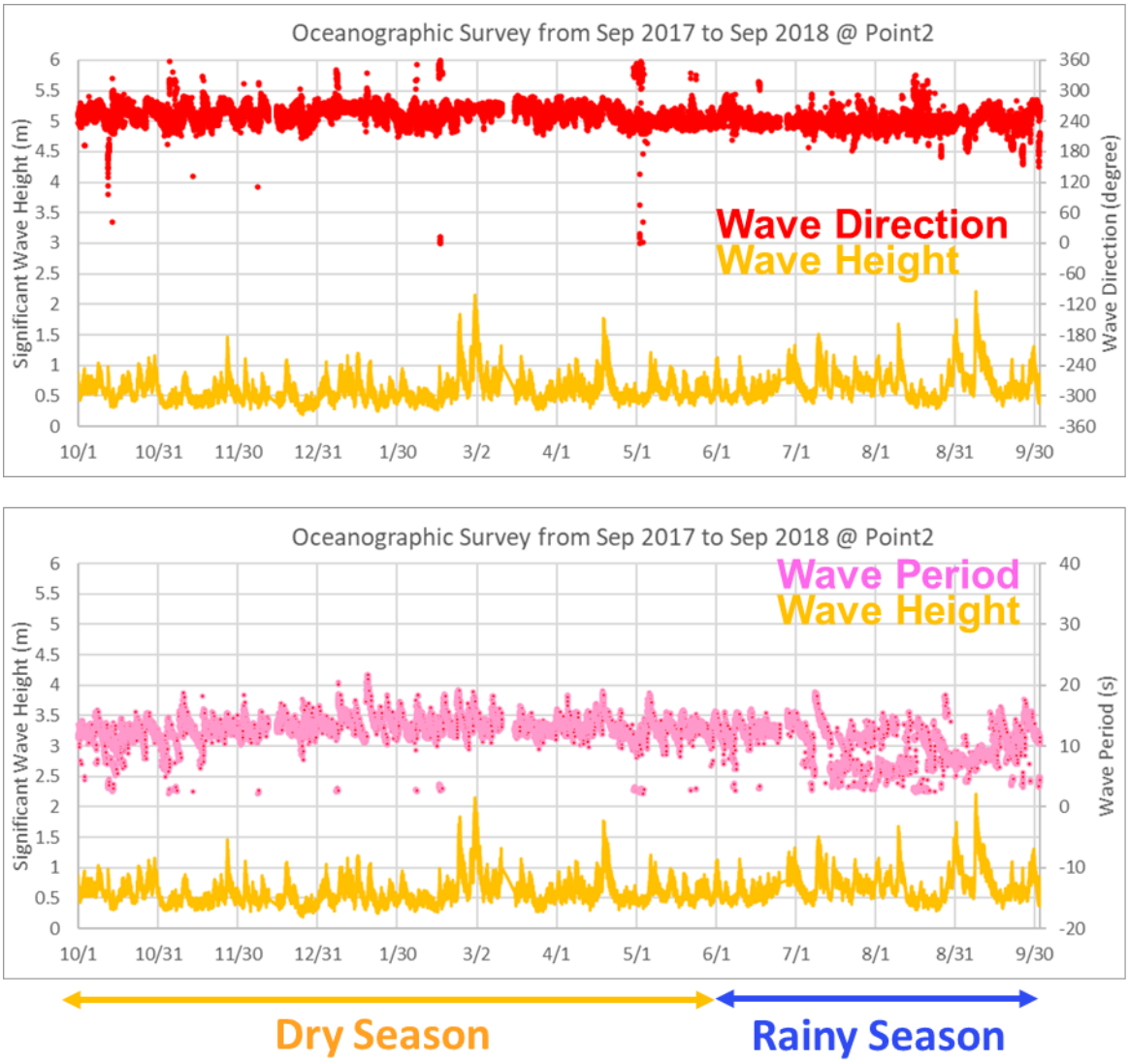


Source: Prepared by JPT based on ERA5/ECMWF

Figure 3.237 Wave Field in the Rainy Season (Upper: August 12, 2018, Lower: August 31, 2018)

To understand the characteristics of waves at nearshore of Ndayane, Figure 3.238 shows the wave observations from October 2017 to September 2018. The peak period is dominated by swell waves of about 13s and wind waves of about 7s in the early part of the dry season from October 2017 to December 2017. In the latter part of the dry season from January 2018 to May 2018, swell waves are dominant and wind waves have little influence. Thereafter, waves during the rainy season from June 2018 appear to vary more frequently than during the early part of the dry season, rotating between swell waves of about 13s and wind waves of about 7s. Wave directions converge to from SW to W

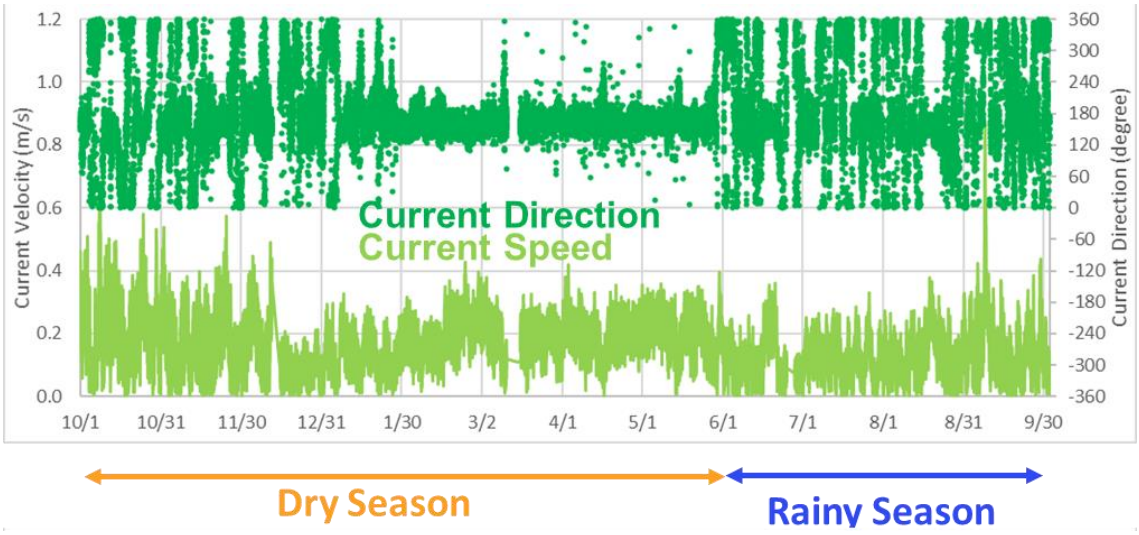
almost perpendicular to the shoreline in both rainy and dry seasons due to refraction and diffraction effects.



Source: JPT

Figure 3.238 Wave Observation at Nearshore of Ndayane

To understand the current characteristics at the nearshore area of Ndayane, the current observations from October 2017 to September 2018 were analyzed as shown in Figure 3.239. During the early part of the dry season from October 2017 to December 2017, northward and southward currents with 0.3 m/s alternated every 2 to 3 days. In contrast, during the latter part of the dry season from January 2018 to May 2018, southward flow dominates. In the rainy season from June 2018, the flow direction alternates again.



Source: JPT

Figure 3.239 Current Observation at Nearshore of Ndayane

The summary of wave and current characteristics at the offshore and nearshore areas of Ndayane is shown as follows.

- Wave characteristics during the dry season (Oct-May)

In the early part of the dry season, the influence of both swell waves with period of about 13 s and wind waves with period of about 7 s was confirmed. In the latter part of the dry season, the influence of swell waves gradually increases, and swell waves arriving from north of Senegal dominate at the offshore area of Ndayane. Waves arriving from the north are influenced by diffraction on the Cape Verde Peninsula, and they enter the shoreline at near right angles to the shoreline in the nearshore area of Ndayane.

- Current characteristics during the dry season (Oct-May)

In the nearshore area of Ndayane, northward and southward currents alternate with a 2~3 day cycle in the early part of the dry season, while southward currents dominate in the latter part.

- Wave characteristics during the rainy season (Jun-Sep)

At the offshore area of Ndayane, wind waves and swell waves come from north and south of Senegal. Therefore, waves of both periods were confirmed at the nearshore area of Ndayane. The waves are incident near perpendicular to the shoreline, and there is no significant variation in wave direction during this period.

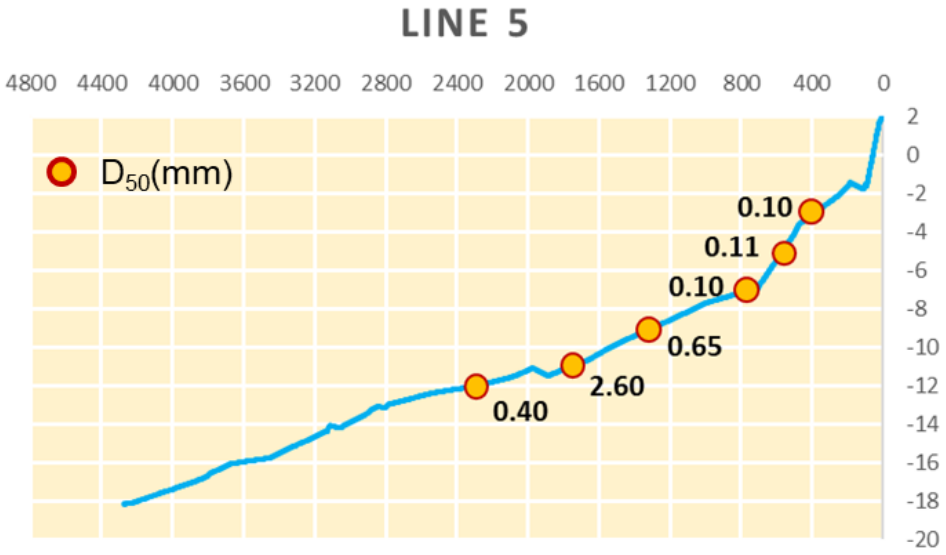
- Current characteristics during the rainy season (Jun-Sep)

At the nearshore areas of Ndayane, northward and southward currents alternate in the same pattern as in the early part of the dry season.

b) Sediment and Turbidity Characteristics at Offshore Area of Ndayane

Figure 3.240 shows the grain size distribution of the bottom sediment sampled offshore of Ndayane. In the area shallower than -8 m depth, fine sand with a grain size of 0.1 mm was observed, while

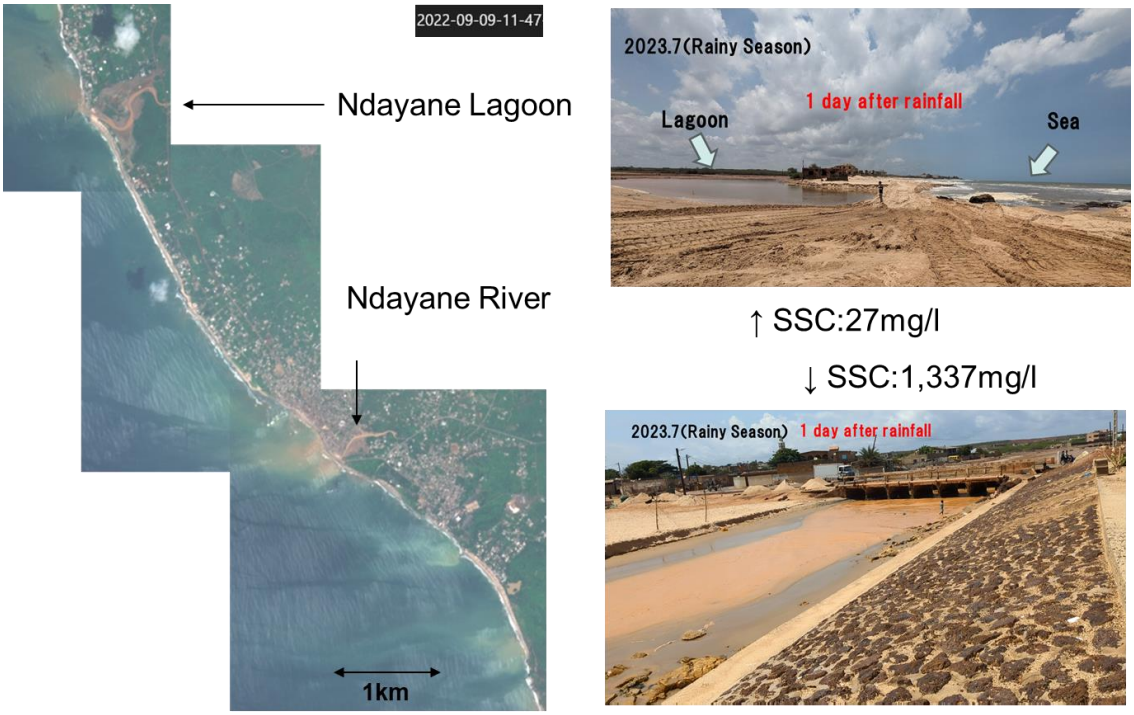
coarse sand or gravel was deposited in the deeper area. This indicates that the wave breaking zone is located around a depth of -8m, and that sand drifting is active in the shallower areas.



Source: JPT

Figure 3.240 Seabed Sediment Sampling Result at Offshore of Ndayane

The project site has a lagoon and a river to the south of the lagoon. During the dry season, the lagoon and the river have low flow rates and little impact on the site, but during the rainy season, discharge increases and runoff with turbidity occurs when rainfall occurs. Figure 3.241 left is a satellite image taken on September 9, 2022. According to the records, about 20 ml of rainfall occurred in 24 hours on September 8, 2022, and one day later, the turbidity flowed out from the lagoon and the river at the project site. In addition, Figure 3.241 right, taken during the field inspection on July 25, 2023, shows SSC of 27 mg/l in the lagoon and 1,337 mg/l in the southern river after one day of rainfall.



Source: Prepared by JPT based on Sentinel-2A/2B

Figure 3.241 SS Diffusion Situation around Ndayane

(2) Topographical Change based on the Line Survey

The line survey results conducted at the offshore area of Ndayane in 2017 and the same line in December 2022 are compared as shown in Figure 3.242 to verify the characteristics of long-term topographic change.

There is a difference near the shoreline shallower than -3 m depth, where sand drifting is active, due to the effects of seasonal sand drift and sediment discharge from the lagoon. On the other hand, in areas deeper than -4 m depth, there is no significant difference between the 2017 and 2022 results, indicating that no major topographic changes have occurred.

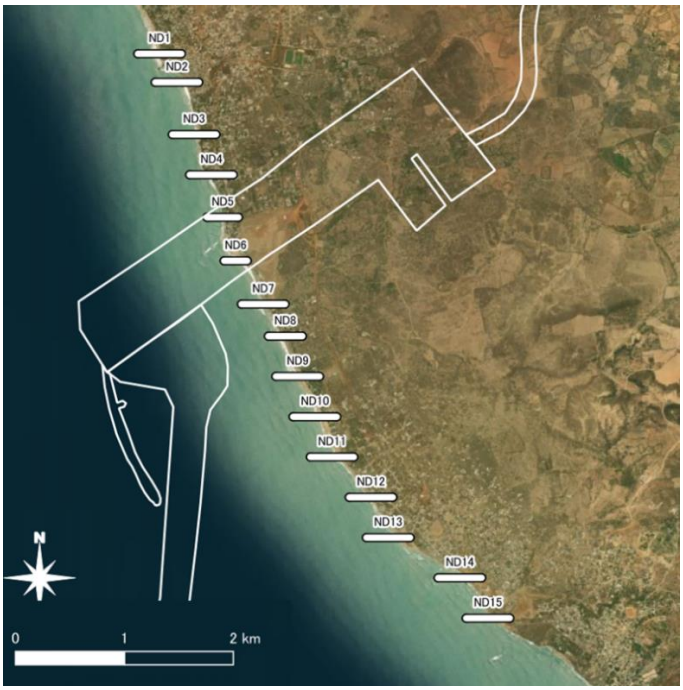
Source: JPT

Figure 3.242 Comparison of Line Survey Result at Offshore of Ndayane in 2017 and 2022

(3) Shoreline Change based on Satellite Image Analysis

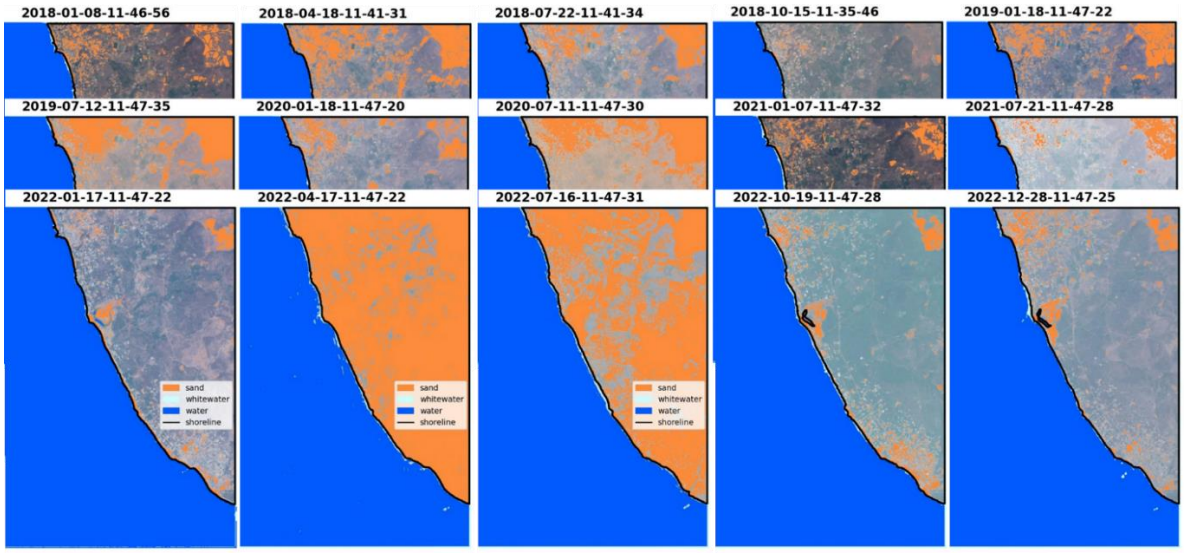
Satellite images were used to extract the shoreline changes around Ndayane from 2018 to 2022. Details of used satellite images are shown below. The extracted area is shown in Figure 3.243, and an image of the extracted area is shown Figure 3.244.

Satellite	Mission	Extracted Period	Scene	Used Band	Resolution
Sentinel-2 (MSI)	COPERNICUS	2018/1/8 ~2022/12/28	367 set	R, G, B, NIR SWIR1	10m 20m



Source: Prepared by JPT based on Sentinel-2A/2B

Figure 3.243 Shoreline Extraction Points around Ndayane

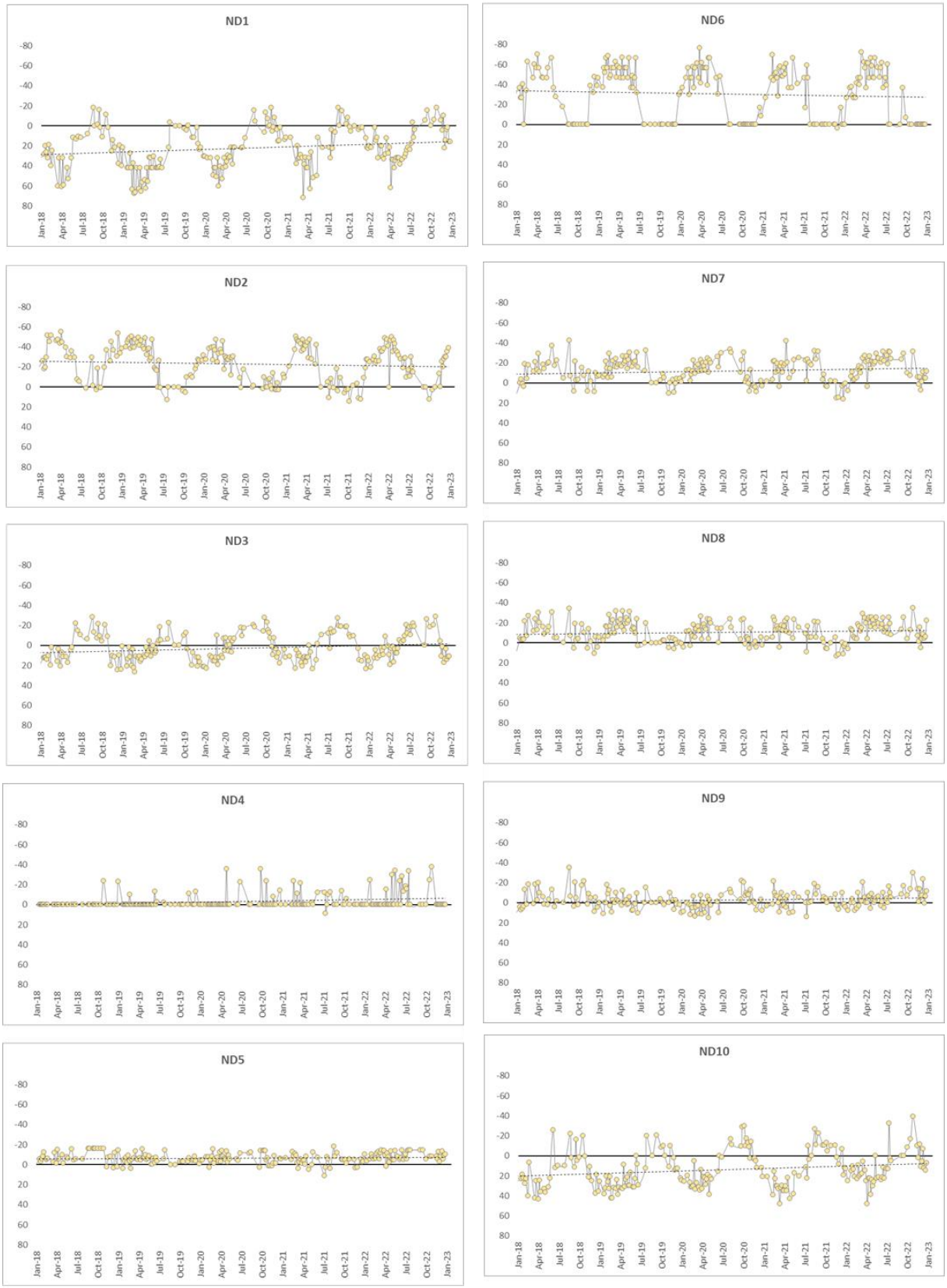


Source: Prepared by JPT based on Sentinel-2A/2B

Figure 3.244 Shoreline Extraction Image using Satellite Images

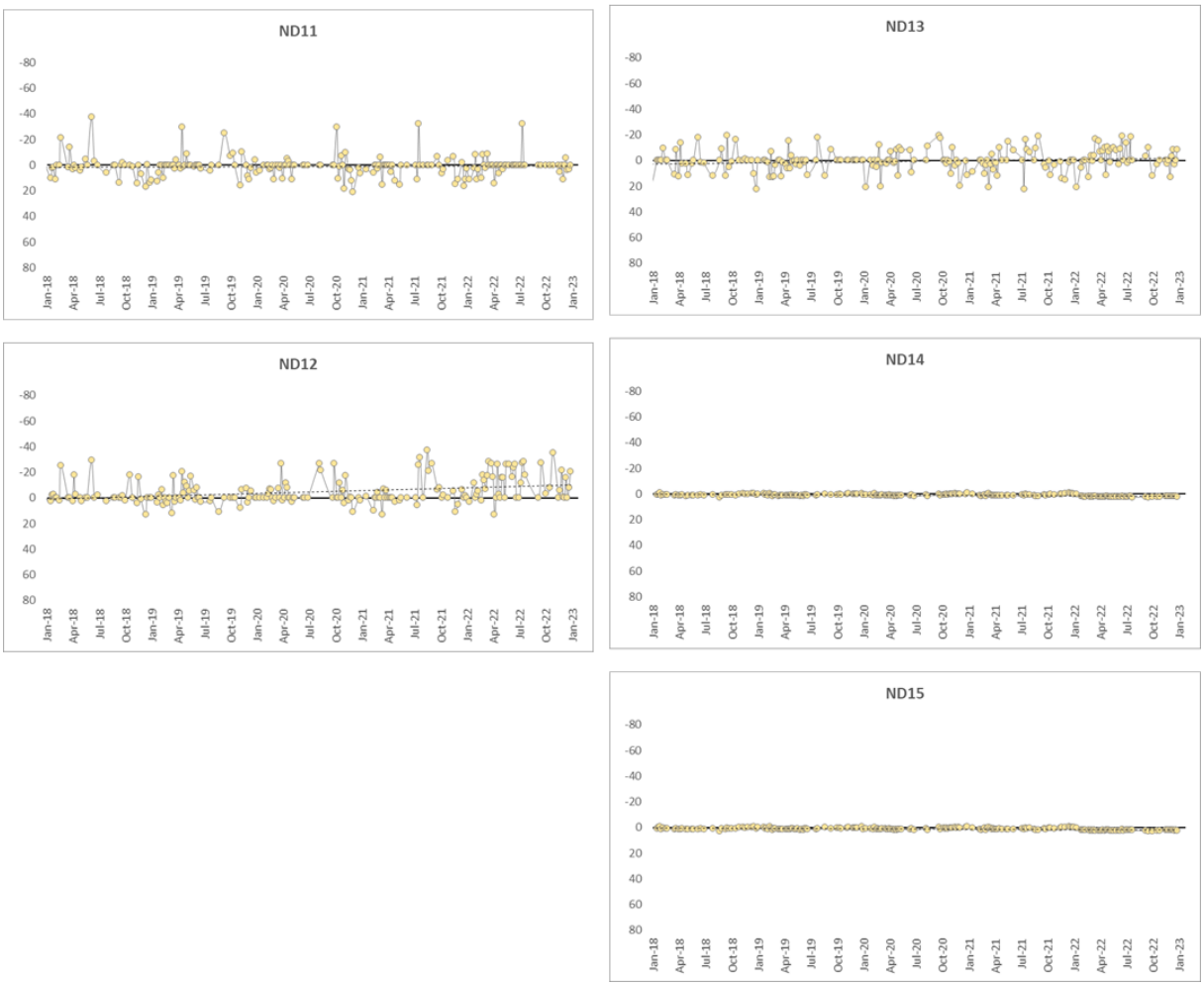
The extracted shoreline changes at each section are shown in Figure 3.245 and Figure 3.246. The horizontal axis of the figure is the time series from January 2018 to December 2022, and the vertical axis is the amount of shoreline change (m), with positive values representing shoreline advance (accretion) and negative values representing shoreline retreat (erosion). Characteristic shoreline changes are shown below.

- ND1 and ND2 are located to the north and south across a groin at north side of Ndayane. At ND1, the shoreline tends to advance during the dry season and retreat during the rainy season. On the other hand, ND2 shows the opposite trend to ND1, where the shoreline retreats during the dry season and advances during the rainy season. This may be caused by an effect of the groin obstructing the sand drift that predominates from north to south during the dry season and from south to north during the rainy season. This trend is repeated every year, but the amount of shoreline change over the total 5-year period is not significant.
- The amount of shoreline changes in ND4 and ND5 is small. This area was originally an area where there were no sandy beaches and cliffs were formed, and this may be caused due to the fact that sand does not settle in this area.
- From ND6 to ND9, there is a trend of shoreline retreat during the dry season and shoreline advance during the rainy season with the similar trend of ND2. The trend is more prominent at ND6, and degreases toward south. The trend is reversed when reaching ND10. This may be because the beach rocks between ND9 and ND10 obstructs the sand drift.
- Shoreline change is smaller from ND10 to the south, and disappears at ND14 and ND15. The angle of the shoreline has changed from ND10, indicating a change in the energy of the waves affecting the shoreline.



Source: JPT

Figure 3.245 Extracted Shoreline Changes from ND1 to ND10



Source: JPT

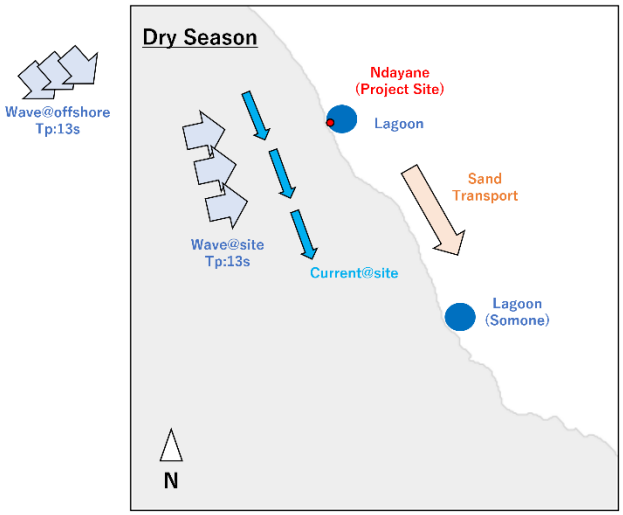
Figure 3.246 Extracted Shoreline Changes from ND11 to ND15

3.16.2 Analysis of Topographic Change Factor

Thes above-mentioned results indicate that there is a difference in shoreline change between the dry and rainy seasons, and that this difference is due to variations in wave and current characteristics. Therefore, it is necessary to consider the mechanism of topographic change for each season.

- Mechanisms of topographic change during dry season

  The mechanism of topographic change estimated to be occurring during the dry season is shown in Figure 3.247 At offshore of Ndayane, swell waves striking from the north are predominant. These waves are affected by diffraction on the Cape Verde Peninsula and enter at directions with W to WSW angle toward the shoreline of Ndayane. Then, the waves are incoming from slightly north relative to the shoreline, and the sediment tends to move from north to south.

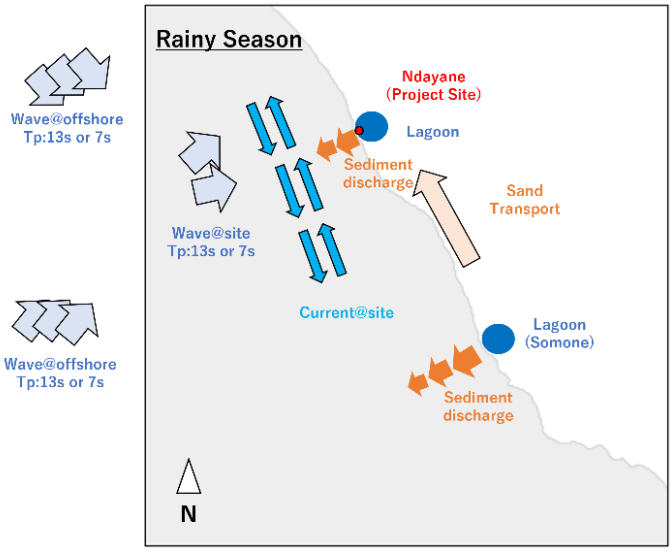


Source: JPT

Figure 3.247 Mechanisms of Topographic Change during Dry Season

➢ Mechanisms of topographic change during rainy season

On the other hand, swell waves and wind waves striking from both the north and south are occurred during the rainy season. At the nearshore area of Ndayane, although swell and wind waves arrive with directions from W to SW angles, the angle from WSW to SW, which enter from the south relative to the shoreline, is slightly dominant, and sand drift from south to north is dominant. In addition, during the rainy season, sediments are discharged from the lagoons of Ndayane and Somone, and the alternating northward and southward flow may deposit sediments in the Ndayane.



Source: JPT

Figure 3.248 Mechanisms of Topographic Change during Rainy Season

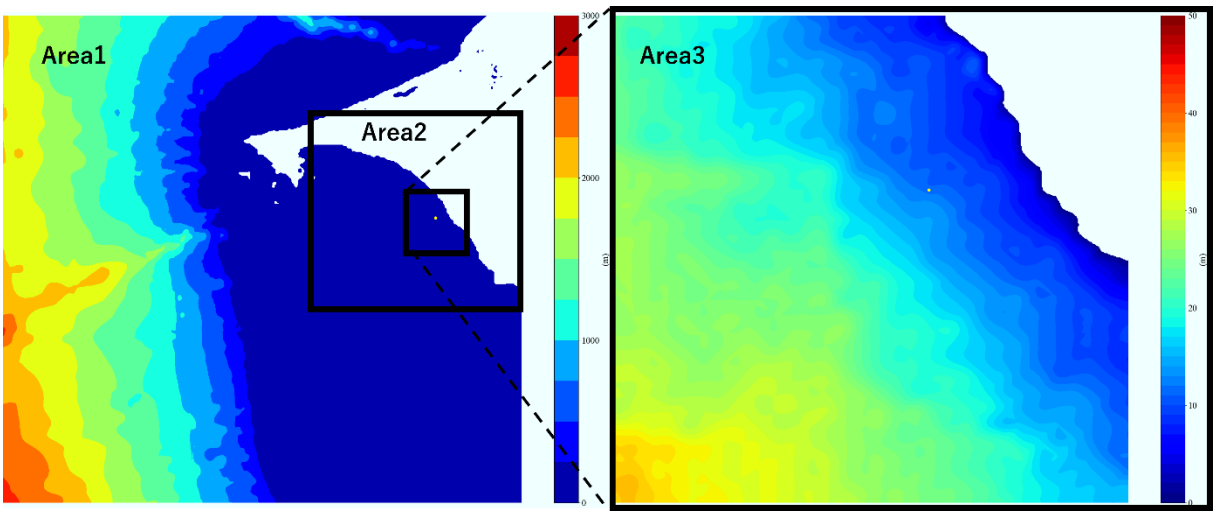
3.16.3 Reproduction Analysis of Topographic Change

Based on the mechanisms described above, the reproducibility of actual topographic changes is verified. First, the external forces (wave and current fields) that cause topographic changes are reproduced. Next, reproduction of shoreline changes for which information on changes has been obtained and sedimentation at offshore in Ndayane area are examined.

(1) Reproduction of External Force Conditions

a) Reproduction of Wave Field

In this study, SWAN (Simulating WAves Nearshore, Cycle 3 Ver. 41.41) developed at Delft University of Technology was used as a wave estimation model for the Ndayane coastal area. In this calculation, nesting technique is performed. Figure 3.249 shows each calculation area and Table 3.228 shows the calculation conditions.



Source: JPT

Figure 3.249 Calculation Area of Each Step for Wave Estimation Model at Ndayane Area

Table 3.228 Calculation Conditions for Eave Estimation Model at Ndayane Area

Calculation conditions	➢ Area1	➢ Area2	➢ Area3
➢ Calculation Scope	➢ N14W18～N15W17	➢ N14.4W17.4～N14.8W17	➢ N14.5W17.25～ ➢ N14.625W17.125
➢ Number of Grids	➢ 483 x 487	➢ 453 x 457	➢ 453 x 457
➢ Grid Space	➢ 270 m	➢ 90 m	➢ 30 m
➢ Time Interval	➢ 30 min		
➢ Bathymetry Data	➢ GEBCO		➢ Bathymetric Survey ➢ (2017.09)
➢ Tide Level	➢ M.S.L.		
➢ Incident Wave	➢ ERA5 swell data	➢ Calculated values for Area 1	➢ Calculated values for Area 2
➢ Wind Direction and Speed	➢ ERA5 wind direction and speed data		
Number of Directional Spectral Divisions	➢ 36		
➢ Frequency Spectral Width	➢ 0.0418～1.17468		
➢ Frequency Spectrum Division Number	➢ 36		
➢ Whitecap Wave Breaking Theory based on Energy Dissipation	➢ Komen et al. (1984). ➢ (C_{ds}=0.59×10^{-5}、$\bar{S}_{PM}$= 3.02×10^{-3})		
Energy Transfer Term	➢ Cavaleri and Malanotte (1981)		
➢ Friction Term	➢ Hasselmann et al., 1973, JONSWAP		

Source: JPT

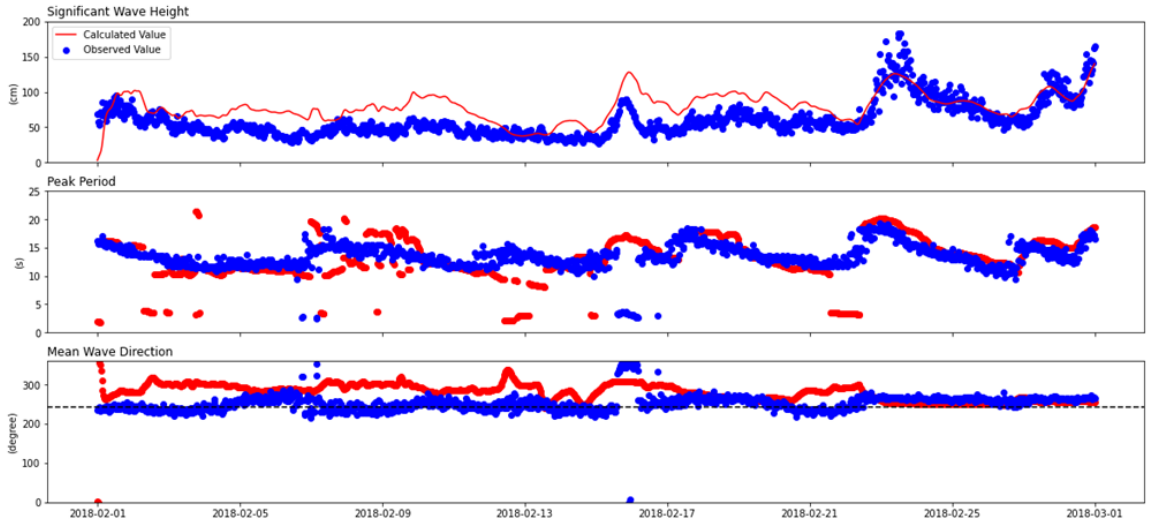
Reproduction calculation and accuracy verification of wave estimation

To confirm that the above model reproduced the wave characteristics of the Ndayane area, observed and calculated values at the sites where wave observations were conducted were compared. Since the wave characteristics varies significantly during the dry and rainy seasons in the Ndayane area, the accuracy of results was verified for each season.

➢ Verification during the dry season

Figure 3.250 compares observed and calculated values during the dry season, February 1 to February 28, 2018. Although the calculated values slightly overestimate the observed values of significant wave

heights (upper figure), the trend of the variability is accurately represented. In terms of peak period (middle figure), the dominance of swell waves during the dry season is reflected in the calculated results. The time series of wave direction (bottom figure) shows that in February 2018, north-incident and south-incident waves in the offshore direction are observed alternately. On the other hand, the calculated results show that the majority of the waves are north-incident and do not reproduce the phenomena observed in the observed results. Therefore, when calculating shoreline change, adjustments should be made so that the observed and set wave energies match. (See Table 3.133)

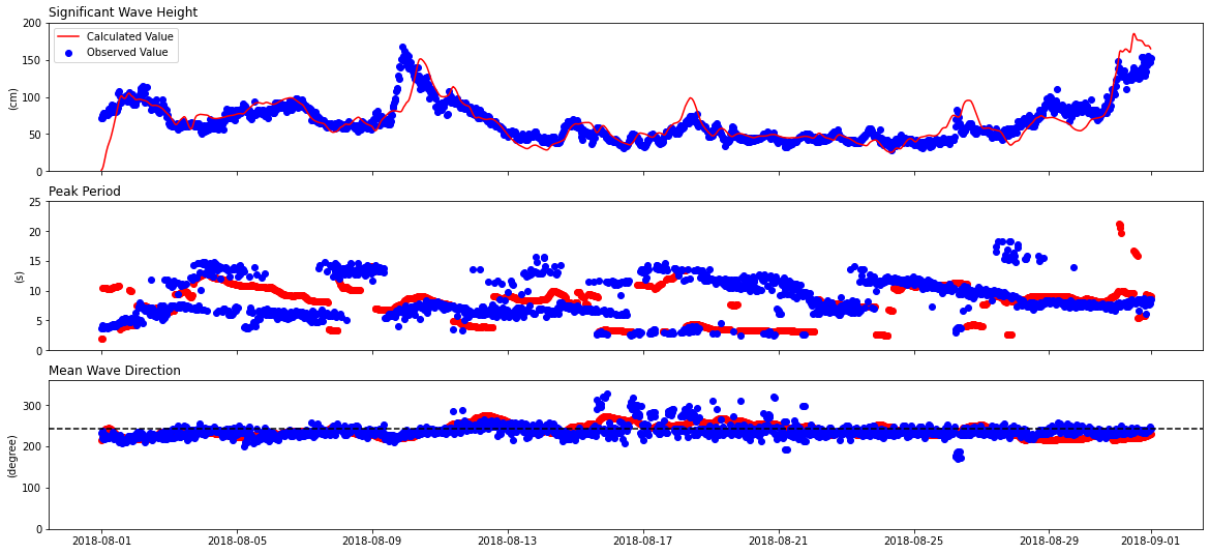


Source: JPT

Figure 3.250 Comparison of Calculated and Observed Waves (Dry Season: February 2018)

➢ Verification during the rainy season

Figure 3.251 compares observed and calculated values during the rainy season, August 1 - August 31, 2018. The calculated values of significant wave heights reproduce the observed value well (upper figure). In terms of peak period, the figure well represents the characteristic of alternating swell waves and wind waves during the rainy season (middle figure). The reproducibility of wave direction (bottom figure) is also good.



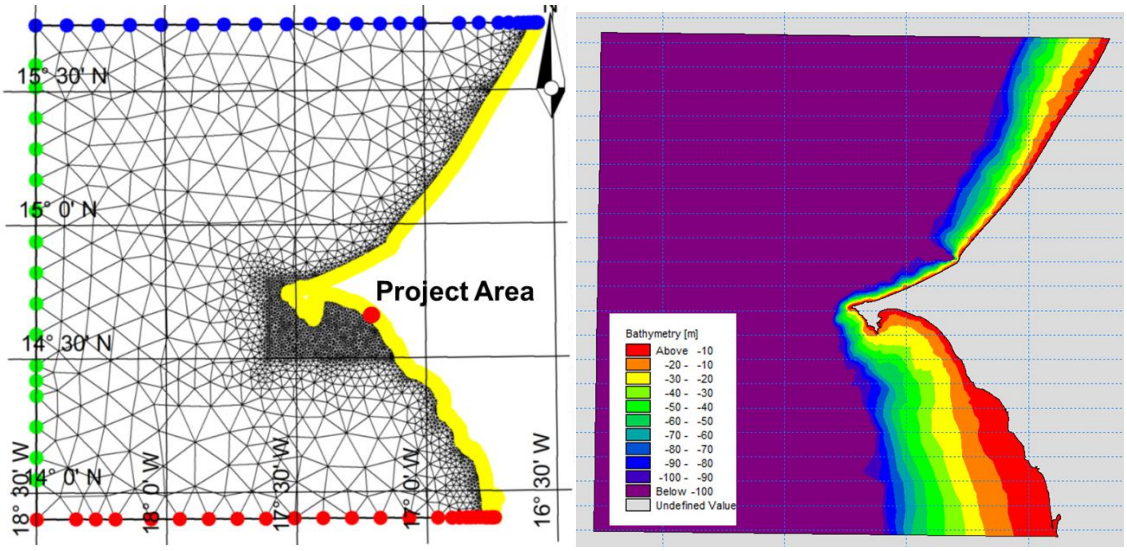
Source: JPT

Figure 3.251 Comparison of Calculated and Observed Waves (Rainy Season: August 2018)

The model accuracy in reproducing the wave characteristics at offshore area of Ndayane is enough, as it is able to represent the wave characteristics well in both the dry and rainy seasons.

b) Reproduction of Current Field

In this study, MIKE21/3 HD module developed by DHI was used to reproduce the flow field in the Ndayan coastal area. the module is a flow model based on the Three-dimensional incompressible Reynolds averaged Navier-Stokes equations. Figure 3.252 shows the computational domain and Table 3.229 shows the computational conditions.



Source: JPT

Figure 3.252 Computational Domain of Current Field

Table 3.229 Computational Conditions of Current Field

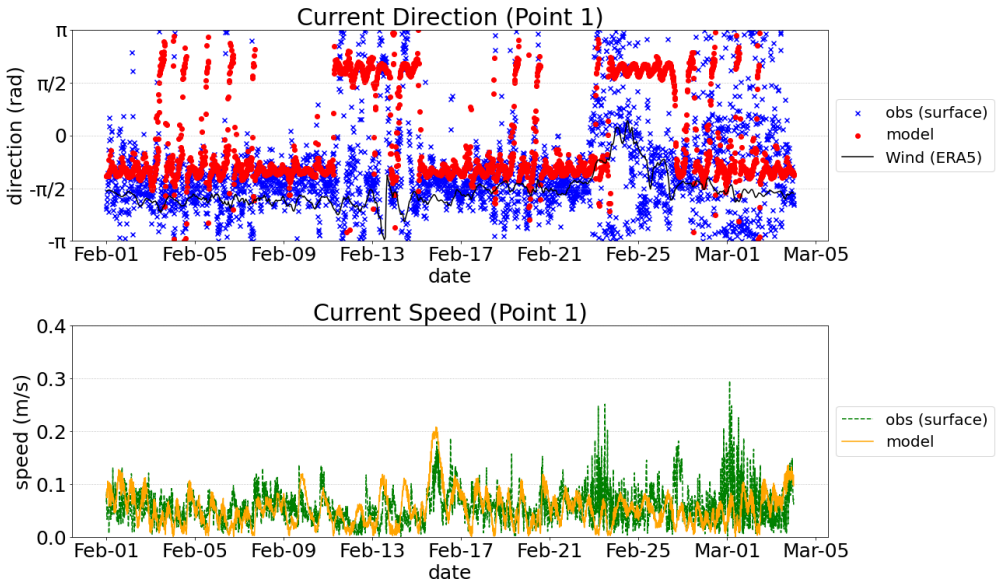
Bathymetry Data	GEBCO (15 seconds) and Chart Large area: approx. 10 km, Target area: approx. 100 m
Computational Period	Dry season: Feb 2018 Rainy season: Aug 2018 (pre-calculation 5days)
External Forces	Wind: ERA5/ECMWF Reanalysis (1 hour interval)
Boundary Conditions	Water Level: Global Tide mode by DTU Space (0.125º x 0.125º resolution)

Source: JPT

To confirm the reproducibility of the current field in the Ndayane coastal area, the observed current field was compared with the calculated current field. Since the flow characteristics differ between the dry and rainy seasons in the Ndayane coastal area, the verification was conducted for each season.

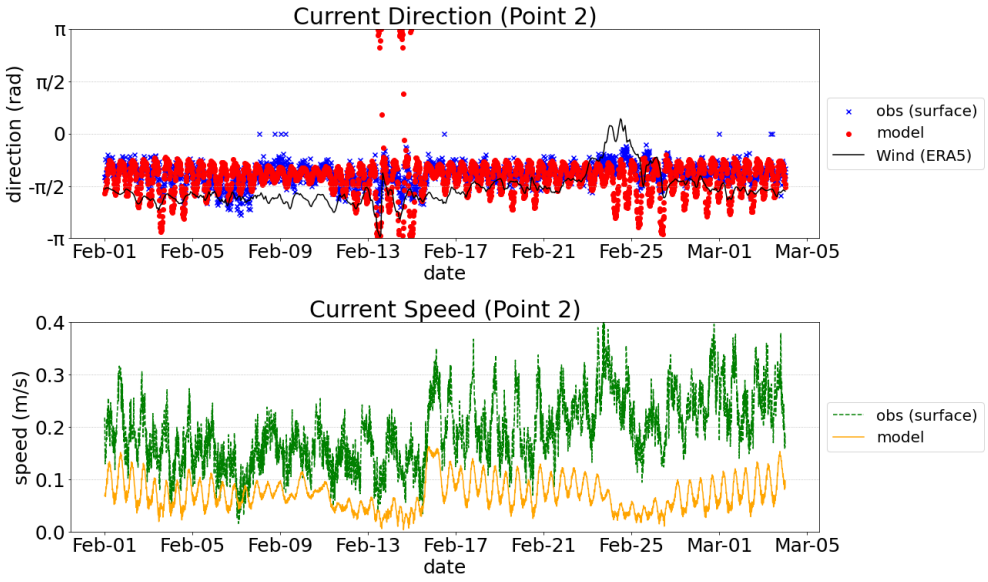
- Verification during the dry season

During the dry season in this region, southward flow dominates at offshore (Point 2), and the calculation result shows a similar trend. Although the flow velocities tend to be underestimated at offshore, the velocity at the Point 1 located on the landward side is consistent.



Source: JPT

Figure 3.253 Comparison of Calculated and Observed Current at Point1 (Dry season: February 2018)

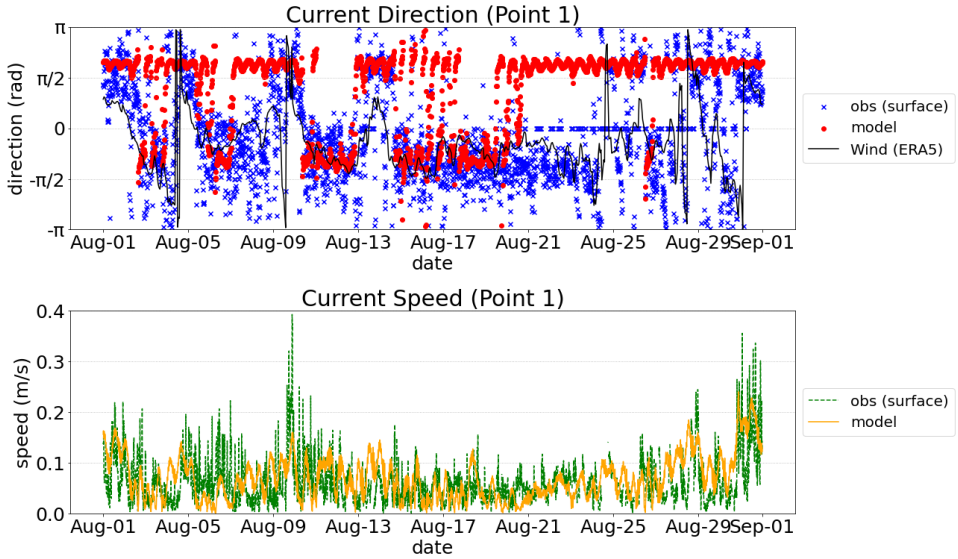


Source: JPT

Figure 3.254 Comparison of Calculated and Observed Current at Point2 (Dry season: February 2018)

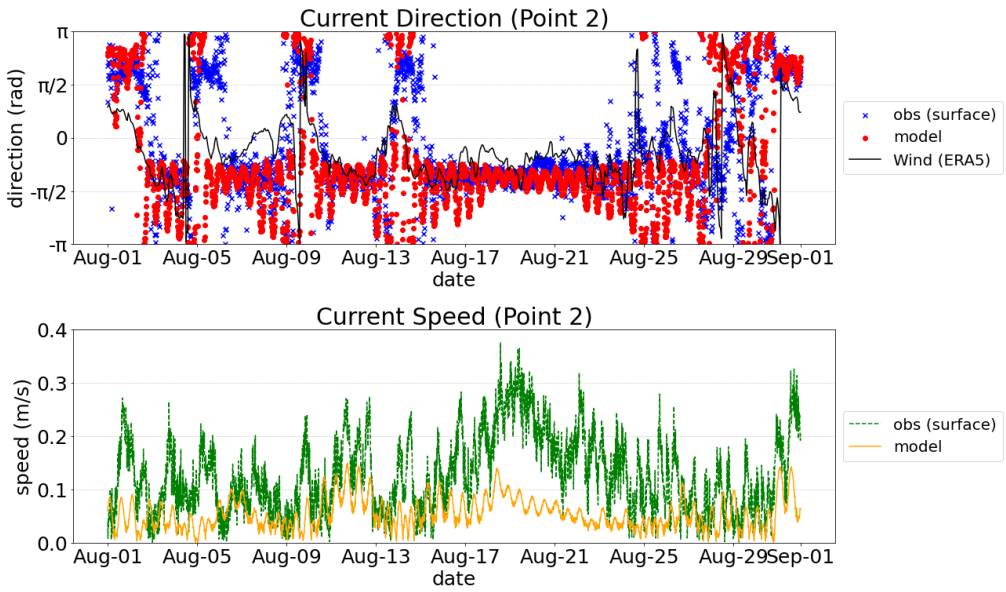
➢ Verification during the rainy season

During the rainy season in this region, alternating southward and northward flow every few days was shown in the observed result, and the calculations show the same tendency. Although the flow velocities tend to be underestimated at offshore, as in the dry season, the velocity at the Point 1 located on the landward side is consistent.



Source: JPT

Figure 3.255 Comparison of Calculated and Observed Current at Point1 (Rainy season: August 2018)



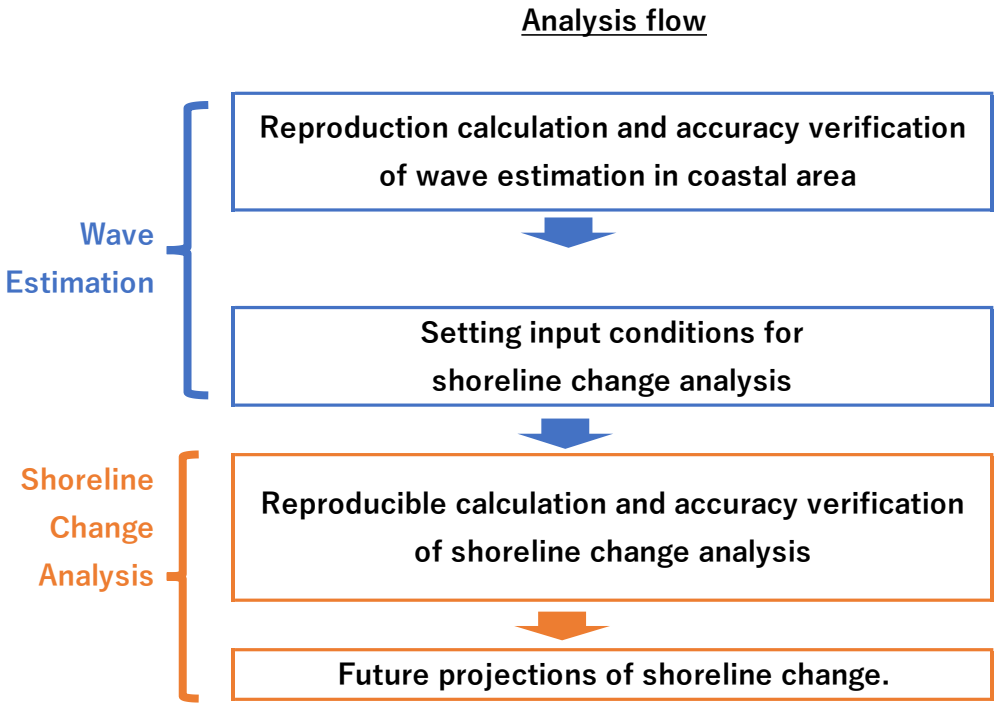
Source: JPT

Figure 3.256 Comparison of Calculated and Observed Current at Point2 (Rainy season: August 2018)

Although the model tends to underestimate current velocity offshore in both the dry and rainy seasons, it is judged that the model can be used to evaluate topographic change in the coastal areas of the target area for topographic change, since both velocity and direction in the coastal areas are well represented in the model.

(2) Shoreline Change Analysis (one-line-model)

The study flow of shoreline change analysis is shown in Figure 3.257.



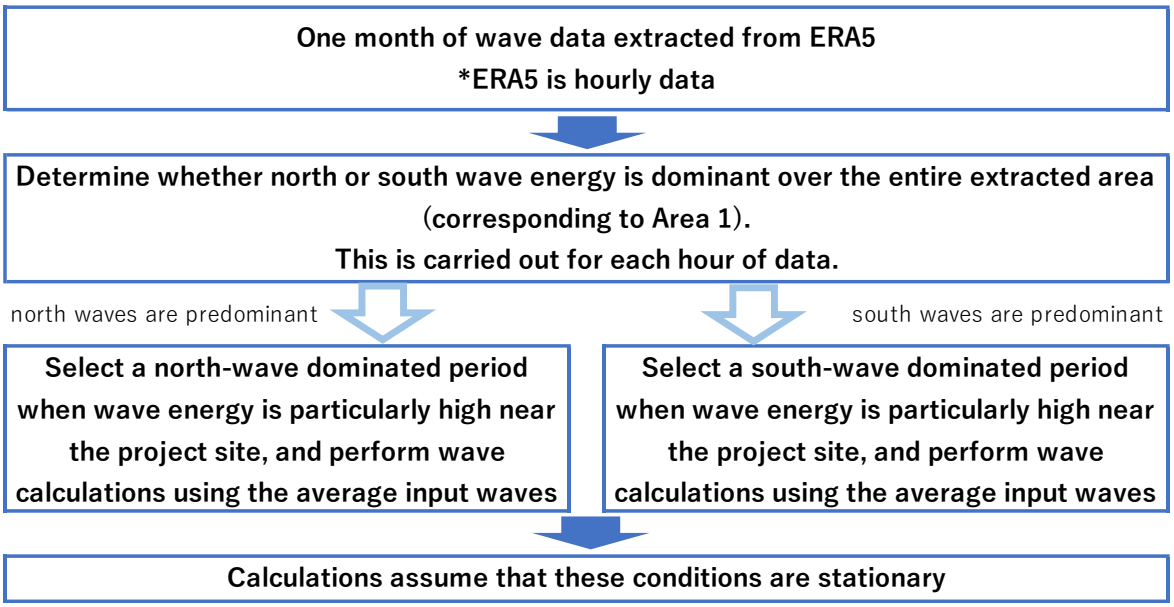
Source: JPT

Figure 3.257 Study Flow of Shoreline Change Analysis

Wave fields for use in the shoreline change analysis

The above model, whose reproducibility was confirmed, was used in the calculations to create the wave input data used in the shoreline change analysis. The shoreline change analysis is conducted throughout the year, changing the wave conditions each month. Monthly wave conditions were set based on the flow shown in Figure 3.258, distinguishing between north waves (waves coming from the north) and south waves (waves coming from the south).

A table comparing the observed and set energy mean wave heights in February and August 2018 is shown in Table 3.230. For the aforementioned reasons, there is a difference between the observed and set wave energies, and in the next step of calculating shoreline change, the set wave energy must match the observed wave energy. Therefore, the difference in energy between observed and setting waves was taken as a bias generated by the wave calculation model used in this study, and the action time was adjusted so that the total energy of setting waves for the full year (October 2017 to October 2018) is equal to the total energy calculated from wave observations for the same period.



Source: JPT

Figure 3.258 Study Flow of Wave Estimation at Ndayane area

Table 3.230 Comparison of Monthly Energy-averaged Wave Heights for Calculations

Period	Dominant Wave	"Observation" of Energy-averaged wave height(m)	"Observation" of Duration (hour)	"Setting" of Energy-averaged wave height(m)	"Setting" of Duration (hour)	adjustment coefficient	Adjusted "Setting" of Duration (hour)
2018/2	southward propagating wave	0.73	445	0.88	672	0.407	273
	northward propagating wave	0.53	227	-	0	0.591	0
2018/8	southward propagating wave	0.60	154	0.35	449	0.407	182
	northward propagating wave	0.70	590	0.73	295	0.591	174

Source: JPT

Shoreline change analysis model (one-line-model)

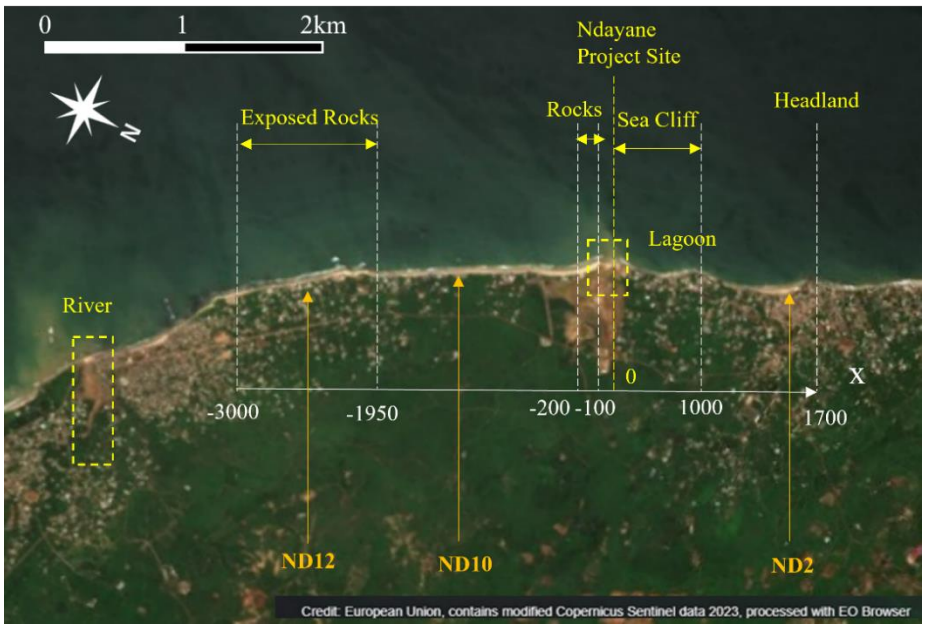
In this study, the one-line-model was used to calculate shoreline change at Ndayane. The one-line model is a model based on the balance of longshore drift (littoral drift) and is a widely used long-term shoreline change prediction method, consisting of the following continuous equation and a littoral drift formula.

Continuous Equation： $\frac{\partial x_s}{\partial t} + \frac{1}{D_s}\left(\frac{\partial Q}{\partial y} - q\right) = 0$

Littoral Drift Formula： $Q = \left(H^2 C_g\right)_B (K_1 \sin 2\alpha_{BS} - K_2 \cos \alpha_{BS} \frac{\partial H_B}{\partial y})$

Whereas, xs is the shoreline position from the baseline, Ds is the sand movement height, Q is the amount of littoral drift, q is the sediment movement in the offshore direction, H is the wave height, Cg is the group velocity, αBS is each breaking wave relative to the shoreline and HB is the breaking wave height K1 and K2 are non-dimensional coefficients, mainly used for calibration to improve the accuracy of the prediction model. K1 and K2 are dimensionless coefficients used mainly for calibration to improve the accuracy of the prediction model. The following values were adopted in this study as a result of calibration.

$$K_1 = 0.31, K_2 = 0.5022$$



Source: Prepared by JPT based on Copernicus Sentinel data in Jan 2023 processed by Sentinel Hub

Figure 3.259 Calculation Area of Shoreline Change Analysis（Reproduction）

Table 3.231 Calculation Conditions of Shoreline Change Analysis（Reproduction）

Calculation Condition	Shoreline change when southward propagating waves dominate.	Shoreline change when northward propagating waves dominate
Calculation Periods	2017/11/20 ~ 2022/12/31	
Calculation Area	4.9 km of coastline above.	
Coastal Directional Interval	10 m	
Incident Wave	Wave estimation under steady state conditions (30m grid spacing) under the prevailing conditions of each wave direction based on ERA5 data for each month is used Linear interpolation is performed to produce data at 10 m intervals.	
Duration	Periods of southward propagating wave dominance in ERA5 data for each month multiplied by the coefficient (0.407)	Periods of northward propagating wave dominance in ERA5 data for each month multiplied by the coefficient (0.591)
Initial Topography	2017/11: Shoreline position in satellite image on November 20, 2017 2018/01-12: Shoreline position of the previous two months plus shoreline change due to north waves and southward shoreline change in the previous month	
Breakwater Depth	4.68 m ＊Calculated from observations	
Sand Movement Height	7.9 m (depth of movement limit) + 1.5 m (berm height) ＊Calculated from observations	
Drifting sand in the offshore direction	Consider sediment inflow from lagoons on the project site (Shoreline change and sediment drift were adjusted to values that reproduce the actual condition of the site.)	
Boundary Condition	North boundary (x=-1700) is a structural boundary (considers the Headland) Southern boundary (x=-3000) is a free boundary	

Source: JPT

Calculation results and accuracy verification of one-line-model

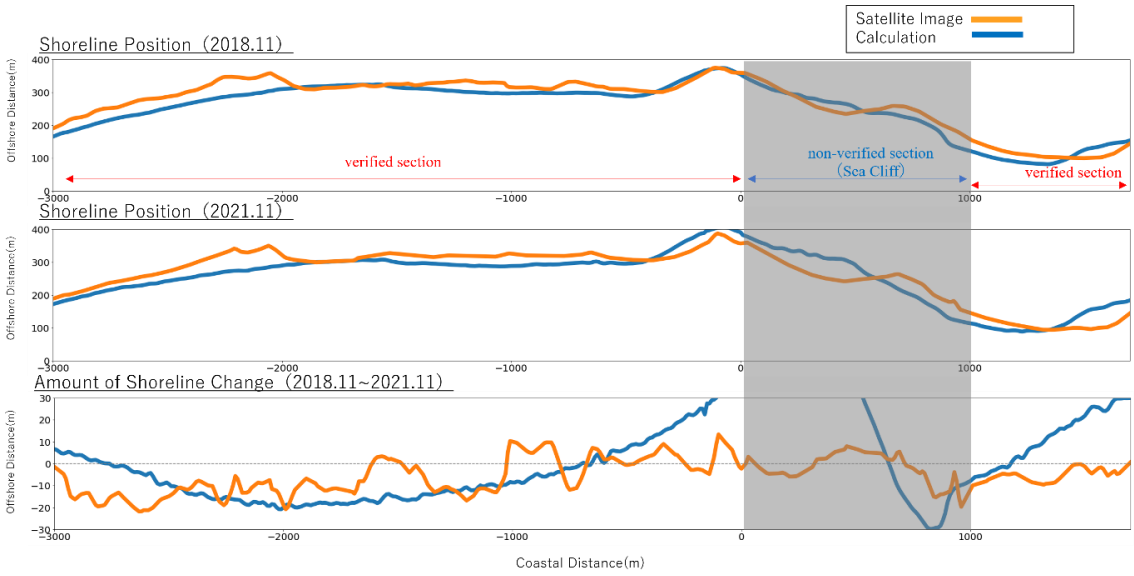
The accuracy of the one-line-model used in this study was evaluated from the following three perspectives.

- Reproducibility of horizontal distribution in shoreline position
- Reproducibility of seasonal variation in shoreline position
- Reproducibility of the amount of longshore sediment transport

a) Reproducibility of horizontal distribution in shoreline position

Figure 3.260 compares the satellite-imaged shoreline position with the calculated shoreline position on the beach in question. Note that the beach includes a section of sea cliff with almost no sand width, but this section is not included in the verification. The upper figure shows the shoreline position in November 2018, and the middle figure shows the shoreline position in November 2021. The lower figure also compares the amount of shoreline variation over the same period (November 2018-November 2021).

From the upper and middle figures, the calculated shoreline positions on each day generally agree with the actual positions and the bottom figure adequately shows the horizontal distribution of shoreline variation. From these results, it can be concluded that the one-line-model used in this study is able to reproduce the topographic changes near the project site.

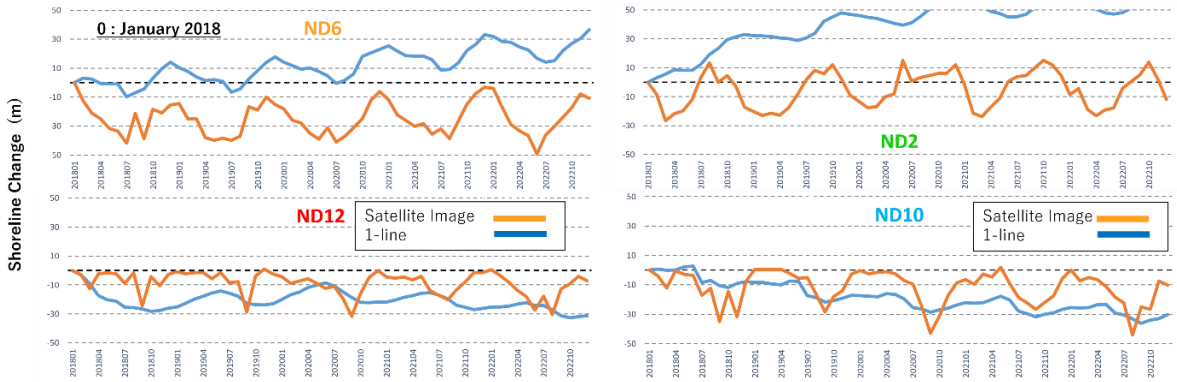


Source: JPT

Figure 3.260 Verification of Horizontal Reproducibility of Shoreline Positions

b) Reproducibility of seasonal variation in shoreline position

Shoreline variation obtained by satellite image analysis was compared with calculated shoreline variation in time series at the four sites shown in Figure 3.261 (ND2, ND6, ND10, and ND12), which have different shoreline change characteristics, to confirm the reproducibility of seasonal variation at each site. For both satellite imagery and calculated values, the January 2018 values were used as a reference, and the variation from the reference is plotted. Although ND2 is outside the area of the bathymetry survey conducted by DPW in 2017 and has not been able to reproduce shoreline fluctuations, the calculation results at ND6, which is closest to the project site, well reproduces the timing of the shoreline position advance/recession in the satellite image. The calculation also reproduces the close trend of variation in the southern part of the coast (ND10 and ND12) in the satellite image. Therefore, it can be concluded that the one-line-model used in this study is able to reproduce the seasonal characteristics of topographic change near the Project site.



Source: JPT

Figure 3.261 Reproducibility of Seasonal Variation in Shoreline Position

c) Reproducibility of the amount of longshore sediment transport

To confirm the accuracy of the littoral drift calculations, the results of line surveys conducted near the project site in December 2022 and September 2023 were used to calculate the volume of longshore sediment transport for a period of approximately 9 months and compared to the calculated values at the same location. As the calculation period does not include the line survey period, the calculated values are for the period from December 2021 to September 2022. Since the years compared between the measured and calculated values are different, this verification is only to determine if the direction of seasonal littoral drift is reproduced. The results of the comparison are shown in Table 3.232. Although there are differences between the surveyed and calculated values, the orders are consistent. In addition, since the amount of longshore sediment transport during the period is positive in both cases, it can be confirmed that the direction of longshore sediment transport is consistent.

Table 3.232 Reproducibility Verification of the Amount of Longshore Sediment Transport

Data Source	Sediment Balance per Unit Width（m3/m）
line survey (22.12~23.9)	+427
one-line-model (21.12~22.9)	+208

Source: JPT

(3) Topographic Change at Offshore in Ndayane Area

As it was not possible to conduct bathymetric survey at offshore area in this study, the amount of long-term trend on topographic changes, which are a target for the reproduction of topographic changes at offshore area, was not obtained. Therefore, the reproduction for each of the factors that have the potential to cause sedimentation based on the information currently available were examined qualitatively. The followings are description of each factor and its reproduction target.

- Topographic changes due to SS discharge from lagoon and rivers

After rainfall, SS runoff is observed from the lagoon and river for about 1 day; SS diffuses over about 1 km offshore (see Figure 3.241).

Seabed soil sampling results in the project vicinity show no silt deposition, and line survey results indicate that no topographic changes have occurred in areas deeper than -4 m water depth (See Figure 3.240 and Figure 3.242).

- Topographic changes due to Sand Transport in Coexisting Wave and Current Fields

Seabed soil sampling results in the project vicinity indicate that although the surface layer is fine sand, no topographic changes have occurred in areas deeper than -4 m depth. (See Figure 3.240 and Figure 3.242)

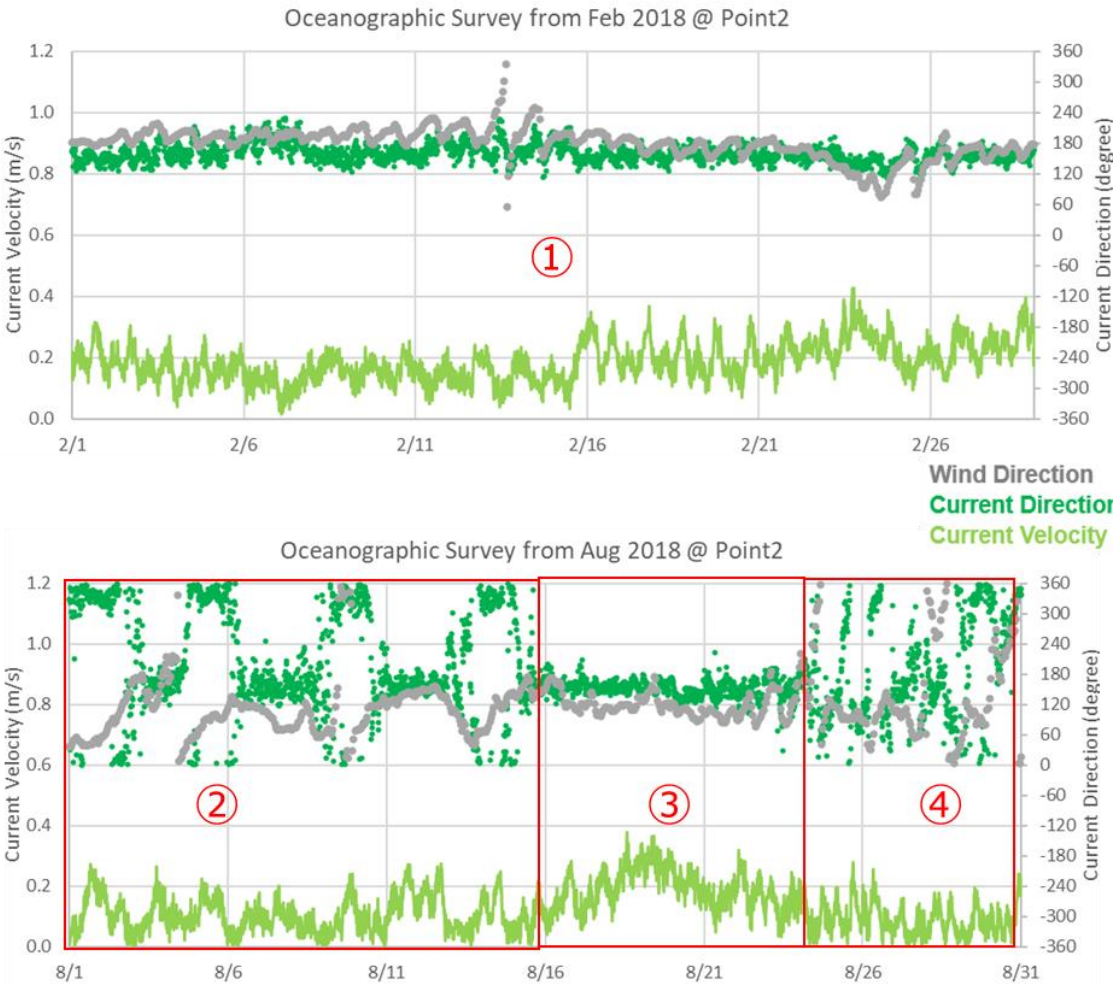
a) Topographic changes due to SS discharge from lagoon and rivers

Topographic changes due to SS discharge from lagoon and rivers was conducted by MIKE21 MT module, which calculates phenomena such as the erosion and deposition of sediment by waves and currents, advection and diffusion of suspended sediment, and sedimentation processes, using the flow field calculated in the previous section as input conditions.

i. Current Flow Condition

The results of the current field reproduction described above are used for this study. Since the current field is related to the wind field, the wind field in the area for 10 years is analyzed and the wind patterns are classified into the following four categories. The flow conditions at the occurrence of the wind field for each pattern are described in Figure 3.262 and the average frequency of occurrence of each pattern is shown in Table 3.233.

① Dry season: southward flow is dominant
② Rainy season: flow direction reverses in 2-3 day cycles
③ Rainy season: southward flow is dominant for more than 4 days
④ Rainy season: current direction reverses in less than 2 days



Source: JPT

Figure 3.262 Current Field Pattern

Table 3.233 Frequency of Occurrence of Current Field Patterns

	(1)	(2)	(3)	(4)
2013	135	47	41	142
2014	160	40	49	113
2015	142	42	57	124
2016	147	46	33	140
2017	138	52	31	141
2018	187	31	40	107
2019	172	34	43	116
2020	145	33	46	136
2021	159	38	31	137
2022	148	47	43	127
Average	**153.3**	**41.0**	**41.4**	**128.3**

Source: JPT

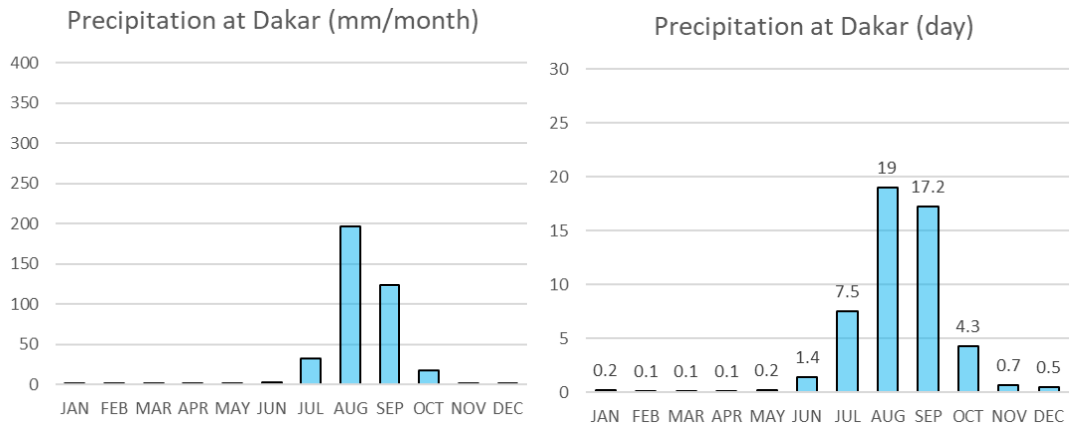
ii. River discharge and SS concentration

The discharge from rivers was estimated from the watershed area at each site, and the SS concentration was estimated based on the field survey results of water sampling conducted after rainfall in the site. The settling velocity was determined by the Stokes equation based on the results of seabed soil sampling results in the site, using a grain size of 0.005 mm as the representative grain size for silt, which has a 3% non-exceedance probability of the grain size identified in the site. SS runoff frequency was assumed to be SS runoff during the first day after rainfall based on the fact that SS runoff was not observed one day after the rainfall during the site visit. The rainfall frequency is based on the number of days of rainfall in Dakar shown in Figure 3.263.

Table 3.234 Computational Conditions of River Discharge, SS Concentrations and Settling Velocity

Computational Period	Rainy Season: August 2018 (pre-calculation: 5days)
River Discharge	Ndayane Lagoon: 200 m3/s Ndayane River: 200 m3/s Somone Lagoon: 1,000 m3/s
SS Runoff	Ndayane Lagoon: 1500 mg/l Ndayane River: 1500 mg/l Somone Lagoon: 200 mg/l
Settling Velocity	2.2×10^{-5} m/s (By Stokes formula: Representative grain size 0.005mm) * 3% non-exceedance probability of the grain size identified in the field.

Source : JPT

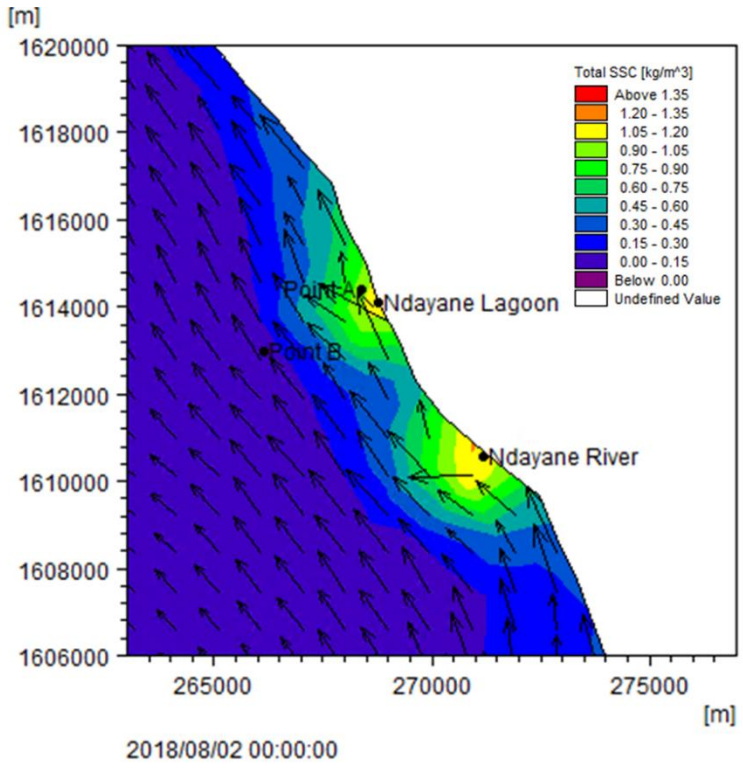


Source : JPT

Figure 3.263 Number of Days of Rainfall in Daka

iii. Reproduction of SS Diffusion

The simulation results of SS diffusion in the current pattern of (2) has the greatest impact on the project site among all flow patterns. The result of this calculation is shown in Figure 3.264. The result shows that SS runoff from the river located in the south of the site reaches the site due to the northward flow that continues for 3 days. The results also indicate that the runoff from the Somone does not affect the project site. This SS diffusion is similar to that shown in the satellite image shown in Figure 3.241.

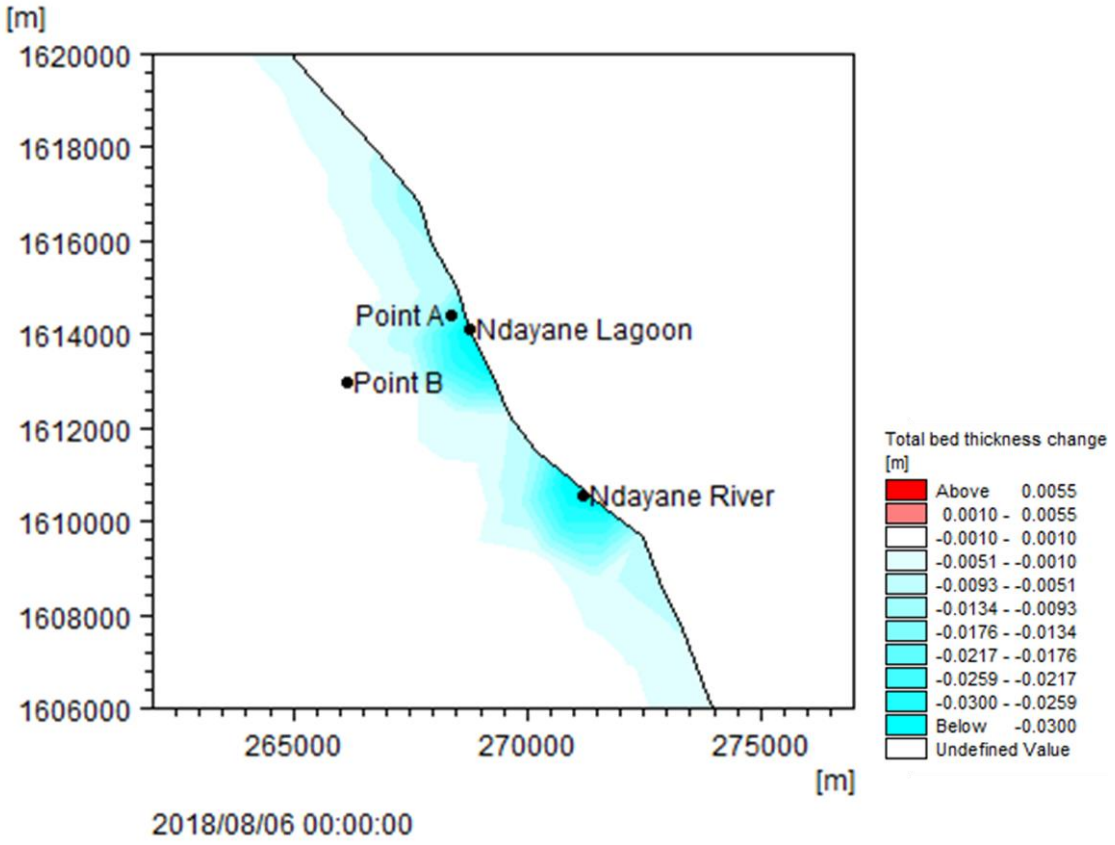


Source: JPT

Figure 3.264 Result of SS Diffusion (Rainy Season: Current Field Pattern (2))

iv. Topographic change due to SS runoff

Figure 3.265 shows the calculated results of topographic change due to SS runoff. Erosion was caused by wave action at nearshore area, but the change on the shore side (Point A in the figure) was about 1mm/day during the 5-day calculation period. The topographic change on the offshore side hardly changed within the calculation period, and the effect on the topography is considered to be even smaller than that on the shore side. The above results indicate that no sedimentation by the SS runoff occurred, which is consistent with the observation that no change in the existing topography occurred.



Source: JPT

Figure 3.265 Topographic Change of SS Runoff (Rainy Season: Current Pattern (2))

b) Topographic Changes due to Sand Transport in Coexisting Wave and Current Fields

Next, topographic changes due to sand transport in a wave/current coexisting field are examined. The MIKE21 ST module is used to calculate the erosion, transport, and deposition of sand under the action of waves and currents as external forces, and to predict the sediment transport rate in the longshore and cross-shore directions based on past findings of relationship between soil conditions and sand transport.

i. Computational conditions

For the current field, the above-mentioned four patterns are considered. For the wave field, the energy-averaged wave field used in the shoreline change analysis described above and high-wave pattern

obtained by extracting the top 5% of the waves in each of the dry and rainy seasons and averaging their energy are taken into account for the calculation. Other calculation conditions are as follows.

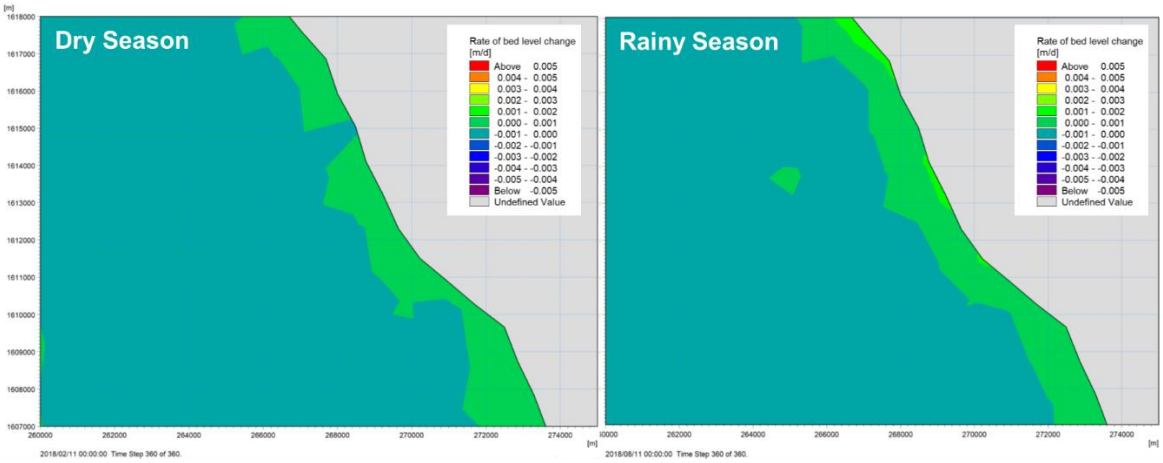
Table 3.235 Computational Conditions of Sand Transport in Coexisting Wave and Current Fields

Computational Period	Dry season: Feb. 2018, Rainy season: Aug. 2018 *For a month with five days pre-calculation
Boundary Conditions	Water Level: Global Tide mode by DTU Space (0.125º x 0.125º resolution) Semidiurnal: M2, S2, K2, N2 - Diurnal: S1, K1, O1, P1, Q1 - Shallow water: M4. by 0.125º x 0.125º
External Force	Wind: ERA5 Grid data (Reanalysis, 1 hour time interval, and 0.25º x 0.25º spatial interval) Wave: Wave estimation results by MIKE21 SW (energy balance equation) with ERA5 wave estimation data as boundary conditions
Seabed Soil Conditions	D50: 0.1mm (Fine Sand) ※Based on the field survey Porosity of the bottom sediment: 0.4 Sediment density: 2.65

Source: JPT

ii. Topographic Changes based on the existing topography

Figure 3.266 shows the results of the calculations. In both dry and rainy seasons, sand transport was observed only in the area close to land. This result is consistent with local observations that no topographic change has occurred on the offshore side.



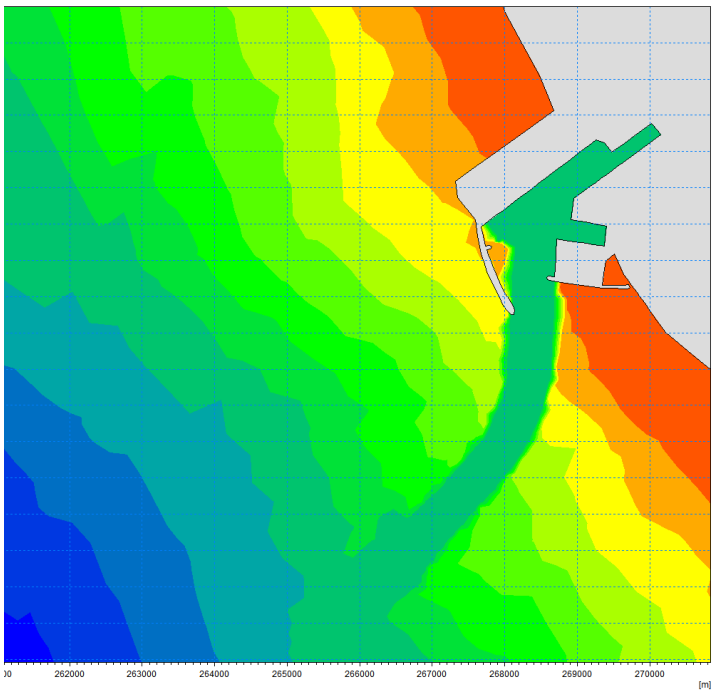
Source: JPT

Figure 3.266 Topographic Changes due to Sand Transport in Wave/Current Coexisting Field

3.16.4 Future Projections of Future Topographic Changes

(1) Future Projections of External Force Conditions

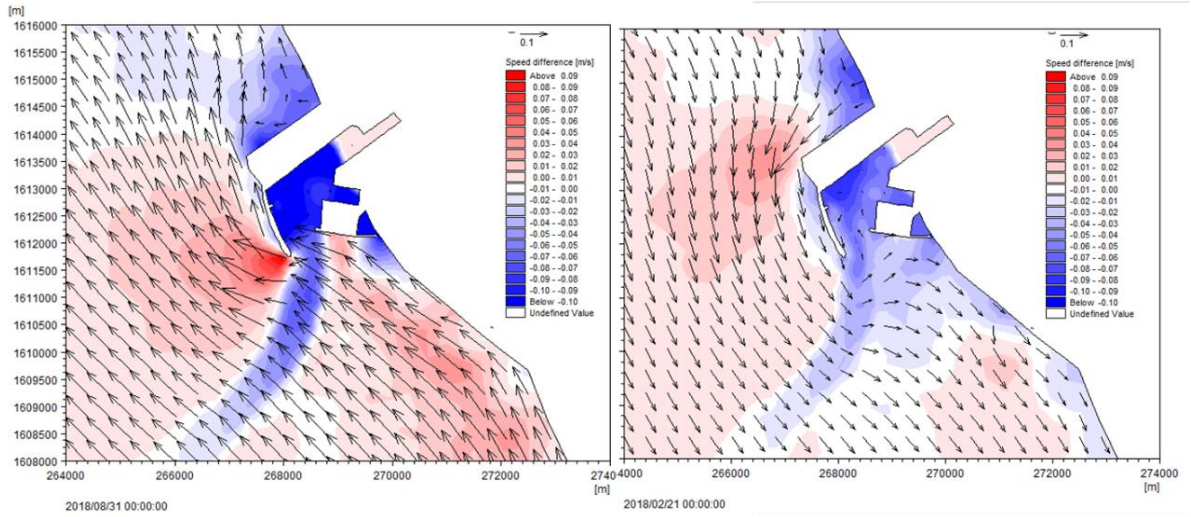
Future projections are made using the model studied above. The topography used for future projections is shown in Figure 3.267.



Source: JPT

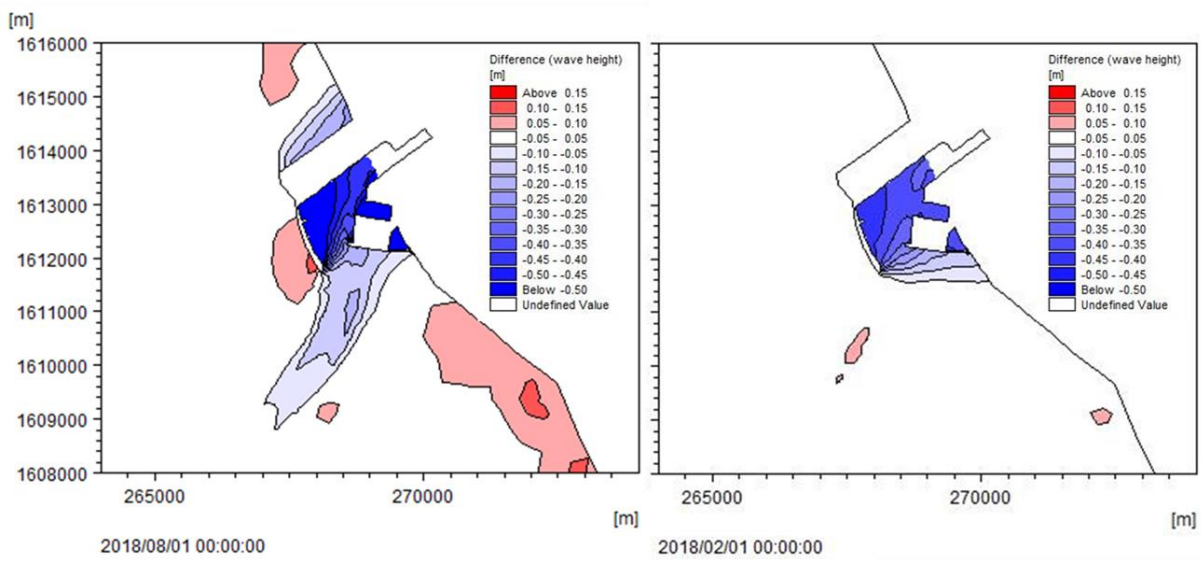
Figure 3.267 Topography Used for Future Projections

Figure 3.268 and Figure 3.269 show a comparison of the current and wave field results calculated under the future topography with those calculated in the above-mentioned reproduction study. It was confirmed that the values of both current and waves were smaller in the harbor due to the breakwater, and also smaller in the navigation channel.



Source: JPT

Figure 3.268 Differences in Current Conditions between Future and Original Topography (Left: Rainy Season, Right: Dry Season)



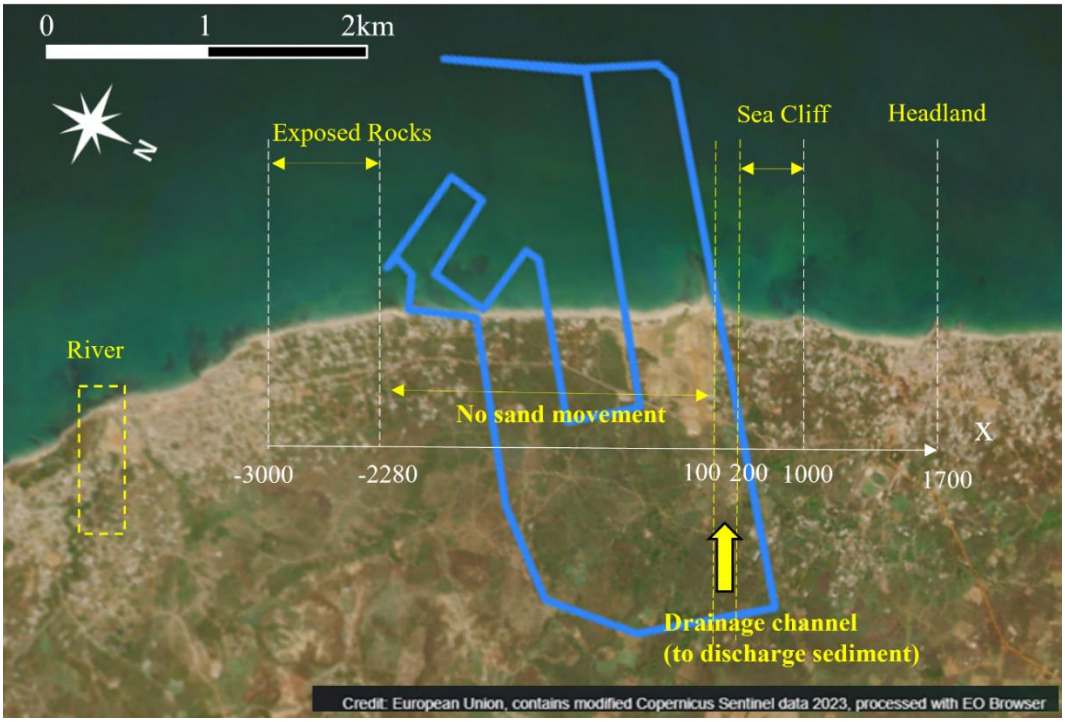
Source: JPT

Figure 3.269 Differences in Wave Conditions between Future and Original Topography (Left: Rainy Season, Right: Dry Season)

(2) Future Projections of Shoreline Changes

a) Calculation Conditions for the Projection

The one-line-model with confirmed reproducibility was used to evaluate the impact of Ndayane Port on the subject coast. In calculating the shoreline change, based on the calculation conditions set in the reproduction calculation, the boundary conditions and the amount of sand drifting offshore were set considering the topography after dredging and reclamation of Ndayane Port, and the calculated wave field results in the future topography were used as input conditions to predict the shoreline change in the future topography. Figure 3.270 shows the computational domain in the future calculations and Table 3.236 shows other computational conditions.



Source: Prepared by JPT based on Copernicus Sentinel data in Jan 2023 processed by Sentinel Hub

Figure 3.270 Computational Domain of Shoreline Change Analysis (Future Projection)

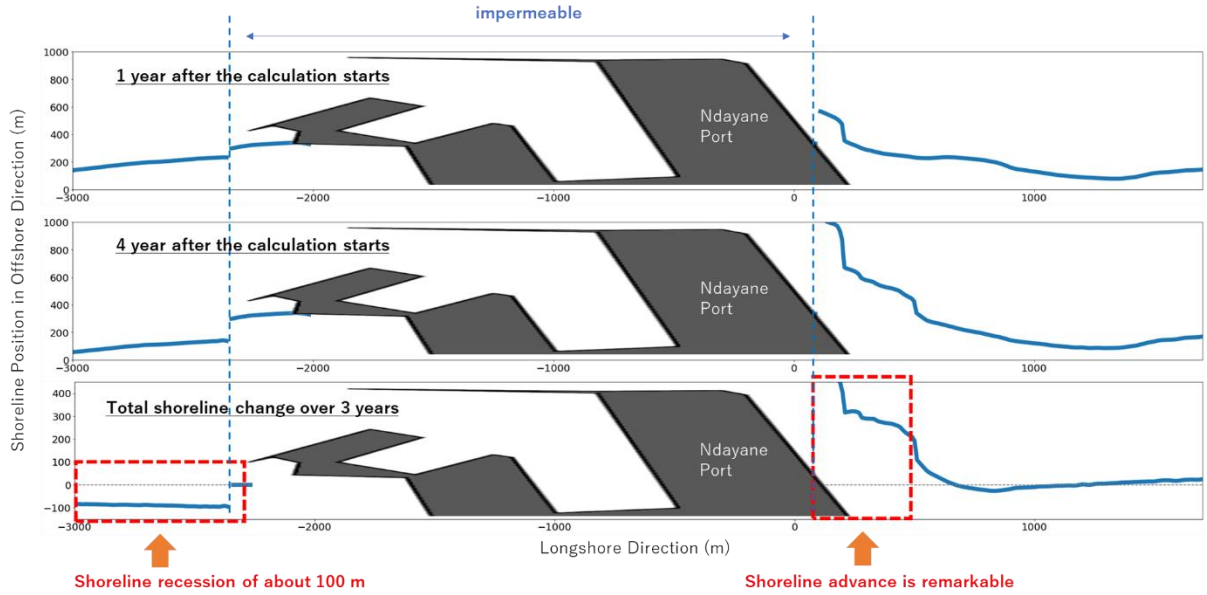
Table 3.236 Calculation Condition of Shoreline Change Analysis (Future Projection)

Calculation Condition	Shoreline change when southward propagating waves dominate.	Shoreline change when northward propagating waves dominate
Calculation Periods	5 years Section except *(-2280≤x≤100)	
Calculation Area	4.7 km of coastline above.	
Coastal Directional Interval	10m	
Incident Wave	Wave field calculated by taking into account future topography Wave estimation under steady state conditions (30m grid spacing) under the prevailing conditions of each wave direction based on ERA5 data for each month is used. Linear interpolation is performed to produce data at 10 m intervals.	
Duration	Periods of southward propagating wave dominance in ERA5 data for each month multiplied by the coefficient (0.407)	Periods of northward propagating wave dominance in ERA5 data for each month multiplied by the coefficient (0.591)
Initial Topography	2017/ 11: Shoreline position in satellite image on November 20, 2017 2018/01 ~ 2022/12: Shoreline position of the previous two months plus shoreline change due to north waves and southward shoreline change in the previous month	
Breakwater Depth	4.68m ＊Calculated from observations	
Sand Movement Height	7.9m (depth of movement limit) + 1.5m (berm height) *Calculated from survey results	
Drifting Sand in the Offshore direction	In accordance with the drainage plan, sediment equivalent to the inflow from the lagoon was drained from the north end of Ndayane Port (100≤x≤200)	
Boundary Condition	North boundary (x=-1700) is a structural boundary (considers the Headland) Southern boundary (x=-3000) is a free boundary The proposed site of Ndayane Port (-2280≤x≤100) was set to zero sand movement as a structure boundary	

Source: JPT

b) Results of the Projection

The following figures are the results of the shoreline change analysis of the future prediction calculations. South of Ndayane Port (-3000≤x≤-2280), the shoreline retreats about 100m in the three years, indicating that there is an erosion trend. On the other hand, the area north of Ndayane Port (100≤x≤300), where there is a drainage channel, shows a remarkable shoreline advance. The southward migration of sediment discharged from the drainage channel is dammed by the breakwater on the north side of Ndayene Port, which is thought to cause the shoreline advance on the north side of the port and erosion tendency on the south side.



Source: JPT

Figure 3.271 Prediction Calculation Results of Shoreline Change Analysis (Top: 1 Year after the Start of Calculation, Middle: 4 Years after the Start of Calculation, Bottom: Amount of Shoreline Change between 1 Year and 4 Years after the Start of Calculation)

c) Summary of Shoreline Change Analysis

The assumptions of this study can be summarized as follows.

- On the coast at Project site, the southward littoral drift in the dry season and northward littoral drift in the rainy season are dominant, but the net sand movement is dominated by the southward direction.
- As a result of the reproducibility verification of the amount of longshore sediment transport, the reproducibility was improved by considering cross-shore sediment transport. Therefore, it was assumed that there was sediment inflow from the lagoon in this study.

Considering the above assumptions, before the development of new port, it is expected that the sediment inflow from the lagoon would have reached the southern part of the coast, but after the new port was constructed, the southward sediment would have been dammed by the breakwater and

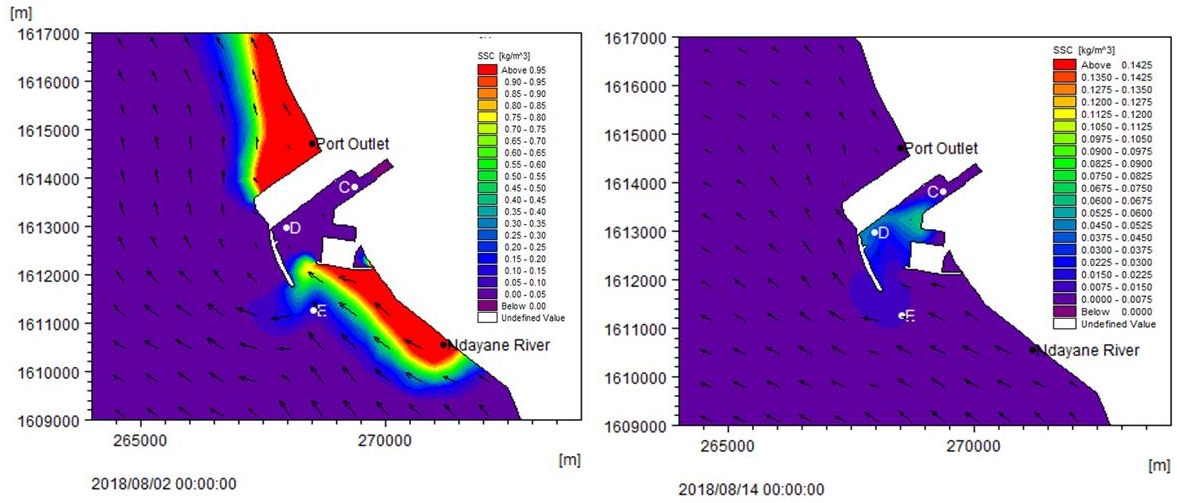
deposited on the north breakwater, resulting in an erosional trend in the southern part of the coast. It should be noted, however, that these results are based on the above-mentioned assumptions and that there are uncertainties in the evaluation of the amount of longshore and cross-shore sediment transport. Therefore, it is desirable to continue monitoring during and after construction by DPW to evaluate characteristics of external forces, verify sand drift mechanisms, and improve the accuracy of shoreline change analysis.

(3) Future Projections of Channel Sedimentation

Topographic changes at offshore area by SS runoff from the lagoon and river and by sand transport in waves and currents coexisting field was considered under the future topography.

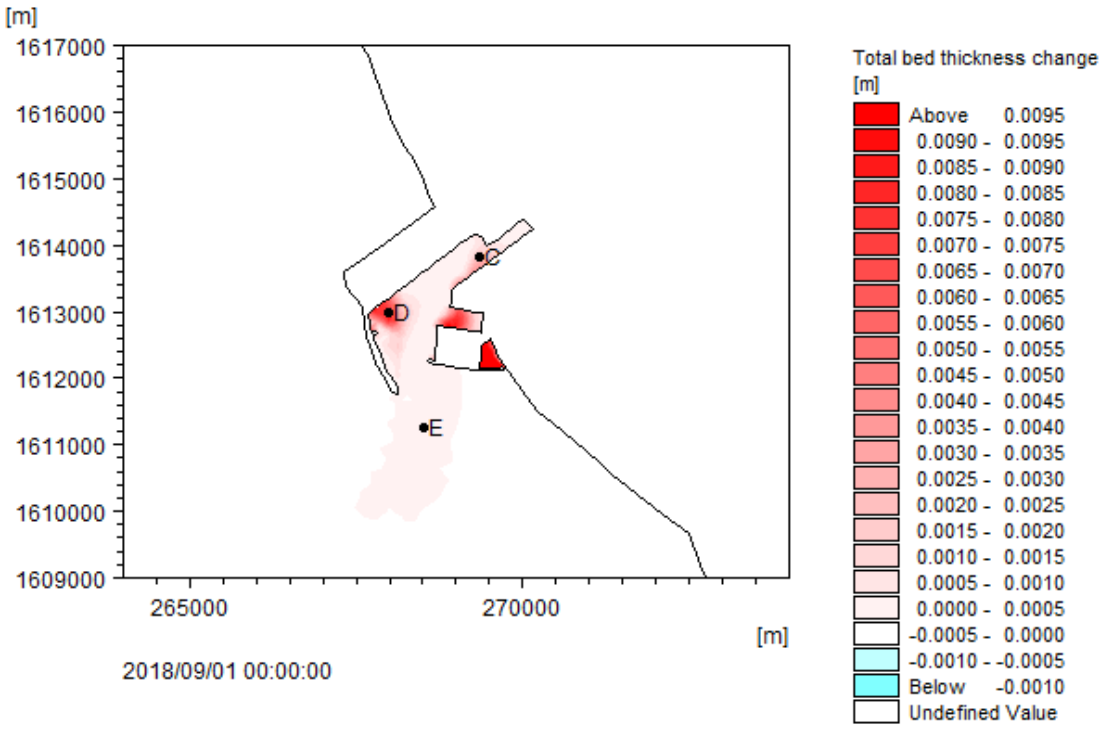
a) Topographic change at offshore area by SS runoff from the lagoon and river

The SS dispersion in the current field pattern (2), which most affects the project site, is shown below. SS from the river at south of the project site is transported to the site in the northward flow direction. When the flow direction shifted to the south, SSC are stagnated near the port and flow into the port and settle down. Since the flow in the port is not fast, the SS transported into the port is deposited as it is, and the deposition thickness is considered to be about 3 mm/day at the port mouth and 8 mm/day.



Source: JPT

Figure 3.272 SS Transport Conditions in Future Topography (Rainy Season: Current Field Pattern (2))

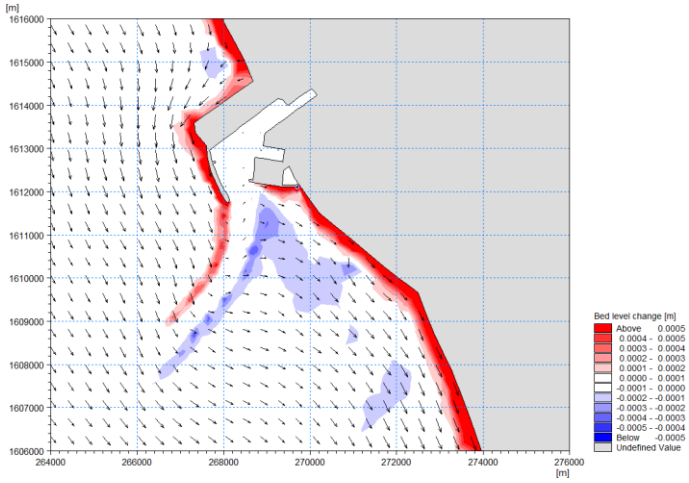


Source: JPT

Figure 3.273 Future Projections of Topographical Changes due to SS Runoff (Rainy Season: Current Field Pattern (2))

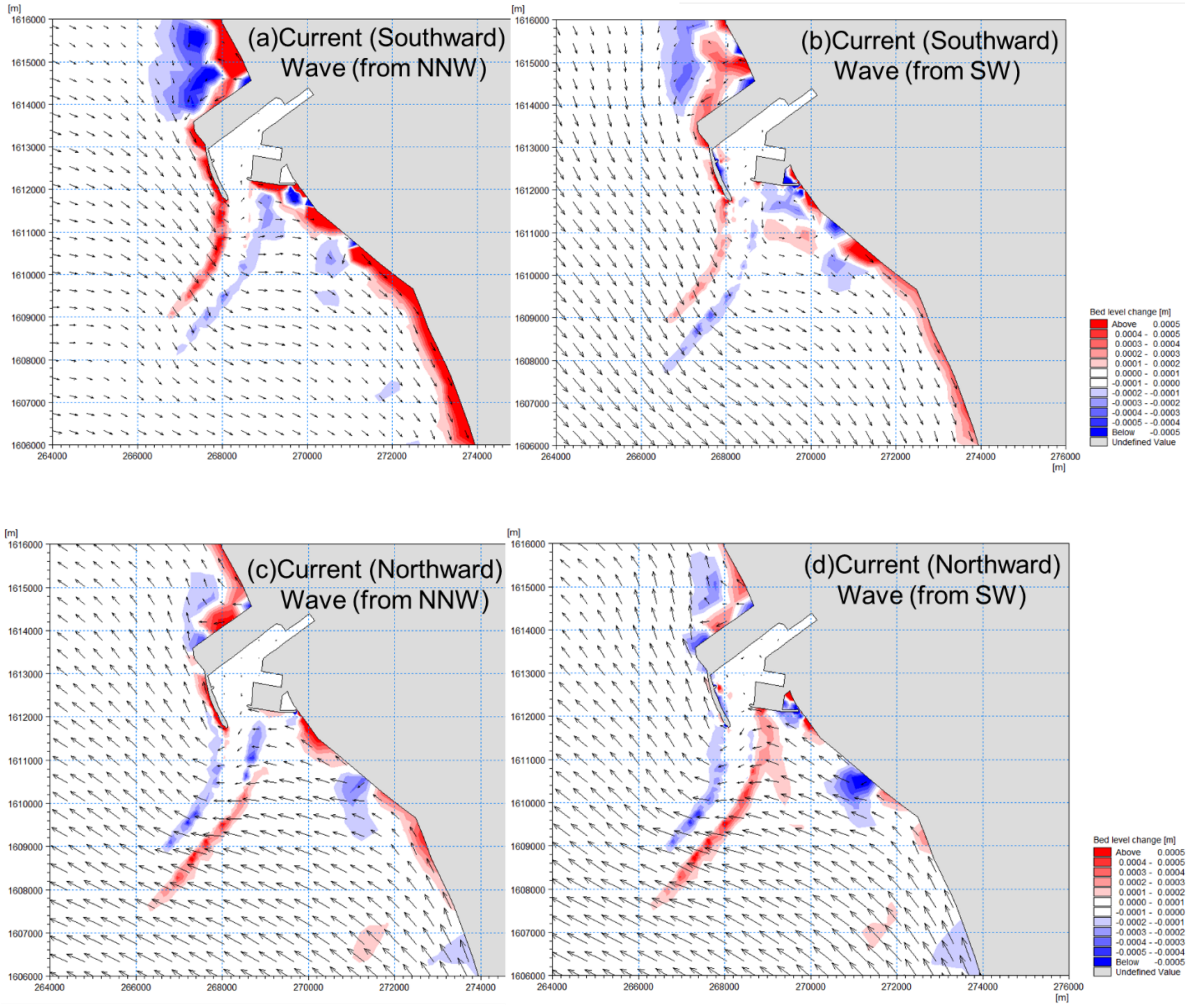
b) Topographic changes due to sand transport in waves and currents field

Topographic changes due to sand transport in waves and currents during the dry and rainy seasons is shown in Figure 3.274 and Figure 3.275. Due to the effect of the breakwater, sand movement in the port area due to waves and currents does not occur in both the rainy and dry season, because the waves and currents become weak in the port area. In the dry season, sedimentation occurs on the north slope of the channel area and erosion occurs on the south slope, while in the rainy season there are some periods of reverse sedimentation/erosion. This is due to the fact that the offshore waves, which come in from SW during the rainy season and from NNW during the dry season, enter the site from a direction nearly perpendicular to the shoreline due to diffraction and refraction, and the wave energy contributing to sand movement is small while the energy by current flow is dominant.



Source: JPT

Figure 3.274 Sedimentation due to Waves and Currents in Dry Season



Source: JPT

Figure 3.275 Sedimentation due to Waves and Currents in Rainy Season (Current Field Pattern (2))

c) Annual Sedimentation/Erosion Volume in the Basin area and the Navigational Channel area

The annual sedimentation/erosion rate is calculated by summing the sedimentation/erosion rates for all patterns considered in (1) and (2) as shown in Table 3.237 and Table 3.238, respectively.

Table 3.237 Annual Sedimentation Volumes for All Patterns

(Unit: m3)	Season	Basin Area	Channel		Sub-total
			West	East	
(1) Sedimentation due to SS Runoff	Rainy	74,545 m3	31 m3		74,576 m3
(2) Sedimentation due to Waves and Currents	Dry	-	60,191 m3	6,482 m3	66,673 m3
	Rainy	-	23,397 m3	21,132 m3	44,529
Maximum Sedimentation Thickness		20.4 cm	32.0 cm		-
Total		74,545 m3	111,233 m3		185,778 m3

Source: JPT

Table 3.238 Annual Erosion Volumes for All Patterns

(Unit: m3)	Season	Basin Area	Channel		Sub-total
			West	East	
(1) Erosion due to Waves and Currents	Dry	-	-1,700 m3	-35,123 m3	-36,823 m3
	Rainy	-	-12,538 m3	-19,013 m3	-31,551 m3

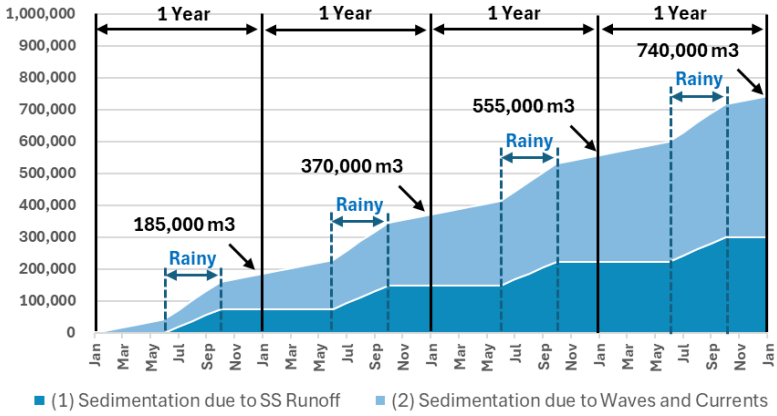
Source: JPT

It should be noted that the results of accretion near breakwaters and shorelines shown in this study do not take into account the structural type of breakwaters and any changes in the slope of the sandy beach, which adapts to be stable time by time, and thus there is an uncertainty in the results. In addition, as the external force conditions such as waves and currents and the amount of SS discharge from the river were set based on the limited period of observed data, variations of sediment amount also occur. Furthermore, there is a possibility that the mechanism of topographic changes may be changed due to sudden human-induced topographic modification such as construction work by DPW. Therefore, it is desirable to continue monitoring the site to verify the mechanism and improve the accuracy of the prediction model.

(4) Maintenance Dredging and Monitoring for Topographic Changes

a) Tentative Maintenance Dredging Plan

Due to the uncertainties in the results as described above, it is considered to determine the maintenance dredging method and frequency after confirming the actual sedimentation distribution and rate through long-term monitoring during and after the construction by DPW. Here, the following maintenance dredging plan is tentatively proposed based on the above simulation results, assuming that sedimentation will continue as shown in Figure 3.276. In addition, the monitoring plan is shown in the section below.



Source: JPT

Figure 3.276 Estimated Sedimentation Trends based on the Simulation Results

In the basin area, it is assumed that sedimentation is mainly caused by SS that discharged from the river during the rainy season. Although SS sediment tends to deposit in areas of the inner port where the current velocity is small, most of the fine-grained sediment is considered to be diffused and widely distributed within the inner port. The annual thickness of sedimentation is about 0.2 m at the largest location. Therefore, it is estimated that dredging may be conducted at the end of each rainy season if vessel navigation is disturbed, or every few years if acceptable, to ensure the necessary water depth. The dredging method is expected to use a Trailer Suction Hopper Dredger.

In the navigation channel area, deposition is mainly due to waves and currents, and is expected to continue throughout the year. The annual thickness of sedimentation is larger than that in the basin area, up to about 0.3 m. However, it is not expected to affect ship navigation immediately because the sedimentation starts gradually from the slope of the channel to inside of the channel. Therefore, it is estimated to dredge the sedimentation area every few years to secure the necessary water depth. The dredging method is expected to be a Grab Dredger or a Trailer Suction Hopper Dredger.

If the dredged material is sand with good grain size, it should be reused as reclamation material and stored on land for future use. The shoreline change analysis results described in the above section indicated that sedimentation will occur on the north side of the new port and erosion will occur on the south side in the future. Therefore, it is possible to install the dredged material into the erosion area as a countermeasure against the erosion.

b) Tentative Monitoring Plan

For the monitoring in the navigation channel and basin area, bathymetric survey by using a multibeam sonar should be conducted in the entire area. The differences from previous bathymetry results are also recorded to identify which areas and to what degree of sedimentation is occurred in those areas. Monitoring is conducted twice a year, at beginning of the dry season and rainy season, on a regular and long-term basis from the completion of the navigation channel to the start of its operation. If significant sedimentation is confirmed, it is desirable to take samples of the deposited sediment and

carry out sieve analysis, water content ratio tests, etc., to identify characteristics of the sediment. It is also important to review the sedimentation factors again, such as amount of SS runoff from the river.

Furthermore, shoreline monitoring should be conducted to determine the impact of the new port on the surrounding beaches. It is desirable to conduct that lines with perpendicular to the shoreline such as five on the north side and five on the south side are determined, and line surveys on the lines should be conducted periodically to check for sedimentation/erosion trends. In addition, it is also effective to use a drone to take pictures of the shoreline or satellite images, and record changes in the shoreline, as DPW is currently doing for monitoring during their construction. Since the shoreline has trends of erosion and accumulation depending on the season, it is necessary to understand the impact by considering at not only short-term results but also long-term trends.

3.17 Examination of Priority Development Facilities

Chapter 3.12.8 "Overview of Each Port Facility" shows the facilities required in the M/P of the target year 2047. The priorities and reasons for these facilities are shown in the table below. The “PAD” in the table means not only PAD itself but also private companies of concessionaire for port operation. DPW is not including.

Table 3.239 Priority and Reasons for Development of Each Facility

Facility	Developer	Priority	Reason
Container Terminal	DPW	High	The concession agreement between DPW and PAD is not disclosed, the details are unknown. DPW has promised PAD to relocate the operation from Dakar Port to Ndayane Port. DPW began the construction in 2023 and will complete in 2028. DPW and PAD have already received approval for the EIA from the Government of Senegal. PAD has the responsibility of the resettlement.
Container terminal expansion	DPW	Low	DPW plans to expand by phasing. Based on the demand forecast by JPT, their development plan is suitable.
RORO Terminal	PAD	High	RORO cargo (mainly imported cars) is one of the reasons for the current yard shortage at the Dakar Port. JPT agreed PAD’s intention to transfer the RORO terminal functions to Ndayane Port as soon as possible. There is also not enough space behind the Dakar Port to store imported cars, so private companies that handle them store them in Diamnadio. The transfer to Ndayane Port will bring about economic benefits.
RORO terminal expansion	PAD	Low	As demand for RORO cargo is expected to grow in the future, a gradual development is expected.
General cargo terminal including dry bulk	PAD	High	The import of general cargo, particularly grain, is one of the reasons for the current shortage of berths at the Dakar Port. The Bargny-Sendou Port is scheduled to open in 2024, and is expected to relocate from the Dakar Port. Therefore, there is little need for early development of Ndayane Port. However, due to the need to relocate dry bulk exports such as ores and to offload general cargo that cannot be handled at Bargny Sendou Port, a general cargo terminal, including dry bulk, will be required at Ndayane Port in the future.
Expansion of general cargo terminal including dry bulk	PAD	Low	Demand in Senegal is expected to grow steadily, making the general cargo terminal necessary for expansion in the future.

Facility	Developer	Priority	Reason
PAD Administration Building	DPW	High	An administration building is needed immediately to supervise container terminal, operate and manage the RORO terminal, and implement pilot services and maintenance of each facility by PAD. JPT received information from PAD that DPW will be constructing inland.
Breakwater	DPW	High	DPW started the construction in 2023 and will complete by 2028. PAD informed that once completed, it will be transferred to PAD with fees, and that PAD will be responsible for its maintenance.
Dredging of Channel and basins	DPW	High	DPW started the construction in 2023 and will complete by 2028. PAD informed that once completed, it will be transferred to PAD with fees, and that PAD will be responsible for its maintenance.
Dredging of Channel and Basins Expansion	DPW	Low	In the future, expansion of each terminal will require dredging of the channel, basin, and berthing area.
Access road	PAD	High	In order to efficiently handle cargos at each terminal and operate factories in the SEZ and PIZ, sufficient access roads connecting the terminal to the national road (N1) is required.
Widening of access roads	PAD	Low	Due to the development of the port and hinterland, widening will be required in the future.
Drainage	PAD	High	Since Ndayane Port is at the outlet of the rainwater catchment area, construction of drainage channels to prevent flooding at Ndayane Port is needed from the first phase.
PIZ	PAD	High	Early construction is expected to contribute to the cargo handling volume at the Ndayane Port and boost Senegal's economic development.
PIZ Extension	PAD	low	It is considered desirable for the development of this system to progress in line with future economic development in Senegal.
DPW SEZ	PAD	Moderate	PAD does not open the DPW's plans. But compared to ports, development appears to be lagging behind. If the PIZ for PAD is established early, the problem is likely to be small.
DPW SEZ Expansion	PAD	Low	It is considered desirable for the development of this system to progress in line with future economic development in Senegal.
Future expansion Area	PAD	Low	No development is required at present.
Railway	PAD	Moderate	It is important for the transfer of dry bulk and general cargo import/export functions from the Port of Dakar, and is a high priority, given that there are plans to extend the rail line to Ndayane in 5-10 years as a result of interviews with Senegalese government/private railroad officials. Nevertheless, it is unknown whether the plan to extend the rail line will proceed smoothly, and overall, the priority level is moderate.
Green Space	PAD	Low	It is suitable to have green area developed together with the port facilities, but this is not essential. It is advisable to secure the site by JPT.
Ship dismantling Factory	PAD	not clear	We received a call from PAD, but the details are unclear so we are unable to make a judgment.

Source: JPT

3.18 Formulation of a Staged Development Plan Based on Demand and Financial Plans

3.18.1 Formulation of a Staged Development Plan

Target year for the first phased (short-term) development plan is 2030. It was agreed upon by PAD and JICA in the Record of Discussion (RD), Target year of 2047 of the final year of the Master Plan (long term development plan) also agreed by the RD. Target year of 2035 for the middle term development plan was requested by PAD during the IT/1 explanatory meeting. The cargo handling demand and

required facility size for the three target years of 2030, 2035, and 2047 have been shown in previous chapters. Here we present an overview of the phased development plan and layout plan. The proposed funding plan, i.e., the development entity, is as shown in "Consideration of organizational structures and systems related to port operation and management (including use of PPP)." PAD will rely on private funding as much as possible, but for facilities for which it is difficult to secure private funding, PAD will use its own funds and/or financial assistance from JICA and other donors to construct the facilities. However, after interviewing PAD, JPT was informed that apart from the JICA grant aid for Dakar Mole 3, they have no experience of construction using financial assistance from other donors.

Table 3.240 Development Schedule of each Facility

	Facility	Short									Medium					Long											
		2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039	2040	2041	2042	2043	2044	2045	2046	2047
DPW	Container Terminal (based on DPW M/P)	Berth length(940m) Depth(20m) Area(105ha)							(Same as left)			Berth length(1410m) Depth(20m) Area(125ha)					Berth length(2080m) Depth(20m) Area(167ha)											
DPW	Breakwater (based on DPW M/P)	Approx. 1000m							(Same as left)			(Same as left)					(Same as left)											
DPW	Dredging (based on DPW M/P)	Berth length(1040m：1st and 2nd berth) outside port route Width(400m) Depth(20m)Turning basin(20mφ800m)							(Same as left)			Berth length(520m：3rd berth) Depth(20m)					Berth length(520m：4th berth)											
DPW	Tugboats and other small boat mooring	Base of container-side breakwater							(Same as left)			(Same as left)					(Same as left)											
PAD	Access Road(between wharf and N1)				two-lane road				(Same as left)			four-lane road				(Same as left)	eight-lane road										
PAD	Drainage				River mouth - downstream end of airport drainage channel				(Same as left)			(Same as left)					(Same as left)											
PAD	General Cargo (including Dry) Terminal											Berth length(250m)×2berth Depth(15m) Area(19.4ha)					Berth length(250m)×6berth Depth(15m) Area(87.6ha)											
PAD	RORO Terminal				Berth length(300m)×2berth Depth(14m) Area(39ha：Temporarily used with General)							(Same as left)					Berth length(300m)×2berth Depth(14m) Area(39ha)											
PAD	Breakwater(RORO wharf side)				unnecessary							(Same as left)					(Same as left)											
PAD	Sand pockets (for the time being, used as fishing boat landing sites)				sandbank 100m、revetment length 730m							(Same as left)					(Same as left)											
PAD	PIZ (not including DPW SEZ)				Land development, basic infrastructure, roads, plants (Total 503ha)							Land development, basic infrastructure, roads(Total 253ha)				(Same as left)	(Same as left)											
PAD	Railway																1)Bargny Sendou～Ndayane or 2)Airport～Ndayane											

Source: JPT

Source: JPT

Figure 3.277 Ndayane Port Short-Term Development Plan (Target Year: 2030)

Source: JPT

Figure 3.278 Ndayane Port Middle-Term Development Plan (Target Year: 2035)

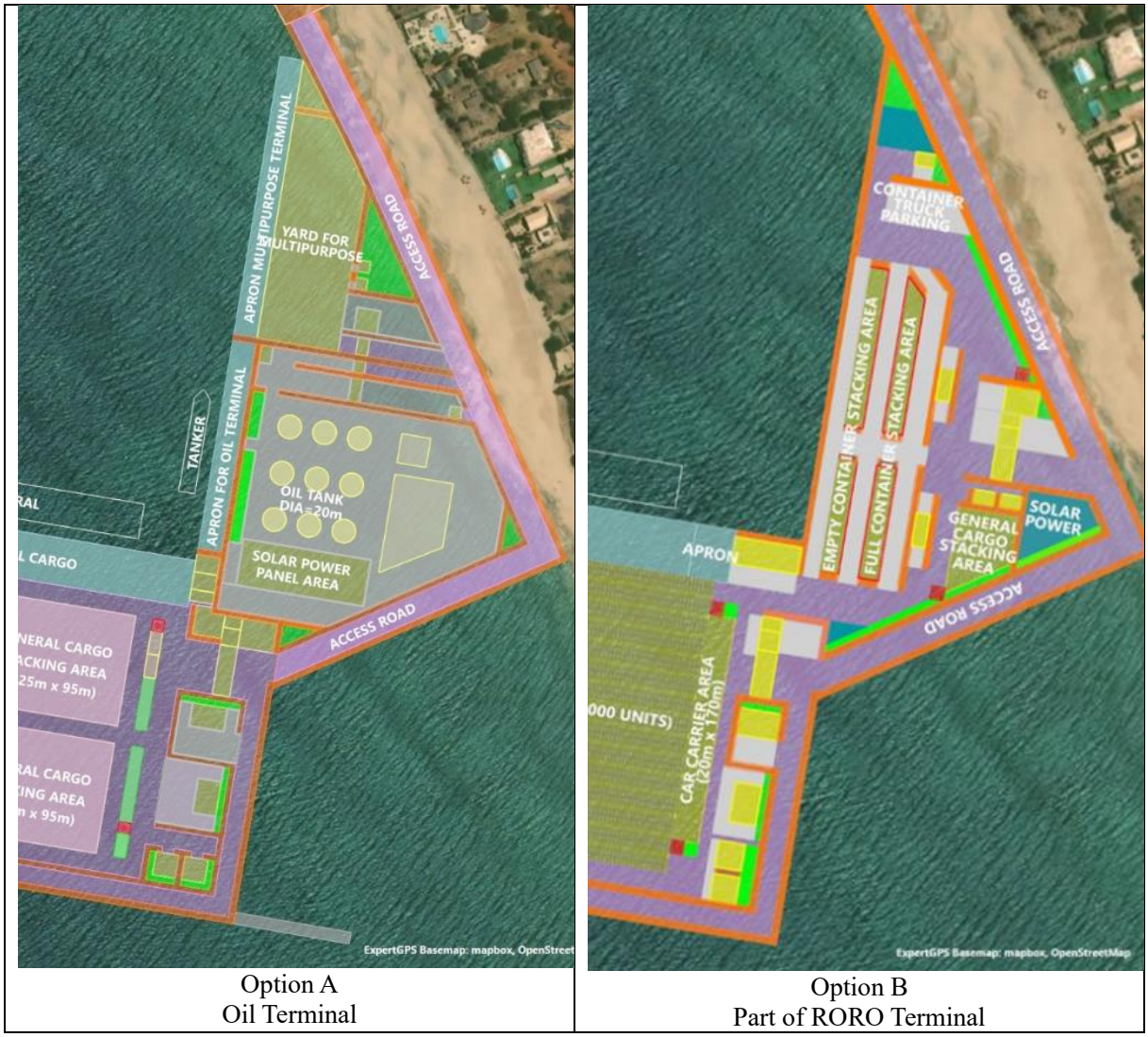
3.18.2 Bunkering facility at Ndayane Port

Currently, oil is imported and stored at the Port of Dakar, and fuel is shared with vessels using oil barges. In the future, after the opening of Bargny Sendou port, oil is planned to be imported and stored at Bargny Sendou port as well, and construction of oil tanks is in progress. On the other hand, there are no plans to import oil at Ndayane port, and fuel used at Ndayane port and PIZ is expected to be transported by land or sea from Dakar or Bargny Sendou port.

The function of supplying fuel to vessels is necessary at Ndayane Port, which has the largest water depth quay in Senegal and is the gateway port to West Africa.

A candidate site for a bunkering facility (oil berths and fuel storage base) could be the triangular reclaimed area of Ndayane Port (Alternative A). On the other hand, this area would also be beneficial to operate as part of a RORO terminal (revetment, container stacking area and cargo yard) (Alternative B). Compare and contrast the two alternatives, one to be operated as a bunkering facility and the other as part of a RORO terminal (see figure below). The table below summarizes the advantages and disadvantages of the option of locating the oil berth and fuel storage base in the triangle area of Ndayane port instead of operating it as part of the RORO terminal. Based on the comparative study, JPT considers

that it is preferable to operate this area as a part of the RORO terminal without locating the oil terminal.



Option A
Oil Terminal

Option B
Part of RORO Terminal

Source: JPT

Figure 3.279 Comparison of Triangle Area Uses

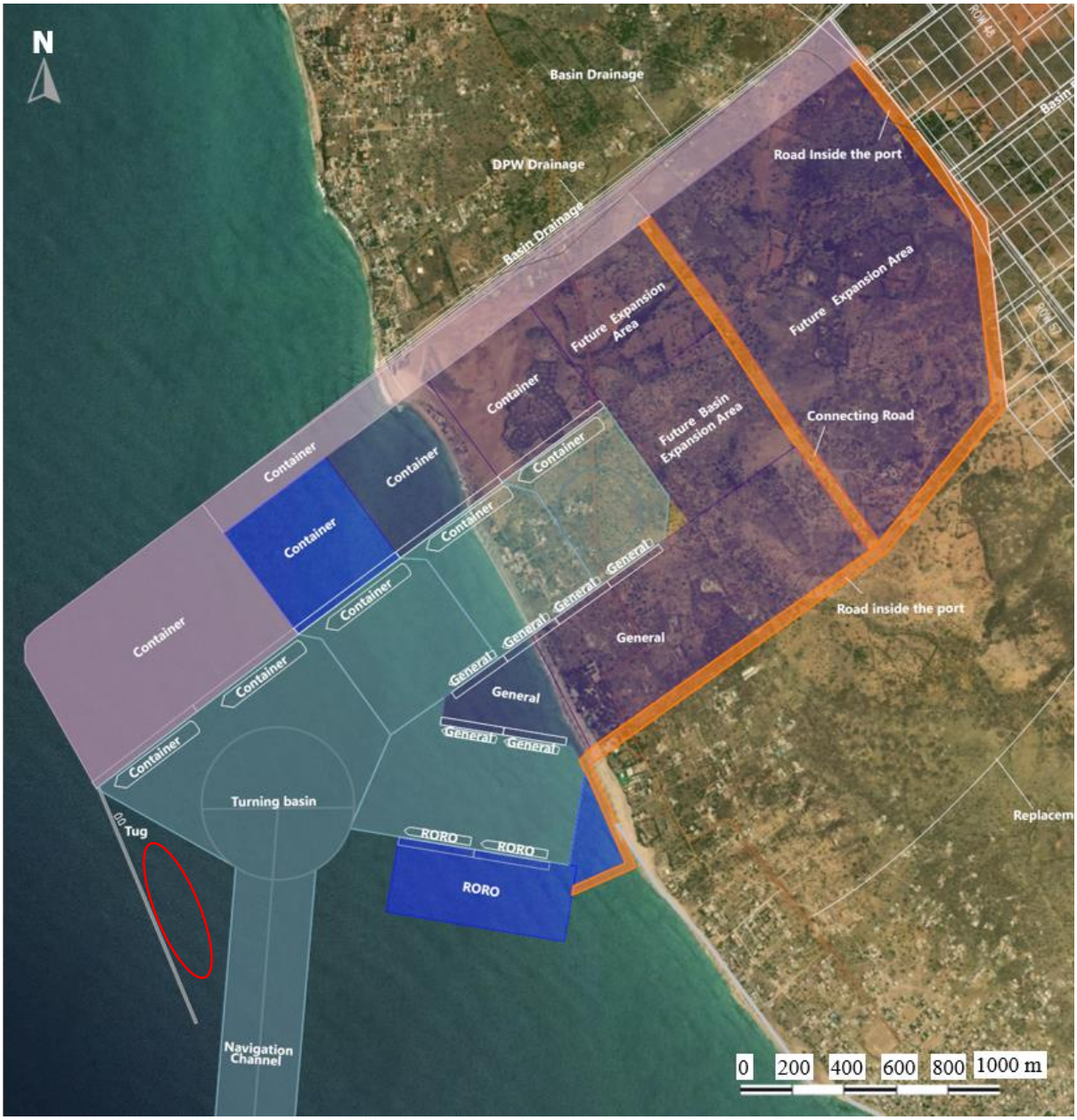
Table 3.241 Comparison of advantages between oil terminal and part of RORO terminal

	Option A **Oil terminal**	**Option B** **Part of RORO terminal**
Advantage	-The oil berths and oil tank yards are located in Ndayane port, which provides fast, reliable, and convenient fueling for vessels. -Redundancy is high with a fuel storage base also located in Ndayane.	-Changing the structure from a quay to a revetment improves calmness in the port and reduces construction costs. -The space for containers and general cargo would improve the overall profitability of Ndayane port. -The RORO terminal next to the terminal lacks a yard space, and making this area part of the RORO terminal would improve the operational efficiency of the RORO terminal.
Disadvantage	-The proposed site for fuel storage base is close to outside of Ndayane Port site (private residences, etc.), which raises safety concerns. -Since the oil barge is to be located behind the RORO terminal and the GC terminal, there are safety concerns such as collision with these large vessels.	

Source : JPT

As described above, bunkering facility (oil berths and fuel storage base) are not optimal for the triangular reclaimed area of Ndayane port. Therefore, JPT proposes the area behind the western breakwater (circled in red as shown in the figure below) as the area for bunkering facility.

The area has a safety advantage due to its distance from other facilities. The proximity to the channel and basin area also allows for sufficient water depth, making it possible for large ships to berth. However, the western breakwater is currently being constructed by DPW, and will require discussions with DPW and design changes.



Source : JPT

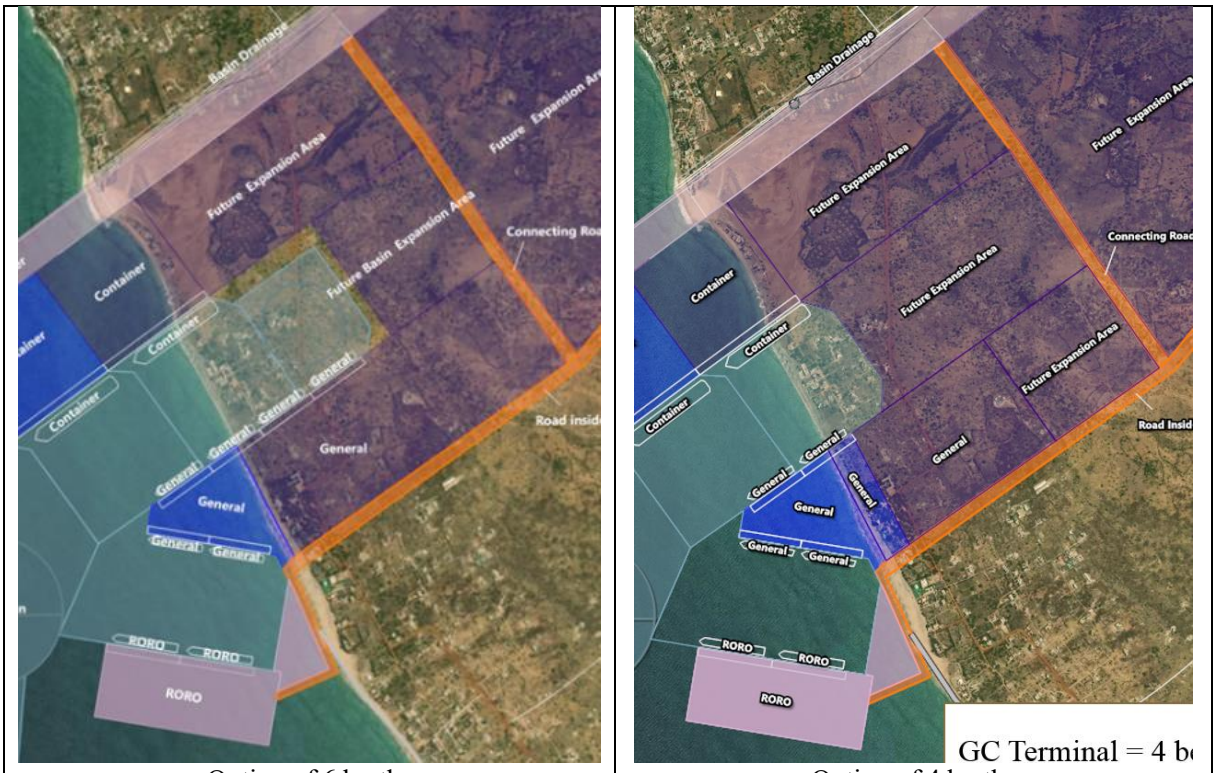
Figure 3.280 Bunkering Facility Proposed Location

3.18.3 Number of Berths at General Cargo Terminal at Ndayane Port

One idea is to use the site of the existing container terminal at the Port of Dakar as a general cargo terminal after DPW moves to Ndayane port. Another idea is to continue using the existing general cargo terminal at the Port of Dakar as is, or to convert it to uses other than cargo handling, such as a ferry terminal or waterfront development.

After the opening of Ndayane port, the general cargo handling volume of the entire Senegal would be shared between the Port of Dakar and Ndayane port, so if the general cargo handling volume at the Port of Dakar is increased, the general cargo handling volume at Ndayane port will decrease. Conversely, if the general cargo handling volume at the Port of Dakar is reduced, the general cargo handling volume at Ndayane port can be increased.

If the general cargo terminal at the Port of Dakar is continued to be used and the site of the container terminal at the Port of Dakar is also used as a general cargo terminal, the capacity of the general cargo terminal at the Port of Dakar will be increased, so that a 4-berth general cargo terminal at Ndayane port will be sufficient instead of 6 berths. In the case of a 4-berth general cargo terminal, the plane layout would be as shown in the figure below, and the excavated area of the land area would be significantly reduced.



Option of 6 berths In case the DPW site at the Port of Dakar is not used as a GC terminal and general cargo is relocated to Ndayane	Option of 4 berths In case the DPW site at the Port of Dakar is used as a GC terminal and general cargo handled at Dakar is not relocated to Ndayane

Source: JPT

Figure 3.281 Comparison of layout of general cargo terminals at Ndayane port with different number of berths

The advantages and disadvantages of increasing the general cargo handling capacity of the Port of Dakar, i.e., reducing the handling capacity of the general cargo terminal at Ndayane port, are presented below. As a result of the comparative study, JPT considers it desirable not to increase the general cargo handling capacity at the Port of Dakar, i.e., to increase the handling capacity of the general cargo terminal at Ndayane port and to secure 6 berths.

Table 3.242 Advantages and disadvantages of increasing general cargo handling capacity at the Port of Dakar

Advantages	Disadvantages
-The construction cost of Ndayane port is reduced. -Relocation costs for PAD and private companies currently handling general cargo at the Port of Dakar are reduced.	-Cargo trucks coming in and out of the Port of Dakar are one of the factors causing traffic congestion in the city of Dakar, and it is the basic policy of Senegal's ports to reduce the volume of cargo at the Port of Dakar and transfer its functions to Ndayane port. It conflicts with the policy of alleviating traffic congestion in the city of Dakar. -Since Ndayane port has deeper depths than Dakar port, there will be a loss of opportunity for large vessels to come to the port. Small vessels are more expensive to transport per unit weight than large vessels, which increases the economic loss to the Senegalese country. -The extension of the railroad line is planned for the area including Ndayane port. By transporting cargo handled at Ndayane port by rail, it would contribute to the reduction of logistics costs for the country as a whole and help extend the railroad line.

Source：JPT

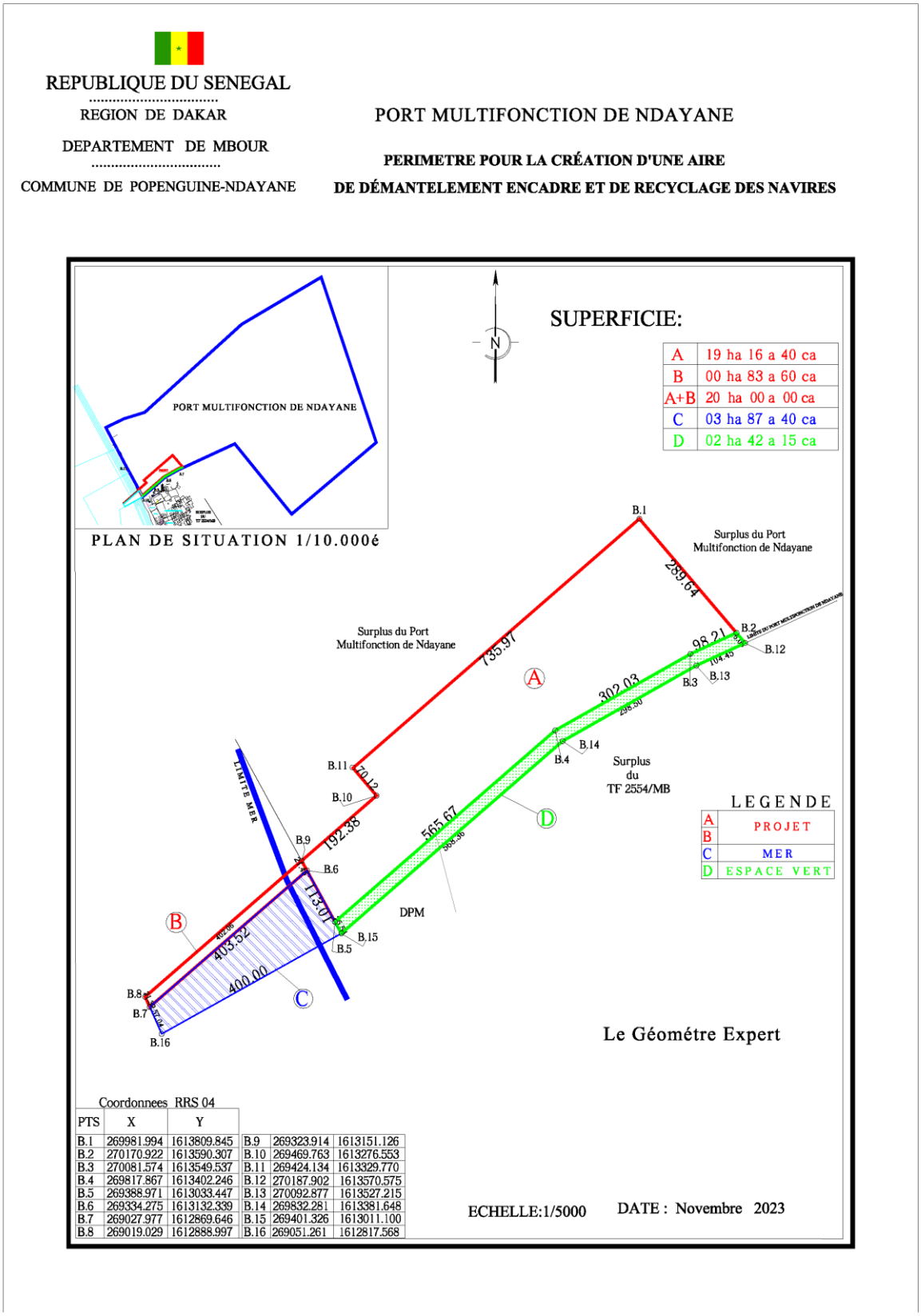
3.18.4 Study of Ship Dismantling Factory

The progress and history of coordination with PAD regarding the Ship Dismantling Factory proposed by PAD until March 2024 is as follows:

Table 3.243 Discussion with PAD Regarding Ship Dismantling Factory

Timing	Discussions
September, 2023	At the TC and JCC meetings on IT/2, JPT explained to PAD the master plan and demand forecast results for the target year of 2047, and received general approval from PAD.
Mid-January, 2024	Based on the master plan and demand forecast results for the target year of 2047 approved by PAD, JPT prepared layout plans for the phased development plan for 2030, 2035, and 2047. After obtaining confirmation from JICA, the draft plan was submitted to PAD for their final confirmation.
End of February, 2024	JPT received only one drawing of Ship Dismantling Factory from PAD.
Early March, 2024	JPT informed PAD that JPT might not recommend the Ship Dismantling Factory at the location shown on the drawing, considering the overall development of Ndayane Port. JPT requested PAD to provide additional information on the outline of the Ship Dismantling Factory 's business plan (opening year, business entity, benefits, costs, berth length, etc.) for comparative consideration.
Mid-March, 2024	JPT explained to PAD the location of each terminal and the Ship Dismantling Factory in the master plan. PAD informed that the location of the ship dismantling factory should be at the southernmost point of the entire Ndayane Port (including the RORO terminal and general cargo terminal), and PAD will reconfirm the latitude and longitude. In addition, the JPT will propose additional layout plan. The following information was provided verbally by PAD: The project owner is a Chinese company. The occupied area is 20ha. The berth length is 400m. The project owner will now conduct natural condition surveys and environmental surveys. Based on the results, the project owner will submit a business plan to PAD. PAD will decide whether or not to proceed with the project based on that business plan. After PAD approval, the project owner will start construction immediately. However, PAD staff do not have any information on the project's revenue, construction costs, concession contract conditions, etc.
March 21, 2024	PAD shared again the latitude and longitude data for the 1,200ha PIZ, so JPT re-confirmed that the latitude and longitude were correct. JPT explained the location of the 1,200ha PIZ boundary in relation to the master plan.
March 22, 2024	JPT sent additional Options (Option 3 & 4) with the comparison table to PAD.
March 25, 2024	PAD replied that "Alternative 4 is preferable." PAD does not inform any other information by the end of March.
July, 2024	JPT explained to PAD the history of the Ship Dismantling Factory study and each of the alternatives at the TC meeting and JCC meeting. JPT confirmed that there is no problem with Alternative 5, which is located to the southeast of this M/P. On the other hand, PAD did not provide any additional information on the Ship Dismantling Factory.

Source : JPT



Source : PAD

Figure 3.282 Location Map of Ship Dismantling Factory

The above figure shows the location map of the ship dismantling factory received from PAD. As shown in the figure on the upper left, it is located to the southwest of the boundary line of PIZ 1200 ha. The area is 20 ha and consists of an offshore reclaimed area and an onshore area. According to a later oral information from PAD, the quay length shall be 400m.

<table>
<tr>
<td>

Short-Term Development Plan (2030)</td>
<td>

Middle-Term Development Plan (2035)</td>
</tr>
<tr>
<td>

Long-Term Development Plan (2047)</td>
<td><Affect by Ship Dismantling Factory>
For short-term (2030):
No affect
For middle-term (2035):
Affect to general cargo terminal on sea and on land
For long-term (2047):
Affect to excavated navigation channel and container terminal operation</td>
</tr>
</table>

Source : JPT

Figure 3.283 Over lapping on JPT Master Plan with Ship Dismantling Factory on the Original Location

Based on the location map and coordinates of the ship dismantling factory received from PAD, the layout of the ship dismantling factory and each phase of development plan are superimposed on each other as shown in the figure above. The ship dismantling factory is located almost in the center of Ndayane Port, largely overlapping the terminal and anchorage.

<table>
<tr>
<td>

Short-Term Development Plan (2030)</td>
<td>

Middle-Term Development Plan (2035)</td>
</tr>
<tr>
<td>

Long-Term Development Plan (2047)</td>
<td><Affect by Ship Dismantling Factory>
For short-term (2030):
No affect.
For middle-term (2035):
General Cargo Terminal changes the shape a little. Yard of General Cargo Terminal changes the location. The cargo handling efficiency will reduce so much.
For long-term (2047):
Excavation area shall be increased (Cost will be increased so much). General Cargo Terminals shall be separated.</td>
</tr>
</table>

Source : JPT

Figure 3.284 Adjustment Layout Plan with Ship Dismantling Factory (Option 1)

The above figure shows the layout by moving the terminals and berths of each phase of the development plan and eliminating overlaps, without changing the ship dismantling factory. The ship dismantling factory is located almost in the center of Ndayane Port. General cargo terminal shall be separated. Cargo handling and ship maneuvering for the container terminal will be limited. Port operation efficiency will be reduced, and port construction cost will be increased.

Short-Term Development Plan (2030)

Middle-Term Development Plan (2035)

Long-Term Development Plan (2047)

<Affect by Ship Dismantling Factory>
Move to seaside (backside of RORO terminal)
Ship Dismantling Factory needs reclamation.
Good shape (Square) of Ship Dismantling Factory.
Co-development is needed with RORO terminal.
Breakwater will be extended around 300m.

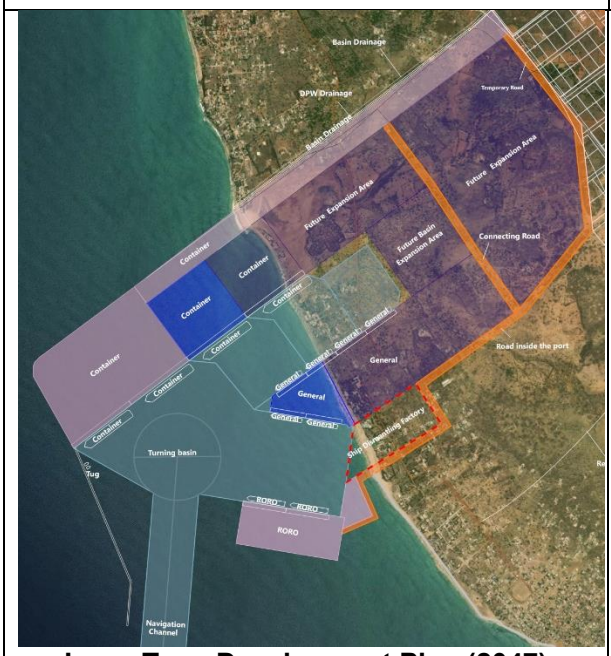
Source : JPT

Figure 3.285 Adjustment Layout Plan with Ship Dismantling Factory (Option 2)

The location of the ship dismantling factory will be moved to the south side of the RORO terminal. As a result, there will be little impact on Ndayane Port. However, if the berth of the ship dismantling factory is on the west side, it may be necessary to extend the breakwater by approximately 300 meters to ensure calmness. On the other hand, if the berth is on the east side, there is no need to extend the breakwater, but channel dredging will be needed. No additional resettlement will occur. Since it will be located south of the RORO terminal, it will be necessary to align the construction timing with the RORO terminal.

Short-Term Development Plan (2030)

Middle-Term Development Plan (2035)



Long-Term Development Plan (2047)

<Affect by Ship Dismantling Factory>
Move to landside (backside of GC terminal)
Ship Dismantling Factory needs resettlement.
Similar shape of Ship Dismantling Factory from the original idea.
Co-development is not needed with RORO terminal.
Breakwater will not be extended.
Outside of 1200ha of PAD development area.
Resettlement is needed more.

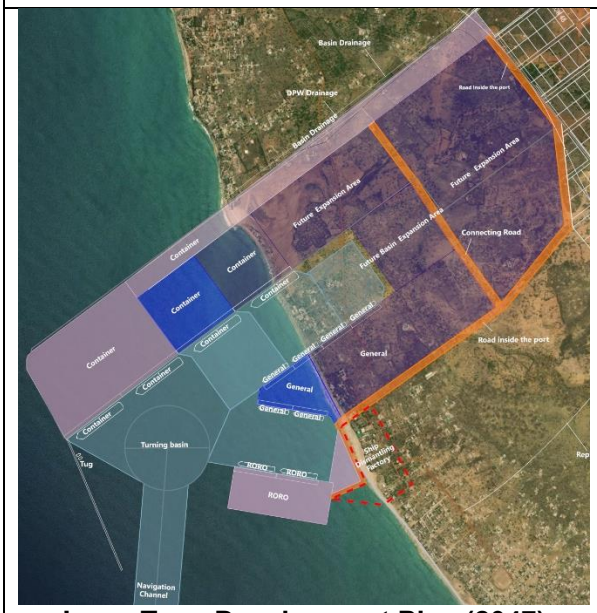
Source : JPT

Figure 3.286 Adjustment Layout Plan with Ship Dismantling Factory (Option 3)

Move the ship dismantling factory to the southeast of the general cargo terminal. The ship dismantling factory 's berth faces the inside of the port and is very quiet. There is no need to synchronize the construction timing with the RORO terminal, but since it is outside the 1200 ha PIZ area, PAD will need to obtain development rights and take measure of additional resettlement.

Short-Term Development Plan (2030)

Middle-Term Development Plan (2035)



Long-Term Development Plan (2047)

<Affect by Ship Dismantling Factory>
Move to landside (backside of GC terminal)
Ship Dismantling Factory needs resettlement.
Similar shape of Ship Dismantling Factory from the original idea.
Co-development is not needed with RORO terminal.
Breakwater will not be extended.
Outside of 1200ha of PAD development area.
Resettlement is needed so much.
Maintenance dredging will be needed for siltation.

Source : JPT

Figure 3.287 Adjustment Layout Plan with Ship Dismantling Factory (Option 4)

Move the ship dismantling factory to the southeast of the triangle area. The berth of the ship dismantling factory faces the outside of the port and is not very quiet. There is no need to synchronize the construction timing with the RORO terminal, but since it is outside the 1200 ha PIZ area, PAD will need to obtain development rights and will take measure of additional resettlement. Initial dredging is required in front of the berth, and maintenance dredging may be required.

As mentioned above, JPT proposes four options other than the original plan that does not take into account a ship dismantling factory. The original plan that does not take into account a ship dismantling factory is designated as “Option 0”, and the four alternatives and comparative evaluation results are shown in the table below. JPT believes that “Option 0” is the best option, PAD is already discussing with the representative in charge of the ship dismantling factory. If Option 0 is difficult, JPT believes

that Option 4, which does not affect JICA M/P, is the next best alternative. On the other hand, since no additional information on ship dismantling factory can be obtained from the PAD, it shall be removed from the consideration of JICA M/P.

Table 3.244 Comparison of the Ship Dismantling Factory Options

	Option 0	Option 1	Option 2	Option 3	Option 4
	JPT recommended Layout Plan without Ship Dismantling Factory	Without Re-location (South-West End of 1200ha) of Ship Dismantling Factory	Re-location to Seaside of Ship Dismantling Factory	Re-location to Landside of Ship Dismantling Factory (Berth is inside of Port)	Re-location to Landside of Ship Dismantling Factory (Berth is outside of Port)
Ship Dismantling Factory	Not to allow to construct and operate in Ndayane Port	To allow to construct and operate at the expected location. It can be constructed any time.	To move from the expected location to reclamation area beside of RORO terminal. It should be constructed in cooperation with RORO terminal. The construction cost will be increased.	To move from the expected location to reclamation area beside of GC terminal. It can be constructed any time. Outside of 1200ha. Resettlement is needed.	To move from the expected location to reclamation area beside of RORO terminal. It can be constructed any time. Outside of 1200ha. Resettlement is needed. Maintenance dredging will be needed for siltation.
Effect to the other terminals	No affect to the other terminals.	Construction cost will be increased. Some limitation of port operation will be happened.	Almost None.	Not So much	Not So much
Total B/C (Benefit /Cost) of Ndayane Port	No benefit from Ship Dismantling Factory. Construction cost will be smallest. Maybe, Ndayane Port's B/C will be highest.	There is benefit from Ship Dismantling Factory, but the other terminals' benefit will be down. Total construction cost will be most expensive. Maybe, Ndayane Port's B/C will be lowest.	There is benefit from Ship Dismantling Factory. The other terminals' benefit will not be down. Total construction cost will be middle. Maybe, Ndayane Port's B/C will be middle.	There is benefit from Ship Dismantling Factory. The other terminals' benefit will not be down. Total construction cost will be middle. Maybe, Ndayane Port's B/C will be middle.	There is benefit from Ship Dismantling Factory. The other terminals' benefit will not be down. Total construction cost will be middle. Maybe, Ndayane Port's B/C will be middle.
Evaluation by JPT	**Better**	**Bad**	**Fair**	**Fair**	**Fair**

Source : JPT

3.18.5 Environmental Conservation Measures

Since the Paris Agreement adopted in 2015 at the Conference of the Parties to the United Nations Framework Convention on Climate Change, it was decided that every country promotes decarbonization for a decreasing level goal they determined. The importance of installing environmental protection technologies is recognized all over the world. Hence, it is expected that promoting energy efficiency or utilizing energy that has less environmental impact. In Japan, the basic principle for achieving Carbon Neutral by 2050 had legislated. Government of Japan (herein after GOJ) enacted "Port 2030" as mid and long-term policy aim to promoting greenization at ports and logistics in order to form Carbon Neutral Port (herein after CNP).

To comply with this policy, it is considered and facilitated that to install power generation facilities by renewable energy sources, electrify cargo handling equipment and cold ironing (as known as shore power supply system). Additionally, the development of ships fueled by renewable energy is ongoing, and it has been put to practical use in some fuels. Therefore, it is also required to establish port facilities that is suit for new typed ship to achieve sustainable society.

In the TC and JCC meeting of PR/R on July in 2024, the member of PAD and JCC requested JPT to provide information about environmental measures/protections. What they have interest especially is 1) green port: technologies to generate electricity from renewable energy sources and measures to reduce CO2 emissions from cargo handling equipment and anchored vessels, 2) ballast water treatment at ports, 3) ships utilizing eco-fuel and 4) ship dismantling factory. This chapter describes the related technologies and their introducing status in Japan as a reference information. PAD have not established the environmental measures yet and it has just started introducing solar power generation in Dakar port. It is better if each environmental measures are introduced in not only Ndayane port also in Bargny-Sendou and Dakar port. It is expected the following reference information would be useful of introducing those measures.

(1) Green Port

A concept of Green Port is a port that aims to minimize its ecological footprint by promoting environmentally considerate port operations like utilizing renewable energy, optimizing energy consumption, etc. Many worldwide ports engage to decrease the electricity consumption and CO2 emissions, and the CNP policy in Japan is one of policy to aim it. Three efforts that is spread widely around the world are described below.

a) Electric Generation Utilizing Renewable Energy

Taking advantage of ports' regional character, having vast grounds and easy access to natural energy, electric generation utilizing renewable energy such as solar or wind power is introduced.

As of July 2024, a total of 1.0 GW of solar power generation has been introduced at 73 major ports in Japan. An average output in each port is 13.7 MW. A part of introducing examples of solar power generation at ports is shown in the table below.

Table 3.245 Examples of Introducing Solar Power Generation at Ports

Port name	Introduced output	Place
South port distribution center (Osaka south port)	7.5 MW	28,160 solar panels, On the rooftop
Tokyo port, Oi container pier the 4th berth	200 kW	1,200 solar panels on the rooftop of the gate building and car wash building
Tokyo port, Oi container pier the 7th berth	135 kW	On the rooftop of the IN gate
Tokyo port, Oi container pier the 6th berth	200 kW	On the rooftop of the multistory storage
Yokohama port Daikoku pier	300 kW	On the rooftop of the public storage area
Hiroshima port new international CFS	1,848 kW	On the rooftop of CFS

Source: Based on Trina solar HP and released document by MLIT, created by JPT

Given the single solar panel size (approximate output 400W) is generally 1.24 m^2 to 1.63 m^2, it is understandable that vast grounds are required to introduce the Mega Solar: with total output over 1MW. Solar panels have been mainly installed on the rooftop of storage buildings and vacant area at ports sites. However, currently, the practical application of new generation panels, which is lither and more flexible than conventional one, is expected to lead the wider introduction such as building wall, where have been difficult in the past. Furthermore, the diversification of introduction sites is underway such as the verification test is implemented to introduce offshore floating solar panels at Tokyo port. In addition, it is not an introducing example at port, but it has been becoming introduced Solar Car Port that is a roof at parking area and introduce solar panels on the top of that. Some examples are shown in the table below.

Table 3.246 Examples of Introducing Solar Car Ports

Introduction sites	Volume	Area	CO_2 emissions	Cost
Factory	695 kW	200 parking spaces	372t-CO_2/year	Approx. 173 million Yen
Commercial building	234 kW	82 parking spaces	147 t-CO_2/year	Unrevealed
Factory	1,422 kW	426 parking places	970 t-CO_2/year	Approx. 232 million Yen
University	1,36 2kW	506 parking places	923 t-CO_2/year	Approx. 416 million Yen

Source：Based on documents of Ministry of the Environment Japan, created by JPT

Currently, onshore wind power generation is facing difficulties to ensure the project sites due to the increasing of the scale in wind power generation projects and facilities. Hence, the introduction of offshore wind power generation has promoted. Especially, port sites are known as a suitable site to introduce offshore wind power generation because there is plenty electricity system; infrastructures for constructing and managing offshore wind power generation facilities are adjacent to; and it is the space with the best developed system of management and use coordination of the sea area. The method of generating electricity by offshore wind power is basically the same with onshore wind power generation, but additional construction such as cable to send electricity to storage facility or fundamental to mount to offshore is required.

In Japan, as of 2024, approximately 250 MW of offshore wind power generation has been adopted around the ports area in 3 places, 47 machines. GOJ aims to forge projects with 10 GW by 2030, 30

GW to 45 GW by 2040 and succeeded to form approximately 4.6 GW cases in 10 facilitating regions under law. A part of introducing example of solar power generation at ports is shown in the table below.

Table 3.247 Examples of Introducing Wind Power Generation at Ports

Where to place	Introduced volume	Detail information
Ishikari Bay New Port	Approx 110 MW, 500ha	Implemented in January 2024 8,000kW×14 machines, Approx wind size 90m, Approx blade size 80m
Mutsu Ogawara port (planned)	Approx 80 MW, 1000ha	Detail information is unknown
Noshiro port	Approx 84 MW, 380ha	Implemented in January 2023 4,200kW×20 machines
Akita port	Approx 5.5 MW, 350ha	Implemented in January 2023 4,200kW×13 machines
Kashima port (planned)	Approx 160 MW, 680ha	To implemented in 2026 8,400kW×19 machines
Kitakyushu port (planned)	Approx 22 MW, 2,700ha	To implemented in 2025 9,600kW×25machines

Source: Based on documents of Ministry of Economy, Trade and Industry (METI) Japan, created by JPT

b) Approaches to Reduce CO2 Emissions from Ships while Anchoring.

Conventional vessels get electricity by running auxiliary engine and burning heavy oil when at anchor. Taking Kobe port as an example, annual CO2 emissions is approximately 60,000 ton at the container terminal and 48% of that is emitted from anchoring ships. On the other hand, it is tried to supply electricity to anchoring ships from onshore in order to decrease CO2 emissions lately.

Cold ironing is implemented via the facilities which consists of a connection between onshore power supply facilities and the ship side, and cables connecting the connection and the power receiving and transforming facilities. Since large container ships requires to use the high-voltage power receiving and transforming facilities and the standards for cables and other equipment need to be the same on the supply side as on the receiving side, both port facilities and ships' facilities are required to manage the equipment.

As of 2024, there are few examples of implementing cold ironing to large ships in Japan, but the introduction of cold ironing has been spreading around the world such as main 5 ports in Europe (Antwerp port, Bremen port, Hamburg port, Haropa port and Rotterdam port) issuing a joint statement on carrying out cold ironing to the largest-classed container ship by 2028. This is due to an EU rule "FuelEU Maritime" is enforced in EU on 1st January in 2025. This rule mandates utilizing the cold ironing or zero emission technologies while at anchor to the ships (containers and felly) over total gross 5,000 GT. It would be also mandated in LA/LB port, California, the U.S. by 2028.

Ships contain sewage or waste, including ballast water, which must be treated appropriately to forming and operating the green port. The Marpol Convention is established internationally for handling disposal or port reception of sewage and waste. It is ruled to prohibit disposing or emitting regulated substances from ships, reporting obligation and procedures. The regulated substances are such as oil, packed harmful substances, generated sewage on ships, waste from ships, nitrogen and

sulfur oxide from ships engine. Both Japan and Senegal ratified the Marpol convention. In the amendment to this convention, since 1st January in 2013, it is forbidden to dispose waste to the ocean from ships such as cargo residue, detergents and additive in detergent water, dunnage lining, dead animal, all plastics, food scraps, food oil, fishing tools, daily waste and other waste, and ports are required to deal with them appropriately. To comply with this amendment, MEPC (Marine Environment Protection Committee), which is one of the associations under IMO, developed guideline "2017 Guidelines for the Implementation of Marpol Annex V" for ports and operators to consider necessity of appropriate port receiving facilities for dealing with ships waste. Besides, the Japanese ports also examine the feasibility of receiving ports waste. In that study, it was considered the method of direct unloading by the calling vessels and method of transforming the waste once to another dedicated vessel and unloading it, based on each port's characteristic.

c) Electrification of Cargo Handling Equipment

As of 2024, installation of electrification of RTG and other cargo handling equipment is recommended in Japan, and each port are promoting the installation with utilizing subsides. Due to cargo handling activities with electrified equipment, it is expected that energy cost and CO2 emissions decrease. As the power supply is generally used the ground supply method with cable reels, electrification requires to install the new cable reels. When moving away from cables such as to a maintenance area or to centralized loading lane, the RTG itself can lift detachable generator-type container and move under its own power by receiving power from this generator.

In addition to the electrified RTG, hybrid types combining conventional diesel engines and storage batteries are also being introduced. This means electricity is generated and stored to rechargeable battery during lowering and while hoisting, combine with diesel sourced energy and rechargeable battery to handle cargos. Furthermore, the development related to loading hydrogen fuel cell or engine are ongoing to look ahead achieving CNP in the future.

d) Initiatives for Enhancing Port Sustainability

In recent years, as global demands have increased for action on climate change, coexistence with local communities, and reduction of environmental burdens, improving sustainability in port development has become a critical issue. In response, the International Association of Ports and Harbors (IAPH) launched the World Ports Sustainability Program (WPSP) in 2018 as a framework to promote sustainable development of ports worldwide.

i. Overview of the WPSP

The WPSP, led by IAPH, is an international program that aims to promote sustainable practices at ports through cooperation among port authorities and related organizations around the world. The program is aligned with the United Nations' Sustainable Development Goals (SDGs) and seeks to achieve a balance between environmental conservation, social responsibility, and economic sustainability in port operations. As of 2025, a total of 195 ports across 71 countries are participating in the program.

ii. The Five Pillars of the WPSP

The WPSP defines five priority areas (5 Pillars) that comprise sustainability and categorizes and promotes specific initiatives in ports.

1. Climate and Energy

Promoting low-carbon port operations through greenhouse gas emissions reduction, adoption of renewable energy, and development of onshore power supply systems.

2. Community Outreach and Port-City Dialogue

Encouraging dialogue and cooperation with local communities to mitigate port-related impacts such as noise, air pollution, and traffic congestion.

3. Safety and Security

Ensuring occupational safety, protecting worker health, and strengthening cybersecurity to establish a solid foundation for sustainable operations.

4. Governance and Ethics

Promoting transparency, fair contracting and procurement, and the establishment of codes of conduct to prevent corruption.

5. Resilient Infrastructure and Smart Ports

Enhancing resilience against natural disasters and promoting smart port development through the use of ICT, IoT, and AI technologies.

iii. Examples of Initiatives (including Japan)

The WPSP's official website features a wide range of sustainable port initiatives worldwide, including hydrogen utilization at the Port of Rotterdam and zero-emission logistics initiatives at the Port of Los Angeles.

In Japan, major ports such as Yokohama and Kobe are participating in the WPSP and have implemented the following initiatives:

- Development of onshore power supply systems to reduce ship emissions
- Installation of environmentally-friendly quay walls
- Construction of energy management systems within port areas

In Africa, the Kenya Ports Authority (KPA) has shared its initiatives:

- Establishment of the world's first Green Port Policy in 2015
- Installation of over 750 kWh of solar power generation at the Port of Mombasa, significantly reducing operational and electricity costs
- Introduction of hybrid and electric-powered equipment

(2) Ballast Water Treatment at Ports

Ballast water means sea water that is loaded to take a balance while ships does not load enough cargos to keep draught appropriate for safety shipping. Depending on the data released by IMO, it is estimated that annually 3 to 5 billion tons of ballast water is moved internationally by shipping. When cargos are loaded, ballast water is no longer required and is discharged, but if the discharged sea area is different from the area from which the water was taken, the aquatic micro-organisms mixed in the ballast water and taken on board may be transferred to a different sea area, which is not their natural habitat. As a consequence, it causes the damage or harmful effects to conventional nature and ecology living in their sea area or people living near there. Examples of damage caused by ballast water are summarized in the table below.

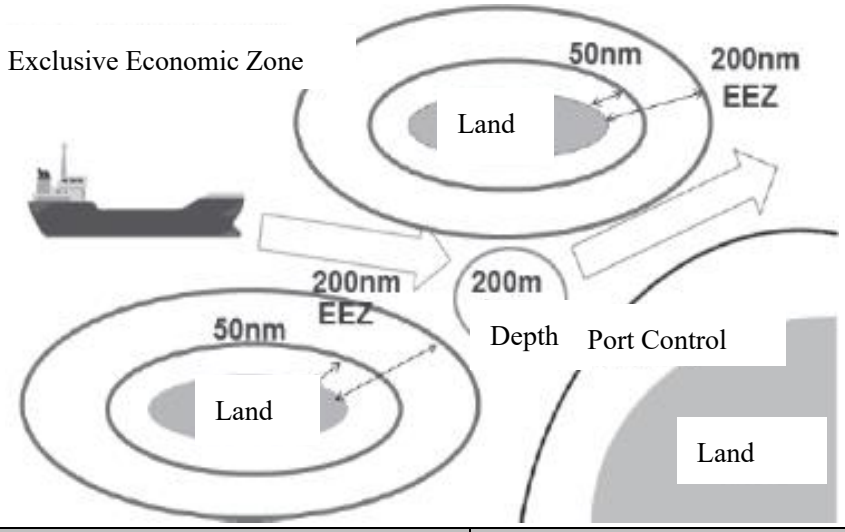
Table 3.248 Examples of Damage Caused Ballast Water

Nation	Age	Detail Information
Australia	1986	Toxic plankton causing paralytic poisoning has occurred in South Tasmanian waters, resulting in cases of poisoning by oysters caught in these waters. It is speculated that the plankton was carried by ballast water from ships visiting from Japan.
America	1980s	Invasive alien species entered the freshwater areas of the Great Lakes via ballast water. Amongst others, damage caused by a European species of bivalve mollusk was identified, which adsorbed into the intakes of power plants and factories, completely blocking them and rendering the facilities inoperable.
Japan	1970s	Fishing damage caused by purple mussels occurred in Hiroshima Bay and elsewhere.

Source: Based on Takeo IKEGAMI “Ballast water problem” and documents of MLIT, created by JPT

In response to these damages, an international convention “International Convention for the Control and Management of Ship’s Ballast Water and Sediments” for preventing the transfer of aquatic organisms affecting the marine environment by ships' ballast water had been adopted in 2004 and enforced on 8th September in 2017. Japan had ratified the convention in 2014 but as of July in 2024, Senegal has not ratified. As a measure to prevent the transfer of aquatic organisms, loading ballast water treatment equipment is obligated to all ships except some ships in this convention. And that equipment is only installed which is certified by competent authority as ship's country of registry following guidelines on that convention. The ballast water treatment equipment works a two-stage process that relatively large micro-organism and floating substances removed thorough filters while draining and disinfect by ultraviolet rays etc.

In this convention, conditions in the sea area where is possible to discharge and criteria of water quality has been defined as shown in figure below.



Size/Kinds of Target Organism	Criteria for Discharging
over 50 μm (mainly for zooplankton)	Less than 10pcs / m^3
Over 10 μm to less than 50 μm (mainly for phytoplankton)	Less than 10pcs / ml
Vibrio cholerae	Less than 1 cfu / 100 ml
Escherichia coil	Less than 250 cfu / 100 ml
Enterococcus	Less than 100 cfu / 100 ml

(ml = cc) (1 cfu = colony forming unit)

Source: Katsumi TAKEDA, Yuki KAMIMURA "abstract of Ballast water convention," translated by JPT

Figure 3.288 Conditions in the Sea Area where is Possible to Discharge and Criteria of Water Quality

As mentioned above, this convention aims to prevent the transfer of aquatic organism by mandating ships to install ballast water treatment equipment, and it does not obligate ports to install ballast water treatment equipment. Thus, this equipment is not generally managed at the ports in Japan. According to the preliminary feasibility study from economically and logistically for installing this equipment at Port of Baltimore conducted by University of Maryland center for Environmental Science, it was concluded that installing this equipment is infeasible at Port of Baltimore and it also said if the study is conducted at another port, the result does not change.

(3) Ships Utilizing Eco-Fuel

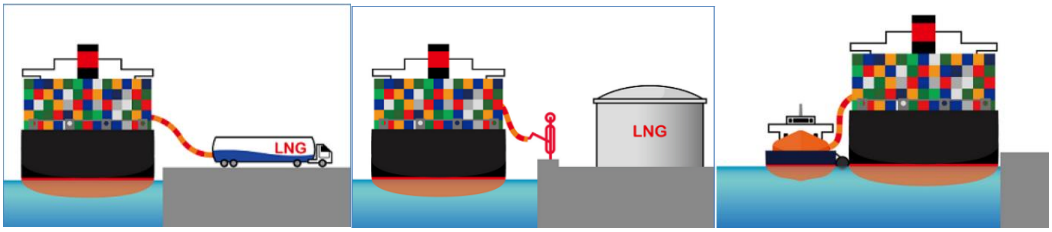
While international maritime shipping is responsible for a large part of logistics, it has a significant impact on global warming: as of 2018, approximately 700 million tons of CO2 had been emitted by this industry and it is the same number of 2.1 % of world emissions. As one of the major factors contributing to the impact on global warming, conventional vessels has used diesel for fuel that emit substances which causes global warming because of cost and diesel is suitable for high-powered engine. Following this background, the development of ships using renewable energy as a fuel instead of diesel has been advancing to decrease the CO2 emissions. In line with this development, ports are required to install the bunkering facilities to supply energy for such ships. In Japan, the development of ships fueled by hydrogen, ammonia and LNG (Liquified Natural Gas) is advancing. The development status by fuel in Japan, characteristic and challenges are summarized in the table below. And the development of ethanol fueled ship is advancing in overseas.

Table 3.249 Comparison of each Fuel

Fuel	Current Situation	Characters and Challenges
LNG	・Implemented ・Construction of 300 m class container ship is scheduled (Japan)	・Less GHG emission compared to conventional fuel ・Compared to another fuel, supply is stable and cheap
Hydrogen	・To start verification test implementation for multi-purpose ship on 2027. (JAPAN) ・The world first commercial ferry started sailing in 19th July 2024.	・Zero emissions of CO2 ・Required 4.5 times volume fuel as heavy oil to obtain same calorific volume ・Required to storage under -253 but impurities are eliminated and there is no toxicity.
Ammonia	・Construction of ammonia fueled ship for ship ammonia is scheduled on 2026 (JAPAN) ・Aim to practical use container ship fueled ammonia (NORWAY)	・Zero emissions of CO2 ・Corrosive and toxic, flame retardant. ・Required 2.7 times volume fuel as heavy oil to obtain same calorific volume
Ethanol	・Implemented ・Construction of bulk carrier is scheduled on 2025 (JAPAN)	・Less GHG emissions, compared to conventional fuel ・GHG emissions would be zero, if possible to use green ethanol ・High energy density ・Possible reuse present supply facilities

Source: Based on Mitsui O.S.K.Lines HP, Nippon Yusen Kaisha Line HP and METI, created by JPT

Furthermore, safety bunkering ways to supply energy to ships are considered in Japan. The three under envisaged bunkering methods are shown in the figure below and shown each characteristic in the table below.



Source: Based on METI, created by JPT

Figure 3.289 The Method of Bunkering

Table 3.250 Comparison of Bunkering Method

Bunkering Method	Characteristics
Truck to Ship	・relatively less volume bunkering compared to others ・low investment for managing facilities ・limited possible quay and ship type
Shore to Ship	・to use many volume bunkering ・big investment for managing facilities ・limited possible quay and ship type
Ship to Ship	・relatively much volume bunkering compared to truck to ship ・big investment for dedicated ships ・not limited possible quay and ship type ・got easily effected because acted on offshore

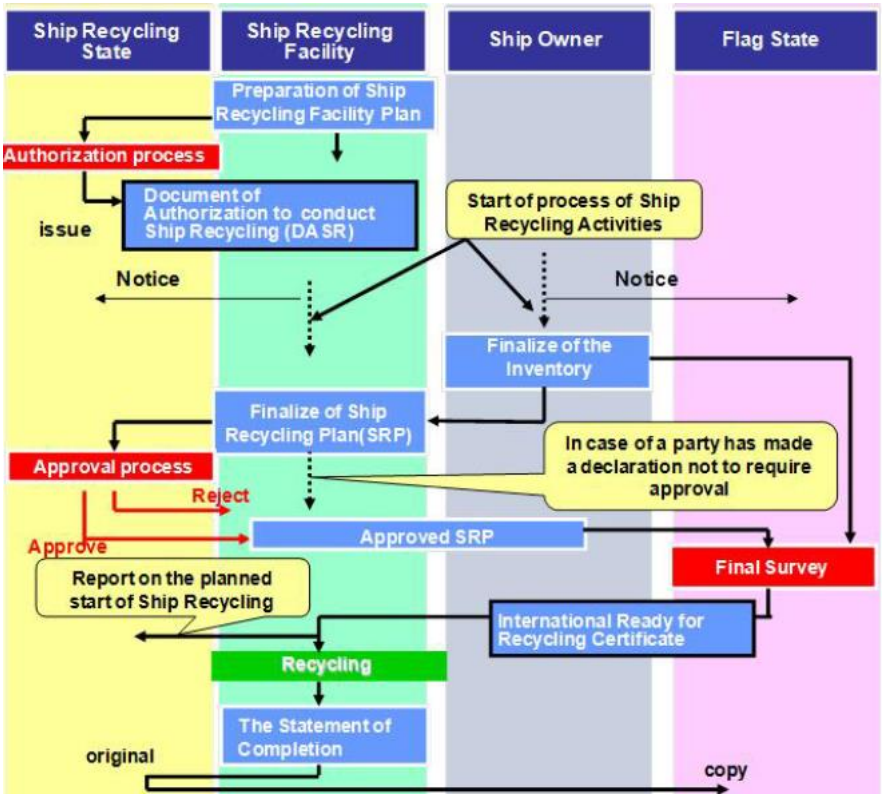
Source: Based on METI, created by JPT

(4) Ship Dismantling Factory

In the early of 20th century, around 90 % of ship dismantling was implemented in Japan, but currently

over 90 % of it is implemented in India, Bangladesh, Pakistan and China. As of 2023, the market size was evaluated $3.98 billion, and it is estimated that the market size would be grown $7.64 billion. Ship dismantling can ensure many steels. For example, the 70% of steel internal demands in Bangladesh is satisfied by a steel ensured with ship dismantling. Additionally, many people are hired in ship dismantling industry: the indirect working population of this industry is estimated 500 thousand people. While this industry contributes to ensure the steel or create working opportunity, environmental problem, caused by oil or harmful substances such as asbestos, ozone depleting substance etc. leaking, working problem and occupational accidents has happened there. In 2020, at least 10 dead and 14 serious injuries had been reported in ship dismantling factory at Bangladesh. Accidents happened at ship dismantling factory has been caused by exploding gas cylinders or falling while dismantling operation.

Besides, it did not end as accidents, but some poor working conditions are reported such as found bare foot worker in dismantling area. Legislation and checking system are required to be considered to decrease accidents and poor working conditions like shown above. To comply with this background, "Hong Kong international Convention for the Safe and Environmentally Sound Recycling of Ships, 2009" has been adopted and it would be enforced on 6th June in 2025. As of January 2024, 24 countries had ratified, Japan is included and Senegal has not ratified. This convention subject for ships which signatory country as flag country or ship dismantling factory which operated under parties, and based on the possessing ships as of 2024, all top 3 ranked countries had ratified. After this convention would have been enforced, harmful substances such as asbestos are forbidden or regulated to load to new ships, and list the inventory about loaded harmful substances and submit it to the right department. Moreover, ship dismantling undertaken in the signature countries is only allowed to dismantling factories where the competent authority has certified. To be certified by as a ship dismantling factory, the owner of that is required to form the "Ship Recycling Facility Plan" which includes the methods to ensure the safety for worker and environment. The content that has to be included to this plan is written in "2012 Guidelines for Safe and Environmentally Sound Ship Recycling" and "2012 Guidelines for the Authorization of Ship Recycling Facilities" and most of them is checking about workers health and environmentally sound. In addition, when dismantling agent start recycling in practice, agent is asked for submitting and to be certified their Ship Recycling Plan by competent authorization. The procedure from planning ship dismantling factory to dismantling ship in practice is shown in figure below.



Source : Japan Maritime Center HP

Figure 3.290 The Flow of Ship Dismantling Implementation under Convention

As a measure for oil leaking, a ship dismantling factory in India uses non-permeable floors and a system in which oil flows into gutter. And also, to prevent oil leaking while monsoon and typhoon, oil-skimmer which is equipment for separating mixed liquid with water and oil into each liquid is introduced in each yard. These are measures to be taken before oil is released into the sea, but just in case, the consideration of methods for after oil is leaked.

The methods to retrieve oil are separated into two ways; 1) utilizing machines, 2) utilizing oil- fence. First of all, with utilizing the machines way, dedicated ships for retrieving oil exists but as other machines dredging ship or grab ship is utilized to collect leaked oil. Secondly, the way with utilizing oil fencing is the way that encloses the assumption area where the spill had occurred, and after that utilize oil treatment chemicals (need to be paid attention to using because this itself can be a cause of environmental pollution) or oil adsorbent.

Source: Petroleum Association of Japan HP

Figure 3.291 View of Using Oil Fencing

Additionally, for the measure to keep human right such as occupational accidents, automation in the ship dismantling industry has occurred. In November 2022, the European Regional Development Fund, the fund that provides funding to all organization in the EU aim to revision the economic, social and territorial disparities, provided funding to start-up company in Netherlands which is developing automation process for ship dismantling industry.

Transboundary movement of hazardous waste is regulated under the Basel Convention on the Control of Transboundary Movements of Hazardous Wastes and Their Disposal (commonly referred to as the Basel Convention). This international environmental treaty was adopted in 1989 in Basel, Switzerland, and entered into force in 1992. Both Japan and Senegal ratified the convention in 1993.

The Basel Convention was established in response to growing international concern over the improper export and disposal of hazardous waste from developed to developing countries, which had led to serious environmental and health issues. The treaty requires that exporting countries obtain Prior Informed Consent (PIC) from importing countries and strengthens systems for tracking and sharing information on waste movements. As of 2024, more than 190 countries are parties to the convention, making it the global framework for hazardous waste management.

The Basel Convention also applies to ship dismantling. In particular, when decommissioned vessels are transferred to other countries for dismantling, they may be classified as hazardous waste. In such cases, the exporting country must comply with the PIC procedure, and without the importing country's explicit consent and a proper disposal plan, the export of such vessels is, in principle, prohibited. In practice, the application of the convention is determined with careful consideration of the timing of deregistration and the clarity of the dismantling purpose. Complementing the Basel Convention, the Hong Kong International Convention for the Safe and Environmentally Sound Recycling of Ships was developed specifically to regulate ship recycling, and coordinated application of both frameworks is required.

Currently, the Port of Dakar functions as an offshore supply base, providing equipment and materials to offshore installations. Globally, the updating and dismantling of offshore oil and gas production facilities has led to an increase in the volume of hazardous waste. However, challenges remain, including shortages of final disposal facilities that comply with the Basel Convention and public opposition to

bringing such waste onshore. It is anticipated that similar decommissioning and dismantling of offshore facilities will occur in Senegal in the future. Accordingly, it is essential to develop relevant domestic legislation and infrastructure to ensure compliance with the Basel Convention.

3.18.6 Phased Development Plan Aligned with Senegal Vision 2050

(1) Concept of Phased Development Plan

Based on the R/D concluded between JICA and PAD on February 28, 2022, this project has been studied with the target year of the long-term development plan being 2047. Subsequently, after the 2024 presidential election, based on the Senegal Vision 2050 announced in October 2024 and the results of the JCC consultation on June 3, 2025, it was decided to additionally consider a phased development plan based on the following three assumptions:

- In line with Senegal Vision 2050, the long-term planning target year will be 2050, with the aim of opening only the container terminal by 2030.
- Considering PAD's plan to use wharf 6th and 7th of Dakar Port (former DPW site, quay length approximately 700m) for general cargo handling, the transfer of the functions of two general cargo berths to Ndayane port will be postponed until after 2035 due to the use of the former DPW site.
- Considering that negotiations have begun between Dakar Terminal, which currently operates the RORO terminal at Dakar port, and PAD, it is assumed that the RORO terminal will be relocated to Ndayane port in 2035.

(2) Outline of the Phased Development Plan Aligned with Senegal Vision 2050

The phased development plan aligned with Senegal Vision 2050 is shown in Table 3.251.

Table 3.251 Phased development Plan Aligned with Senegal Vision 2050

Target year / Facility	2030	2035	2050	After 2050
	Short term	Middle term	Long term	Future
Breakwater	Follow DPW Plan	Same as left	Same as left	Same as left
Channel	Follow DPW Plan	Same as left	Same as left	Same as left
Turning basin	Follow DPW Plan	Expansion to the inner port	Expansion to the inner port	Expansion to the inner port
Container Terminal	Follow DPW Plan	Follow DPW Plan	Follow DPW Plan	Follow DPW Plan
RORO Terminal	No Construction	Water depth -14.0m, berth length 600m	Water depth -14.0m, berth length 600m	Water depth -14.0m, berth length 600m
General Cargo Terminal	No Construction	No Construction	Water depth -15.0m, berth length 500m (including bulk cargo)	Water depth -15.0m, berth length 1500m (including bulk cargo)
Access road	Follow DPW Plan	Access road (2 lanes on each side) and temporary road	Widening of access road (4 lanes on each side)	Widening of access road (8 lanes on each side)
drainage canal	Follow DPW Plan	Mouth of river to the end of airport drainage	Same as left	Same as left
PIZ	No Construction	503 ha	756 ha	Same as left
Railway	No Construction	No Construction	Airport to Ndayane	Same as left

Source: JPT

Source: JPT

Figure 3.292 Layout of Short-term Development Plan for 2030 (for Senegal Vision 2050)

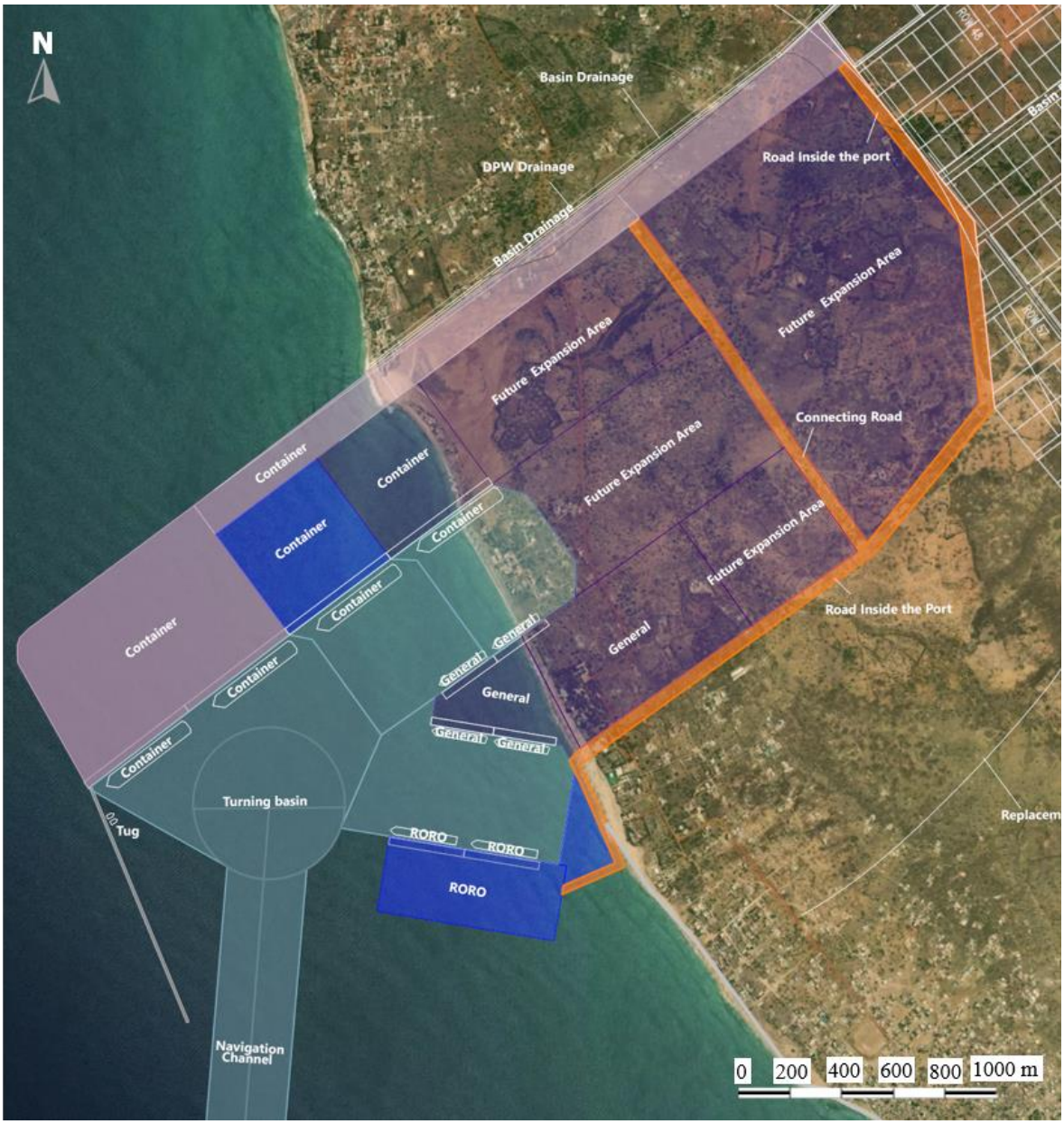
The short-term development plan for 2030, as shown in Figure 3.292, covers facilities that DPW is currently constructing with the aim of opening in 2027-2028. Specifically, the projects include breakwater, dredging of channel and basin, container terminal quay and yard, drainage, access road and PAD's administrative office. This will result in the transfer of container handling functions from Dakar port to Ndayane port, and it is also expected that PAD staff managing port operations will also be transferred to Ndayane port.

Source: JPT

Figure 3.293 Layout of Middle-term Development Plan for 2035 (for Senegal Vision 2050)

Regarding the middle-term development plan for 2035, it is assumed that DPW will add one container terminal berth as shown in Figure 3.293. It is also assumed that RORO cargo handling functions will be transferred from Dakar port. For general cargo, it is assumed that the site of the former DPW container terminal at Dakar port can be used, and no transfer of functions to Ndayane port is envisaged in 2035. The former site of Dakar Terminal's RORO terminal is also capable of handling general cargo, and future development plans for Dakar Port by PAD are awaited. The facilities to be developed by 2035 include one berth container terminal, two-berth RORO terminal, a multi-purpose storage yard for containers and other items (triangular reclamation area) next to the RORO terminal, access roads connecting to the RORO terminal, drainage, and part of the PIZ.

This is expected to increase the volume of containers handled at the container terminal at Ndayane port and transfer RORO cargo handling from Dakar port to Ndayane port, thus easing congestion at Dakar port. In addition, the development of the PIZ is expected to lead to increased handling of PIZ-related cargo and increased employment by companies located in the PIZ.

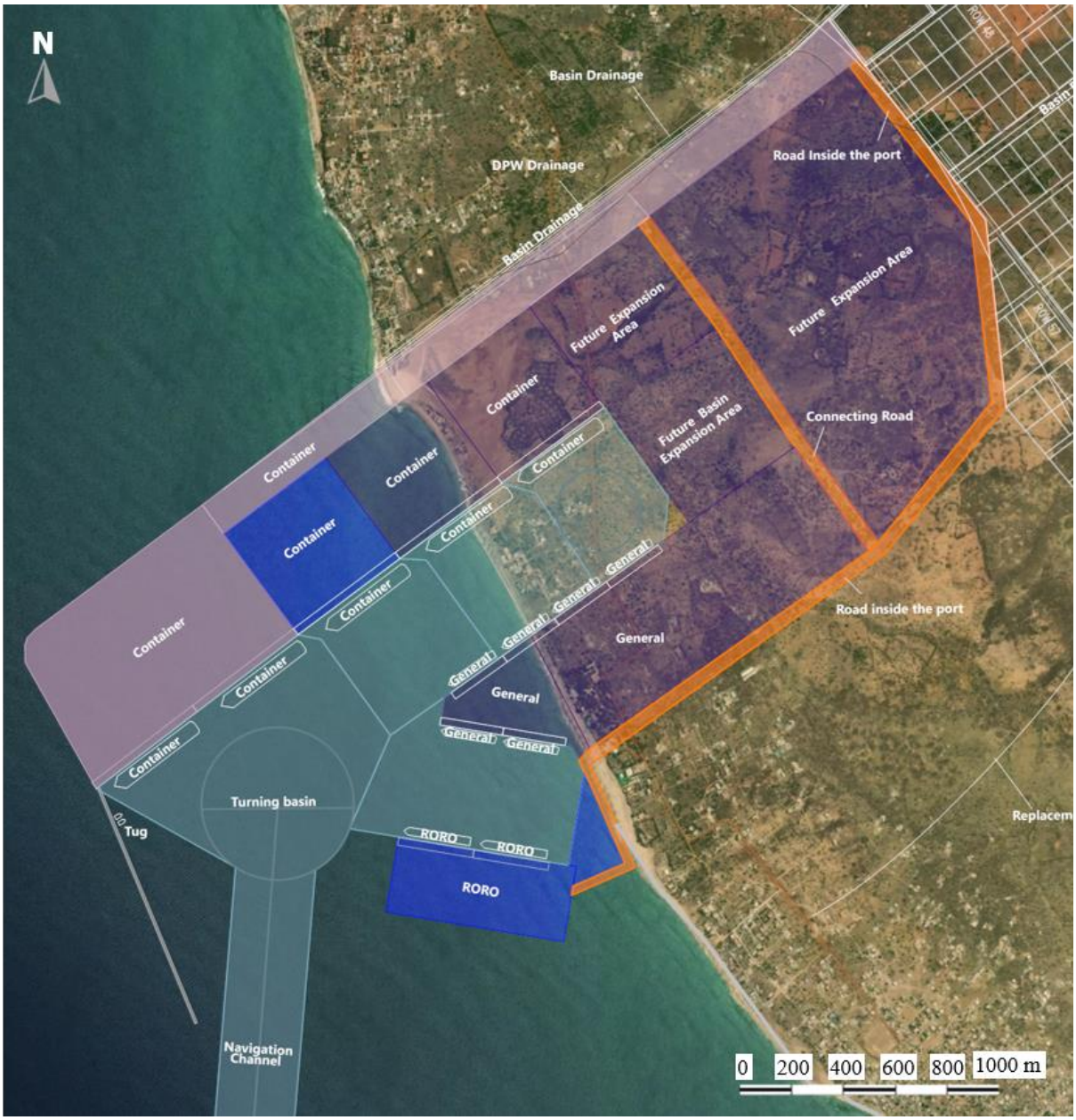


Source: JPT

Figure 3.294 Layout of Long-term Development Plan for 2050 (for Senegal Vision 2050)

Regarding the long-term development plan for 2050, it is assumed that DPW will add one container terminal berth, the total is four berths, as shown in Figure 3.294. In addition, based on forecasts of general cargo demand, including bulk cargo, throughout Senegal, the general cargo handling capacity of Dakar port will be exceeded, and general cargo handling functions will also be required at Ndayane port, so it is envisaged that four general cargo berths will be developed at Ndayane port. In addition, the extension of the railway will enable efficient import and export of bulk cargo, and it is expected

that development of the remaining space in the PIZ will be completed by 2050.



Source: JPT

Figure 3.295 Layout of Future Development Plan after 2050 (for Senegal Vision 2050)

Regarding future development plans after 2050 as shown in Figure 3.295, it is assumed that DPW will add one container terminal berth, the total is five berths. Additionally, in line with the predicted growth in general cargo demand, it is planned to develop a total of six general cargo terminal berths. Basins for container ships and general cargo ships are constructed by excavation.

(3) Project Evaluation of the Phased Development Plan Aligned with Senegal Vision 2050

The demand forecast results, construction costs, project costs, construction period, and economic and financial analysis results for the phased development plan aligned with Senegal Vision 2050 are shown in Table 3.252 to Table 3.256. Based on these, the timing of each project is appropriate, and the project has sufficient feasibility in both 2035 and 2050.

Table 3.252 Demand Forecast for Phased Development Plan Aligned with Senegal Vision 2050

Cargo	Port	Scenarios aligned with Senegal Vision 2050		
		2030	2035	2050
Container (000 TEU)	Senegal total	1,811	2,223	3,104
	Dakar	0	0	0
	Ndayane	1,811	2,223	3,104
	Bargny Sendou	0	0	0
RORO (000 units)	Senegal total	210	250	350
	Dakar	210	0	0
	Ndayane	0	250	350
	Bargny Sendou	0	0	0
General and bulk cargo (000 ton)	Senegal total	28,597	35,767	67,995
	Dakar	7,489	8,920	7,205
	Ndayane	0	0	7,877
	Bargny Sendou	21,108	26,848	52,912

Source: JPT

Table 3.253 Construction and Project Costs for Phased Development Plan Aligned with Senegal Vision 2050

Target year		Overall	DPW	PAD	Construction period (PAD portion)
		Million EUR	Million EUR	Million EUR	
2030	Construction cost	1,417	1,417	0	-
	Project cost	2,268	2,268	0	
2035	Construction cost	887	322	565	4 years
	Project cost	1,419	515	904	
2050	Construction cost	970	616	354	3 years
	Project cost	1,552	985	567	
After 2050	Construction cost	468	16	452	4 years
	Project cost	748	25	723	

Source: JPT

Table 3.254 Economic and Financial Analysis Results of Long-term Development Plan Aligned with Senegal Vision 2050

	Economic Analysis			Financial Analysis	
Target Year	EIRR	NPV	B/C	FIRR	NPV
2050	22.13%>9.0%	3,629,305>0	1.59>1.00	14.02%>2.15%	17,540,701>0
2035	18.25%>9.0%	474,915>0	2.00>1.00	3.61%>2.15%	1,654,206>0

Source: JPT

Table 3.255 EIRR Sensitivity Analysis Results Aligned with Senegal Vision 2050

Base	Case1	Case2	Case3
22.13%	18.80%	18.47%	15.53%

Source: JPT

Table 3.256 FIRR Sensitivity Analysis Results Aligned with Senegal Vision 2050

Base	Case1	Case2	Case3
14.02%	11.63%	12.23%	10.07%

Source: JPT

3.19 Formulation of an Action Plan for Realization of the Master Plan

PAD informed that if PAD obtains development rights from the Presidential Office and obtains EIA approval, it will be able to begin construction after consultation with residents. On the other hand, approval from the Presidential Office is not required for maritime areas. PAD has been granted development rights for 1,200 hectares from the Presidential Office. DPW carried out EIA on part of the land area of the 1,200 hectares and began construction after receiving approval from the Senegal government. PAD is still under consultation about resettlement with residents in 2024.

Of the master plan presented by JPT, all of the land areas covered by the 2030 development plan are within the 1,200 hectares for which PAD has acquired development rights, and construction can begin once PAD approves the project, the EIA is approved, and residents are agreed.

On the other hand, since some facilities planed in 2035 and 2047 are outside the 1,200ha area, PAD will need to obtain development rights from the Presidential Office. The construction work is expected to take three to four years, and before construction start, it will be necessary to obtain development rights, EIA approval, and consent from residents.

3.20 Confirmation of legal status of this master plan and approval process

Master plans for ports, urban development and transport infrastructure are developed based on national strategies and legislation—not only in Senegal—and are approved with the involvement of government agencies and local communities.

3.20.1 Legal status of the Master Plan

(1) Alignment with national development plans

As mentioned above, in Senegal, the "Plan Sénégal Émergent (PSE)" serves as an important

development guideline that comprehensively supports the country's economic development, urban planning, infrastructure development, and environmental protection, and master plans are formulated based on this national strategy. The PSE is a plan aimed at promoting economic growth, improving infrastructure and improving social welfare, and the master plan will guide the development of cities and regions in line with this plan.

a) Urban Planning Code (Code de l'Urbanisme)

In Senegal, urban and regional development is carried out based on the Urban Planning Law. Within the framework of this law, the Master Plan is positioned as a guideline aimed at the sustainable development of the region. This law includes land use planning, infrastructure development guidelines, environmental protection, etc., which are necessary for comprehensive control of urban growth, including land use, building regulations, and transportation infrastructure.

b) Environmental Protection Law (Code de l'Environnement)

In Senegal, environmental protection laws are applied to control the impact of development on the environment. The master plan includes a requirement to assess the environmental impact of developments and to carry out strategic environmental impact assessments for large-scale developments such as Ndayane port. This will ensure that large-scale projects such as urban and port development can be carried out in a sustainable manner.

c) Consistency with international frameworks

Senegal's port development and urban planning are linked to support from international organizations and regional cooperation frameworks. For example, projects supported by the African Development Bank (AfDB) or the World Bank develop master plans based on international standards in addition to Senegalese standards, and projects receiving support from JICA must also follow JICA guidelines.

3.20.2 Master Plan Approval Process

(1) Formulation stage

Master plans are usually formulated by local governments or government agencies in each city. At the national level, the Ministry of Urban Planning (Ministère de l'Urbanisme) and the Ministry of Infrastructure (Ministère des Infrastructures) play key roles. Meanwhile, at the local level, local governments develop plans based on local needs. Planning experts, engineers and environmental consultants will provide technical assistance in formulating the plan. Ndayane port is under the control of PAD, including the PIZ behind it. AFD, Enabel, DPW and JICA are supporting the development of master plans and development plans for the development of Dakar Port, regional ports and Ndayane Port.

(2) Stakeholder meetings and SEA formulation

During the master plan formulation stage, stakeholder meetings and SEA will be conducted. This is discussed in more detail in the Environment chapter.

(3) Government Approval

After the implementing agency formulates the master plan, it will be officially adopted after obtaining approval from each relevant agency. In Senegal, particularly large port and infrastructure projects require approval from the Ministry of Transport and Infrastructure, the Ministry of Urban Planning, and in some cases the Presidency. The Dayang Port Master Plan requires approval from the Office of the President. When approved, the master plan is checked to see whether it is aligned with national economic strategies and regional development plans.

(4) Implementation and monitoring

The plan will be implemented based on the approved master plan. During this phase, infrastructure construction will proceed while the project's progress and environmental impact are monitored. As the plan is implemented, it will be reevaluated as necessary and adjustments will be made to allow for flexibility in adapting to changing circumstances.

3.20.3 Overview of the legal status and approval process of port master plans in Japan (for reference)

Japan's port master plans are legally binding based on the country's Port and Harbor Act and related regulations, and serve as important guidelines for national and regional economic development and infrastructure development. The plan will be implemented in accordance with environmental protection and regional development goals, undergo approval processes by the Ministry of Land, Infrastructure, Transport and Tourism and local governments, and undergo long-term monitoring.

(1) Legal Framework Based on the Port Law

Japan's port master plans are formulated mainly based on the Port and Harbor Law. The Port and Harbor Law is the basic law concerning the planning, development, and operation of ports, and is defined in the following two legal respects:

Port areas are designated by the national or local government, and land use and development within these areas are carried out in accordance with the port master plan. The construction of buildings and facilities within the port area is regulated in accordance with the planning guidelines.

Under the Port and Harbor Law, port administrators (national and local governments, port management associations, etc.) are obligated to formulate master plans for the appropriate management and operation of ports. This plan will be formulated as a long-term vision, taking into account factors such as logistics, economy, environmental protection, and infrastructure development.

(2) Consistency with national and local government policies

Port master plans are required to be consistent with national infrastructure development plans and local government land use plans. As ports are important elements of national infrastructure, they are closely linked to policies aimed at strengthening the nation's overall resilience, disaster prevention, and sustainable development. In addition, because port master plans play an important role in promoting regional economies and industrial development, they are formulated to be in line with local government economic development plans and regional development policies.

(3) Coordination with environmental protection laws

Because port development and construction can have a significant impact on the environment, it is necessary to comply with laws such as the Basic Act on the Environment and the Nature Conservation Act. In particular, there may be legal requirements to carry out a Strategic Environmental Assessment (SEA).

(4) Port Master Plan Approval Process

The approval process for port master plans in Japan is a multi-step process involving national and local governments. The general approval process is described below.

a) Formulation of a basic plan

The port administrator will formulate basic policies based on the current state of the port and future needs. This master plan often includes elements such as improving logistics efficiency, infrastructure development, and environmental protection.

b) Consultation with stakeholders and solicitation of opinions

Ports involve many stakeholders, so consultation and coordination are important. Once the plan is formulated, opinions will be collected from relevant government ministries, local governments, and logistics companies. In addition, several public hearings will be held to gather input from residents and other stakeholders.

c) Strategic Environmental Assessment (SEA)

Any large-scale port development requires a strategic environmental impact assessment. It may be necessary to assess the plan's impact on the environment in advance and revise the plan based on the results. Based on the results of the environmental impact assessment, a final plan will be formulated that incorporates environmental considerations.

d) Approval

The final master plan will be submitted by the port authority to the relevant local and national authorities for approval. In Japan, approval is required from the Ministry of Land, Infrastructure, Transport and Tourism and relevant departments of local governments (such as port authorities). The plan is then checked for consistency with national and local policies and formally approved.

e) Implementation and monitoring

Based on the approved master plan, specific development projects will be implemented. During the implementation phase of the plan, regular monitoring will be carried out and the plan will be revised as necessary.

f) How to check

Information about the port master plan will be made available on the port authority's official website. You can check the latest master plan and approval status by contacting the Port Bureau of the Ministry of Land, Infrastructure, Transport and Tourism or the port department of your local government. The SEA report will also be made public, allowing people to see the environmental impact of the plan.

(5) Differences between developed and developing countries (general consideration)

Although the legal status and approval processes for master plans in developed and developing countries are institutionally similar, there are often substantive differences. In developed countries, legal systems are well developed, transparency is ensured through citizen participation and public surveys, and there is a strong tendency to place importance on sustainability and public opinion. In contrast, in developing countries, economic growth and infrastructure development are prioritized, and systems are sometimes not well-implemented or have sufficient transparency.

The differences between developed and developing countries are mainly due to the following factors:

In terms of legal status, in developed countries, master plans are usually formulated as detailed, long-term plans based on multiple laws and regulations. Urban planning laws, land use laws, environmental protection laws, etc. are in place, and local governments and specialized urban planning agencies are responsible for formulating and monitoring master plans. Complex coordination takes place at national and regional levels, and the following frameworks are commonly seen:

For example, European and North American countries have highly developed urban planning and regional development laws, and master plans based on these are formulated at the national, state, and city levels.

In developed countries, master plans emphasize sustainable development rather than just economic development. Key themes include environmental and social sustainability, transportation, energy efficiency, urban greening and carbon neutrality.

The approval process is also highly institutionalized, resulting in a high level of transparency in governance. This typically involves a public participation process, a multi-stage approval process and a thorough Strategic Environmental Assessment (SEA).

Particularly with regard to the environment, public surveys and public participation processes are essential, and a system has been established to widely solicit opinions from residents, businesses, and other stakeholders and reflect them in the plans. Such a process would increase transparency and allow objections and concerns to be resolved at an early stage of a project.

On the other hand, in developing countries, compared to developed countries, legal frameworks are often underdeveloped and systems are often implemented more loosely. Even when legal systems exist, they may not be fully implemented or may be incomplete. In addition, in many developing countries, although urban planning laws and land use laws exist, the systems may not function adequately. Corruption and administrative inefficiency can also affect the planning approval process. In developing countries, master plans often prioritize economic growth and infrastructure development, sometimes relegating environmental and social sustainability to a secondary role. Particularly in urban areas, the development of infrastructure in response to rapid population growth tends to be given priority.

In some cases, public participation and public research is not carried out sufficiently, or is merely

carried out as a formality. Planning is sometimes driven by central governments and international funding agencies, without sufficient input from local governments and civil society. Even where Environmental Impact Assessments (EIA) are required by law, they are often incomplete or their results are not fully incorporated into planning.

3.21 Examination of organization structure/system (including utilization of PPP) related to port operation and management

3.21.1 Government Orgazination

Senegal is a unitary presidential republic; since the country's foundation in 1960, it has been recognized as one of the most stable countries on the African continent. According to 2023 V-Dem Democracy indices Senegal is ranked 52nd in electoral democracy worldwide and 4th in electoral democracy in Africa. The state was formed as part of the independence of French West Africa from French colonial rule.

(1) Ministries of Senegal

Government ministries of Senegal as of 2023 are shown in the table below.

Table 3.257 Ministries of Senegal

1	Ministry of Interior
2	Ministry of Armed Forces
3	Ministry of Justice
4	Ministry of Foreign Affairs and the Senegalese Diaspora
5	Ministry of Oil and Energy
6	Ministry of Finance and Budget
7	Ministry of Infrastructure, Land Transport and Opening Up
8	Ministry of Tourism and Leisure
9	Ministry of Economy, Planning and Cooperation
10	Ministry of Water and Sanitation
11	Ministry of National Education
12	Ministry of Vocational Training, Apprenticeship and Integration
13	Ministry of Agriculture, Rural Equipment and Food Sovereignty
14	Ministry of Higher Education, Research and Innovation
15	Ministry of Mining and Geology
16	Ministry of Women, the Family and the Protection of Children
17	Ministry of Labor, Social Dialogue and Relations with Institutions
18	Ministry of Health and Social Action
19	Ministry of Environment, Sustainable Development and Ecological Transition
20	Ministry of Urban Planning, Housing and Public Hygiene
21	Ministry of Commerce, Consumer Affairs and Small and Medium Enterprises
22	Ministry of Industrial Development and Small and Medium-Sized Industries
23	Ministry of Fisheries and Maritime Economy
24	Ministry of Territorial Authorities, Planning and Territorial Development
25	Ministry of Air Transport and Airport Infrastructure Development
26	Ministry of Youth, Entrepreneurship and Employment
27	Ministry of Livestock and Animal Production
28	Ministry of Communication, Telecommunications and Digital
29	Ministry of Civil Service and Public Sector Transformation
30	Ministry of Microfinance and the Social and Solidarity Economy
31	Ministry of Culture and Historical Heritage
32	Ministry of Community Development, National Solidarity and Social and Territorial Equity
33	Ministry of Sports
34	Ministry of Crafts and Transformation of the Informal Sector
35	Ministry of Investment Promotion and Partnerships

Source https://www.presidence.sn/en/institutions/government

a) Ministry of Fisheries and Maritime Economy (Ministère de la Pêche et de l'Economie Maritime – MPEM)

The Ministry of Fisheries and Maritime Economy is under the authority of the Prime Minister since 4 July 2012. The mission of the Ministry of Fisheries and Maritime Affairs is to prepare and implement the policy defined by the Head of State in the fields of fisheries, fish farming, and development in value of the seabed, port infrastructure and maritime transport. As such, it ensures information of public authorities on the state of fisheries resources and ensures sustainable use by both artisanal fisheries and industrial. In connection with the Minister of the Armed Forces and the Minister of the Interior, is responsible for the protection of fisheries resources and fisheries surveillance. The new political regime renamed the Ministry of Fisheries and Maritime Economy (MPEM) into Ministry of Fisheries, of Maritime and Port Facilities (MPIMP).

The Ministry of Fisheries and Maritime Economy:

- Monitors industrial fishing to ensure that it does not destroy or deplete the natural marine environment
- Is responsible for ensuring that the processing of fishery products runs smoothly, for the management and exploitation of the seabed and for setting up and developing port infrastructures in line with the best international standards.
- Ensures that these products are recycled.
- Encourages their export.
- Ensures that fishing professionals have the appropriate qualifications.
- Supports small-scale fishing and promotes its modernization
- Examines fishing licence applications and issues authorisations following a transparent public tendering procedure
- Represents Senegal at all international fisheries meetings and signs fisheries agreements between Senegal and foreign countries
- Promotes and monitors the development of fish farming and aquaculture, in conjunction with the Ministry of Ecology.

In this capacity, it oversees the Ports, the Merchant Navy and all the structures in charge of shipbuilding and maintenance.

The Ministry of Fisheries and Maritime Economy is the line-ministry of PAD. Therefore, every project of PAD should be in line with the Ministry's policies and strategies.

b) Institutions of Ministry of Fisheries and Maritime Economy

The Ministry of Fisheries and Maritime Economy of Senegal oversees various institutions related to fisheries and maritime affairs in the country. The institutions under this ministry are:

- Cabinet and related departments
  - Internal inspection
  - Communication Unit
  - Industrial Redeployment Unit
- General Secretariat and related departments
  - Public Procurement Unit
  - Studies and Planning Unit
  - Legal Affairs Unit
  - IT Unit
  - Gender and Equity Unit

- Archives and Documentation Unit
- Joint Mail Service.

➢ Directions:

- Maritime Fisheries Directorate
- Fisheries Protection and Surveillance Directorate
- Fisheries Processing Industries Department
- Seabed Management and Exploitation Department
- Inland Fisheries Division
- Port Infrastructure Department
- General Administration and Equipment Department

➢ Other administrations:

- National Maritime Training School
- National Training Centre for Fisheries and Aquaculture Technicians
- Centre for Fishing Improvement, Experimentation and Extension
- National Maritime Affairs Agency (ANAM)
- National Aquaculture Agency
- Richard Toll fish farming station

Source: DECREE NO. 2019 - 769 OF 08 APRIL 2019 CONCERNING DISTRIBUTION OF STATE SERVICES AND THE CONTROL OF PUBLIC ESTABLISHMENTS, NATIONAL COMPANIES AND COMPANIES WITH BETWEEN THE PRESIDENCY OF THE REPUBLIC THE PRESIDENCY OF THE REPUBLIC, THE PRIMACY AND THE MINISTRIES)

3.21.2 Acts, Regulations, Laws related to ports

Acts, regulations and laws related to ports are referred to Chapter 2.5.

3.21.3 Port Autonome de Dakar (PAD)

Since July 1, 1987, PAD has gone from the status of a public industrial and commercial establishment (EPIC) to that of a national company with capital of 52 billion FCFA. This is the purpose of law No. 87-28 of August 18, 1987 as amended.

The mission of the national company of PAD is: the operation and maintenance of the Dakar seaport and its outbuildings, the management of its movable and real estate assets, as well as the execution of improvement and extension works on its facilities; the creation or acquisition, and operation of any funds or establishments of the same nature; the participation of the company, by all means and in whatever form, in all companies created or to be created; and generally, the carrying out of any commercial, industrial, movable or real estate or financial transaction relating directly or indirectly to the object defined above.

The supervision of PAD is exercised jointly by the Minister of Fisheries and Maritime Economy and the

Minister of Finance.

PAD is administered by a board of directors composed of:

- Representative of the President of the Republic, (PCA)
- Representative of the Prime Minister's Office (Vice – President)
- Ministry of Fisheries and Maritime Economy
- Ministry of Economy and Finance
- Financial Control (participates in a consultative manner)
- Chamber of Commerce and Industry of Dakar
- Senegalese Shippers Council (COSEC)
- National Agency for Maritime Affairs (ANAM)
- Staff Representative of PAD
- Union of Transport Auxiliaries of Senegal (SATS)
- Union of Port Handling Companies of Senegal (SEMPOS)
- Group of Hydrocarbon Refuelers
- Malian warehouses in Senegal (EMASE)

The Board of Directors deliberates on all measures concerning the management of PAD, in particular:

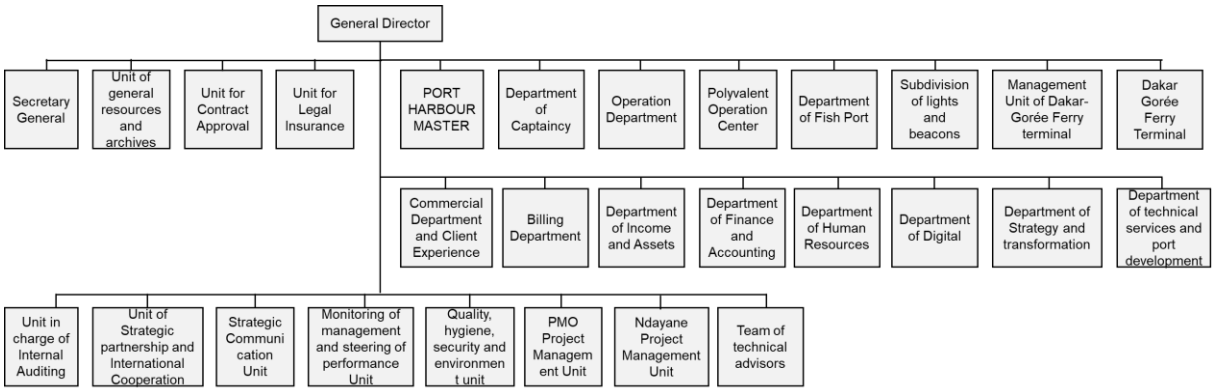
- The Rules
- Multi-year action and investment programs
- Budgets and forecast accounts
- Acquisitions and alienations of assets
- Financial participation
- Year-end accounts
- Draft collective establishment agreements
- Port operating regulations
- Rates for port fees and services
- The organization chart of the company
- Authorizations to occupy the port area for a period greater than or equal to nine (09) years

The board ensure the application of these deliberations by the Director General. It deliberates each year on the management report and the company's social report presented by the Managing Director.

The board is informed of presidential directives, in particular those resulting from the reports of the

control bodies on the management of the company, and deliberately each year on a report from the General Director relating to the application of these directives.

Organization chart and departments under PAD are as below:



Source: JPT based on PAD material

Figure 3.296 Organization chart of PAD

Table 3.258 Departments under PAD and Their Roles and Functions

Departments	Roles and Functions
HIGH PORT COMMAND	➢ Under the authority of the General Manager, the Port Captain is responsible for: ➢ Monitoring national and international regulations; ➢ The port's core business activities, and coordinates the Operations, Harbour Master's Office, Fishing Port, Maritime Station and Multi-Purpose Operations Departments; ➢ Coordinating related structures (Liaison Maritime Dakar-Gorée and Lights and Beacons) and other administrations involved in the port.
DEPARTMENT OF THE CAPTAINCY	➢ To ensure that the services rendered to the ships, the goods, passengers and approved companies; ➢ To ensure the proper use of the facilities available to customers, the cleanliness of the bodies of water, embankments, hangars, traffic lanes and docks; ➢ To monitor and conserve the water body, channels and port facilities; ➢ To monitor pollution and events that may affect fluidity, safety and security of the port by ensuring the police of the water bodies, the environment and the marking; ➢ To ensure the tracking of dangerous goods or goods not in transit on the Port, in compliance with the regulation; ➢ To enforcing operational and port policing laws and regulations; ➢ To participate in the management of the safety and security of the maritime district; ➢ To organize the harbour towing to all useful proposals that will allow to guarantee to the best interests of the different actors, while preserving the harbour infrastructures and vessels;

Departments	Roles and Functions
	➢ To constantly analyze the regulatory environment of port towing and make proposed changes to current regulations to comply with standards in this area; ➢ To ensure the level playing field between towing companies at the same time transparent and objective; ➢ To guarantee the obligation of the licensee to provide the public towing service in the Port of Dakar.
OPERATIONS DEPARTMENT	➢ Under the authority of the General Manager and the supervision of the Port Commander, it is responsible for: ➢ Implementing a plan to improve landing/embarking rates; ➢ Implement truck flow management; ➢ Operating and managing the port domain located inside the customs barrier, in particular by examining applications for occupancy, preparing and monitoring the execution of specifications for occupancy of the port domain in conjunction with the Legal Affairs and Insurance Unit, and the Customer Experience Commercial Department; ➢ Managing logistics platforms and dry ports, implementing the strategy defined for their operation; ➢ Ensuring the application of laws and regulations concerning port operations and policing; ➢ Monitoring the activities of companies operating in the platforms and ensure compliance with commitments made to SONAPAD; ➢ Participating in the development and improvement of port facilities; ➢ Taking all necessary measures to guarantee free access to ships and the transit of goods in the best safety and security conditions within the port perimeter, including the inner roadstead; ➢ Managing land, warehouses and commercial buildings inside and outside the customs barrier; ➢ Facilitating smooth invoicing and debting collection in conjunction with the Invoicing Department and the Revenue and Assets Department; ➢ Ensuring the safety of port facilities throughout the port domain, through prevention and intervention; manage weighing stations and control billing elements for services rendered to ships and goods, unmarked berths, property, water and electricity deliveries; ➢ Ensuring compliance with the provisions of Regulation 14 of the West African Economic and Monetary Union (UEMOA) and all other agreements; ➢ Implementing an equipment maintenance policy and monitor refit work in conjunction with Technical Services; ➢ Setting up a statistical information processing system and methodology; ➢ Collecting, processing and periodically disseminating PAD operational statistics, in conjunction with the relevant departments.
MULTIPURPOSE OPERATIONAL CENTER	➢ Under the authority of the high Port Command, the Manager of the polyvalent Operation Center is responsible for:

Departments	Roles and Functions
(POLYVALENT OPERATION CENTER)	➢ Managing access to the Port in conjunction with law enforcement agencies, and managing truck traffic flows; ➢ Ensuring the safety and security of the land and sea area; ➢ Alerting in the event of an incident and organizing rescue operations in the port district, under the orders of the Port Commander.
DEPARTMENT OF FISH PORT	➢ Under the authority of the General Manager and the supervision of the Port Commander, it is responsible for: ➢ Operating and managing the fishing port domain located& inside the customs barrier, in particular examining applications for occupation, repairing and monitoring the execution of specifications for occupation of the fishing port domain, in conjunction with the structures concerned; ➢ Monitoring the proper execution of concession contracts; ➢ Entering manifest and domain occupancy data for invoicing purposes, in conjunction with the relevant departments; ➢ Assisting the legal departments with any litigation or amicable settlement relating to the occupation of the fishing grounds; ➢ Controlling and monitoring the landing, shipment and transshipment of fish products; ➢ Drawing up invoices; ➢ Ensuring that the fishing port is brought up to European Union approval standards; ➢ Monitoring, with the relevant departments, the development and application of international maritime conventions.
SUBDIVISION OF LIGHTS AND BEACONS	➢ Maintenance of the public maritime signalling works on the national territory; ➢ To assistance and control to the private sector within the framework of the installation of maritime signalling works; ➢ Hydrography of navigable inland waterways within the framework of the control or of channels layout; ➢ Hydrography of the Dakar port water level and control of dredging operations; ➢ Transmission of all nautical information necessary for the safety of navigation with a view to their publication, dissemination and updating; ➢ Dissemination and transmission of notices to mariners to enable, as far as possible, the maintenance and updating of nautical maps and publications;
MANAGEMENT UNIT OF DAKAR INTERNATIONAL SHIPPING STATION	➢ NA
MANAGEMENT UNIT OF DAKAR-GOREE FERRY	➢ Under the authority of the General Manager and the supervision of the Port Captain, it is responsible for:

Departments	Roles and Functions
TERMINAL	➢ Ensuring optimum quality of service under regulatory safety and security conditions for the benefit of people and their property; ➢ Ensuring the proper execution of the specifications of shipping companies and other tenants located within the terminal perimeter and/or benefiting from its services; ➢ Coordinating, in liaison with the managers of the structures operating at the station, all activities of general interest developed within the station and/or its immediate surroundings; ➢ Ensuring the proper operation and maintenance of the station's infrastructure and equipment, as well as the protection of the environment within the station's perimeter; ➢ In conjunction with the Commercial Department and the managers of the structures operating at the terminal, making proposals for improving conditions for the cruise industry; ➢ Promoting and developing the terminal; ➢ Maintaining and improving customer service performance indicators.
SECRETARY GENERAL	➢ Under the authority of Managing Director, the General Secretary is responsible for ➢ Implementing instructions issued by the Managing Director, the company's governing bodies and supervisory authorities; ➢ Acting as secretary to meetings of the General Management's decision-making and coordinating bodies; ➢ In charge of the General Resources and Archives Unit, the Procurement Unit, the Legal Affairs Unit and the Insurance Unit.
UNIT OF GENERAL RESOURCES AND ARCHIVES	➢ Under the authority of the General Secretary, it is responsible for: ➢ Proposing and implementing general resources management policy; ➢ Responding promptly to requests from departments or units, to enable them to operate ➢ Properly and to help them achieve the objectives assigned to them; ➢ Ensuring well-being in the workplace by guaranteeing safety, hygiene and quality conditions in line with accepted standards; ➢ Managing supplies and inventories in the most cost-effective and efficient manner; ➢ Managing the vehicle fleet; ➢ Managing the administrative aspects of assignments; ➢ Managing archives and documentation; ➢ Managing office furniture and equipment, reprographics and postage; ➢ Managing and maintaining the port's office and residential buildings.
PROCUREMENT UNIT	➢ Under the authority of the General Secretary, it is responsible for: ➢ Examining in advance any document to be submitted to the Contracting Authority, to persons in charge of contracts or to third parties, in matters of public procurement;

Departments	Roles and Functions
	➢ Establishing at the beginning of the year the annual consolidated procurement plan for PAD; ➢ Establishing the general procurement notice and ensuring its publication in accordance with the provisions of the Public Procurement Code; ➢ Conducting, in conjunction with the various structures, procurement operations; ➢ Producing up and maintaining dashboards on implementation deadlines for the various stages of procurement procedures and contract execution schedules; ➢ Managing liaison with external missions, in particular contract audit missions initiated by the Regulatory Authorities.
UNIT OF LEGAL INSURANCE	➢ Under the authority of the General Secretary, it is responsible for: ➢ Identifying, preventing and managing the port's legal risks; ➢ Ensuring the legal security and proper conduct of all legal and contentious matters; ➢ Ensuring pre-verification of the legality of the port's acts (deliberations, agreements, decrees, decisions, various correspondence, etc.) and procedures; ➢ Monitoring compliance with internal operating and ethical rules by all structures; ➢ Taking part in all actions designed to assess the port's compliance with current regulations; ➢ Verifying compliance with the legal framework and the correct application of procedures, methods and instructions; ➢ Participating in the drafting, negotiation and monitoring of all types of contracts and public tenders, as part of the implementation of the port's missions; ➢ Ensuring legal and regulatory watch; ➢ Assistance in the preparation of legal and administrative documents (notifications, minutes, statutes, internal regulations, circular letters, etc.); ➢ Participating in the management, investigation and monitoring of files (formal notice, summons to appear in court, appeals, relations with lawyers); ➢ Managing all insurance policies taken out by the company, in liaison with insurance consultants and insurance companies; carrying out legal audits.
UNIT IN CHARGE OF INTERNAL AUDITING	➢ Under the authority of the General Manager, it is responsible for: ➢ Assisting the General Manager and all managers and staff of PAD, by providing them with analyses, assessments, opinions, information and recommendations, so that they can carry out their responsibilities effectively and thus contribute to the achievement of PAD‘s objectives.

Departments	Roles and Functions
	➢ Developing and monitoring the company's internal management methods and procedures; audit management processes and ensure their reliability; ➢ Ensuring the protection of assets, the efficient use of resources and compliance with directives; ➢ Monitoring the implementation of audit recommendations; ➢ Assessing the internal control systems implemented at departmental level with a view to contributing, through appropriate recommendations, to controlling the risks inherent in the activities concerned; ➢ Promoting the internal control approach among all PAD staff so as to encourage each department head to put in place specific internal control systems to improve control over his or her activities.
STRATEGIC PARTNERSHIPS AND INTERNATIONAL COOPERATION UNIT	➢ Under the authority of the General Manager, it is responsible for: ➢ Assisting the Deputy General Manager in defining and implementing, on the basis of an annual or multi-annual action plan, the PAD's policy in the areas of strategic partnership, cooperation and international relations; ➢ Monitoring relations with international, regional and sub-regional, public and private organizations specializing in the maritime and port fields; ➢ Preparing the PAD's participation in conferences, symposia and workshops organized by the above organizations; ➢ Developing inter-port cooperation at sub-regional, regional and international level, in conjunction with the relevant departments; ➢ Managing relations between PAD and the Community of Port Actors (CAP Dakar).
STRATEGIC COMMUNICATIO N UNIT	➢ Under the authority of the General Manager, it is responsible for: ➢ Assisting the General Manager in defining and implementing the communications policy in conjunction with the relevant structures; ➢ Defining and implementing corporate communications in conjunction with the relevant structures; ➢ Collecting and managing strategic information relating to the company's development from General Management (governance, corporate project, management project, etc.); ➢ Defining and implementing the internal and external communications strategy; ➢ Managing relations with the public and private media in the interests of the company.
MANAGEMENT CONTROL AND PERFORMANCE MONITORING UNIT	➢ Under the authority of the General Manager, it is responsible for: ➢ Drawing up and keeping up to date a management chart showing, on the basis of indicators, the development of the activity of PAD; ➢ Drawing up the budget and monitoring its implementation in terms of both revenue and expenditure;

Departments	Roles and Functions
	➢ Reporting regularly, in conjunction with the structures concerned, on the implementation of the operating, investment and cash budgets; ➢ Regularly reviewing the implementation of the budgets of attached departments and the impact on the PAD's cash position, in conjunction with the said departments and the DFC; ➢ Monitoring the budgetary compensation payable by the State and the City of Dakar for the management of the LMDG public services and the Maritime Safety Service, in accordance with the agreements signed for this purpose; ➢ Preparing the management report required by article 19 of the law of 26 June 1990, including an update on the implementation of budgets and multi-year action and investment programs; ➢ Monitoring the implementation and evaluation of strategic and operational plans and contracts of objectives; ➢ Monitoring on an ongoing basis, changes in staff numbers and the wage bill for the PAD and related departments, in conjunction with the structures concerned; ➢ Setting up a cost accounting system.
QUALITY, HYGIENE, SAFETY AND ENVIRONMENT CELL	➢ To implement the quality, health and environmental policy in accordance with current standards, taking into account the regulatory requirements, needs and expectations of clients and stakeholders; ➢ To monitor the Facilities classified by the Environmental Protection (ICPE) of PAD; ➢ To ensure that applicable requirements, expectations and needs of clients and stakeholders are taken into account in internal processes; ➢ To define and implement the systems aspects (mandatory procedures in relation to the requirements of current standards); ➢ To ensure that development projects take into account the company's environmental requirements; ➢ To carry out a pollution control mission; ➢ To propose and monitor the quality audit, health, safety and environment programs; ➢ To ensure a permanent awareness of the staff and the harbour community about the issues and requirements related to the Quality, Health, Safety and the Environment; ➢ Implementing and following a risk management policy in all areas of the company's business.
PROJECT MANAGEMENT OFFICE	➢ Under the authority of the General Manager, the Project Management Office (PMO), which is responsible for monitoring and evaluating the Transformation Plan, provides strategic support to General Management and metrological support to project managers. ➢ Its mission is to: ➢ Define project management methodology and training users

Departments	Roles and Functions
	➢ Provide adequate support for project resources in the operation of the management software used (access management, project opening, use, closure, reporting); ➢ Ensure that projects are implemented on time and on budget; ➢ Supervise the effective allocation of resources and advise on the planning of leave for people assigned to projects; ➢ Monitor projects, draw up weekly progress reports and budget consumption reports, and provide monitoring tables to management and project managers.
SALES MANAGEMENT AND CUSTOMER EXPERIENCE	➢ To develop and implement the commercial policy of PAD; ➢ To prepare and implement all measures aimed at permanently taking into account the quality requirements of the service providers of PAD and its actors as well as the expectations of the customers in relation with the Unit in charge of Quality; ➢ To elaborate and implement a marketing plan likely to develop the market shares of the port of Dakar on the traffics of any nature; ➢ To expedite the processing of customer complaints; ➢ To ensure the proper functioning of the Port Advisory Committee and the application of the clauses of the standard specifications of the port professions; ➢ To prepare and publish the periodical note on the economic situation and forecast as well as the company's annual report.
DEPARTMENT OF BILLING	➢ Under the authority of the General Manager, it is responsible for: ➢ Initiating and implementing an appropriate; ➢ Proposing and implementing an efficient billing procedure; ➢ Participating in studies relating to fee schedules; ➢ Ensuring the application of the port fee schedule; ➢ Controlling, editing and distributing service providers' invoices; ➢ Regularly forwarding invoices to data entry structures; ➢ Processing customer complaints; ➢ In conjunction with the Revenue and Asset Management Department, ensure the contractualization and invoicing of all commercial services provided by the port; ➢ Ensuring pre-archiving of invoicing documents (manifest, data entry form, dispute elements, etc.). ➢ Collecting, processing and periodically distributing general and specific statistics on PAD activities, in conjunction with the Information Systems Department; ➢ Working towards the fullest possible digitization of the department's services.
DEPARTMENT OF REVENUE AND PROPERTY	➢ Under the authority of the General Manager, it is responsible for:

Departments	Roles and Functions
	➢ Proposing niches to the General Management to improve PAD's income; ➢ Preparing and managing the port domain located outside the customs barrier, in particular by examining applications for occupation, preparing and monitoring the execution of specifications for the occupation of the port domain, in conjunction with the Legal Affairs and Insurance Unit, the Customer Experience Sales Department and the Operations Department; ➢ Proposing a revenue optimization system for all Port services; ➢ Enhancing the value and profitability of the PAD's assets; ➢ Setting up agreements for the occupation of the port domain outside the customs barrier; ➢ Coordinating all activities relating to port billing control and collection, with a view to improving efficiency; ➢ Coordinating the appropriate follow-up of customer receivables with the departments concerned; ➢ Setting up and managing a port dues billing and collection control system; ➢ Defining land policy and monitoring procedures for transferring or inspecting land ownership; ➢ Participating in the port concession process and in all studies and actions relating to the port's exterior, and in the preparation and implementation of master plans for the development of the port; ➢ Setting up a system to increase land reserves; ➢ Monitoring performance indicators for billing control, collection and weighing.
DEPARTMENT OF FINANCE AND ACCOUNTING	➢ Contributing to the definition of a sustainable financial policy that ensures respect for fundamental balances; ➢ Establishing and managing an efficient value date cash flow; ➢ Negotiating, monitoring and controlling the application of bank conditions; ➢ Negotiating and monitoring financing agreements and managing foreign exchange risks; ➢ Developing short and medium term financial forecasts; ➢ Investing cash surpluses at the best interest rate and security conditions; ➢ Supervising and controlling all payments from the banks; ➢ Developing cash flow plans; ➢ Participating in the development of financing plans; ➢ Assisting and advising the Financial Director in research and supervision tasks.
DEPARTMENT OF HUMAN RESOURCES	➢ Complying with the legislative, regulatory and conventional texts applicable to the staff;

Departments	Roles and Functions
	➢ Assisting the organizations of PAD in the formulation and adaptation to organisational and managerial changes in accordance with the Collective Agreement and the objectives of the company; ➢ Developing and implementing training policies, recruitment and planning jobs and skills management (GPEC) and personnel; ➢ Conducting collective negotiations in relation to workers' organizations; ➢ Implementing performance evaluation and staff motivation systems; ➢ Establishing a more motivating staff remuneration management policy and ensuring the guarantees granted to workers by the provident institutions (IPRES and Caisse de Sécurité Sociale "Social Security Fund") ➢ Developing and implementing the company's social policy, ➢ Carrying out systematic screening and prevention of occupational diseases by implementing annual prevention and occupational health promotion programmes; ➢ Participating in all actions likely to improve the management of the policy staff health insurance in relation with the General Secretariat; ➢ Setting up a social management control system and analytical accounting applied to human resources; ➢ Ensuring business intelligence; ➢ Drawing up the social balance sheet and carrying out social audits.
DEPARTMENT OF DIGITAL	➢ Reporting to the General Manager, it is responsible for: ➢ Drawing up and implementing an IT and telecommunications master plan, and ensuring its application in conjunction with the departments concerned; ➢ Taking charge of digitalization in the key areas of production, support, marketing and strategy; ➢ Ensuring optimal, concerted management of IT systems and telematics resources; ➢ Monitoring developments in new information and communication technologies, and implement concerted measures to adapt the PAD to telematic resources; ➢ Guiding strategic and technological choices with regard to investments in software and equipment; ➢ Participating in setting up and developing a community IT system, in conjunction with the professional organizations of the Dakar port area; ➢ Contributing to staff training and the dissemination of new information and communication technologies, in conjunction with the Human Capital Department; ➢ Setting up the infrastructure required for the development and implementation of business intelligence systems.
DEPARTMENT OF STRATEGY AND TRANSFORMATI	➢ Under the authority of the General Manager, it is responsible for:

Departments	Roles and Functions
ON	➢ Proposing prospective studies to promote the port's growth potential and define long-term development strategies: ➢ Drawing up a master plan for the development of the Autonomous Port in conjunction with the relevant departments; ➢ Evaluating the real impact of economic policies and reforms on the conditions of use and on the physical and institutional environment of the port; ➢ Providing technical support to structures in the formulation of their short- and long-term strategies, and in the search for funding; ➢ Participating in the search for strategic partners for infrastructure financing and concessions, in conjunction with the structures concerned; ➢ Ensuring business intelligence and develop new products; ➢ Developing a business intelligence policy in all areas; ➢ Monitoring the implementation of the master plan and its adaptation to the changing requirements of maritime transport and the global economic environment, in conjunction with the Technical Services and Planning Department; ➢ Carrying out prospective studies on traffic and the development of the national economy, as well as sub-regional and international trade; ➢ Proposing any innovative or creative action likely to improve the company's performance; ➢ Drawing up administrative and accounting procedure manuals.
DEPARTMENT OF DIRECTOR OF TECHNICAL SERVICES AND PLANNING	➢ Conducting all general or specific studies relating to the development of the port equipment, to its rehabilitation and maintenance; ➢ Carrying out new works regarding the Infrastructures and Superstructures and to ensure their maintenance; ➢ Maintaining the port facilities and carrying out their rehabilitation according to the traffic needs; ➢ Ensuring the cleanliness of the port at all times; ➢ Carrying out dredging work on the water surface and channels; ➢ Operating and maintaining the land-based rolling stock and the water, sewerage and electricity network and renewing them; ➢ Renewing, refurbishing and rehabilitating naval equipment, in relation with the Port Commander; ➢ Participating in the search for strategic partners for the financing of port infrastructures in relation with the Strategic Partnership and International Cooperation Unit; ➢ Preparing and controlling the implementation of the multiannual investment programmes and development plans of the company in relation with the Departments concerned; ➢ Entering water and electricity pre-billing elements.

Source: PAD

NA= JPT requested to PAD but PAD did not share.

3.21.4 PAD Business Plan

Corporate Social Responsibility is a new management concept whose foundation is religious because it is based on the values of sharing and solidarity specific to religions.

PAD wanted to be a company that listened to the times by integrating CSR as an essential element of performance. By setting up a Human Capital and Organization Department, the General Management aims to better support the aspirations of workers in terms of development, training and motivation with particular attention to women and retirees. By implementing a social housing policy, the Port is committed to ensuring that each worker has a decent roof and that the concept of "one port, one roof" becomes a living reality.

To address staff expectations more efficiently, an internal satisfaction survey was conducted. It will provide a clearer vision of the social policy that the General Management intends to pursue to strengthen the feeling of belonging.

PAD also wants to be a pioneer in supporting the State in taking care of certain social needs. In order to give more emphasis and efficiency to its CSR policy, the PAD has decided to set up "a Dakar Autonomous Port Foundation.

3.21.5 Schedule of Fees Applicable to Ships

(1) Fee Schedule For Pilotable Ships

A ship becomes pilotable as soon as its volume, determined in accordance the following (1) Basis of Assessment for Pilot-Operated Vessels, reaches 1500 m3.

a) Basis of Assessment for Pilot-Operated Vessels:

The base used to establish the fees for pilot-operated vessels is the volume "V" expressed I in m3 defined as follows.

V=L x l x Tme

L= overall length of the vessel expressed in metres

l = maximum beam of the vessel expressed in metres

Tme= Maximum summer draught, expressed in metres, which may under no circumstances be less than less than 0.14 square root of L x l.

b) Pilotage And Buoyage Fees

A pilotage and buoyage charge is levied for each movement of vessels of at least 1500 m3 (entering the port, leaving the port, moving within the port area).

i. Basic tariff per operation

- Commercial vessel carrying out a commercial operation 11.80 FCFA/m3

- Commercial vessel not carrying out a commercial operation (Bunkering, repair) 5.90 FCFA/ m3
- Vessel operating on MBAO 14.16 FCFA/ m3
- Vessel in port for medical assistance, crew relief or unloading stowaways 5.90 FCFA/ m3
- Fishing vessel carrying out a commercial operation 3.54 FCFA/ m3
- Fishing vessel not carrying out a commercial operation 1.72 FCFA/ m3

This fee includes a portion intended to cover services actually provided to vessels by the buoyage service

ii. Minimum charge per operation

- Fishing vessel 33,409 FCFA
- Commercial and other vessels 94,424 FCFA

iii. Maximum collections per operation

- Vessel in port for medical assistance, crew relief or disembarkation of stowaways or landing of stowaways 295,075 FCFA

iv. Surcharge per operation

- From 01 October to 31 March from 7pm to 7am, rate increased by : + 25%
- From 01 April to 30 September from 8 p.m. to 6 a.m., rate increased by : + 25 %

c) Travel Within the Pilotable Zone

i. Rate applied

- A 50% reduction is applied to the above rates.

ii. Minimum charge per trip

- Fishing vessel 35,409 FCFA
- Commercial and other vessels 94,424 FCFA

iii. Surcharge for night trips

- From 01 October to 31 March from 7 p.m. to 7 a.m., rate increased by : + 25%
- From 01 April to 30 September from 8 p.m. to 6 a.m., rate increased by : + 25 %

d) Charges For Mooring or Unmooring Vessels

i. Basic mooring or unmooring tariff

This tariff is applied to each mooring or unmooring operation.

- Oil tanker operating on MBAO 7.7 FCFA / m3 / operation
- All vessels in port operating commercially 1.6 FCFA / m3 / operation
- All ships in port in non-commercial operation 1.1 FCFA/ m3 / operation

ii. Minimum charge per operation

- Fishing vessel 22,000 FCFA
- Commercial vessels and others 44.000 FCFA

iii. Surcharge for night operations

- Tariff increased by + 15%.

e) Residence Charges for Piloted Vessels

i. Basic rate in FCFA per m3 per day

- Vessel staying on MBAO 3.54 FCFA/ m3/ day
- Vessel in commercial operation 14.16 FCFA/ m3/ day
- Vessel in non-commercial operation (bunkering, victualling, repairs) 7.08 FCFA/ m3/ day
- Fishing vessel in commercial operation 4.72 FCFA/ m3/ day
- Fishing vessel in non-commercial operation 2.36 FCFA/ m3/ day
- Vessel carrying out national cabotage 7.08 FCFA/ m3/ day
- (Dakar base port) 1 Specialised tariff

ii. Minimum daily collection in FCFA per m3

- Vessel staying on MBAO 94,424 FCFA / day
- Fishing vessel 16.524 FCFA / day
- Commercial vessel 94,424 FCFA / day
- Vessel carrying out national cabotage 47,212 FCFA / day

3.21.6 Schedule of Fees Applicable to Non-Pilotable Vessels

(1) Basis For the Rates for Non-Pilotable Vessels

Reminder: "non-pilotable" ships are ships of less than 1,500 m3 (size of the ship estimated by applying the formula.

V= L x l x 0.14 (L x l) ½).

For these ships, pilotage is not compulsory. Should pilotage be required, the following will apply application of the general tariff (see above chapter).

In all cases, non-pilotable vessels pay a fee for buoyage, shelter and use of the protected water area of the protected stretch of water, calculated on the basis of the volume "V", expressed in m3 of the vessel:

V=L x l x Tme

L= overall length of the vessel expressed in metres

l = Maximum beam of the vessel expressed in metres

Tme= Draught is obtained by applying the formula: Tme= 0.14 (L x l) ½ (0.14 times the square root of the product L x l).

(2) Shelter, buoyage and residence fees for non-piloting vessels

a) Basic rate

- Non-piloting fishing vessel based in Dakar 1032.76 FCFA / m3/ year
- Foreign fishing vessel participating in fishing campaigns (Indivisible campaigns of six (6) months) 516.33 FCFA / m3/campaign
- Foreign fishing vessel on holiday 2.95 FCFA / m3/ day

b) Minimum charge

- Vessels based in Dakar 95,899 FCFA/ year
- Ships on call 5,902 FCFA / day

c) Security fees (ISPS Code)

i. Piloted vessels

The security fee is set per port of call according to the volumes and rates below:

Table 3.259 Security Fee

From VOLUMES NAVIRES	Royalties (Euros)
from 1500 to 5000 m3	300
from 5001 to 10000 m3	400
from 10001 to 15000 m3	500
from 15001 to 20000 m3	600
from 20001 to 25000 m3	700
from 25001 to 30000 m3	800
from 30001 to 35000 m3	900
from 35001 to 40000 m3	1,000
from 40001 to 45000 m3	1,200
from 45001 to 50000 m3	1,400
from 50001 to 55000 m3	1,600
from 55001 to 60000 m3	1,800
from 60001 to 65000 m3	2,000
from 65001 to 70000 m3	2,200
from 70001 to 75000 m3	2,400
from 75001 to 80000 m3	2,600
from 80001 to 85000 m3	2,800
from 85001 to 90000 m3	3,000
from 90001 to 95000 m3	3,200
from 95001 to 100000 m3	3,400

Source: PAD

ii. Non-pilotable vessels

The fee applicable to non-piloting vessels is set at 10% of the amount of the Taxe d'Utilisation du Plan d'Eau (TUPE) with a minimum amount of 10,000 FCFA.

iii. Vessels at anchor

A vessel at anchor is defined as any vessel that is not waiting for a berth or berthing in the port.

The fee is set at 50% of the amount of the fee applicable according to the volume of the vessel.

Non-pilotable vessels at anchor are subject to the rate of 150 euros per call.

3.21.7 Acts, Regulations, Laws related to PPP

In March 2021 Senegal implemented a new PPP Law, law No 2021-23 dated 2 March 2021.

The new PPP Law establish the National PPP Support Unit, UNAPPP (Unité nationale d'Appui aux Partenariats public-privé) which replaces the Infrastructure Council (Conseil des infrastructures).

Before the 2021 PPP Law, the institutional framework was less simplified:

The National Committee for Support to Public-Private Partnerships (CNAPPP), located in the Ministry of Investment Promotion and Partnerships and responsible for preliminary project assessment, capacity building and technical support for contracting authorities through the project lifecycle, and PPP promotion.

The Directorate of Finance and Public-Private Partnerships, located in the Ministry of Investment Promotion and Partnerships, acting as the national PPP Unit pending the effective settlement of the National PPP Committee. The Directorate is the technical arm of the Committee. It used to be a Directorate located in the Ministry of Infrastructure, Transports and Energy (2009-2012) and a PPP Division in the Ministry of Economy and Finance (2012-2013).

The Infrastructure Council (Conseil des Infrastructures) is an independent body with 12 members comprising 3 magistrates, 3 private sector representatives, 3 civil society and consumer associations representatives, and 3 members of Parliament. The Infrastructure Council is responsible for dispute resolution, regulation of procedures, and auditing. Its activities are no longer restricted to infrastructure projects since the adoption of the 2014 Law.

APIX is an implementing agency located in the Ministry of Investment Promotion and Partnerships and is responsible for investment promotion, business climate improvement, development of special economic zones, and the implementation of major public works.

(1) Port Management Models

According to the World Bank Port Reform Toolkit, Second Edition, 2007, several factors influence the way ports are organized, structured and managed, including:

- The socio-economic structure of a country
- Historical developments
- Location (urban or rural)
- Types of cargoes handled (bulk solids and liquids, general cargo, containers)

(2) World Bank Characterization of Port Management Models

The World Bank Port Reform Toolkit identifies five main port management models based upon the responsibility of the public and private sectors. These are summarized below, according to orientation (public or private) and description. Service and tool ports mostly exist to promote public interests, and landlord ports attempt to balance public and private interests. Private service ports maximize the interests of their shareholders. The models are distinguished by how they differ with respect to such characteristics as:

- Public, private, or mixed services, such as pilotage and towage
- Local, regional, or global orientation
- Ownership of infrastructure, including port land
- Ownership of superstructure and equipment, particularly ship-to-shore handling equipment, sheds, and warehouses
- Status of dock labour and management

(3) Model Orientation and Description

The most productive model for a particular port will vary depending on many factors to be discussed herein. First, it is important to understand the basic definitions or characterizations of alternative port management models.

a) Public Service Ports

The port authority performs the whole range of port related services – operations, cargo handling, etc., in addition to owning the entire infrastructure. Most of the employees are civil servants. Some ancillary services are with private companies. The number of these ports is declining because of their inefficiencies.

b) Tool Ports

These ports are similar to a public service port, differing only by the private handling of its cargo operations, even though the terminal equipment is owned by the port authority. The port authority also develops and maintains infrastructure and superstructure, and port authority staff handles equipment. A tool port in some instances may be a transitional form between a public service port and a landlord port.

c) Landlord Ports

This model is the most common. Infrastructure, particularly terminals, are leased to private operating companies with the port authority retaining ownership of the land. The private company is granted a long-term lease. The private operator is also responsible to provide terminal equipment so that operating standards are maintained.

d) Corporatized ports

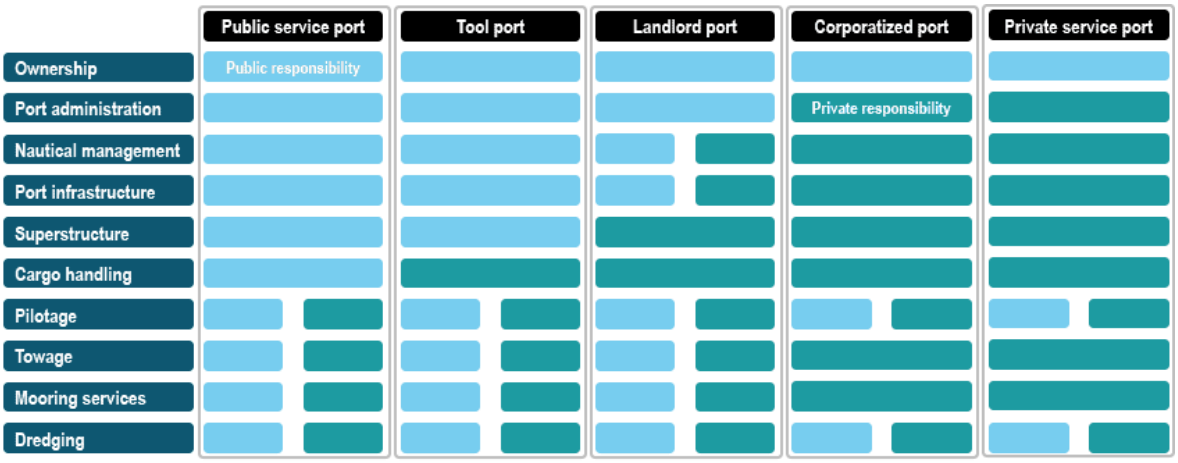
These ports have almost been entirely privatized, and ownership remains public and often assumed

as a majority shareholder. The port authority behaves as a private enterprise. This model is the only one where ownership and control are separated.

e) Fully Privatized Ports

In this model the port authority is entirely privatized with almost all functions under private control with the public sector retaining a standard regulatory oversight.

The following chart illustrates the concepts of these five models by color. Blue represents the characteristics of port models with public responsibility and green represents the facets with private responsibility.



Source: https://porteconomicsmanagement.org/pemp/contents/part4/port-reform-and-governance/public-private-roles-port-management/

Figure 3.297 Port Model

3.21.8 Concession contract between PAD and Private Company

The concession contracts of PAD are as follow:

Table 3.260 Concession Contracts Between PAD and Private Companies

Terminal (Cargo)	Name of Company	Contract Year
Container	DPW FZE	2007
Bulk (Mineral Sand)	Grande Côte Opérations (GCO)	2007
Container Terminal	DPW Dakar	2011
RORO (Vehicle)	AGL main shareholder (Dakar Terminal)	2013
Wharf 8	TVS (“Alia”, Sea Invest)	2013
Bulk (Minerals)	Necotrans	2014
Oil Terminal	Terminaux Pétroliers de Dakar (main shareholder: Sea invest)	2015
Oil logistic base	Senegal Supply Base (main shareholder: Consortium Sénégalais des Investisseurs « COSENI »	2021
LNG Terminal	ELTON	2021
Fishing Port	IBE Fish	2022

Source: PAD

3.21.9 PPP model at Ndayane Multifunctional Port

(1) PPP model at Dakar Port

At Dakar Port, PAD employs a concession model, landlord port model, for DPW and all its concession contracts. Under this arrangement, PAD grants concessions within the port domain, delineating authorized activities outlined in the concession contract. DPW, as the concessionaire, assumes responsibility for managing operations within the conceded perimeter. While PAD retains its role as the licensing authority, DPW manages internal regulations and fees, including charges for quay wall handling activities for ships, as well as land handling and storage fees for importers and exporters. In exchange for these rights and responsibilities, DPW in return pays fixed and variable fees to PAD.

The concession lasts for a duration of 25 years, and it can be renewed once, just like other concessions in the Port of Dakar. DPW, as the concessionaire, is obligated to pay a fixed fee per square meter they use and a variable fee depending upon import, export, and transshipment activities through the Port of Dakar.

Security oversight within the Port and Terminal is a shared responsibility, with PAD assuming overall port security obligations in accordance with the ISPS Code. DPW also bears specific responsibility for security within its own terminal.

Taxation is governed by the provisions outlined in the General Tax Code, including certain favorable incentives tailored to promote foreign investment within the region. Regarding revenue distribution, the Board of Directors holds authority in determining the allocation of revenues. Under the revenue sharing arrangement, PAD receives 40%, while DPW retains 60% of the revenue share.

The tasks allocations by PAD or under management of PAD (not under Terminal Operator) are as

follows:

Table 3.261 Task Allocation by PAD or under management of PAD at Dakar Port

Service	Operator
Port Administration	PAD
Nautical/Navigational Management	PAD
Port Infrastructures such as Breakwater	PAD
Port superstructure such as terminal yard and berth facilities	PAD
Cargo Handling	PAD, STEVEDORES
Pilotage	PAD
Towage	PAD
Mooring Services	PAD
Dredging	PAD

Source: PAD

(2) PPP Process

PAD have not yet applied the implemented law No 2021-23 on PPP. Currently, PAD adheres to the provisions outlined in law No. 92-223 of December 22, 1992, which remains in effect.

Based on this law, there are two options applied by PAD. The first option is the General Director receives an unsolicited offer from a partner, which he studies and then starts the concession approval procedure. The second option is the General Director issues a call for expressions of interest, conduct a pre-selection, gives specifications, receives submissions from companies submit and then makes a selection.

Following the selection process, the General Director accesses the Tender Proposal and established an internal committee which reports to the Board of Directors, informing them of the concession agreement. In short, this is a summary of feasibility study.

Upon approval of the Board of Directors, PAD proceeds to negotiate with the selected partner, submitting a draft concession agreement for discussion and negotiation. If both parties reach an agreement on a project, it is then submitted to the Board of Directors for final approval. Once authorized by the Board, the General Director signs the concession contract which includes financial conditions, guarantees, royalties, investment program, commencement date and other relevant details.

Subsequently, the implementation phase begins during which PAD hands over the concession perimeter and proceeds according to the chosen investment plan.

Essential validation procedure involves the Board of managers to whom the General Director submits the decision and requests authorization to start the negotiations. After the negotiations are completed, the General Director submits the finalized contract to the Board of Managers for validation.

(3) PPP Model at Ndayane Port

The new port will be located at Ndayane, about 50 km down the coast from the existing highly-congested port of Dakar, and close to Blaise Diagne International Airport (which opened in 2017 and took in $620 million of investment by the African Development Bank, the Islamic Development Bank, and Agence Française de Développement). The port's construction by DPW has been started and is expected to be completed by 2026.

In port management, there are four main models based upon the respective responsibility of the public and private sectors. It is crucial to adopt which model can be drawn by considering several key factors based on an analysis of the strengths and weaknesses of various port management models. The following table shows the strengths and weakness of those models.

Table 3.262 Strengths and Weakness of Port Management Models

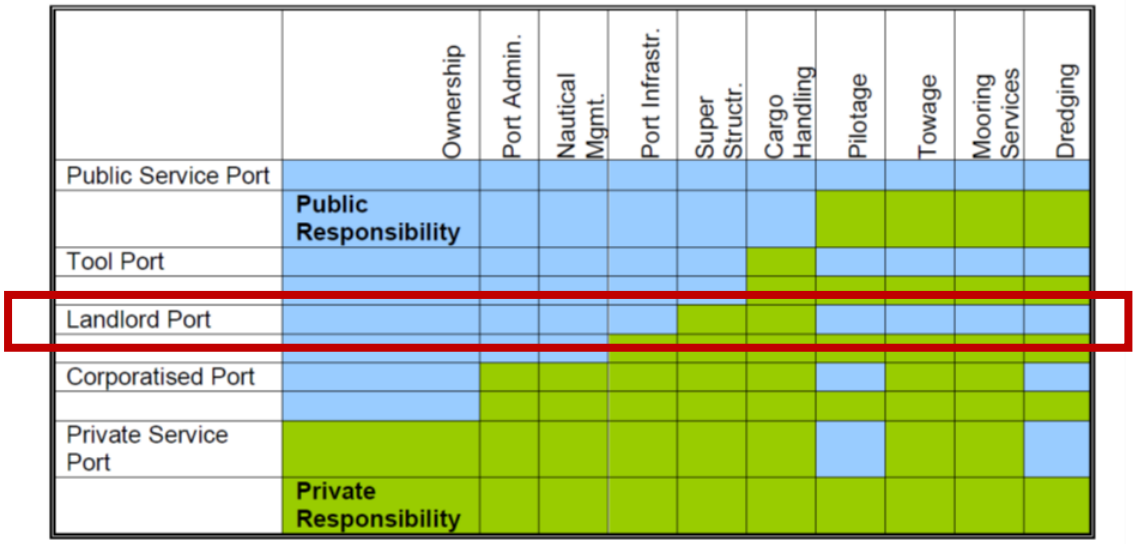
Port Models	Strengths	Weakness
Public Service Port	➢ Superstructure development and cargo handling operations are the responsibilities of the same organization (unity of command)	➢ There is no role or only a limited role for the private sector in cargo handling operation. ➢ There is less problem solving capability and flexibility in case of labour problems, since the port administration also is the major employer of port labour. ➢ Ther is lack of internal competition, leading to inefficiency. ➢ Wasteful use of resources and underinvestment as a result of government interference and dependence on government budget. ➢ Operations are not user or market oriented. ➢ Lack of innovation. ➢ No or limited access to public funds for basic infrastructure.
Tool Port	➢ Investment in port infrastructure and equipment (particularly ship/shore equipment) are decided and provided by the public sector, thus avoiding duplication of facilities.	➢ The port administration and private enterprise jointly share the cargo handling services (split operation), leading to conflicting situations. ➢ Private operators do not own major equipment, therefore they tend to function as labour pools and do not develop into firms with strong balance sheets. This causes instability and limits future expansion of their companies. ➢ Ris of underinvestment. ➢ Lack of innovation.

Port Models	Strengths	Weakness
Landlord Port	➢ A single entity (the private sector) executes cargo handling operation and owns and operates cargo handling equipment. The terminal operators are more loyal to the port and more likely to make needed investments as a consequence of their long-term contracts. ➢ Private terminal handling companies generally are better able to cope with market requirements.	➢ Risk of overcapacity as a result of pressure from various private operators. ➢ Risk of misjudging the proper timing of capacity additions.
Fully Privatized Port	➢ Maximum flexibility with respect to investments and port operations. ➢ No direct government interference. ➢ Ownership of port land enables market-oriented port development and tariff policies. ➢ In case of redevelopment, private operator probably realizes a high price for the sale of port land. ➢ The often strategic location of port land may enable the private operator to broaden its scope of activities.	➢ Government may need to create a port regulator to control monopolistic behavior. ➢ The government (national, regional, or local) losses its ability to execute a long-term economic development policy with respect to the port business. ➢ In case the necessity arises to redevelop the port area, government has to spend considerable amounts of money to buy back the port land. ➢ There is a serious risk of speculation with port land by private owners.

Source: https://www.ppiaf.org/sites/ppiaf.org/files/documents/toolkits/Portoolkit/Toolkit/module3/index.html

The landlord port model, as demonstrated at the Dakar Port, involves the leasing of terminal operations to private operators while the port authority retains ownership and oversight of port infrastructure. This approach promotes specialization, with private operators bringing expertise and investment into terminal operations, while the port authority focuses on infrastructure development and regulatory oversight.

Implementing the landlord port model at the Ndayane Multifunctional Port presents a strategic opportunity to optimize port operations, enhance efficiency, and promote sustainable growth. Drawing from the successful application of this model at the Dakar Port, extending its framework to Ndayane Multifunctional Port promises numerous benefits for stakeholders and the broader maritime industry.



Source: The World Bank, Port Reform Toolkit, Second Edition, 2007MP

Figure 3.298 Proposed Model

3.21.10 Functions at Ndayane Multifunctional Port

(1) Customs

The customs clearance process begins when the goods arrive, and the summary declaration (manifest) is filed. The goods are then declared in detail at the customs clearance office to which the manifest refers, where customs duties and taxes are calculated, and the goods inspected by the customs department. Following this thorough inspection, the duties and taxes are collected by the Treasury.

The Customs IT System is the Customs Administration's automated platform for centralizing customs clearance procedures and storing related information. Payment of duties and taxes is made via the Treasury, either automatically as soon as the goods have been validated by Customs (credit d'enlèvement), or in cash by means of a receipt issued by the relevant Treasury departments.

Indeed, container inspection can be physical or non-intrusive, but a container can also be released on the basis of a simple physical check. It all depends on the risk of fraud determined by the SIAR (computerized risk analysis system).

Once the customs clearance office has validated the removal order, the declarant approaches the appropriate brigade for removal formalities. Here, too, another check is carried out before the container is finally removed

(2) ORBUS Single Window System

The computerized customs service ORBUS Single Window is a joint initiative by the customs authorities and port operators. Its management committee is a public-private partnership aimed at upgrading customs formalities. The economic interest group GAINDE 2000 was set up to design and run the ORBUS Single Window and to interconnect it with the customs' IT system. The aim of the Single

Window was to modernize pre-clearance formalities in Senegal and reduce the associated costs and delays. In July 2004, GAINDE 2000 launched the ORBUS Single Window for automated data collection and submission of customs declarations through a network enabling the main foreign trade operators to process applications for mandatory import, export or transit authorizations and certificates electronically.

ORBUS Single Window has largely contributed to revolutionizing the foreign trade environment in Senegal. Consolidation of the efforts undertaken since ORBUS was launched has turned the country's paper-based customs process into an entirely paperless system, with:

- A legal framework for electronic commerce in place since 2008; and
- A certification authority to facilitate implementation of the ORBUS electronic signature system.

This has significantly reduced the delays in pre-clearance and clearance formalities and the related costs, improved customer service quality, and eliminated almost all use of paper. Thanks to the ORBUS system, Senegal was ranked as the top global reformer in the Doing Business 2009 report and is one of Africa's best-performing countries according to the World Bank's ease of doing business criteria. Under the South-South partnership, Senegal makes its expertise and technologies available to other countries, particularly Kenya and Burkina Faso.

The Senegalese Single Window, called ORBUS, was established in order to achieve the following objectives:

- Reduction of customs clearance time-limits
- Reduction of customs clearance costs
- To improve the quality of the service offered to importers and exporters
- Elimination of red tape

The following documents are covered by ORBUS:

Table 3.263 Documents covered by ORBUS

NO.	CODE	DOCUMENTS
1	DPI	Déclaration Préalable d'Importation
2	AC	Autorisation de Change
3	AI	Attes13tation d'Importation
4	EC	Engage1415ment de Change
5	AE	Attestation 16d'Exportation
6	FD	Facture Définitive
7	FP	Facture Pro Forma
8	QT	Quittance de paiement Trésor
9	BAE	Bon A Enlever Douane
10	PA	Police d'Assurance
11	CON	Connaissement
12	COI	Certificat d'Origine Import
13	COE	Certificat d'Origine Export. (7 types de certificats)
14	CSD	Certificat Sanitaire DIREL (8 types de certificats)
15	CZSD	Certificat Zoo – Sanitaire DIREL (6 types de certificats)
16	CSDO	Certificat Sanitaire DOPM
17	CCOS	Certificat de Contrôle d'Origine Sanitaire
18	DIPA	Déclaration d'Importation de Produit Alimentaires
19	RDIIM	Récépissé de déclaration d'Importation des Instruments de Mesure
20	CQ	Certificat de Qualité
21	PI	Permis d'Importation DPV (2 types de demandes)
22	CPS	Certificat PhytoSanitaire
23	PVIPI	Procès Verbal d'Inspection Phytosanitaire à l'Importation

Source https://www.oecd.org/aidfortrade/casestories/casestories-2017/CS-135-Guichet-Unique-Electronique-Orbus-English-translation.PDF

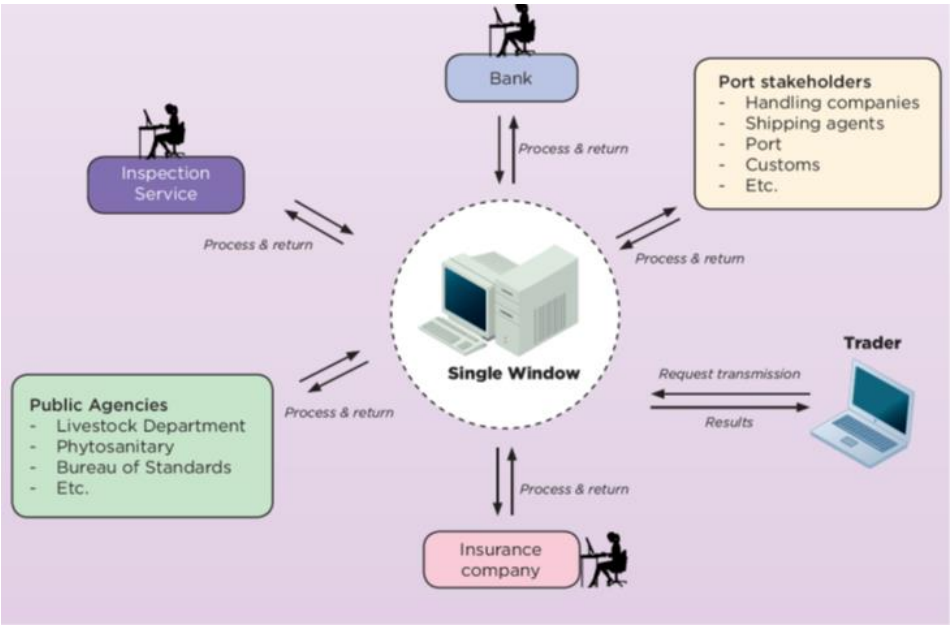
Senegal's single window is interconnected to the following

- Agencies
- Banks
- Currency and Credit Department (DMC): in charge of controlling exchange permits
- Insurance Companies
- Plant Protection Office (DPV)
- Livestock Department (DSV)
- Foreign Trade Division (DCE)

- Maritime Fishery Department (DITPP)
- Control and Quality Division (DCQ)
- Metrology Department (DM)
- COTECNA: Inspection Company authorized by the Senegalese authorities.
- Forestry Authority (DEF)

The central servers of ORBUS are hosted by customs. So ORBUS and the customs system (Trade X) share the same central infrastructure and maintenance costs are supported by Customs administration.
Advantages of ORBUS Single Window System

- Coordination between stakeholders
- Reliability of transactions
- Improvement of competitiveness
- Reduction of the time require to complete pre clearance formalities (from 4,5 days to 0,5 days)



Source : https://unece.org/fileadmin/DAM/cefact/single_window/sw_cases/Download/Senegal.pdf

Figure 3.299 Operation model of Senegal Single Window

(3) Security

Ndayane Multifunctional Port adheres to stringent security protocols in accordance with international standards, including the International Ship and Port Facility Security (ISPS) Code. This comprehensive framework outlines guidelines and requirements for port facilities to enhance security measures and prevent security incidents.

Security responsibility is shared between PAD and terminal operators. While PAD maintains oversight of overall port security, terminal operators are also responsible for implementing security measures

within their respective terminals. This collaborative approach ensures comprehensive security coverage across the port premises.

Furthermore, Ndayane Multifunctional Port collaborates closely with the following relevant authorities and other stakeholders, to coordinate security efforts and exchange intelligence information and to ensure the security of the port area. This partnership facilitates proactive security measures and enhances the port's ability to address emerging security challenges effectively.

- The National Authority for Port Security (ANSP) is responsible for implementing the State's policy on the Merchant Navy, in its various aspects (fishing, commerce and yachting), as well as the implementation of provisions of Law No. 2002-22 of August 16, 2002 on the Merchant Marine Code, maritime conventions international standards and other laws and regulations in force. It is the Designated Authority of the Republic of Senegal (ISPS Code, part B, 1.7) with the IMO, i.e. it is Senegal's respondent in terms of monitoring, control and assessment of port and maritime safety and security systems.
- HASSMAR (High Authority responsible for the coordination of maritime safety, maritime security and the protection of the Marine environment) is invested with a general mission of coordination of safety and security at sea in maritime waters and under Senegalese jurisdiction Order No. 006944 of October 17, 2006 on the organization and functioning of HASSMAR provided for the creation of a Main Center for the Coordination of Maritime Rescue (MRCC) in Dakar and that of two secondary centers for the Coordination of Maritime Rescue (RSC) in the northern and southern maritime zones of the country. Pending the commissioning of the MRCC, the CCO (Operational Coordination Center) of the French Navy acts as MRCC.
- The French Navy supports the port in the surveillance of territorial waters, in disaster relief.
- The National Fire Brigade acts in the prevention and management of fires, accidents, pollution and disasters.
- The Customs Services made up of the Regional Directorate of the Port, the Regional Directorate of Petroleum Products and specialized units ensure the general supervision of any operation relating to goods in the port area, the inspection of ships, the control of imports and exports in with a view to ensuring the collection of duties and taxes, the security of the international trade logistics chain, the application of foreign trade and exchange measures, the fight against arms and drug trafficking and counterfeiting, its assistance to other jurisdictions.
- The Maritime Border Health Control Service provides surveillance and health control in accordance with the International Health Regulations concerning health policy on board ships.

Overall, security remains a top priority at Ndayane Multifunctional Port, with continuous efforts to strengthen security measures, adapt to evolving threats, and maintain a safe and secure environment for port operations and stakeholders.

For more detail of port security and organization, it is referred to Chapter 2.5.

3.21.11 Port System

The functions of a port system typically shall consider:

- Port-wide administration and support activities:
  - Harbourmaster office
  - Coastguard customs and border security
  - Port authority and administration offices
  - Navigation assistance (pilots, tugboats, aids to navigation (AtoN), vessel traffic services (VTS), etc.)
  - Value-added services
    - Commercial storage
    - Cargo de consolidation
    - Bonded warehouses
    - Free trade zones
    - Logistics and distribution centers
  - Auxiliary functions:
  - Privately owned vehicle (POV) parking
  - Fuel stations
  - Port gates and security systems
  - Rail yards
  - Inspection areas
  - Power stations
  - Pumping stations, wastewater treatment plants, etc.

3.21.12 Proposal for Operation and Management of Ndayane Multifunction Port

Considering the current port operation and management system at Dakar Port, the following is the port operation and management system that the Study Team considers desirable for Ndayane Multifunction Port.

(1) Breakwater and Dredging

DPW has assumed the primary role in the construction of a container terminal at Ndayane Port along with financing and constructing the essential infrastructures for the operation of the container terminal such as breakwater and dredging. PAD has indicated that once the construction is completed, these infrastructures will be transferred, along with a fee. Additionally, PAD will directly manage the common facilities such as breakwater and dredging, mirroring the management structure of the current Dakar Port

(2) Container Terminal

Container Terminal at Ndayane Port, like the current container terminal at Dakar Port, is a joint venture under the concession agreement between PAD and DPW. The facilities necessary for the operation of the container terminal including quays, yards, and cargo handling equipment will be financed and constructed by DPW. Additionally, the port operation will be carried out by DPW. Like the current Dakar Port, PAD will contribute capital and receive a share of concession fees and profits,

(3) RORO Terminal

RORO Terminal has a total berth length of 600 m and a yard area of 21.3 ha. The ownership of the terminal will be held by PAD which aims to engage in a concession agreement to outsource the operation and maintenance of the terminal to a private entity. In order to ease congestion at Dakar Port, it is important to accelerate the transition of the functions to RORO terminal at Ndayane Port.

(4) General Cargo Terminal (including Dry Bulk Terminal)

General Cargo Terminal for general cargo is designed with a total berth length of 1500 m and a large yard area of 93.6 ha. General Cargo Terminal includes two types of cargo: dry bulk and general cargo. Dry bulk shall be loaded by a mobile conveyor and unloaded by a mobile harbor crane. The ownership of the terminal is PAD and the procurement and operation of cargo handling equipment shall be carried out by a concessionaire. Regarding the timing of transferring functions from Dakar Port, while it is of lesser priority compared to RORO terminal, it is recommended to complete by 2035. It is assumed that most of the agri-bulk such as wheat will be transferred to Bargny Sendou Port.

The construction, port operation and maintenance of General Cargo Terminal will be directly managed by PAD, mirroring the current setup of Dakar Port. As the current cargo handling efficiency of the Port is low and requires to be improved, it is assumed that it will be difficult to transfer the functions of Dakar Port quickly. Additionally, it is necessary to relocate the port workers. Therefore, the terminal should preferably commence operations by 2047, the target year of the master plan.

(5) Access Road

Establishing a direct access road from Ndayane Port to Senegal's road network, particularly connecting to the N1, the nearest major national road, is important. Ndayane Multifunction Port comprises a container terminal and Special Economic Zone (SEZ) managed by PAD and operated by DPW, as well as a multifunction terminal and Port Industrial Zone (PIZ) managed and operated by PAD. However, it is not practical to construct a separate access road within Ndayane Multifunction Port. Therefore, the access road shall be constructed and managed by PAD. On the other hand, DPW cannot wait until PAD road is constructed. Therefore, it is recommended DPW should build a temporary access road which meets the basic requirements. Furthermore, since the area between PIZ and N1 is not a port site, it should not be constructed and managed by PAD but rather by the government of Senegal. However, it is considered that PAD still has the option to construct it and transfer the ownership to the government.

(6) Drainage

Ndayane Prot is located at the mouth of a small river, and the rainwater catchment extends to the

southern end of Diass Airport, covering an aera of less than 50 km2. PIZ and DPW's SEZ are about 18 km2 of this area. Since the drainage canal upstream of PIZ is not a port site, it should not be built and managed by the PAD, but by the government of Senegal much like the aforementioned area between PIZ and N1.

(7) Port Industrial Zone (PIZ)

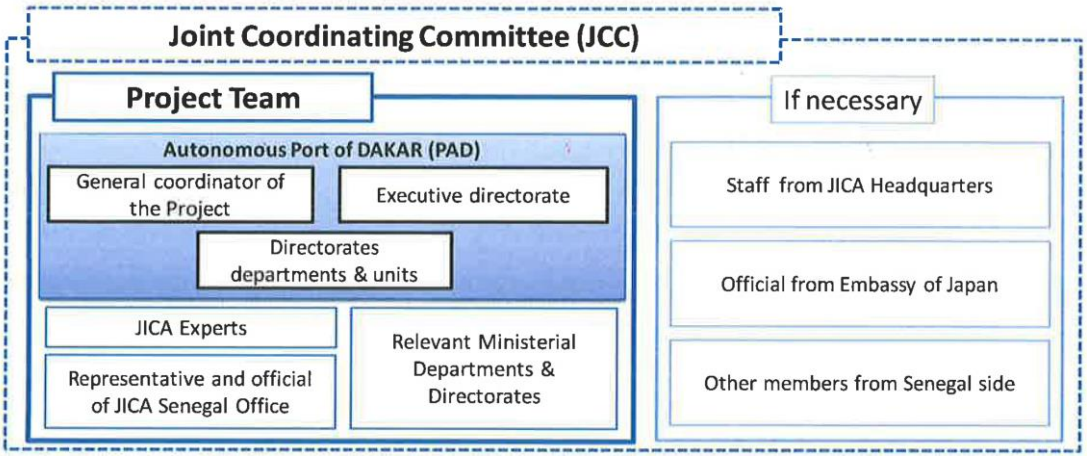
Phase 1 of the Ndayane Port PIZ will comprise 245 ha and 102 lots, while Phase 2 will consist of 238 ha and 49 lots of industrial land. Both phases are premised on a long-term lease agreement of 25 years.

PAD, acting as the landowner, developer, and operator of PIZ, will retain ownership throughout all phases of the project. Potential financing options include the Senegalese government's own budget, Official Development Assistance (ODA), bank loans, and Public-Private Partnerships (PPP). For more detail, see Section 3.11.

3.22 Support for Joint Coordinating Committee

Joint Coordinating Committee (JCC) was agreed between JICA and PAD on the Record of Discussion signed on 28 February 2022. JCC will be organized to monitor the progress of the Project among the Project members as shown below organization.

- To discuss and approve the work plan of the Project to be formulated under the framework of RD
- To evaluate the achievement of the work plan and overall progress of the Project
- To review and exchange opinions on major issues that arise during implementation of the Project



Source: Record of Discussion (2022)

Figure 3.300 Organization of JCC agreed on RD between JICA and PAD

The first meeting of Joint Coordination Committee (JCC) was scheduled to take place at the beginning of the Project. But during the meeting of IC/R, PAD requested a change of the scope of works (addition of PIZ study), and the JCC could not be held until the scope change was finalized. JPT discussed with PAD about the details of the scope changes, and the contract between JICA and JPT was revised on April 2, 2023. JPT requested PAD to hold the JCC, and PAD held the first JCC on 9:30-12:00 (Senegalese

time) May 16, 2023 at the PAD conference room. The agenda is shown in Table 3.264. The main purpose of the JCC was to disseminate the pre-concept proposals for IT/1 and PIZ and to gather opinions. Since this is the first time, the background and project outline were also explained. The number of participants is shown in Table 3.265, with a total of 32 people participating. The Director General (DG) of PAD was scheduled to participate, but unfortunately, he was suddenly unable to attend. JPT requested DG to participate in the next 2nd JCC. JCC participants generally agreed IT/1. Some matters that were not explained in IT/1 or additional requests that were not included in the original scope would be addressed as much as possible in IT/2 or subsequent reports. The detail comments from participants and JPT's response direction to comments are shown in Table 3.266.

Table 3.264 Meeting Agenda of 1st JCC

09:30-09:40	Opening Speech by Secretary General of PAD
09:40-09:45	Opening Speech by JICA H.Q.
09:45-11:00	Explanation of IT/1 by JPT
11:00-11:50	Comments, Question and Brief Reply
11:50-12:00	Closing Speech by Secretary General of PAD

Source: JPT

Table 3.265 Participants of 1st JCC meeting

Secretary General of PAD
Harbour Master of PAD
Project Director of PAD
Chief of each Department of PAD
Representative of related organization of Gov. of Senegal
JICA H.Q.
JICA Senegal Office
JPT

Source: JPT

Table 3.266 Comments from 1st JCC Participants and JPT's Answer

Comments from JCC	Answer by JPT	Action by JPT in IT/2 and PR/R
ANAM suggested JPT to revise 'Slide 4'. According to him, as PSE is the unique document of reference for the strategic development in Senegal, it would be better to mention PSE instead of "Development plan of Senegal."	Action 1 on slide 4, "Development plan of Senegal" will be revised to "Development plan of Senegal including PSE"	Revised.
With regard to the output number 2, JPT mentioned "short-term development plan targeting 2030". In order to be more coherent, he underlined that it would be more relevant to align it with the target year of PSE which is 2035 and the National Port Strategy of Senegal.	JPT will propose the target of 2035 also.	2035 was also considered and proposed.

Comments from JCC	Answer by JPT	Action by JPT in IT/2 and PR/R
In “Slide 9”, he outlined that there is a new decree which allows PAD the authority to manage all the ports in Senegal. Therefore, a close relationship between the port of Kaolack, Ziguinchor and Saint-louis as secondary ports and the port of Ndayane should be established for harmonious and global connection.	JPT will receive the "New Decree". And JPT will confirm the meaning of "manage".	Request made to PAD but not received.
In “Slide 14”, according to the national economic situation and the fact that Senegal is a strategic maritime crossroad between Europe and southern Africa, etc., he underlined that it would be important to mention the strategic position of Senegal in this slide although JPT mentioned it in the PIZ.	JPT will mention.	Described.
On cargo demand forecast, he explained that there is a difference between the data on national strategic plan and data in the document. Therefore, he suggested JPT to use the existing data to update the study on the cargo demand. He said that he is ready to share the data on the national strategic plan with JPT. There are some diagnostic cargos forecast data which are available, even for 2050. Although JPT has used national strategic data, he proposes to share with JPT more data.	JPT is under requesting to share the data to PAD. JPT will re-estimate the cargo demand based on the latest data.	Revised based on received data.
In “Slide 17”, he suggested JPT not to focus only on Senegal GDP. The consideration of GDP of other countries like landlocked countries as Senegal is willing to integrate ZLECAF (African Economic Free Trade Zone) which is an open market.	The current macro estimation is based on correlation analysis with not only Senegal's GDP, but also the GDP of West Africa (16 countries including the Economic Community of West African States and Mauritania), the population of Senegal, and the population of West Africa (16 countries), and the correlation coefficient with cargo volume. It is adopted after verifying. If there is a correlation, the indicator is judged to be statistically correct, so there is no problem with the estimation results. ZLECAF aims to have all 55 African countries join, and currently 36 countries have ratified it, but as of the start of January 2021, only three countries are participating in free trade. JPT think the correlation is small.	Answered.

Comments from JCC	Answer by JPT	Action by JPT in IT/2 and PR/R
In “Slide 23” the issue in this part is how to make the port attractive. It should be better to consider international transportation and river transportation.	The international transport network of container ships (liner network) is considered in this slide. Consider how to represent liner and tramp ship networks, as well as descriptions of river transport.	The international transport network for container vessels (liner network) has already been described in the slide. Information on domestic transport was requested to PAD, but information was not provided and cannot be considered.
Railway transportation is not reflected in the document. It should be better to include in the study because in the development policy of Senegal, it is planned to re-develop the railway transportation sector.	There are no railway experts assigned to this project, therefore, a brief review will be conducted after confirming the DPW M/P and DPW's current plan.	Requested information to PAD but not provided; only railway line layouts within 1200 ha were considered and described.
In “Slide 26” the ship draft should be considered in addition to the ship size in the study.	JPT will mention not only LOA but also maximum draft	Described.
In ‘Slide 47”, JPT should mention “Security equipment” instead of “Safety equipment”. In addition, the ISPS code is taken into consideration for the security of ships and port facility instead of safety.	It was miss-translation. JPT will revise.	Reconfirmed.
AGEROUTE in "Slide 35” focused his comments on roads to the port and around the port as there are roads around the port which are managed by AGEROUTE. He commented that it is good to propose options for road junctions, but it is better to explain how to make it possible as with of the existence of the port, it is expected to face big traffic of trucks going back and forth to the port. He also suggested JPT specify the kind of roads structures required due to the weight of the trucks using the roads.	[Situation related to route settings] The current status of the access road route is as follows. ・DPW is planning this as an access road that will also accept vehicles from other facilities. However, there is no specific information on the route, number of lanes, width, etc. DPW would like to receive drawings and reports from PAD, but JPT have not yet been provided. ・PAD is scheduled to be outsourced to a consultant as an access road shared by each facility. ・JPT is based on Plan B in "Slide 35," but it was desirable to achieve consistency with the DPW plan, and it was thought that it was also necessary to coordinate with the PAD plan. ・We set up an online meeting with PAD, but it had to be rescheduled due to the other party's circumstances, so we are currently making arrangements. [Response policy] Since DPW planning information and PAD consideration policy are unknown, JPT will proceed with the following policy. ・The route will proceed as Plan B. (Route connecting PIZ and N1 Airport Road intersection)	Requested DPW information to PAD, but not provided. JPT action is as described in the answer.

Comments from JCC	Answer by JPT	Action by JPT in IT/2 and PR/R
	- The required number of lanes is set by considering only the multi-function terminal and PIZ. ・To counter congestion, it will be necessary to secure the required number of lanes based on the amount of cargo handled and improve the N1 intersection, but examination of intersection improvements will be carried out after the route has been determined according to the above policy. - Road pavement structure will also be implemented after basic specifications such as route and road width have been determined.	
In “Slide 35”, as the connection point is displaced as shown in the map, he asked the question about the feasibility as with regard to the standard it is not allowed to connect local public road to the port because of the danger with respect to the users and residents.	As stated in the evaluation on Slide 36, Plan C is an alternative plan to be considered when other plans are not feasible and are not recommended. As mentioned in PAD's comments, the road that will be connected to Plan C is a local road (community road), which is unsuitable for a large number of large freight vehicles, and the current road width and due to the poor pavement condition, extensive renovation will be required if it is to be used as a port road. In addition, since the Dakar direction, N1 access, and A1-highway access will each require a major detour, this plan will only be considered if other plans (routes) are not feasible. It will be considered as a rejected option in route consideration.	Answered.
Ministry in charge of Industry wanted to know first whether consultation with beneficiaries (Ministerial departments, private sectors) is planned in the Project or not.	When JPT confirmed with PAD, they said, "We are thinking that it is too early to invite private companies to the IT/2 and PG/R JCC. We are thinking about inviting private companies to the DF/R JCC."	Waiting for PAD response.
Then, he proposed PAD to include the private sector in JCC as members. Regarding the presentation, he asked the question about the specific vocation of the PIZ, the targeted industries (agrifood, mining, etc.…).	In order to take advantage of the functions of deep-sea ports, it is necessary to export products or import raw materials, and the sector does not require industrial agglomeration and can maintain international competitiveness as below. - Assembly, processing and manufacturing industry (home appliances, especially air conditioners, printers, automobiles, construction machinery, pharmaceuticals) - Existing resource-based (fisheries processing, especially fishmeal and	Answered.

Comments from JCC	Answer by JPT	Action by JPT in IT/2 and PR/R
	fish oil, aquaculture, agricultural product processing, especially feed production) - New resource-based (fertilizer production, especially urea fertilizer) - support sectors (logistics, BPO, ICT, data centers, etc.)	
He also underlined the necessity to consider the installation security of industries in the PIZ as well safety because Ndayane port combined with the PIZ will be very attractive.	Regarding safety in terms of PIZ operations (including avoiding the leakage of duty-free items, etc.), the operational management plan will be proposed refer to advanced SEZ examples.	Described
According to him, as there are many industrial platforms in the area of Ndayane and some ports, a network between these infrastructures and the Ndayane port through a railway network should be considered by JPT.	Ditto	Requested to PAD to provide information on railways, but not yet considered as information is awaited.
General Secretary, thanked the Japanese government for their support and JPT for complying with deadline regarding the submission of reports. She also recalled the importance of the PIZ in the Master Plan and the availability of PAD to support the Project for the benefit of the Senegalese Government.	JPT agree.	Described
Technical advisor of the Ministry of fisheries explained that based on the environmental and social considerations resulting from the SEA, the concerns of local residents should be considered in public consultations. Among these concerns, it can be noted that the locality is an area where small-scale fishing is a main activity that will probably be impacted by the Project. However, what measures are being considered for local fishermen impacted by the Project?	At SEA procedure, stakeholder consultations will be hold to collect and analyze opinions from various parties. It will also consider the impact on small-scale fishers and recommend appropriate mitigation measures.	Stakeholder consultations have been carried out and the views of various stakeholders have been collected and are being analyzed. Impacts on small-scale fishermen will also be considered and appropriate mitigation measures will be proposed.
In addition, it is known that the locality is surrounded by attractive tourist areas, like Toubab Dialaw. Therefore, he would like to confirm what is planned by the Project to consider these tourist sites.	The Toubab Dialaw area is adjacent to the north side of Ndayane, and indirect impacts on this area are expected. JPT plan to consider the impact on tourist destinations during the SEA procedure and propose necessary mitigation measures.	The impact on tourist destinations will be considered during the SEA procedure and necessary mitigation measures will be proposed.

Source: JPT

The 2nd meeting of JCC was held on 9:30-12:30 (Senegalese time) September 25, 2023, at the PAD conference room. The agenda is shown in Table 3.267. The main purpose of the JCC was the demand forecast, the required facilities, scale and layout plan for the Ndayane Port Master Plan for 2047, the results of the PIZ study, and the draft training plan. The participants are shown in

Table 3.268, with a total of 31 people participating. The Director General (DG) of PAD was scheduled to participate, but unfortunately, he was suddenly unable to attend. JPT requested DG to participate in the next 3rd JCC. JCC participants generally agreed IT/2. Some matters that were not explained in IT/2 or additional requests that were not included in the original scope would be addressed as much as possible in PR/R. The detail comments from participants are shown in Table 3.269.

Table 3.267 Meeting Agenda of 2nd JCC

09:30-09:40	Opening Speech by Harbour Master of PAD
09:40-09:45	Opening Speech by JICA Senegal Office
09:45-11:45	Explanation of IT/2 by JPT
11:45-12:15	Comments, Question and Feedback
12:15-12:30	Brief Reply by JPT

Source: JPT

Table 3.268 Participants of 2nd JCC Meeting

Harbour Master of PAD
Project Director of PAD
Chief of each Department of PAD
Representative of related organization of Gov. of Senegal
SEA Consultant
JICA Senegal Office
JPT

Source: JPT

Table 3.269 Comments from 2nd JCC Participants

Comments from JCC	Action by JPT in PR/R (as of March 2024)
Access road to Ndayane Port: Where the plan is for 8 lanes in each direction which seemed debatable according to PAD, given that Senegal does not have roads with 8 lanes in each direction. It would be preferable to change this development plan and propose a road with 2 times 4 lanes in each direction.	After the 2nd JCC, JPT explained to PAD.
Consistency of Master plan with Government's Priority Action Plans: It was asserted the importance of the consistency of the master plan with the priority action plans of the government, for example PAP 3 which is scheduled for 2024-2028 and PAP 4 for 2028-2030.	The basic direction is consistent.
Cargo volume data from Border countries: In the demand forecast, strategies should be found to take into account cargo volumes and traffic to border countries (cargo volume to Mali). Cargo volumes should also be brought in line with FTAA (Free Trade Area of the Americas) requirements.	No further analysis can be made from the information provided or obtained from PAD.
Oil, gas and blue economy: We need to take oil and gas into account, and with the development of the blue economy, we are moving towards the decarbonization of ships. LNG should be included in this report as an important aspect, given that Senegal currently has reserves that are almost being exploited.	It has already been described in the report that Senegal has an LNG oil field under development.

Comments from JCC	Action by JPT in PR/R (as of March 2024)
Dockyard for ship reparation: The absence of ship repair was raised. It was judged that a strategic port of the size of the port of Ndayane should not be planned without considering ship repair.	Described JPT's view of ship dismantling facility.
Railway system: The absence of integration of the railway line, which was judged as a shortcoming, given that Senegal is in the process of finding ways of restoring its railway network. This is a comment that had already been raised in the first JCC and which unfortunately has not been considered in this second report.	Requested rail information to PAD several times, but not received. The report included plans only within the port area.
Connecting Ndayane Port to Regional Ports: A suggestion was made to take into account in the master plan the relationship and the connection between Ndayane Port and the ports of Ziguinchor, Kaolack and Saint Louis (and all the ports in Senegal), all these ports should be connected to the port of Ndayane, since PAD has, based on the presidential decree, the management of all ports in Senegal.	Requests to PAD for information on regional ports have not been received and therefore cannot be considered.
Discussion and exchange with relation public organization: The port of Ndayane is a very large-scale Project, and public companies such as SENELEC should be involved in drawing up the master plan to avoid problems or overlapping in the future.	JPT missions operate under R/D between JICA and PAD. changes to RD TORs require consultation between PAD and JICA.
Translation issue: There was a translation problem with the terms "Safety" and "Security". The first means "Sécurité" in French and the second refers to "Sûreté".	To be reconfirmed.
Merging DPW SEZ and Ndayane PIZ: It was suggested to merge the SEZ of DPW and the PIZ of the Ndayane Port. That would be advantageous for Senegal because of DPW's ability to attract large-scale companies, investors, and financial backers.	If the SEZ of the DPW was to be incorporated into the M/P prepared by JPT, it was necessary to request information on the SEZ of the DPW from the PAD, but the PAD refused to provide the information. Therefore, it was agreed with the PAD that the SEZ of DPW would not be included in the M/P prepared by JPT.
Data from Hinterland in the demand forecast: The idea of taking into account the traffic volume from the hinterland in the cargo forecast because unfortunately this seems to be avoided in the IT/2. This is all the more important during the presentation whereas Senegal is now counted as a new gas and oil producing country.	It was assumed that liquid bulk would be handled at Bargny Sendou port.
Cooperation with Agencies and parties related to the Project: It was noted on slide 35 of PPT JCC IT/2 presentation, which JPT considered to be the most important slide, as it dealt with the roadmap for the port of Ndayane, and the importance of cooperation among agencies and related parties such as APIX, DPW, etc. According to her, it is good to establish collaboration through the coordination the Ministry of Finance in charge of the Project, has offered to facilitate.	Requests were made to PAD, but meetings and information were not achieved.
JPT Meeting with AGEROUTE regarding access road: It is clear that the development of the access road is planned on a stage basis depending on the volume of traffic and cargo. It would be important for the JPT to meet with AGEROUTE to find out road design procedures in Senegal. This is necessary insofar as roads with 8 lanes for each direction do not exist in	Requests were made to PAD, but meetings and information were not achieved.

Comments from JCC	Action by JPT in PR/R (as of March 2024)
Senegal and the construction of these roads with 8 lanes in each direction will require the identification of public connection networks to avoid problems in the national development plan. It also was requested to JPT to think on the possibilities to connect the 8 lanes for each direction to the existing lanes and how AGEROUTE could take these connections into account.	
Importance of the Progress Report: Even if the IT/2 stage is important, the progress report is more important, and PAD suggested to JPT to postpone the date of submission and presentation of the report until April because of the presidential elections scheduled in late February and they are likely to constitute a real obstacle to the organization of such activities. This would also facilitate the opportunity to meet government organizations and more of the related department and would help to bring about significant improvements in the integration of the comments made by the various stakeholders present on this Joint Coordination Committee.	It was agreed with PAD to change the Progress Report meeting to May, as the elections were pushed back by a month.

Source: JPT

The 3rd meeting of JCC was held on 9:30-13:30 (Senegalese time) July 30, 2024, at the PAD conference room. The agenda is shown in Table 3.270. The main purpose of the JCC was the demand forecast, the required facilities, scale and layout plan for the Ndayane Port Master Plan for 2047, the results of the cost estimate and economic/financial analysis, the results of channel sedimentation and the progress of SEA. The participants are a total of 36 people participating. Some matters that were not explained in IT/2 or additional requests that were not included in the original scope would be addressed as much as possible in PR/R. The detail comments from participants are shown in

Table 3.272.

Table 3.270 Meeting Agenda of 3rd JCC

09:30-09:40	Opening Speech by Project Director of PAD
09:40-09:45	Opening Speech by JICA Senegal Office
09:45-10:45	Explanation of PR/R by JPT
10:45-11:00	Coffee Break
11:00-12:00	Comments, Question and Feedback from JCC
12:20-13:20	SEA National Level Stakeholder Meeting
13:20-13:30	Summary and Way forward by PAD

Source: JPT

Table 3.271 Participants of 3rd JCC Meeting

Project Director of PAD
Environment and Classified Establishments
Ministry of Economy, Planning and Cooperation
Ministry of Finance and Budget
Ministry of Fisheries, of Maritime and Port Facilities
Ministry of Industry and Commerce
ANAM (National Agency of Maritime Affairs)
Chief of each Department of PAD
Representative of related organization of Gov. of Senegal
SEA Consultant
JICA Senegal Office
JPT

Source: JPT

Table 3.272 Comments from 3rd JCC Participants

Item	Comments from JCC	Action by JPT in DF/R
Requests for PAD	Sharing of minutes and reports from each JCC meeting to date	When JPT confirmed with PAD, they said that they only provide PPTs and do not plan to provide progress reports to other ministries.
M/P formulation project process	Looking at the overall schedule, how many months have passed and how many months remain?	Included in the report and ppt.
Bargny Sendu Port	Bargny Sendou port is yet to open. It is scheduled to be completed at the end of 2024.	A progress report was prepared in September 2023 based on information that the project was scheduled for completion and opening in 2023, but this was revised in DF/R.
DPW Information	Are you able to get information from DPW?	JPT visited the DPW construction site and requested both DPW and PAD to provide useful information for the Pre-FS. However, they replied that they could not provide any further information.
Demand forecasting	Does this include transshipment cargo volume?	Containers have been taken into consideration, but the demand volume follows the figures from DPW. RORO and general cargo are not considered.
Terminal Layout	Generally, RORO ships have a shallower draft than general cargo ships and are shallower further into the harbour. Therefore, it is proposed that Ndayane also change the layout of RORO and general cargo, placing RORO at the back of the port next to the PIZ.	Details are included in the report.
Ship Dismantling Factory	Ship dismantling factory have problems with wastewater/pollution, so their location should be reconsidered.	It was reaffirmed to PAD that the ship dismantling factory is outside the scope of the M/P. Although PAD did not require any study on ship dismantling factory, they requested some general recommendations on ship dismantling factory, and it was added these to DF/R.

Item	Comments from JCC	Action by JPT in DF/R
Cargo handled	Are you considering relocating the oil supply base functions to Ndayane port?	The plan is to use bunker barges for vessel fueling for full container vessels and RORO vessels calling at Ndayane Multifunctional Port, and does not envision the construction of a terminal to handle oil.
Port facilities for green energy ships	The number of green energy ships, such as LNG ships, is increasing worldwide. Wouldn't it be better to include it in the plans for Ndayane port?	PAD has not yet officially decided on any policies or strategies regarding Greenport. Currently, the port of Dakar is only considering installing solar panels on the roofs of warehouses. Regarding this M/P, JPT were asked to include general measures and examples in other countries in DF/R. It was added these to DF/R.
Hazardous materials handling port facilities	The main cargo handled is hydrocarbons, which require sealed tanks and fire extinguishing measures.	In the short-term development plan, JPT proposed a layout at the general cargo terminal that would take up space with other cargo.
Safety and Security	Safety and Security are linked.	It is highly likely that the French translation was incorrect (both were translated as the same word). Checked and corrected in DF/R.
VTMS	Regarding VTMS, it is desirable to have both individual systems for the three ports as well as a centralized system.	Since the current status regarding VTMS at the three ports is unknown, the effectiveness of centralized management, although conceptual, was described. JPT will be explained in next JCC meeting.
Investment	The Ministry of Economy has the mandate to involve large-scale investments. There was a mention of PPP, but investments need to reduce debt as much as possible. If there are any methods of fundraising or other schemes, please let us know.	In the short-term development plan development, the division of roles between the public and private sectors was proposed and funding was described.
road	What kind of facilities are you considering building in the middle of the access road?	When a wide central strip is provided, it is often used as a park, but it is also possible to set up sports facilities such as mini tennis, or to rent it out to the private sector for the establishment of commercial facilities. However, since this is a road exclusively for port facility users, whether or not the central strip should be opened to the public depends on the views of the access road's property owner and maintenance agency. It was added these to DF/R.
Construction Plan	A four-year construction period is too long for a short-term development plan. Could it be shortened to three years? I do not have any particular reason for this.	There is a possibility that the construction period could be shortened, but construction costs would increase. Since more detailed consideration is planned for the Pre-F/S, the possibility of shortening the construction period was considered and described in DF/R.
Natural Condition Survey	Bathymetry and other surveys are being carried out, but have they been verified by a third party?	Regarding natural conditions surveys, JICA projects generally do not ask a third party to review the results, so this will not be the case in this project. The results of the investigation will be provided to the PAD, and if the PAD requires a third-party review, the PAD will be requested to do so.

Item	Comments from JCC	Action by JPT in DF/R
dredging	We request further detailed consideration of maintenance dredging.	No further details are possible based on the information currently available. Proposals for future monitoring surveys, etc. was added to DF/R.
dredging	Please give us your suggestions on whether or not we need a dredger.	Considering the current estimated amount of sediment, it would be more efficient to outsource maintenance dredging to a dredging company rather than procuring a dredger and conducting the work ourselves. Based on the information currently available, it is not possible to examine the details of further maintenance dredging and therefore it is not possible to make any recommendations as to whether it is necessary or not.

Source: JPT

The 4th meeting of JCC was held on 9:30-13:00 (Senegalese time) June 3, 2025, at the PAD conference room. The agenda is shown in Table 3.273. The main purpose of the JCC was results of MP and Pre-FS studies, cost estimation and construction plan, economic and financial analysis, progress of SEA, and responses about previous JCC. The participants are shown in Table 3.274, with a total of 33 people participating. JPT presented the following as recommendations, which were generally agreed. The detail comments from participants are shown in Table 3.275.

- As mentioned by PAD at the TC meeting on 27th May 2025, JPT understands that PAD plans to finalize the four-year port relocating plan based on this master plan. We would like PAD and related organizations to proceed with the development of Ndayane Port.
- Because DPW is under construction, adjustments will be required based on the latest construction status, when conducting the F/S and D/D of the facilities in this M/P and Pre-F/S.
- PPP is useful for early opening of the port.
- After the completion of DPW construction, PAD will need to formulate an appropriate maintenance dredging plan based on the monitoring results.
- After the JCC, PAD will promptly submit a draft SEA report to METE and follow up until the Ministry's approval.
- Appropriate EIA procedures, including sufficient consultation with stakeholders, will be required for each individual F/S procedure.
- For the existing roads that will be divided due to the construction of Ndayane Port, JPT shows replacement routes for reference. When conducting F/S and D/D, adjustments will be required with Ageroute, the road administrator, regarding the replacement route, cost burden, maintenance management entity, etc.

- The basin drainage channel planned in this M/P is planned to be connected to the drainage channel being constructed by AIBD. When conducting F/S and D/D, adjustments will be necessary to reflect the latest status of AIBD construction.

Table 3.273 Meeting Agenda of 3rd JCC

09:30-09:35	Opening remarks and speech by JICA
09:35-09:50	Introductive Words by the Secretary General of PAD
09:50-10:15	Coffee break
10:15-11:20	Presentation of the Progress Report by JPT
11:20-12:25	Questions and Discussions
12:25-12:45	Presentation of the SEA study
12:45-12:55	Questions and Discussions
12:55-13:05	Summary and Way forward by PAD

Source: JPT

Table 3.274 Participants of 4th JCC Meeting

Secretary General of PAD
Ministry of Economy, Planning and Cooperation
Ministry of Finance and Budget
Ministry of Fisheries, of Maritime and Port Facilities
ANAM (National Agency of Maritime Affairs)
Ndayane project unit members of PAD
SEA Consultant
Embassy of Japan in Senegal
JICA Headquarter
JICA Senegal Office
JPT

Source: JPT

Table 3.275 Comments from 4th JCC Participants

Item	Comments from JCC	Action by JPT in F/R
Financing Analysis	In relation to the financial analysis, JPT chose 10% as the discount rate while in Senegal, the rate is 9%.	The discount rate in the financial analysis was revised to 9%.
Alignment of the Project with Senegal's Policy	At previous JCC meetings, JPT was asked to align the study project with Senegal's new national development strategy. In addition, in terms of the alignment, the Project should be aligned to Senegal 2050 vision instead of the projected 2047.	Previously, the year was set to 2047 in line with the R/D, but after discussions with JICA, the year 2050 was additionally considered and added to the report.
Demand Forecast, Target Ship Size and Facility Design	In terms of demand, Senegal is now an oil and gas producer. It would therefore be important to take these factors into account in the project document. The demand forecast should take into account the African Continental Free Trade Area (AfCFTA) which has the	The plan is to handle the import and export of liquid bulk at Bargny Sendou port, not at Ndayane port. Environmental issues and international regulations regarding oil and gas production were added. The draft and other specifications of the

Item	Comments from JCC	Action by JPT in F/R
	ambition to increase the intra-African trade from 5% to 20%. As for draft, the maximum depth envisaged by JPT is 16 m, which is shallow given the global trend towards larger ships. Drafts must also be aligned with global trends in maritime traffic, Senegal's geographical position and the Senegalese government's trade ambitions. JPT is therefore requested to re-examine in its study the elements relating to the size of target vessels, the depth of the quays and the depth of the access channel.	target vessels were reviewed and reconsidered in the AfCFTA and reconfirmed with PAD, which confirmed that the specifications of the target vessels proposed by the DFR are correct.
Wording and Translation	In the project document, the names Port of Ndayane and Port of DPW are mentioned, whereas it should be understood that there is the Port of Ndayane and the Container Terminal conceded to DPW. Therefore, JPT is requested to make the necessary corrections in the report. On "slide 29, 3.3", there are some problems of French translation related to safety and security. Instead of equipment of security, it is equipment of safety.	Reconfirm the wording of Ndayane Port, DPW Port, DPW Container Terminal, etc. and modify as appropriate. International ports must comply with the International Convention on Port Security (ISPS), which lists essential security facilities for international ports. While these facilities are beneficial to safety, the main purpose of this slide is security.
Recommendation to International Conventions	With regard to the conventions, PAD is requested to make the necessary steps to ratify them. Ballast water also requires ratification in order to have all the legal elements in place to manage these issues at the Port of Ndayane. JPT is requested to incorporate the above elements into the recommendations to be made in the report, asking Senegal to take the necessary steps to ratify the conventions relating to ballast water and ship dismantling facilities.	The details were not included in the presentation at JCC, but were included in the report of DF/R; the same will be included in F/R.
Bunkering Station	It is important to have a bunkering terminal at the Port of Ndayane because unloading at the Port of Ndayane and going elsewhere to bunker is a waste of time that can discourage ships. With International Maritime Organisation (IMO) regulations on decarbonisation, it is important to have a modern bunkering facility at the Port of Ndayane.	A bunkering facility is proposed on the inner port of the west breakwater.

Item	Comments from JCC	Action by JPT in F/R
Mitigation Measures	JPT is requested to take mitigation measures into account in its studies, given the scale of the Project and the impact that the Port of Ndayane will have on the environment in this area.	Mitigation measures were not described in detail in the presentation at JCC, but have already been described in previous reports and in the SEA report. It was also described in F/R.
Railway System	JPT's proposal concerning the railway system should be further detailed or developed based on the Government's vision of developing the railway corridor between Senegal and Mali and competition with other ports such as the Port of Dakhla in Morocco.	The railway plan for this M/P was proposed in October 2024 based on information provided by the Senegalese side (CFS, SENTER, etc.). Since then, JPT have made requests to confirm the details of the proposed plan and additional information many times. But these requests have not been realized. JPT would appreciate considerations during future F/S surveys, etc.

Source: JPT