Survey on Polysilicato-Iron (PSI) Coagulant for Water Punification in Malaysia

Final Report (Summary)

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as of January 2013

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GDP	Gross Domestic Product
JICA	Japan International Cooperation Agency
KeTTHA	Ministry of Energy, Green Technology and Water
MWIG	Malaysia Water Industry Guide
NWRC	National Water Resources Council
NTU	Nephelometic Turbidity Unit
O&M	Operation and Maintenance
ODA	Official Development Assistance
PAAB	National Water Asset Management Company
PAC	Polyaluminium-Chloride
PFI	Private Finance Initiative
PPP	Public Private Partnership
PSI	Polysilicato-Iron
RM	Ringgit Malaysia
SAMB	Syarikat Air Melaka Berhad
SPAN	National Water Service Commission
SW	Scheduled Waste
WHO	World Health Organization

1. Objectives

(1) Background and objectives of the study

The Malaysian Government focusing on environmental measures, has applied the revised Environmental Rules of 2005 (SW 204), ranked sludge containing aluminium generated in treated water as scheduled waste, and is demanding appropriate disposal of the same. However, there is only one plant that can appropriate dispose of such waste within the country, and since enormous expenses will be incurred for disposal, the treatmentof sludge containing aluminum is an issue for water treatment personnel.

Polysilicate iron (hereafter referrred to as PSI) is a coagulant for removal of aluminum, and its usage technology is specific to Japan. Because of the interest in PSI, there was a move to change over to coagulant. The Ministry of Energy, Green Technology and Water (KeTTHA), the National Water Service Commission (SPAN: which gives permission and guidance for water supply projects) and private water supply management companies visited Japan and toured the PSI manufacturing plant of Naoji Chemical Co., Ltd., which made the proposal during the JICA training program in 2010. Training on sludge management using PFI was given at the Okubo Water Treatment Plant in Saitama Prefecture.

Japan's PSI technology will be introduced in the main water treatment process of the water treatment plant, which is an important water infrastructure, and environmental measures will be promoted. The sludge generated will be used in the agricultural sector, and this will contribute to restricting the total cost through water tariff.

(2) Project development

The project envisages three stages: the first stage in which installation will be at two water treatment plants onsite, the second stage in which developments will take place in the states of Selangor and Malacca, and the third stage in which developments will take place all over Malaysia. The present study has the objective of realizing the targets of the first stage.

Fig. 1.1 shows the project scheme and the implementation system visualized in the first stage. The possibilities of tie-ups with various companies managing water treatment plants as partners on the Malaysian side will be studied in this stage.

First Stage (June 2013 to December 2017)

The target is to manufacture coagulant PSI for water treatment at the onsite plants to be constructed within two water treatment plants – one in Selangor State and one in Malacca State, and to supply the same. During this stage, the advantages and the economics of PSI will be validated for demonstration purpose so as to gain a foothold for diffusion of the PSI. The sludge treatment at this point of time will be the treatment of general wastes.

Second Stage (January 2018 -)

The spread of PSI will be promoted based on the advantages demonstrated during the First Stage. When the actual use of PSI in several water treatment plants has been ensured in this stage, local manufacturing plants for PSI will be established with the objective of supplying the same to water supply management companies. The entire states of Selangor and Malacca will be visualized for this purpose. On the other hand, a constant quantity of sludge will be generated, therefore the course to make effective use of this sludge for agricultural purpose will also be explored.

Third Stage

Based on the results of the First Stage, country-wide development of the project will be aimed for, and if necessary, more PSI manufacturing plants will be set up. The operatiions of sludge treatment facilities and the routes for re-utilizing sludge for agriculture and so on, will be established with the aim of building up the sludge management cycle.

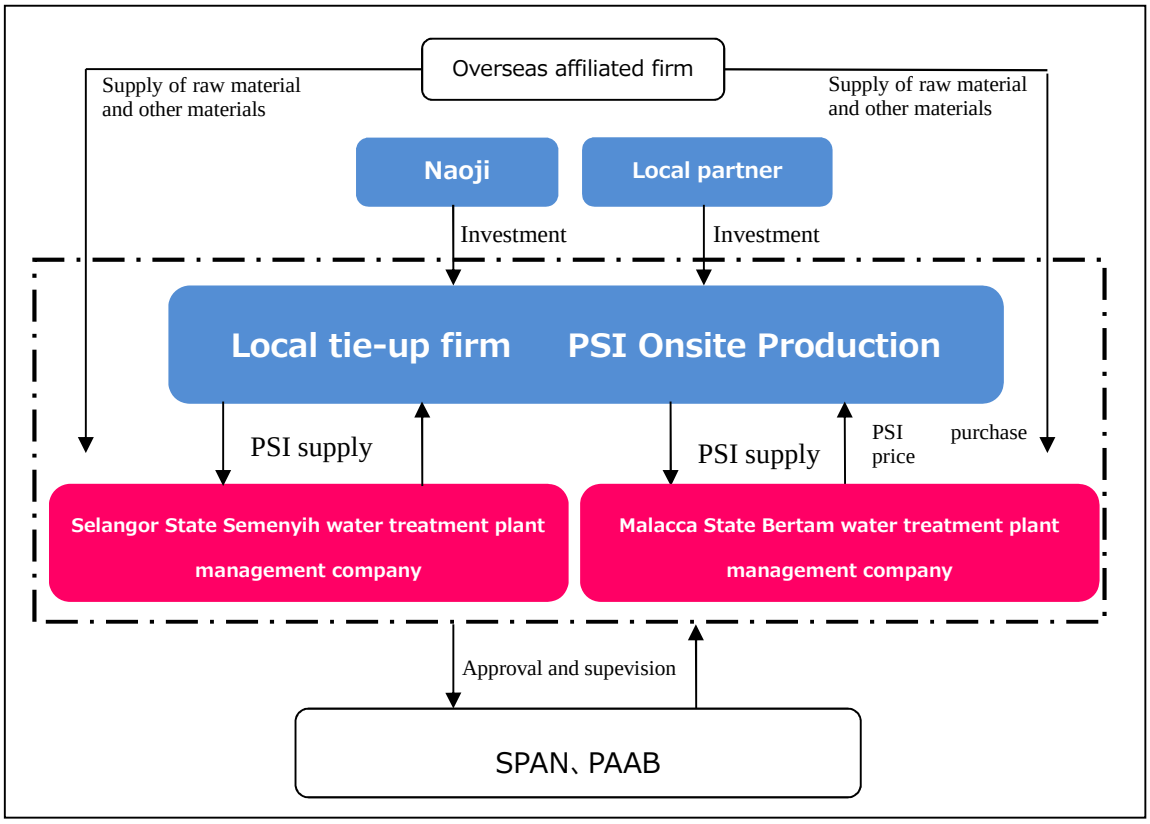


Fig. 1.1 Project scheme and implementation system envisaged in the First Stage

2. General condition of water supply works

(1) Development and associated organizations

"Strategic plans for sustainable growth" and "Resilience and competitiveness" have been raised as goals in the Ninth Malaysian Plan. Reorganization of waterworks administration has also been promoted in the country. These reorganization is meant for establishing sustainable and sound water supply works. In 2006, the National Water Asset Management Company (PAAB) was established to take charge of assets management of the nationalized water suply and sewage works and the operation, maintenance and management of the water supply and sewerage works. Moreover, in 2007, the National Water Service Commission (SPAN) was established having the role of a supervisory organization responsible for permissions, disposals, etc., related to water supply and sewerage works.

Table 2.1 Roles of the water supply sector

Organization	Description
Ministry of Energy, Green Technology and Water (KeTTHA)	Water policies of the whole country in line with the government policy
State Governments	Water source adjustments and river basin management
National Water Resources Council (NWRC)	Adjustments among state governments related to rivers and dams
National Water Service Commission (SPAN)	Permissions to water supply and sewerage industries, guidance and supervision
National Water Asset Management Company (PAAB)	Nationalization, new installations, improvements and operational management of water supply and sewerage facilities
Water Operator	Assume charge of and implement operation and management work in sewerage and water supply facilities

The State Government used to fully manage all activities from the water source to the water distribution in the past. However, after 2007, the water sources continued to be under the jurisdiction of the State Government, and all other activities from the intake facilities to the water distribution came under the juristiction of the National Water Asset Management Company, that is, PAAB. However, the handing over of charge from the State Government to PAAB has not progressed mainly due to political reasons in the federal and state governments.

- PAAB jurisdiction: Six states in all including Johor State, Malacca State, Negeri Sembilan

State, Perak State, Penang State, Perlis State

- State government jurisdiction: Six states in all including Selangor State, Kedah State, Pahang State, Terangganu State, Sabah State and Sarawak State

(2) Status of water supply

(a) Served population ratio

The served population ratio in Malaysia was 84.4% for the whole country in 2011, 96.8% in urban areas, and 90.1% in rural areas, indicating very high ratios. Selangor State and Malacca State, which are the areas under the scope of the study had ratios of 99.8% and 100%, which are higher than the national average.

(b) Water source and facilities operation rate

The water source rate is 15.5 million m^3/day, with 98% derived from rivers (including dams) and the remaining from groundwater. The number of water treatment facilities currently in operation is 461 (17.4 million m^3/day), while the treated water production rate is 14.6 million m^3/day. The operation rate of the facilities is 83.6% indicating a surplus. All the water sources of Selangor State and Malacca State, which are the areas under the scope of the study, are river water sources. The number of water treatment facilities currently under operation in Selangor State is 33 (4.5 million m^3/day), while the treated water production rate is 4.1 million m3/day. The operation rate of the facilities is 93% indicating a slender surplus. The number of water treatment facilities, currently in operation in Malacca State, on the other hand is 8 (0.51 million m^3/day), while the treated water production rate is 0.46 million m^3/day. The operation rate of the facilities is 90% indicating a reasonable surplus.

(c) Status of non-revenue water

The non-revenue water rate for the whole country is at a very high value of 36.7%. The variation in this rate by area is quite large with six states having a non-revenue water rate greater than 40% and four states having a rate greater than 50%. Promotion of measures to reduce non-revenue water such as water leak prevention measures and improvement measures are anticipated. The non-revenue water rate for Selangor State in the study area is 32.3%, which is smaller than the national average. However, the adoption of measures to reduce non revenue water, such as leakage prevention measures, is an urgent task since the number of water sources to cope with the demand and the surplus capacity in water treatment facilities are both small.

(d) Balance status

The annual balance status of the water supply works is as shown in Table 2.2. For Selangor State, which is in the study area, the operation and maintenance cost is 52% of the total income. This is low, but the

total expenditure is 127%, indicating a business deficit. The tariff rate has been set on the premise of full cost recovery, but the deficit is attributed to the lack of progress in tariff modification and other effects such policies. On the other hand, the operation and maintenance cost is 84% of the total income and the total expenditure is 91% indicating that the business return is in the black.

Table 2.2 Balance status of the water supply works

	Annual income (x 1000 RM)			Expenditure/ Total income (%)	
	Total income	Total expenditure	O&M cost	Total expenditure	O&M cost
Whole country	4,240,490	4,531,372	3,045,374	107	72
Selangor State	1,633,868	2,068,462	849,152	127	52
Malacca State	154,947	141,181	130,229	91	84

Source: MWIG 2012

(3) Status of wastewater treatment

Of the 462 water treatment plants in operation as of December 2012, 63% do not have wastewater treatment facilities and these plants discharge wastewater directly into rivers. Presently, some water treatment plants have responded by ensuring reclamation sites for sludge generated by budgetary measures of the PAAB; however, this is not a permanent solution, and the road to a permanent solution is not yet visible.

(4) Project development area

The plan during the First Stage is to use about two water treatment plants in Selangor State and Malacca State as pilot plants. After the Second Stage, developments will be carried out all over the two states using the results of the two treatment plants as a foothold. The goal is to carry out developments all over Malaysia after the Third Stage. SPAN, which grants permits and licenses, and the investing organization, PAAB, had discussions with water supply management companies managing water treatment plants in each stage, and the result was that the two water treatment plants of Table 2.3 were selected as the pilot plants for the First Stage.

Table 2.3 Two water treatment plants selected for case studies

Item	LABU water treatment plant	Bukit Sebukor water treatment plant
Facility owner	PAAB	PAAB
State	Selangor State	Malacca State
Capacity	55,000m^3/day	68,000m^3/day

Type of water source	River surface water (Labu River)	River surface water (Malacca River)
Treatment flow	[Treated water] Floatation + rapid sand filtering [Wastewater treatment] Desludging + thickening + dewatering machine	[Treated water] Coagulation-sedimentation + rapid sand filtering [Wastewater treatment] None
Raw water quality	Turbidity：10 to 15 NTU pH：7 to 8	Turbidity：100 NTU pH：5.5 to 6.5
Coagulant usage status	PAC dosage: 20 mg/L	PAC dosage: 40 mg/L
Treated water sludge disposal method	Ensure land within the treatment plant and dispose by reclamation	Effluent delivery to river without treatment

(5) Advantages of introducing PSI

Environmental rules were revised in 2005 in Malaysia. Sludge in treated water containing aluminum is in the list of scheduled wastes to which SW204 requirements apply. Thus, measures are required for the disposal of sludge in treated water and wastewater containing alumium. On the other hand, sludge containing iron can be disposed of as general waste as is being done until now, therefore, water supply contractors have shown a strong interest in PSI, which is an iron-based coagulant.

To study the life cycle cost that could be incurred when switching over the coagulant chemical from PAC to PSI, costs were compared for the case when PAC is continued to be used as-is with the cost incurred when PSI is used, and the economic advantages were validated. The results showed that when switching over from PAC to PSI, the quantity of chemicals used increases, and although the annual chemical cost becomes 2.6 times the original cost, if PAC is used continuously, construction of wastewater treatment facilities and ensuring sites for sludge disposal will become necessary. Therefore, construction and sludge disposal costs will increase, and for the next twenty-year span, PSI was estimated to be more beneficial from the economic aspect.

3. Investment climate

The World Bank and IFC has been publishing the business environment study report "Doing Business" which is a study implemented for 185 countries every year to evaluate the business environment of each country. According to the overall evaluation for the year 2013, Malaysia has been upgraded from the 14th to the 12th rank compared to the previous year (Japan is 24, while Singapore and Hong Kong are ranked at the top position). The Corruptions Perception Index published by Transparency International indicating the corrpution levels of governments showed an index of 4.4 in 2010, 4.3 in 2011 (the least corruption level is given by a value 10, and the most corruption by 0), ranking Malaysia as 56th in 2010, and 60th in 2011 out of 183 countries (Japan -14, China 75, Thailand 80, Indonesia 100), suggesting that the country was in a favorable group within the ASEAN nations. For this reason also, the overal business environment is generally seen to be satisfactory.

Table 3.1 gives an overview of the economic status in Malaysia.

The situation related to investment climate may be summarized based on the perspectives of the political situation and financial situation of Malaysia, and the macroeconimic trends as follows:

- The transition of economic fundamentals is stable, there is no problem in particular, and the evaluation of investment climate by the World Bank is satisfactory.
- The government too has been promoting development projects based on ETP, is striving to enhance the transparency of its implementation process, and has been acclaimed highly for its efforts.
- However, the manufacturing industry has been facing a severe labor shortage, the government has a policy to reduce dependence on foreign laborers, but there is no prospect of improvement in the near future. This is probably because wages have increased, and new developments are difficult.
- The present economic growth is not through export of industrial products as in the past. A favorable internal demand has been created because of major projects through government initiatives, stable increase in wages and work status almost close to full employment. The government budget deficits in some foreign-ranked companies have still not improved, and there is concern that outstanding loans have reached a level that can no longer be ignored. In contrast, the government has announced that the GDP ratio for budget deficit would be brought to a level of 3% by 2015, therefore concerns of subsidy cuts are a matter of concern.
- The political situation is that general elections are expected in March 2013 and it is not clear whether the ruling party which lost a considerable number of parliamentary seats the previous time will recover or not. The Public Order (Preservation Act) that had backed media controls of the ruling party since the past, is being abolished/ revised; and is beint exposed to more

criticism. The unaffiliated voters consisting of mainly the young people who freely exchange information over the Internet account for a share of 40%; therefore, fluidity of politics is a cause for concern.

- Thanks also to the "Look East" policy adopted by former Prime Minister Mahathir of Malaysia, the Malaysian people generally have a good opinion of Japan and disturbances/demonstrations against Japanese industries are not expected to occur.

Table 3.1 Malaysian economic situation

Item		Units	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
Nominal GDP		Million USD	100,846	110,202	124,749	137,954	156,601	186,774	222,106	192,846	237,797	278,671
GDP per capita (nominal)		USD	4,078	4,352	4,816	5,211	5,839	6,873	8,091	6,917	8,418	9,700
Economic growth rate		%	5.4	5.8	6.8	5.3	5.8	6.3	4.6	-1.7	7.2	5.1
Price increase rate		%	1.8	1.1	1.4	3.1	3.6	2.0	5.4	0.6	1.7	3.2
Unemployment rate		%	3.5	3.6	3.5	3.5	3.3	3.2	3.3	3.6	3.1	3.1
Total trade	Imports	Million USD	79,761	83,299	105,166	114,302	130,350	146,046	155,824	123,328	164,177	187,658
	Exports	Million USD	94,061	104,706	126,646	141,595	160,636	175,793	198,755	156,765	198,325	226,977
Trade items	Imports	—	Electric products, manufactured equipment, transport equipment, metal products, crude oil, petroleum products, steel products, scientific and optical equipment, foodstuff, etc.									
	Exports	—	Electric products, palm oil, chemical products, crude oil and petroleum products, LNG, machinery and instruments, metal products, scientific and optical equipment, rubber products, etc.									
Trading partners	Imports	—	China (13.2%), Singapore (12.8%), Japan (11.4%) * As of June 2012									
	Exports	—	China (13.1%), Singapore (12.7%), Japan (11.5%) * As of June 2012									
Trade with Japan	Imports	x 100 million yen	14,014	14,580	15,263	16,184	18,012	20,469	23,976	15,584	19,874	24,257
	Exports	x 100 million yen	13,776	13,017	13,598	13,829	15,370	17,690	17,054	12,001	15,446	14,966
Japanese direct investment		Million USD	—	—	—	966.2	1,202.1	1,896.1	1,617.0	2,058.9	1,308.2	3,177.0

4. Project strategy

(1) Market scale and customers visualized

The market to be targeted is the water supply works, and the product an alternative to the aluminum-based coagulant used in water treatment plants. The water treatment plants are borrowed from PAAB or state government by the water management companies responsible for operation and maintenance of the same. Presently, the aluminum-based coagulant is being directly procured from chemical sellers by these water management companies.

As mentioned earlier, the present project will be developed over three stages. The project will be developed over the whole of Malaysia during the Third Stage. If all the treatmentplants using river surface water as the water source and using coagulant switch over to using PSI, then the market scale will be extremely huge. In this case a potential demand of surface water source is estimated is maximum of 15.3 million m^3. If the average dosage rate of 40 mg/l of PSI is assumed, then the estimated usage of PSI will be about 223,000 t/year.

Based on reports from water management companies, the introduction of PSI is anticipated with keen interest in Malacca State. Water treatment plants in Selangor State that have not yet adopted measures for sludge from treated water also have expressed keen interest. PAAB has shown keen interest in its desire to switch over to PSI and is lobbying to the water management companies under its jurisdiction, and is likely to set them on course to switching over to PSI. The reason that PAAB, which does not directly manage the water treatment plants, is expressing such keen interest is that SW204 was applied to sludge treatment methods actually containing aluminum in Johor State, and enormous expenditure was incurred through penalties and costs of measures adopted. From interviews of PAAB and SPAN personnel, it became evident that in addition to Johor State, strong interest was evinced by Negeri Sembilan State, Perak State, Penang State, and Terangganu State from the viewpoint of compliance with laws.

Accordingly, the final selection of pilot plants planned for the First Stage wil be made after discussions with the water management companies of these states in the future.

(2) Description and features of products and services

The features of PSI under the premise of its use in Japan are listed below. These features may be treated as similar to Malaysia as well.

① Removal of trihalomethane precursor is high: Organic color component, which is a trihalomethane precursor can be properly removed due to the strong coagulant action.

② Good response even for low water temperature and low turbidity raw water: Due to the action of iron and inorganic polymer (polymer linker), proper treatment is possible without using auxiliary agents even for low water temperatures and low turbidity raw water.

③ Continuous filtration time can be extended: The rate of increase in head loss can be drastically cut down; therefore, the continuos filtration time can be extended by 10 to 20%, and clarified filtered water can be obtained without loading the filter layer.

④ Reduction in the quantity of sludge generated: Thanks to the specific action of good thickening and dewatering by iron and inorganic polymers, sludge with low moisture content can be obtained, and treatment costs can be reduced because of the reduced quantity of sludge generated.

⑤ Application of sludge generated from water treatment to agricultural land is possible: Sludge from treatment of water can be retained in a form that makes it easy for vegetation to use phosphorous, a necessary nutrient source; thus it can be applied to agricultural land.

⑥ Use of environment-friendly raw materials: Although residual aluminum in water treated using aluminum-based coagulants is a cause of concern due to its association with nervous system diseases, PSI has iron and phosphorous as the main components, and it is safe for the human body.

(3) Project goal and development scenario

Fig. 4.1 shows the scope of the project. A company will be set up jointly with a local partner, PSI will be manufactured, sold and and supplied. As shown in Fig. 4.2, three stages are visualized for the project goal and development scenario.

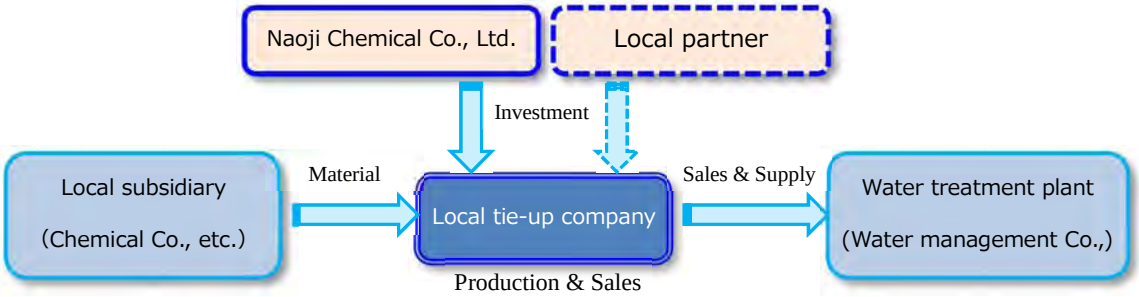


Fig. 4.1 Scope of the Project

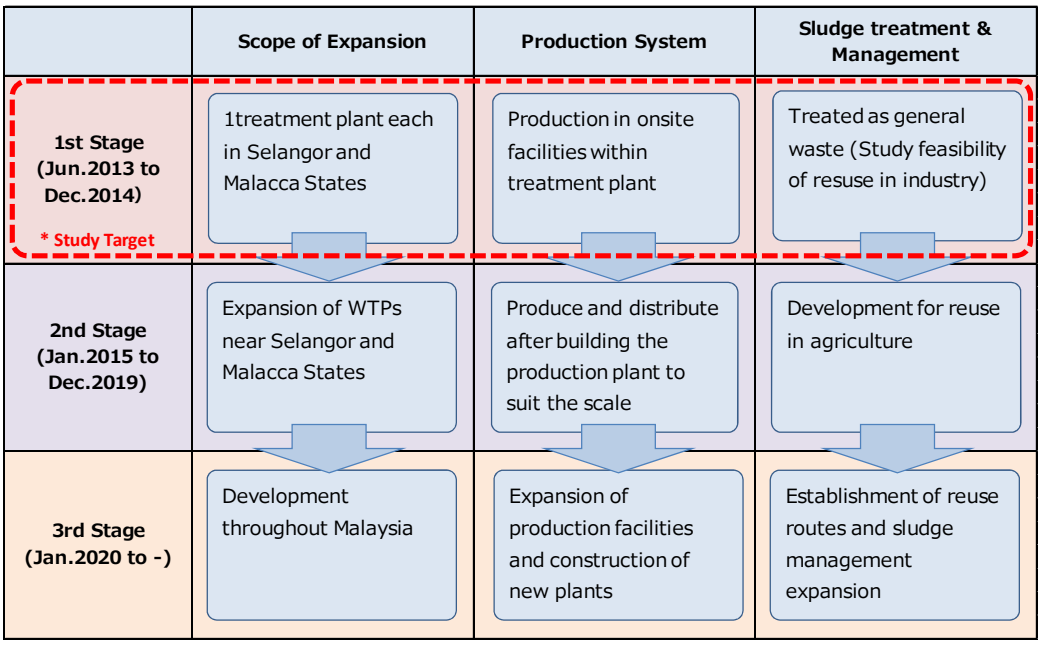


Fig. 4.2 Visualization of project stages

(4) Procurement plan for raw materials and other materials

Raw materials required for this project are chemicals required for producing PSI, and these include silicate of soda, sulfuric acid and ferric chloride. Tap water sill be used because mixing and dilution will be necessary during the PSI production stages. Additionally, during the first stage, materials and equipment such as pipes and fittings, injection pumps, control panels and instrumentation are necessary. These raw materials and other materials are generally available within Malaysia. The main procurement routes for these materials for the LABU and Bukit Sebukor water treatment plants, which are the focus of study in the First Stage, is overland transportation by expressways from Kuala Lumpur.

(5) Production plan

The production plan for this project is as shown in Table 4.1 (PSI injection rate assumed as 70 ㎎/ℓ) . For the Second Stage, the target served population ratio was set as about 50% for the whole of Selangor State and about 80% for Malacca State.

Table 4.1 PSI Production Plan for Each State

	PSI production (t/year)		
	Selangor State	Malacca State	Other States
First Stage	600.5	1,485.0	—
Second Stage	48,960.0	8,839.8	—
Third Stage	97,919.9	11,049.9	204,989.4

(a) Installation plan for onsite plants

During the First Stage, onsite production plants will be constructed at the two water treatment plants mentioned above so that PSI can be produced and supplied. Table 4.2 and Figures 4.3 and 4.4 show the installation location of the plants, installation scale, and approximate expenses for each of the water treatment plants. The setting for injection rate is assumed at this point of time. It will be finally determined based on the results of a detailed study after using raw water in each plant before introducing PSI and performing the table test, and so on.

Table 4.2 Scale of production envisaged in the First Stage

	Unit	Selangor State LABU WTP	Malacca State Bukit Sebukor WTP	Remarks
1. Planned water treatment quantity	m^3/day	55,000	68,000	
2. Turbidity of raw water	NTU	10 to 15	100	
3. PSI injection rate	mg/L	40	70	
4. PSI usage rate	ton/day	1.65	4.07	
5. Plant construction cost	x 1000 yen	46,000	50,000	
6. Solids generated	ton/day	0.81	7.43	
7. Cakes generated	ton/day	981.7	9,038.2	
8. Estimated cost of chemicals	kg/yen	32.7	21.1	PAC：14.6
9. Annual cost of chemicals	yen/year	19,636.7	31,332.4	

The cost of chemicals at the Bukit Sebukor water treatment plant in Malacca State where the usage is high can be reduced and the advantage of installation at this plant is considered to be large since there is not much of a difference in installation cost. However, the cost of PAC, the coagulant being used currently, is 14.6 yen/kg, so the cost of chemicals is expected to increase. For this reason, further studies are necessary henceforth on the procurement cost of raw materials and efforts should be made to reduce the production cost to enhance chances of project implementation.

[LABU Treatment Plant (Selangor State)]

Fig. 4.3 Overview of installation location of facility (LABU water treatment plant)

[Bukit Sebukor water treatment plant (Malacca State)]

Fig. 4.4 Overview of installation location of facility (Bukit Sebukor water treatment plant)

(6) Effective use of sludge in the agricultural sector

(a) Agriculture in Malaysia

63% of the land in Malaysia is covered by forests, 18% is covered by long-term crops, and arable land where general crops are cultivated accounts for 5.5% (as in 2009). Of the main crops cultivated in arable land, palm oil accounts for the maximum used area, and in the last ten years, the cultivation of palm oil crops has increased noticeably. Rubber comes next, followed by rice in third place.

Rice produced in 2010 was 254.8 t, and the self sufficiency is quite high at 71.4% (2010). During the Ninth Malaysia Plan (2006 to 2010), the target self-sufficiency in 2010 for main foodstuff (rice: 90%, fruits: 138%, etc.) was established, but the safety and security measures for foodstuff were reinforced from 2008, with increased storage of rice and measures for stable import of rice, and so on.

Rice is mainly cultivated in the northern part of peninsular Malaysia with approximately 40% being produced in Kedah State. The next in line in production amount is Perak State in the north followed by Kelantan State, Perlis State, Penang State and Selangor State, where the capital Kuala Lumpur is located. These states have soil and drainage and irrigation equipment that are suitable for producting wet-land rice. Two crops per year are being cultivated in the states of Kedah, Perak, Kelantan, and Perlis; however, the production is lower than the average unit crop (4.3 t.ha, unhulled), and there is room for improvement in productivity.

(b) Soil in Malaysia

According to research reports already published, the average value of available silicate (silicate extracted with acetate buffer of pH4) in paddy field soil (top soil, 41 samples) sampled from the entire paddy field belt of peninsular Malaysia was 10.4 mg SiO_2/100 g, which is lower than the average value for all the countries of tropical Asia (27.0 mg SiO_2/100 g), and is the least among the countries of tropical Asia. The locations where samples of paddy-field soil of peninsular Malaysia were taken have not been mentioned in this report. Therefore, it is not possible to judge in which paddy-field soil region the silicate is in shortage; however, it is predicted that paddy-field soil that is short of silicate correspondingly exists in peninsular Malaysia as well.

(c) Plan to effectively use sludge

Although silicate is not an essential component for vegetation, rice crops absorb a large amount of silicate. If the rice crops can absorb silicate sufficiently, improvement in logding resistance, improvement in photosynthetic ability, consequent increase in harvested quantity and quality, improvement in pest resistance, and so on, are the effects that are known to occur. The average value of available silicate in the important paddy-field regions of peninsular Malaysia is low. It is estimated that there are regions where productivity of wet-land rice can be improved by using silicate fertilizer. In these regions, the use of PSI sludge for paddy-field soil is likely to prove effective.

(7) Sludge management

When discussing sludge management in water treatment plants, it is not enough to merely study the treatment of sludge generated, but an overall judgment needs to be made considering treated water flow, coagulant selection, need for pH adjustments, and so on. Inhibiting the sludge generated is also an important matter.

The operation and maintenance status of water treatment plants in Malaysia was checked from these perspectives. Issues in operation and maintenance were found here and there such as, need for pre-chlorination, level of pH adjustments, ensuring appropriate sedimentation time, and so on. By improving these points, not only can quantity of sludge generated be inhibited, but also, improvement in supplied treated water quality can be anticipated. In view of these points, it will probably be effective henceforth to perform transfer of technology related to operation and maintenance of water treatment plant by dispatching experts. Especially, since the level of mangement and engineering personnel and the basic knowledge of operators is high, the transfer of technology can be easily performed through OJT and the like for these proposals.

When PSI is introduced, not only legal issues related to aluminum-based sludge, not only a reduction in the quantity of generated sludge, but also effects, such as reduction in the carryover to the filter basins by improved removal rate in the sedimentation process by generating compartively heavy floccs, a reduction in the backwash frequency of filter basins, and so on, were observed here and there.

In addition, sludge management can be implemented effectively by transferring Japan’s know-how in the operation and maintenance of water treatment plants which generally combines the know-how on obtaining value from sludge after carefully considering the effective use of sludge in the agricultural sector.

5. Project Plan

The outcome of studies in the previous chapter showed that within Selangor State, the Malaysian National Govrnment and the state government are politically independent, transfer of control of the water supply facility assets to PAAB has not been made, and PAAB has direct control of water treatment plant at one location only. The raw water turbidity is also low in the treatment plant; as a result is that PSI production cost becomes high, and its effect is small.

In view of such circumstances, a plan for water treatment plant at one location in Malacca State will be formulated as part of the Project Plan. Site reconnaissance and data collection will be implemented to formulate the Project Plan, which will be implemented for the Bulkit Sebukor water treatment plant for which the facility plan was originally made.

Project Implementation System

- In-house system: A section will be set up in Naoji Chemicals Co., Ltd., directly under the President and one person will be despatched on site as the person in charge of development. Supervisor will be dispatched for about half a year before and after the facility is in operation (personnel expenses to be borne).
- Corporate form: Provisionally, tie-up with water supply management company (SAMB) of Malacca State will be studied.
- Stationing of personnel: In addition to the personnel in charge of development and supervisor mentioned above, 1 operation controller, 2 operators, and 1 person for the general affairs of the joint venture will work on site. Operation controllers and operators will be SAMB engineers, while general affairs work for the joint venture will be performed by a person with experience of working in Japanese industry overseas.

Numerical Plan

Item	Description of Pre-conditions
Estimated Profit and Loss Statement	
Personnel expenses	Assume an annual increase of 5%.
Statutory welfare expenses	Statutory welfare expenses shall be assumed as 13% of the salary amount
Depreciation cost	Refer to “OA equipment, PC, etc.” in “2. Estimated balance sheet …”
Audit remuneration	Taken as 600,000 yen (50,000 yen monthly) annually; to be estimated monthly in the P/L.
Sales tax	Charged at the time of shipping the product (10%) However, the 10% part should be borne by the customer, and recovered together with the credit sales. This amount is paid on behalf of the customer, so it need not be

	considered when preparing PL and CF.
Estimated balance sheet, estimated cash flow sheet, estimated fundraising table	
Collection of proceeds	Collection of proceeds in cash (bank) the following month
Purchase and payment	Payment of purchased amount in cash (bank) the following month
Salary payment	Salary for a month paid the same month
Statutory welfare expenses	Statutory welfare expenses for a month paid the following month
Rent	Rent for a month paid the same month
Payment of expenses	Expenses for a month paid the same month in cash (bank)
Inventories	Product: 10% of the "cost of manufactured goods for the term" of the following month assumed as this month end inventory. Raw materials: 10% of the "raw material cost" of the following month assumed as this month end inventory. In-process items: "This month production → this month completion" assumed. Therefore, no in-process items generated at the end of the month.
This month's production quantity	Since the month end (term end) base stock of raw materials and products is calculated based on fixed assumption, the production quantity is a preliminary estimate. Calculations performed under the following assumptions: ① This month's sales ② 10% of following month's sales (=month end product inventory) ③ 10% of this month's sales (=month beginning product inventory) ④ Production quantity for this month =①+②-③
Capital	60,000 x 1000 yen (amount contributed by Naoji Chemicals, no loans)
OA equipment, PC, etc.	OA equipment, PCs, etc., (1,500,000 yen) are counted as assets of tools and equipment, service life is taken as 5 years, and depreciation cost is estimated by the straight line method taking the salvage value as zero.

(1) Estimated Profit and Loss Statement

The estimated profit and loss statement for the first three terms is as shown in Table 5.1. An increase in the personnel expenses (5% annual increase) is anticipated in the profit and loss plan; therefore, although the profit at each stage will decrease per term, if the planned project structure, sales amount and unit cost can be realized, continuous profits in the project can be ensured.

Table 5.1 Estimated Estimated Profit and Loss Statement for the First Three Terms

(Unit:1000yen)

Topic	1st Term	2nd Term	3rd Term
Proceeds	31,332	31,332	31,332
Cost of sales	24,269	24,410	24,499
Gross profit	7,063	6,922	6,833
Cost of sales and general management cost	3,446	3,514	3,584
Operating profit	3,616	3,407	3,248
Recurring profit	3,616	3,407	3,248
Income before tax	3,616	3,407	3,248
Corporate tax, etc.	723	681	649
Net income for the period	2,893	2,725	2,599

(2) Estimated balance sheet

The estimated balance sheet for the first three terms is shown in Table 5.1. There is no debt financing in this project. The plan envisages covering the required investment by capital at the time of incorporation; therefore, the ratio of net worth is expected to change at a high level. From the profit and loss plan, a surplus can be ensured from the first year since this is a business model with small burden of inventory risk; therefore, liquidity in hand can be adequately ensured, and no problem in project continuity is anticipated from the financial viewpoint.

Table 5.2 Estimated balance sheet in the first three terms

(Unit:1000yen)

Topic	1st Term	2nd Term	3rd Term
Current assets	16,708	23,047	29,270
Tangible fixed assets	48,684	45,029	41,374
Total assets	65,393	68,077	70,644
Current liabilities	2,500	2,458	2,426
Net assets	62,893	65,619	68,218
Total of debts and net assets	65,393	68,077	70,644

(3) Estimated cash flow calculations

Estimated cash flow calculations for the first three terms are as shown in Table 5.3. If the planned project structure, sales amount and unit cost can be achieved, sales cash flow on the plus side can be anticipated every term. After the second term, no exceptional investments are expected; there is no loan repayment

burden too. Therefore, stable increase in cash flow may be anticipated.

Table 5.3 Estimated cash flow in the first three terms

(Unit:1000yen)

Topic	1st Term	2nd Term	3rd Term
Cash flow through sales activities	6,041	6,338	6,221
Cash flow through investment activities	△52,340	—	—
Cash flow through financial activities	60,000	—	—
Changes in amounts of cash or cash equivalents	13,701	6,338	6,221
Balance of cash or cash equivalents at the beginning of the term	—	13,701	20,039
Balance of cash or cash equivalents at the end of the term	13,701	20,039	26,261

(4) Estimated fundraising table

The estimated fundraising table of the first three terms are as shown in Table 5.4. If the planned project structure, sales amount or unit cost can be realized, a plus in the current account can be adequately anticipated, and the financial account and fiscal balance will not change especially after the second term. Therefore, there is no fundraising issue for continuous project activities.

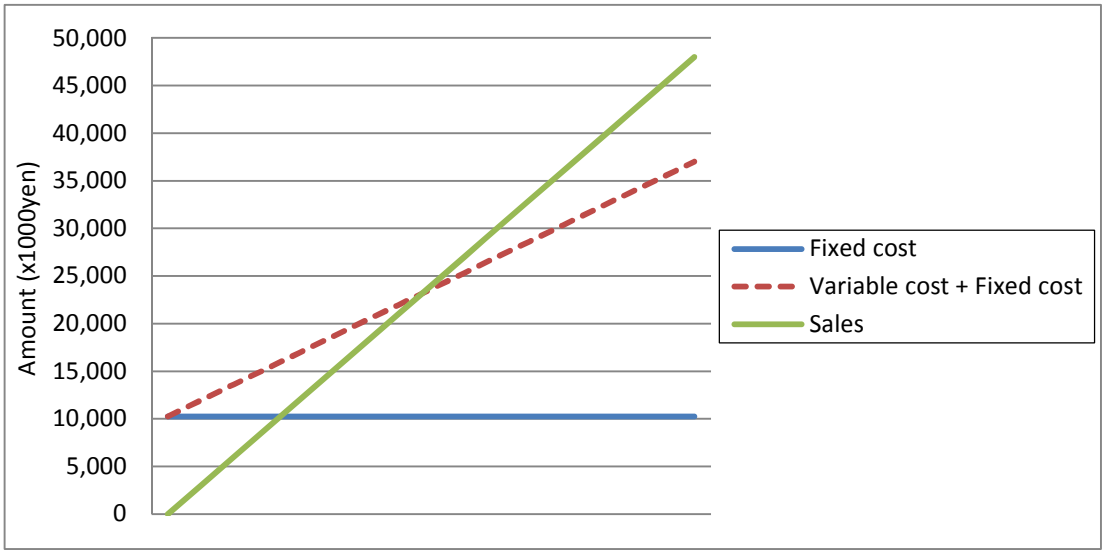
Table 5.4 Estimated cash flow in the first three terms

(Unit:1000yen)

Topic		1st Term	2nd Term	3rd Term
Brought forward from the previous term		—	13,701	20,039
Current account	Current account total	28,671	31,332	31,332
	Recurring expenditure total	△22,630	△24,994	△25,110
	Current account balance	6,041	6,338	6,221
Financial account		△52,340	—	—
Fiscal balance		60,000	—	—
Balance at end of term		13,701	20,039	26,261

(5) Analysis of the break-even point

Analysis of the break-even point for the first three terms is shown in Fig. 1. While an increase (5% annual increase) is anticipated in the personnel expenses, and although an upward trend in the fixed cost is followed, the plan is such that if the planned project structure, sales amount and unit cost can be achieved, the break-even point for each period can be adequately cleared by ensuring stable sales.



Note: Break-even point figures for Second and Third Terms are omitted since they are practically similar to the one in the firstterm

Fig. 5.1 Results of break-even point analysis (first term)

(6) Sensitivity analysis

The “sales price,” “sales amount” and “purchase price”, which are important factors affect this project, were extracted. These factors were varied based on the numerical values of estimated profit and loss statement and estimated fundraising table for the First Term mentioned above, and sensitivity analysis of operating profit and balance at the end of the term was carried out. The results of the analysis are shown below.

Table 5.5 Results of sensitivity analysis (variables: sales price, sales amount)

(Unit:1000yen)

	Sales price / Sales amount	Plus 10%	Base case	Minus 10%
Operating profit	Plus 10%	8,444 ＋133.48%	4,997 ＋38.17%	1,551 △57.12%
	Base case	6,749 ＋86.63%	3,616 —	483 △86.63%
	Minus 10%	5,056 ＋39.80%	2,236 △38.17%	△583 △116.13%

Funds at the end of the term	Plus 10%	18,089	14,934	11,780
		＋32.03%	＋9.0%	△14.01%
	Base case	16,568	13,701	10,833
		＋20.93%	－	△20.93%
	Minus 10%	15,048	12,467	9,887
		＋9.83%	△9.0%	△27.84%

Note: Upper step: Amount under each condition; Lower step: Rate of change from base case

Table 5.6 Sensitivity analysis (variables: purchase price)

(Unit:1000yen)

Purchase price / Sales amount	Base case	Plus 5%	Plus 10%	Plus 15%
Operating profit	3,616	2,740	1,864	988
(Base case)	－	△24.22%	△48.45%	△72.68%
Funds at the end of the term	13,701	12,884	12,067	11,251
(Base case)	－	△5.96%	△11.92%	△17.88%

Note: Upper step: Amount under each condition; Lower step: Rate of change from base case

Note: Sales amount was fixed (base case), only price rise of raw materials was considered in this study.

(7) Feasibility of project operation

Stable sales can be anticipated from this project, and cost burden is restricted in the background of mutual support from investing companies; as a result, profits can be ensured in the short to medium term. There is little cause for worry on the financial stability and fund raising fronts because there is no debt financing, the plan considers covering the necessary investment by capital at the time of incorporation, and moreover, this is a business model with small burden of inventory risk. Accordingly, if the planned project structure, sales volume and cost price can be achieved, it is concluded that continuous project operation is feasible according to the Numerical Plan.

(8) Other points to bear in mind

- Acquisition of investment license
- Acquisition of water supply standards: These standards need not be acquired. When the decision to employ a water supply management company is taken, the standards can be used.
- Acquisition of HALAL approval: For acquiring HALAL approval, the components and their safety must be certified; if approved in Japan, then the certification documents can be attached.

6. Risk analysis

The main risks in implementing the proposed project are as below.

- Creating a framework for environmental rules (SW204): Exemption of aluminum, special measures for water supply works
- Sovreign risks

  ① Political risk: Risks such as demonstrations/riots at the time of change of government may be considered, but these may be hedged by political risk insurance, etc.

  ② Macroeconomic risk: Subsidies for water supply works may be reduced if financial deficit or government debt increases. Deterioration in project profitability due to high raw material cost, high personnel expenses or sluggish PSI sales, is a cause for concern in this proposed project.

  ③ Risk of fluctuation in interest and exhange rate: Both interest and exchange rates are stable, and problems are not anticipated in the short term. However, if the financial situation does not improve, risks in the medium term are a cause for concern. However, procurement from local financial institutions is not planned in this proposed project; therefore, effects of fluctuation in interest rate will not be felt.

  ④ Restrictions on repatriation of foreign currency and motions on import bans: No restrictions exist on sending foreign currency; also, since the country is earnestly pursuing free trade, the possibility of a move toward regulations for protectionism is considered to be very small.

  ⑤ Development and establishment of new laws, increase in taxes: Risks related to significant policy changes due to change in government may be considered. However, since the proposed project is directly linked to lifelines, the effect of policy changes is considered to be negligible.

- Commercial risks

  ① Permits and licenses: There are no instances of private foreign enterprises employed in water supply services; moreover, if permission for joint venture cannot be received, then the project cannot be implemented.

  ② Legal (Tax and labor-related laws and regulations): For employing local laborers, the risk of lawsuits related to treatment of laborers is high, and the effect on the proposed project is large.

  ③ Project: Since single part production and sales is restrictive, if the economic situation deteriorates, it may lead to deterioration in the profitability of the proposed project. Therefore, overall the risk is high.

  ④ Procurement of raw materials: Price rise may occur for local procurement of raw materials affected by international conditions.

7. Action schedule up to the start of the project

Project as envisaged in the First Stage is as given below.

- Total cost: Equipment investment of 5 million yen
- Project implementation schedule;

  7 months from Sept. 2012: Feasibility study

  12 months from Feb. 2013: Installation in water treatment plants, selection of project partners

  March to Dec. 2014: Period for making preparations for establishment

  (Acquire investment license/ SPAN approval and registration/ HALAL approval and registration/ Patent application, etc.)

  Mar. to Oct. 2014: Set up local joint venture company

  Jan. to Dec. 2015: Capital procurement/ construction

  Jan. 2016: Start of project operation

- Project implementation system:

  Joint venture company with investment by 2 companies from the Japanese side (Naoji Chemicals Co., Ltd.) and the Malaysian side