**Ministry of Transport,
The United Republic of Tanzania**

Comprehensive Transport and Trade System Development Master Plan in the United Republic of Tanzania

– Building an Integrated Freight Transport System –

Final Report

Volume 3

Master Plan

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International Development Center of Japan Incorporated**

Note: In this study, the work for Master Plan Formulation and Pre-Feasibility Study was completed at the end of 2012 and a Draft Final Report was issued. This final report incorporates comments on the draft final report received from various concerned parties. In accordance with Tanzanian Laws, the process of Strategic Environmental Assessment (SEA) was carried out after the issuance of the Draft Final Report in order to allow for the study to be officially recognized as a Master Plan. The results of the one year SEA have been incorporated in this report. The report contains data and information available at the end of 2012 and does not reflect changes which have taken place since then, except for notable issues and those related to the SEA.

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Abbreviations and Acronyms

AfDB	African Development Bank
AHP	Analytic Hierarchy Process (Methodology)
AIP	Aeronautical Information Publication
A-PAD	Assessed Pre-Arrival Documentation
ASYCUDA	Automated System for Customs Data
BADEA	Arab Bank for Economic Development in Africa
BOT	Build-Operate-Transfer
CE	Chief Executive
CIF	Cost, Insurance and Freight
CIQ	Customs, immigration, and quarantine
CNG	Compressed Natural Gas
COMESA	Common Market for Eastern and Southern Africa
DED	Detailed Engineering Design
DP	Development Partner
DRC	Democratic Republic of Congo
DSM	Dar es Salaam
EIA	Environmental Impact Assessment
EIS	Environmental Impact Statement
E. P. B	Société Concessionnaire de L'Exploitatioon du Port de Bujumbura
EPZ	Export Processing Zone
EPZA	Export Processing Zone Authority
EU	European Union
FCL	Full Container Load
FINIDA	Finland International Development Agency
FOB	Free on Board
FS	Feasibility Studies
FYDP	Five Year Development Plan
GBS	General Budget Support
GDP	Gross Domestic Product

GOT	Government of Tanzania
IATA	International Air Transport Association
ICAO	International Civil Aviation Organization
ICD	Inland Container Depot
ICL	Inter-Consult Ltd.
IDA	International Development Association
IUCN	International Union for Conservation of Nature
JICA	Japan International Cooperation Agency
JISR	Joint Infrastructure Sector Review
JNIA	Julius Nyerere International Airport
KADCO	Kilimanjaro Airports Development Corporation
KIA	Kilimanjaro International Airport
KOICA	Korea International Cooperation Agency
LNG	Liquified Natural Gas
MCC	Millennium Challenge Corporation
MOF	Ministry of F Finance
MOT	Ministry of Transport
MOW	Ministry of Works
MSCL	Marine Services Co., Ltd.
MT	Motor Tanker, Motor Tugboat
MTEF	Medium Term Expenditure Framework
MTS	Mass Transportation System
MKUKUTA	Mkakati wa Kuondoa Umaskini Tanzania
MV	Motor Vessel
NEAC	National Environmental Advisory Committee
NEMC	National Environment Management Council
NIPP	National Investment Promotion Policy
NORAD	Norway Agency for Development
NRSP	National Road Safety Policy
NTP2003	National Transport Policy 2003

OD	Origin and Destination
OFID	OPEC [Organization of the Petroleum Exporting Countries] Fund for International Development
OSBP	One Stop Border Post
OP	Operational Policy (of the World Bank)
PAD	Pre-Arrival Documentation
PAPs	Project Affected Persons
PCN	Pavement Classification Number
PERTS	Public Expenditure Review for the Transport Sector
PMMR	Performance based Management and Maintenance of Roads
PMORALG	Prime Minister Office – Regional Administration and Local Government
P-PAD	Pre-Assessed Pre-Arrival Documentation
PPP	Public Private Partnership
RAS	Regional Administrative Secretary
RF	Roads Fund
RFB	Roads Fund Board
RMMS	Roads Maintenance Management System
RoRo ship	Roll-on/Roll-off ship
RSA	Republic of South Africa
RSPS	Road Sector Program Support
RUSIRM	Ruvuma and Southern Iringa Road Maintenance
SADC	South African Development Community
SEA	Strategic Environmental Assessment
SEZ	Special Economic Zone
SNCC	Société Nationale des Chemins de Fer du Congo
SNCZ	Société Nationale des Chemins de Fer Zaïrois
STSIP	Short Transport Sector Investment Program
SUMATRA	Surface and Marine Transport Regulatory Authority
TAA	Tanzania Airports Authority
TAFIRI	Tanzania Fisheries Research Institute

TANROADS   Tanzania National Roads Agency

TANSAD   Tanzania Single Administration Document

TAZARA   Tanzania Zambia Railway Authority

TCAA   Tanzania Civil Aviation Authority

TDV2025   Tanzania Development Vision 2025

TEU   Twenty Equivalent Unit

TIC   Tanzania Investment Centre

TPA   Tanzania Ports Authority

TPMP   Tanzania Ports Master Plan

TRA   Tanzania Revenue Authority

TRL   Tanzania Railway Limited

TSIP   Tanzania Transport Sector Investment Program

USA   United States of America

VPO   Vice President's Office

WB   World Bank

Chapter 1   Transport Network and Demand, Current and Future

1.1   Existing and Future Network

In this study, the expansion and strengthening of the transport network was considered with regard to all modes and in various parts of the country. Figure 1.1 shows the existing network and Figure 1.2 shows the future network including the projects considered in this study. As shown later in this report, not all of the projects were deemed implementable within the time horizon of this Master Plan study (i.e., up to 2030).
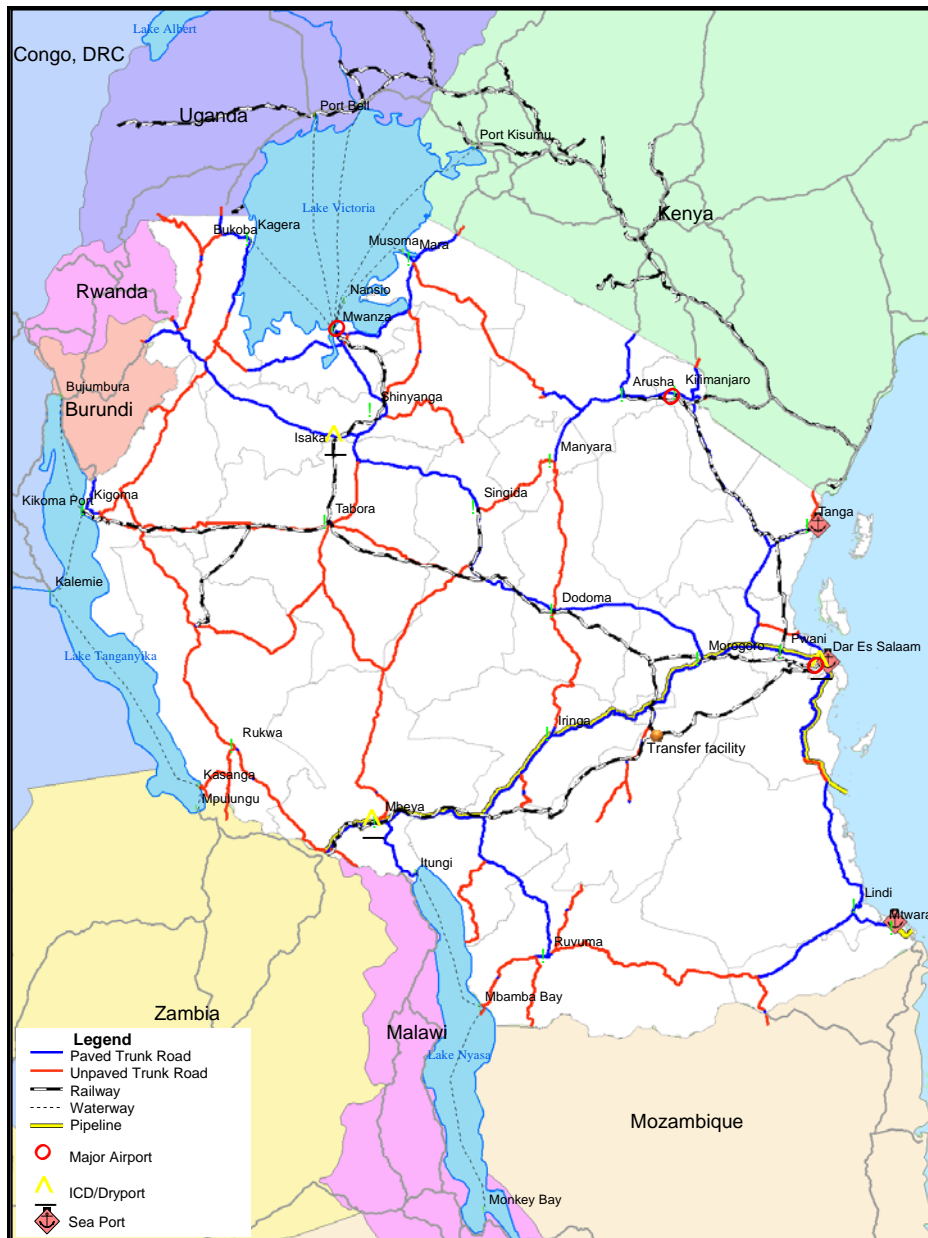
Figure 1.1: Tanzania Transport Network 2010
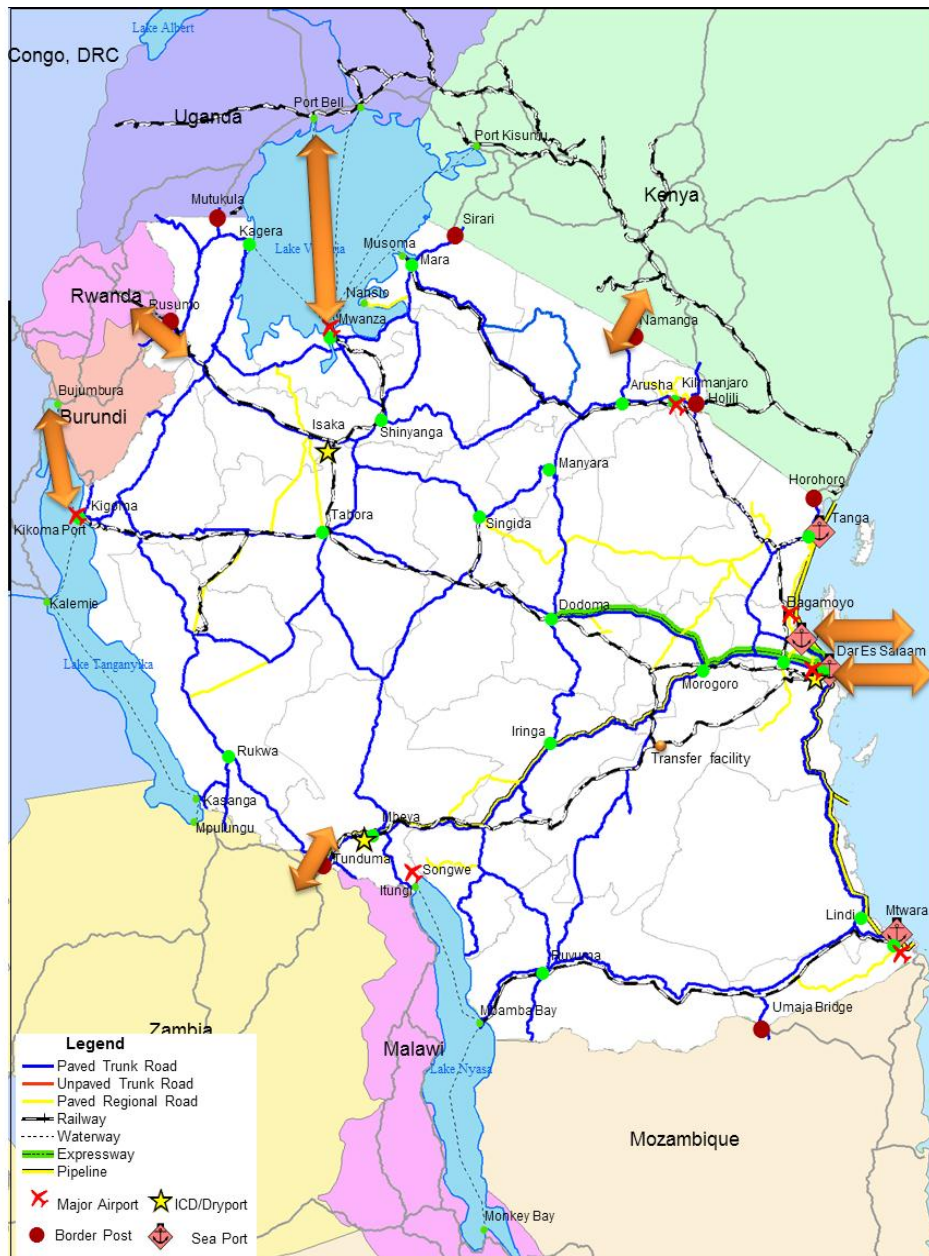
Figure 1.2: Future Network

Table 1.1 summarizes the changes between the existing transport network and the future network.

Table 1.1: Summary of Transport Network Changes, Existing and Future

Road Network

Unit: km

	Existing	Future
Paved Trunk Road	5,537	12,197
Unpaved Trunk Road	6,660	0
Paved Regional and new road	–	9,584
Expressway		
Dar es Salaam–Bagamoyo	–	40
Dar es Salaam–Dodoma	–	445

Railway

Unit: km

	Existing	Future
Tanzania Railway Limited (TRL)		
Dar es Salaam–Tabora	840	840
Tabora–Kigoma	411	411
Tabora–Mwanza	378	378
Mpanda–Kaliua	210	210
Ruvu.J–Mruazi		155
Tanga–Arusha		438
Kilosa–Kidatu		108
TRL new Construction Lines		
Isaka–Kigali		424
Mtwara–Mbamba Bay		705
Arusha–Musoma		459
Tanzania Zambia Railway Authority (TAZARA)		
Dar es Salaam–Tunduma	975	975

Major Airports

Existing	Future
Julius Nyerere International Airport	Julius Nyerere International Airport
Kilimanjaro International Airport	Kilimanjaro International Airport
Mwanza Airport	Mwanza Airport
	Kigoma Airport
	Mtwara Airport
	Songwe Airport
	Bagamoyo Airport

Major Lake Ports

	Existing	Future
Lake Victoria	Mwanza North	Mwanza North
	Mwanza South	Mwanza South
	Bukoba	Bukoba
	Kemondo Bay	Kemondo Bay
	Musoma	Musoma
	Nansio	Nansio
	Mwaloni	Mwaloni
Lake Tanganyika	Kigoma	Kigoma
	Kasanga	Kasanga
Lake Nyasa	Kiwira/Itungi	Kiwira/Itungi
	Mbamba Bay	Mbamba Bay

Seaports

Existing	Future
Tanga	Tanga
Dar Es Salaam	Dar Es Salaam
Mtwara	Mtwara
	Bagamoyo

Pipelines

Unit: km

		Existing	**Future**
TAZAMA Pipeline	Dar Es Salaam–Zambia Border	888	888
Songo-Songo Gas Pipeline	Songo-Songo–Somanga Funga	25	25
	Somanga Funga–Ubungo	207	207
Mtwara	Riser Site–Mtwara	28	28
	Mnasi Bay–Riser Site	5	5
New Line	Da Es Salaam–Tanga		216
	Tanga–Kenya Border		52

1.2   Summary of Existing Demand

1.2.1   Freight Movement at Borders

Using data extracted from the Automated System for Customs Data (ASYCUDA) obtained from the Tanzania Revenue Authority (TRA), the freight flow volume of Tanzania was analyzed at frontier customs offices.

(1)   Trade Throughput

Table 1.2 summarizes trade throughput of freight at major borders, while Figure 1.3 illustrates the shares of import, export, inbound transit and outbound transit at the borders excluding Dar es Salaam.

According to these numbers, it is apparent that Dar es Salaam (mainly the seaport) is the trade hub of Tanzania, handling more than 89% of import volume and 43% of the export volume. The second busiest border crossing point is Tunduma, where huge volumes of transit cargo to/from Southern Africa are handled. In terms of imports, the second largest border crossing point is Tanga, followed by two land border crossing points with Kenya (Sirari and Namanga). Besides Dar es Salaam, relatively large export points are Namanga, Rusumo, Kabanga, and Mtwara. Countrywide, import volume is larger than export volume, whereas in trade with neighboring countries the volume of exports is larger than the volume of imports.

Table 1.2: Trade Throughput by Border Crossing, 2010

Unit: 1,000 tonnes

Border	Import	Export	Inbound Transit	Outbound Transit	Total
Arusha/KIA	21.5	2.4	0.1	0.0	23.9
Dar es Salaam	8,048.8	893.0	1,982.9	836.5	11,761.2
Holili	48.5	47.2	0.0	0.0	95.7
Horohoro	64.6	93.3	31.4	11.1	200.3
Kabanga	1.6	112.3	16.0	252.2	382.1
Kasumulu	36.8	80.3	46.0	128.1	291.1
Kigoma	3.1	58.9	0.9	69.9	132.7
Mtwara	21.4	110.2	0.0	0.2	131.7
Mutukula	84.7	18.5	0.1	29.4	132.7
Mwanza	34.9	39.4	0.0	35.3	109.5
Namanga	105.0	223.2	45.1	44.8	418.1
Rusumo	1.7	169.3	8.9	390.0	569.9
Sirari	137.2	59.0	3.0	0.0	199.3
Tanga	299.0	72.9	0.1	0.1	372.1
Tunduma	59.8	86.0	647.1	796.4	1,589.3
Others	3.5	3.3	0.7	188.5	196.0
Total	8,972.0	2,069.1	2,782.2	2,782.2	16,605.6

Source: Analyzed by JICA Study Team based on ASYCUDA data from TRA
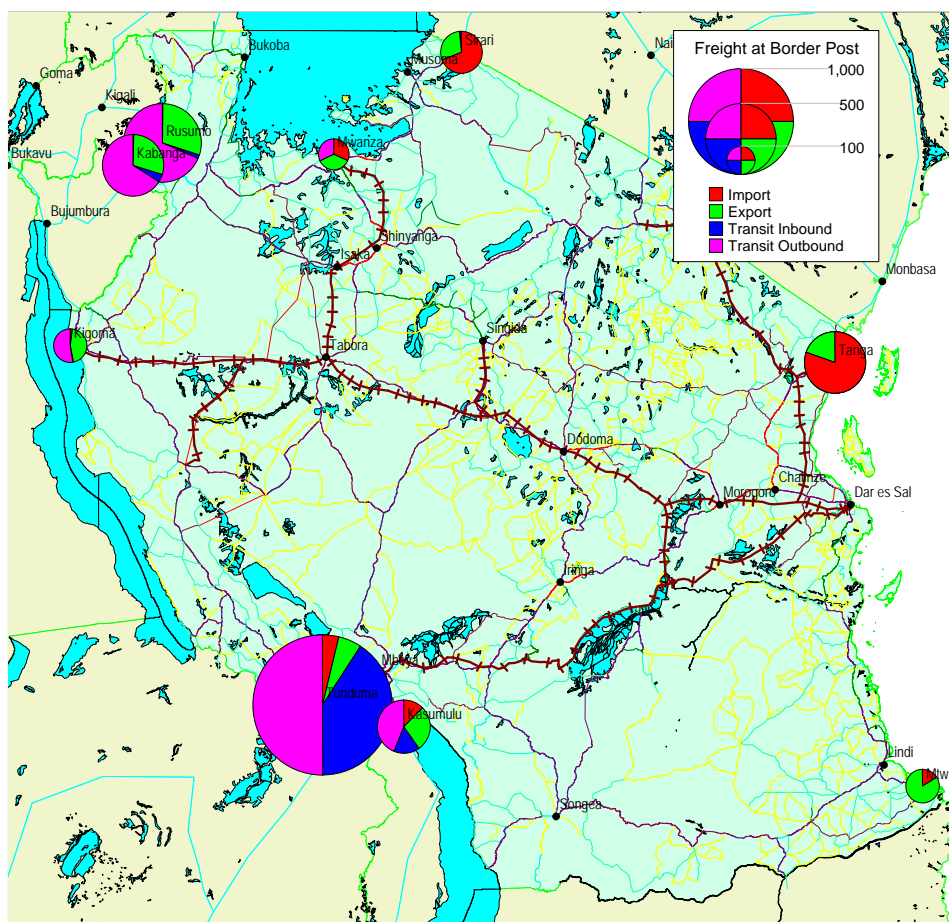
Figure 1.3: Trade Throughput by Border Crossing (excluding Dar es Salaam)

(2) Share by Commodity

A breakdown of transported commodities is summarized in Figures 1.4 and 1.5 by major border crossing point. Fuel is the leading import item (43% of total), followed by vegetable products (19%). Some frontier customs offices specialize in clearing a few categories of commodities, e.g., fuel in Dar es Salaam, mineral products in Horohoro and Tanga, vegetable products in Mwanza. Other offices such as Holili, Namanga, and Sirari deal with a variety of import commodities.

The leading export commodities are vegetable products (33%), mineral products (17%), and foodstuffs (15%). In terms of destination countries, mineral exports account for the largest share at Holili, Kabanga, Kasumulu, and Kigoma, wood products the largest share at Horohoro, and foodstuffs the largest share at Mutukula.
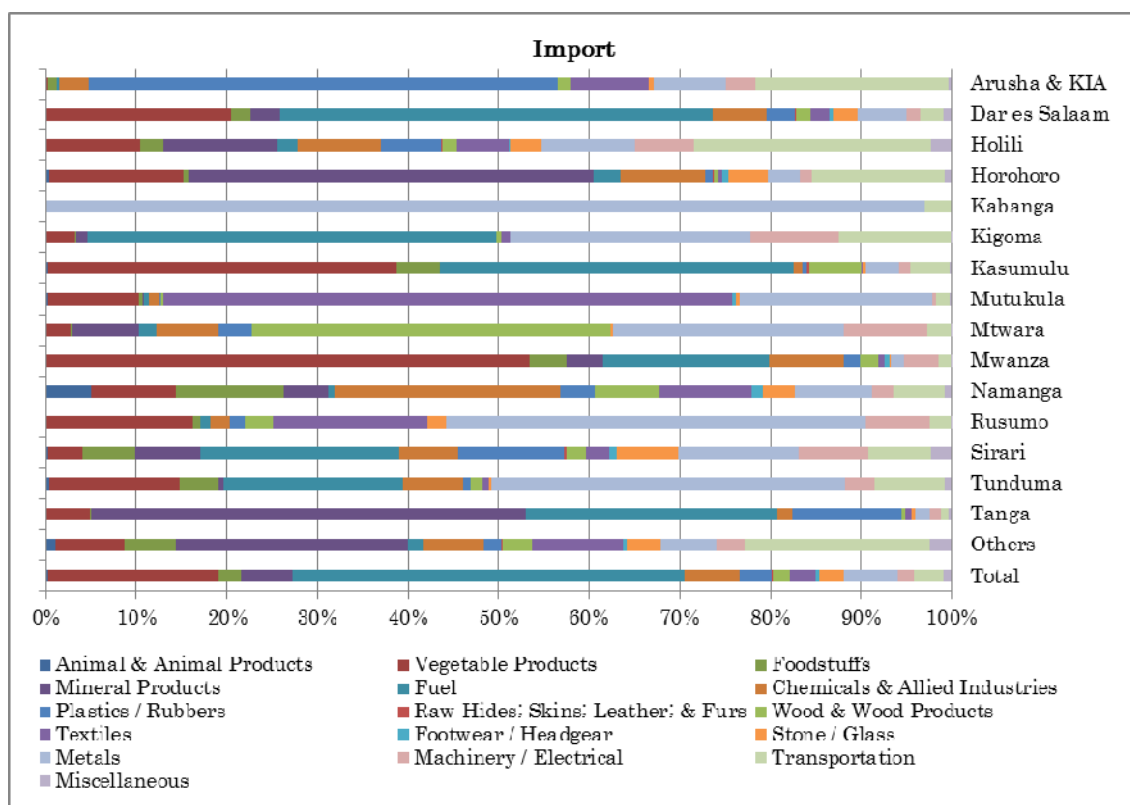
Figure 1.4: Share of Import Commodities by Border Crossing, 2010
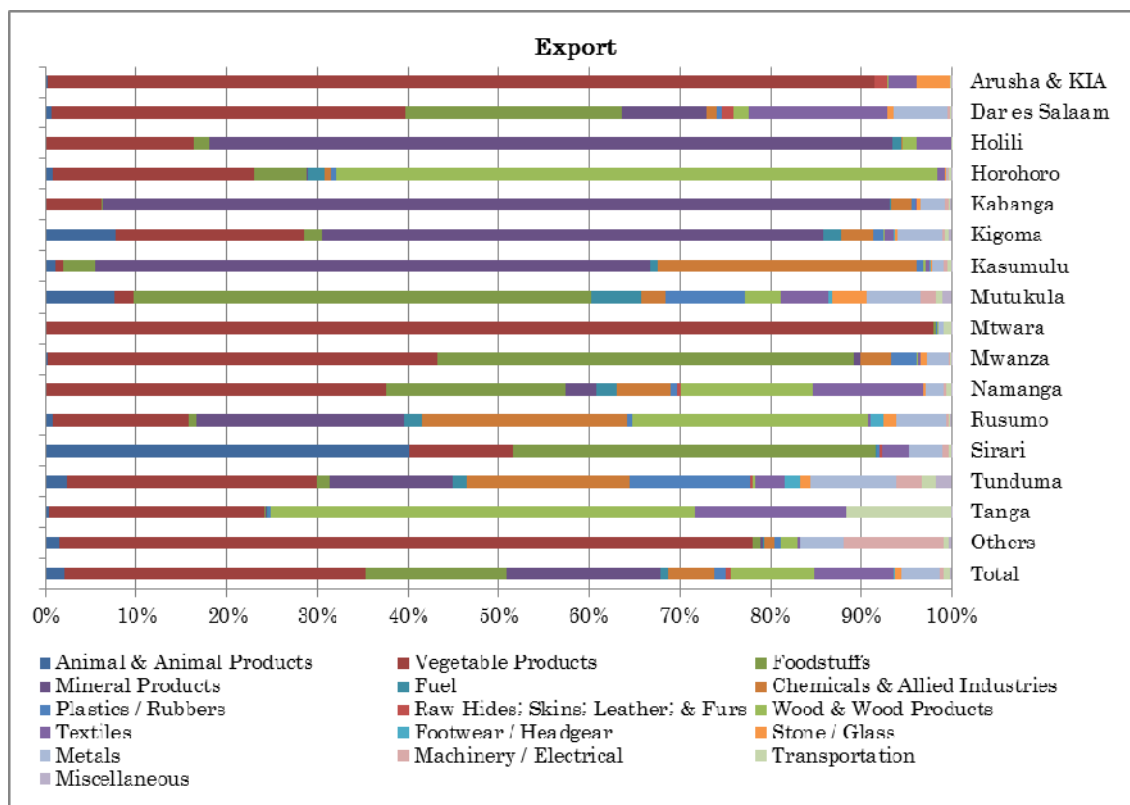
Figure 1.5: Share of Export Commodities by Border Crossing, 2010

1.2.2   Freight Movement by Railways

(1)   TAZARA

Figure 1.6 shows the annual trend of freight hauled by the Tanzania Zambia Railway Authority (TAZARA) from 1995 to 2008. It shows a slightly decreasing trend in the range of 500,000–700,000 tonnes with a peak volume of 660,000 in 1996.
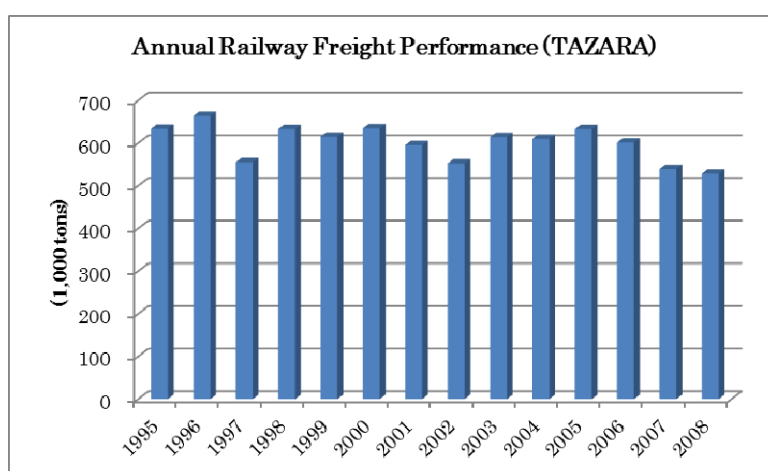
Source: TAZARA, Report published by Ministry of Infrastructure Development, 2009

Figure 1.6: Annual Performance Trends of TAZARA

Figure 1.7 and 1.8 illustrate major cargo flows handled by TAZARA for inbound and outbound flows, respectively. This figures summarize records of major flows in the cargo origin-destination (OD) database and Tanzania Ports Authority (TPA) statistics in 2010. For inbound flows, the largest volume is from Dar es Salaam to Zambia (138,000 tonnes), followed by the volume from Dar es Salaam to Malawi (58,000 tonnes). The largest volume of outbound flows transported by TAZARA is the traffic from Zambia to Dar es Salaam.
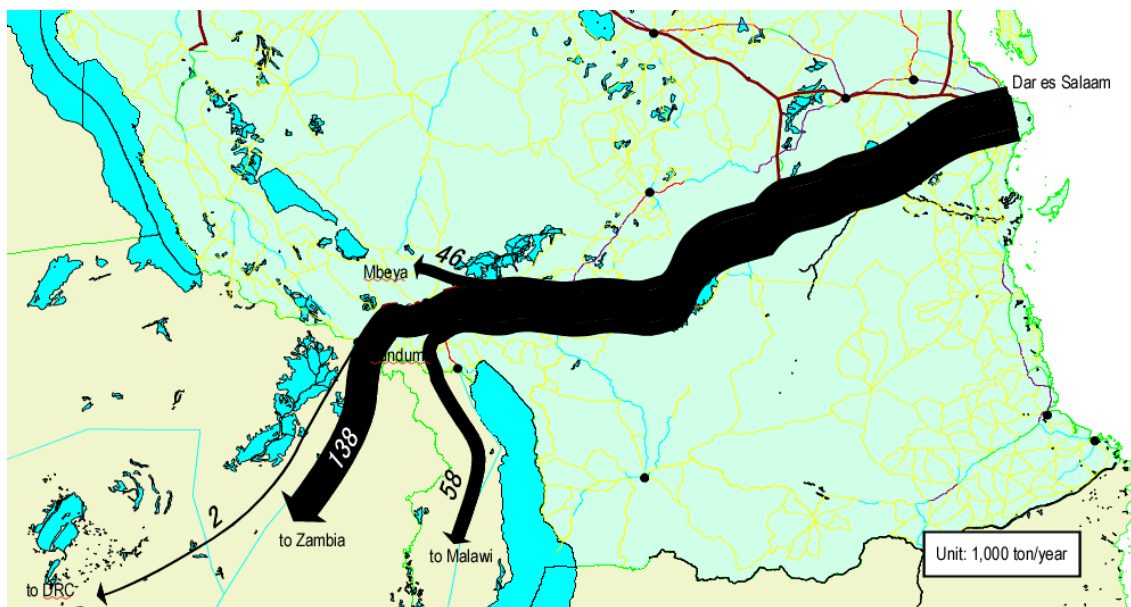
Figure 1.7: Major Inbound Flows of TAZARA, 2010
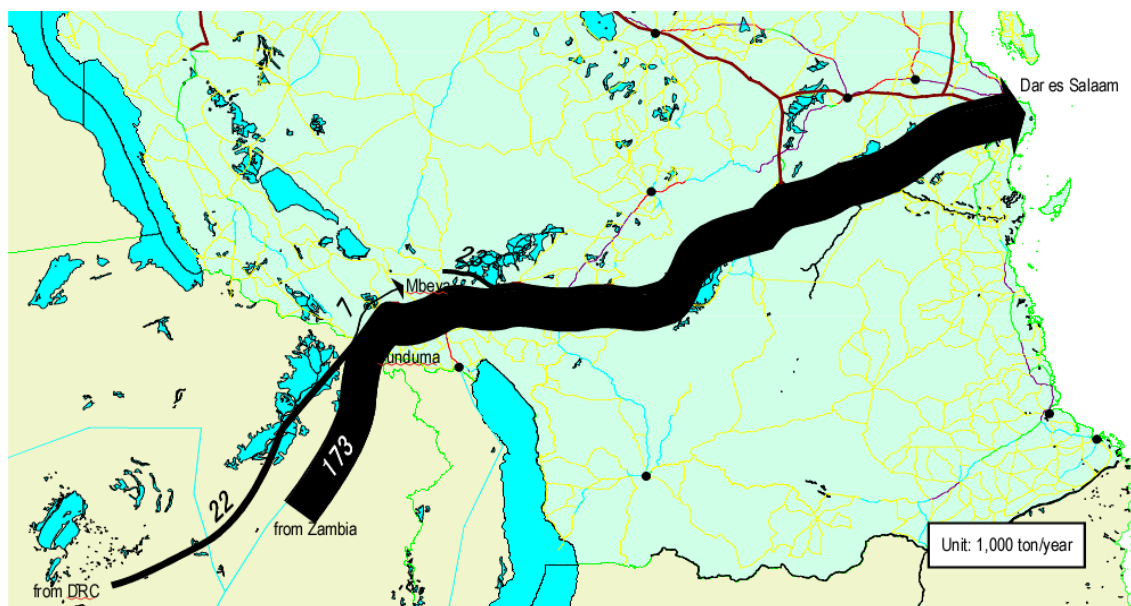
Figure 1.8: Major Outbound Flow of TAZARA, 2010

Table 1.3 shows the commodity share of the major flows illustrated in the figures above. Fuel and general cargo are the major commodities in the inbound flows going to Mbeya and Zambia. The major commodities hauled by TAZARA in the outbound flows is mineral products (e.g., copper and zinc).

Table 1.3: Type of Commodity by Origin and Destination, 2010

Origin	Destination	Major Commodity
Dar es Salaam	Mbeya	Mining (26%), Fuel (40%), Industrial (34%)
Dar es Salaam	Zambia	Fuel (25%), General Cargo (75%)
Zambia	Dar es Salaam	Mining (100%)
Zambia	Mbeya	Mining (100%)
DRC	Dar es Salaam	Mining (100%)

Source: Compiled by the JICA Study Team based on station OD statistics obtained from TAZARA

(2) TRL

Figure 1.9 illustrates the annual trend of freight handled by the Tanzania Railway Limited (TRL) from 1995 to 2008. As seen in the figure, the performance of TRL railway exhibited a decreasing trend from 1995 to 1998, followed by a rebound until 2003 when 1.4 million tonnes were carried. After the peak years of 2002 and 2003, however, freight volume declined sharply, reaching only about 500,000 tonnes in 2008.
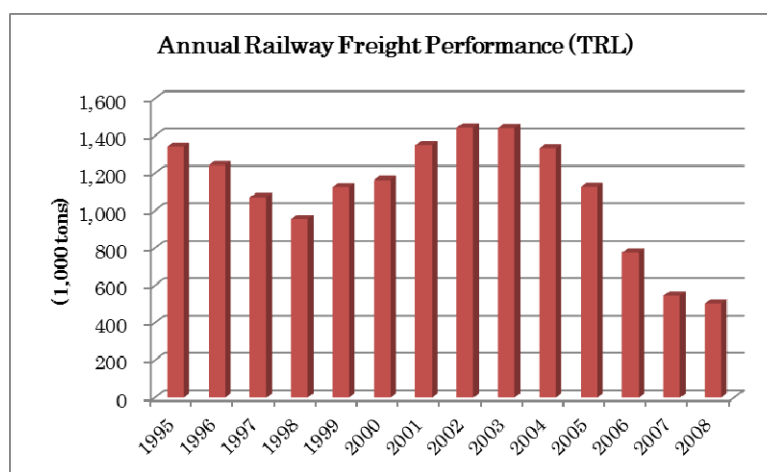
Source: TRL, Report published by Ministry of Infrastructure Development, 2009

Figure 1.9: Trend of Annual Performance for TRL

Figure 1.10 illustrates the major flows of freight transported by TRL in 2009, while Table 1.4 shows their commodity share. This analysis was based on detailed performace statistics obtained from TRL. The major flows are the inbound ones, from Dar es Salaam to inland areas, which accounted for more than 75% of the total in 2009. These flows mainly were in three directions: to Kigoma (111,000 tonnes), to Mwanza (110,000 tonnes) and to Isaka (62,000 tonnes).

As for the commodity share of these flows, general cargo and fuel are largest for Kigoma and Isaka, while agricultural goods, such as wheat, sugar, and maize, also represent high shares, as shown in Table 1.4.
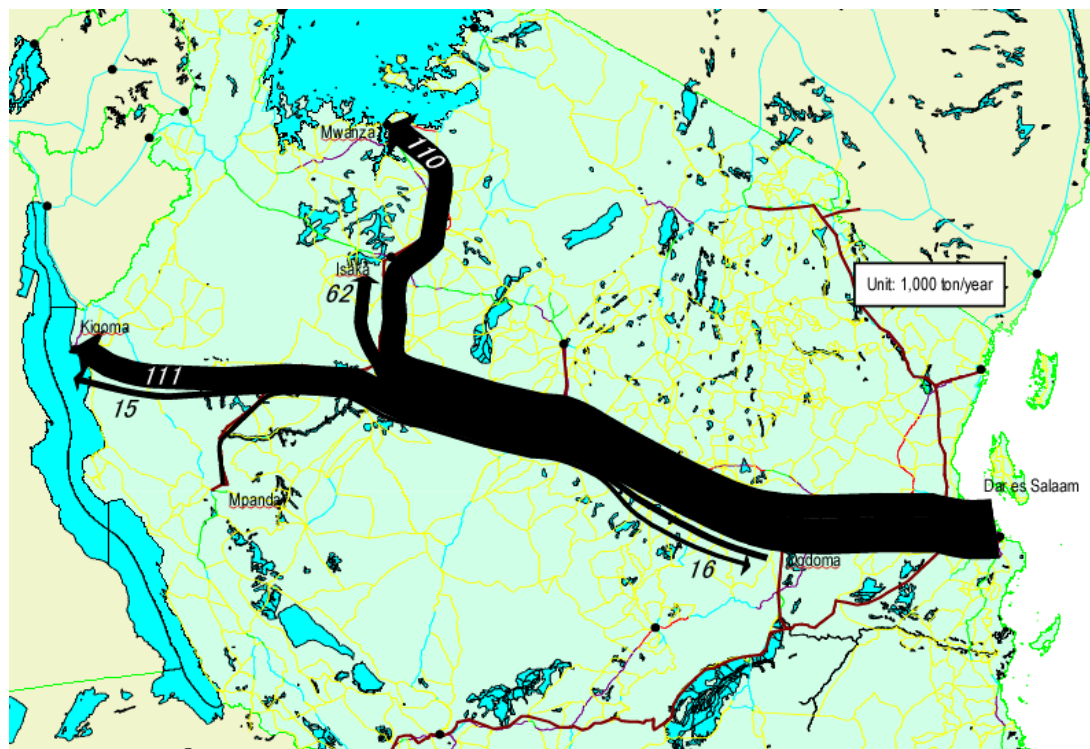
Figure 1.10: Major Freight Flow by TRL, 2009

Table 1.4: Types of Commodities by Origin and Destination, 2009

Origin	Destination	Major Commodity
Dar es Salaam	Isaka	Agriculture (17), Fuel (36), Gen. Cargo (47)
Dar es Salaam	Kigoma	Agriculture (12), Fuel (15), Industrial (11), G. Cargo (61)
Dar es Salaam	Mwanza	Agriculture (85), Fuel (4), Industrial (4), G. Cargo (7)
Dodoma	Kigoma	Agriculture (15), Processed agriculture (12), G. Cargo (73)
Mpanda	Dodoma	Agriculture (100)

Note: Numbers in parentheses are percentages.
Source: Compiled by the JICA Study Team based on station OD statistics obtained from TRL

1.3   Transport Demand Forecast

1.3.1   General

An OD table was developed as shown in Figure 1.11. The table consists of four parts: (i) inter-regional freight, which is domestic movement inside Tanzania; (ii) export trade from Tanzania; (iii) import trade to Tanzania; and (iv) trade among the rest of countries and areas. The fourth part includes trade among the neighboring countries of Tanzania and between the neighboring countries and other countries. Of the fourth part, some trade, for example, Burundi exports to the Middle East, may possibly be transported along a corridor inside Tanzania. This type of trade was estimated, while the trade with other countries that has no possibility to be transported inside Tanzania was not estimated.

In order to develop an existing OD table representing freight movement between two countries, statistical data of trade volume by type of commodity was obtained the from United Nations Commodity Trade Statistics Database (UN Comtrade). After compiling this data in the format of an OD table between two countries, the part that represents imports to and exports from Tanzania were distributed to regions for domestic traffic. The part of other countries was

aggregated into other areas including Asia, the Middle East, and Europe. This distribution was made by taking regional ratios of variables such as population and gross regional domestic product into consideration.

		Domestic					Neighboring Countries					Other Area				
		Arusha	DES	Dodoma	…	Tanga	Burundi	DRC	Kenya	…	Zambia	Other Africa	Asia	Middle East	Europe	Others
National	Arusha															
	DES															
	Dodoma															
	…															
	Tanga															
Neighboring Countries	Burundi															
	DRC															
	Kenya															
	…															
	Zambia															
Other Area	Other Africa															
	Asia															
	Middle East															
	Europe															
	Others															

Figure 1.11: Form of OD Table

The structure of zones used for OD formulation is shown in Table 1.5. There were 21 zones representing each region of the Tanzania mainland, 8 zones for the neighboring countries, and 5 zones for countries in the rest of the world. In total, the OD table consists of 34 zones.

Table 1.5: Zone Table

	Zone No.			Zone No.	
Domestic	1	Arusha	Neighboring Countries	22	Burundi
	2	Dar es Salaam		23	DRC
	3	Dodoma		24	Kenya
	4	Iringa		25	Malawi
	5	Kagera		26	Mozambique
	6	Kigoma		27	Rwanda
	7	Kilimanjaro		28	Uganda
	8	Lindi		29	Zambia
	9	Manyara	Other Area	30	Other Africa
	10	Mara		31	Asia
	11	Mbeya		32	Middle East
	12	Morongo		33	Europe
	13	Mtwara		34	Others
	14	Mwanza			
	15	Pwani			
	16	Rukwa			
	17	Ruvuma			
	18	Shinyanga			
	19	Singida			
	20	Tabora			
	21	Tanga			

Source: JICA Study Team

1.3.2 International Trade

(1) Methodology

Statistics on import and export trade reported by the trade authority of major countries around the world has been compiled in the UN Comtrade database, which consists of information for freight that is transported between the two countries and expressed both in terms of value (USD) and volume (tonnes). In this study, by picking up necessary data from this database and compiling them, an OD table was created representing current trade among Tanzania, neighbouring countries, and other areas according to the form previously described.

Subsequently, this compiled OD table representing the trade between countries was converted into an OD table of trade volume in terms of weight. For this conversion, the ratio of value and weight by type of commodity, which can be calculated based on information in the database, was used. However, the more detailed the calculation of the ratios by commodity, the less stable the ratios. Therefore, the ratios were calculated by the following integrated categories of type of commodity (Table 1.6), which were determined by taking the possibility of containerization and industrial structure into account.

Table 1.6: Categories of Integrated Commodity

No.	Category
1	Agricultural products
2	Mineral products
3	Fuel/petroleum
4	Agricultural processed products
5	Industrial products
6	Transportation

Source: JICA Study Team

(2) Existing Demand

The estimated OD tables of current bilateral trade (using 2010 figures) in monetary value and in transport volume are shown in Table 1.7 and 1.8, respectively. In these tables, figures of trade with other areas are expressed in an integrated zone named "Others".

According to these tables, Tanzania's exports are estimated at USD 4.1 billion with a total export volume estimated at 2.4 million tonnes. For import trade, the total value is estimated at USD 8 billion and the volume at 11.4 million tonnes.

Table 1.7: Bilateral Trade in 2010

Unit: USD million

Country	Tanzania	Burundi	DRC	Kenya	Malawi	Mozam-bique	Rwanda	Uganda	Zambia	Others	Total
Tanzania	0	56	156	325	46	19	117	60	60	3,211	4,051
Burundi	1	0	16	25	0	0	8	12	0	213	276
DRC	1	1	0	17	0	0	0	12	1,471	4,174	5,677
Kenya	275	56	148	0	90	6	141	1,119	68	3,265	5,169
Malawi	12	0	1	22	0	25	2	2	45	957	1,066
Mozambique	19	1	0	4	50	0	0	1	2	2,166	2,243
Rwanda	1	6	17	46	0	0	0	13	0	177	261
Uganda	18	57	184	210	0	2	173	0	1	974	1,619
Zambia	31	69	326	36	184	3	3	1	0	6,546	7,200
Others	7,654	586	3,459	11,408	1,803	3,509	668	3,444	3,672		
Total	8,013	833	4,308	12,093	2,173	3,564	1,112	4,664	5,321		27,562

Source: JICA Study Team

Table 1.8: Estimated Transport Volume in 2010

Unit: 1,000 tonnes

Country	Tanzania	Burundi	DRC	Kenya	Malawi	Mozam-bique	Rwanda	Uganda	Zambia	Others	Total
Tanzania	0	216	152	535	84	8	131	119	54	1,119	2,420
Burundi	2	0	6	10	0	0	5	20	0	37	80
DRC	2	1	0	7	0	0	0	8	472	2,259	2,749
Kenya	329	31	135	0	43	5	133	2,075	32	1,878	4,662
Malawi	48	0	2	27	0	16	1	20	80	930	1,124
Mozambique	97	1	0	28	114	0	0	0	3	1,355	1,598
Rwanda	3	13	28	66	0	0	0	28	0	61	200
Uganda	39	63	718	445	0	0	671	0	4	690	2,630
Zambia	32	97	787	15	332	1	3	0	0	1,669	2,936
Others	10,828	364	3,070	11,827	1,685	3,913	456	4,515	5,050		
Total	11,381	786	4,898	12,960	2,258	3,944	1,399	6,785	5,695		18,397

Source: JICA Study Team

(3)   Future Demand

A future OD table was estimated based on the existing OD tables estimated in the previous section. Trade volume tends to be is correlated with indicators of socio-economic activity. In this section, elasticity, which is obtained by analyzing the relation between the growth of trade and GDP of each country, will be used to estimate the volume of future trade. The estimates were prepared for two scenarios, one with a conservative (i.e., low) growth rate and another with target growth rate. The GDP growth ratio of each country was assumed to be 5.0% for the former scenario. Tanzania's GDP growth rate was assumed to be 8.0% and the GDP growth estimated by the International Monetary Fund (IMF) was applied for other countries in the latter scenario. However, the GDP growth rate of Burundi was estimated as 4.5% in both scenarios, using the rate employed in the JICA-assisted Burundi ports master plan study. The parameters assumed for both scenarios are shown in Tables 1.9 and 1.10.

Table 1.9: Conservative Growth Rate Parameters (2030)

Country	GDP Growth Rate (%)	Import Elasticity	Import Growth	Export Elasticity	Export Growth
Tanzania	5.0	1.77	4.69	1.74	4.61
Burundi	4.5	1.50	3.62	1.50	3.62
DRC	5.0	1.50	4.00	1.50	4.00
Kenya	5.0	1.66	4.41	1.21	3.22
Malawi	5.0	1.31	3.49	1.52	4.02
Mozambique	5.0	1.04	2.77	0.91	2.41
Rwanda	5.0	1.50	3.98	1.31	3.48
Uganda	5.0	1.54	4.09	1.35	3.59
Zambia	5.0	1.52	4.04	1.50	3.98

Source: JICA Study Team

Table 1.10: Target Growth Rate Parameters (2030)

Country	GDP Growth Rate (%)	Import Elasticity	Import Estimated Growth	Export Elasticity	Export Estimated Growth
Tanzania	8.0	1.77	8.24	1.74	8.09
Burundi	4.5	1.50	3.62	1.50	3.62
DRC	6.5	1.50	5.28	1.50	5.28
Kenya	6.5	1.66	5.87	1.21	4.29
Malawi	5.5	1.31	3.85	1.52	4.44
Mozambique	7.8	1.04	4.67	0.91	4.05
Rwanda	6.0	1.50	4.81	1.31	4.20
Uganda	6.7	1.54	5.64	1.35	4.95
Zambia	7.6	1.52	6.63	1.50	6.53

Source: JICA Study Team

The future OD tables estimated by using the parameters shown above are displayed in Tables 1.11 to 1.14. Future OD tables estimated for 2020 and 2025 using the same method are indicated in the appendix.

Table 1.11: Estimated Bilateral Trade in 2030 (Conservative Growth Rate)

Unit: USD million

Country	Tanzania	Burundi	DRC	Kenya	Malawi	Mozam-bique	Rwanda	Uganda	Zambia	Others	Total
Tanzania	0	294	929	2,217	244	81	674	383	347	13,455	18,625
Burundi	3	0	75	137	0	0	35	59	0	690	997
DRC	7	6	0	101	0	0	0	69	7,341	15,183	22,708
Kenya	1,318	190	570	0	308	17	525	4,605	252	8,856	16,642
Malawi	83	0	5	136	0	102	9	11	241	3,703	4,291
Mozambique	80	2	0	15	149	0	0	3	8	5,139	5,397
Rwanda	7	21	73	220	0	0	0	60	2	521	904
Uganda	95	216	788	1,028	0	5	716	0	3	2,934	5,785
Zambia	209	333	1,782	228	889	14	18	6	0	25,145	28,624
Others	35,784	1,949	13,002	49,246	5,990	9,656	2,445	13,878	13,321		
Total	37,588	3,012	17,224	53,326	7,580	9,875	4,422	19,074	21,515		103,973

Source: JICA Study Team

Table 1.12: Estimated Transport Volume in 2030 (Conservative Growth Rate)

Unit: 1,000 tonnes

Country	Tanzania	Burundi	DRC	Kenya	Malawi	Mozam-bique	Rwanda	Uganda	Zambia	Others	Total
Tanzania	0	1,134	905	3,655	444	37	755	757	312	4,690	12,688
Burundi	13	0	27	55	0	0	22	97	0	118	333
DRC	13	5	0	39	0	0	0	46	2,354	8,218	10,674
Kenya	1,574	106	520	0	147	14	493	8,543	119	5,094	16,611
Malawi	331	0	10	167	0	64	6	119	427	3,598	4,722
Mozambique	408	1	0	109	341	0	0	0	9	3,216	4,083
Rwanda	16	49	115	318	0	0	0	126	0	180	805
Uganda	207	236	3,068	2,185	0	1	2,772	0	15	2,078	10,563
Zambia	216	469	4,302	92	1,606	3	14	1	0	6,410	13,113
Others	50,622	1,210	11,541	51,053	5,597	10,769	1,671	18,193	18,319	0	
Total	53,400	3,210	20,488	57,673	8,137	10,887	5,734	27,882	21,557		73,594

Source: JICA Study Team

Table 1.13: Estimated Bilateral Trade in 2030 (Target Growth Rate)

Unit: USD million

Country	Tanzania	Burundi	DRC	Kenya	Malawi	Mozam-bique	Rwanda	Uganda	Zambia	Others	Total
Tanzania	0	321	1,329	3,166	291	146	900	592	671	25,287	32,703
Burundi	4	0	62	110	0	0	27	52	0	743	997
DRC	10	5	0	101	0	0	0	74	9,884	19,883	29,956
Kenya	1,914	159	625	0	282	24	539	5,463	375	12,766	22,147
Malawi	93	0	4	115	0	109	7	10	275	4,120	4,734
Mozambique	138	2	0	20	160	0	0	4	14	8,751	9,089
Rwanda	10	16	74	224	0	0	0	66	3	699	1,092
Uganda	151	198	946	1,230	0	8	804	0	5	4,621	7,964
Zambia	357	327	2,297	293	954	23	22	8	0	42,648	46,930
Others	63,353	1,983	17,382	65,731	6,675	16,322	3,045	20,023	24,059		
Total	66,029	3,012	22,719	70,990	8,363	16,632	5,344	26,293	35,285		155,611

Source: JICA Study Team

Table 1.14: Estimated Transport Volume in 2030 (Target Growth Rate)

Unit: 1,000 tonnes

Country	Tanzania	Burundi	DRC	Kenya	Malawi	Mozam-bique	Rwanda	Uganda	Zambia	Others	Total
Tanzania	0	1,237	1,293	5,218	529	66	1,008	1,170	604	8,814	19,939
Burundi	14	0	22	45	0	0	17	86	0	127	312
DRC	17	4	0	38	0	0	0	49	3,170	10,761	14,040
Kenya	2,286	89	571	0	134	19	506	10,135	177	7,343	21,262
Malawi	371	0	8	141	0	68	5	109	488	4,002	5,192
Mozambique	700	1	0	140	368	0	0	0	15	5,476	6,700
Rwanda	22	38	118	324	0	0	0	139	0	242	882
Uganda	328	216	3,682	2,616	0	2	3,114	0	25	3,274	13,257
Zambia	369	461	5,546	118	1,725	5	17	1	0	10,872	19,114
Others	89,622	1,231	15,428	68,142	6,238	18,203	2,081	26,248	33,086	0	
Total	93,728	3,277	26,668	76,784	8,995	18,363	6,748	37,939	37,565		100,699

Source: JICA Study Team

1.3.3   Domestic Transport

(1)   Methodology

An OD table of domestic freight representing cargo movement between regions in the Tanzania mainland was prepared based on the results of the roadside OD interview survey conducted by the JICA Study Team in 2011. The processing of the results to develop the OD table is shown in Figure 1.12 and the explanation is provided below.

First, the answers for origins and destinations were coded with zone numbers. The principal information in the interviews, such as type of vehicle, type of commodity, tare, payload, and origin and destination, were checked and validated. If there was incorrect information in some data, the data were rechecked against the original information on the survey sheets and errors corrected. The validated data was expanded based on total traffic observed by TANROADS to represent the total volume of average annual daily traffic (AADT) on the road sections along which the survey was conducted. Possibly duplicated survey data was removed. Finally, the expanded traffic volume was aggregated by zone to develop the OD table.
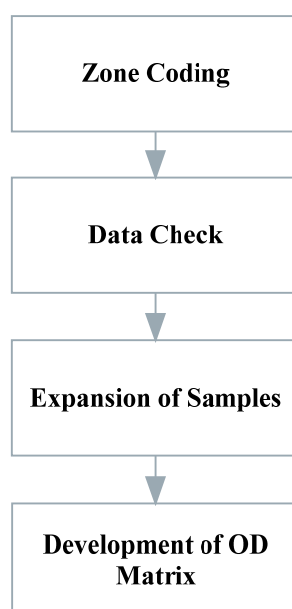
Figure 1.12: Processing for OD Table Formation

(2)   Existing Domestic Transport

The OD table for domestic freight movement developed with the above-mentioned procedure is shown in Table 1.15. The OD interview survey was conducted in 2011. However, the OD table was established for 2010 for consistency with the base year of the bilateral OD tables.

Table 1.15: Estimated Transport Volume in 2010

Unit: 1,000 tonnes

Zone	Arusha	DSM	Dodoma	Iringa	Kagera	Kigoma	Kiliman-jaro	Lindi	Manyara	Mara	Mbeya	Morongo	Mwara	Mwanza	Pwani	Rukwa	Ruvuma	Shi-nyanga	Singida	Tabora	Tanga	Total
Arusha	149	1,042	0	93	5	88	699	0	133	0	90	29	8	143	0	45	0	13	56	1	508	3,102
DSM	1,466	35	1,023	273	435	473	376	108	131	97	992	166	127	2,242	7	0	569	1,364	305	383	237	10,809
Dodoma	137	569	33	28	90	0	195	0	0	0	0	23	4	0	0	0	4	0	0	0	0	1,083
Iringa	117	1,360	85	35	87	0	49	0	0	118	0	54	0	187	0	32	20	275	0	2	0	2,421
Kagera	0	189	67	0	0	0	0	0	0	15	0	0	0	133	0	0	10	94	0	0	0	508
Kigoma	5	276	0	1	0	73	0	0	0	0	0	0	0	67	0	1	0	18	0	0	0	441
Kilimanjaro	53	654	0	41	2	0	72	0	62	0	14	80	0	39	10	0	0	0	190	0	135	1,352
Lindi	0	88	0	0	0	0	0	11	0	0	0	0	26	0	0	0	21	22	0	0	0	168
Manyara	71	277	0	0	0	0	164	0	0	0	0	0	0	0	0	0	0	0	10	0	0	522
Mara	0	187	0	34	0	0	0	0	0	2	15	0	0	119	0	0	8	16	10	14	0	405
Mbeya	411	1,705	243	0	0	0	55	0	0	5	295	37	7	130	0	0	91	9	0	23	65	3,076
Morongo	33	295	22	21	0	0	26	0	15	0	0	0	0	102	0	0	0	99	0	60	41	714
Mtwara	0	141	0	0	0	0	0	23	0	0	0	6	44	0	0	0	11	0	0	0	0	225
Mwanza	223	1,427	21	7	235	85	0	0	0	175	61	73	15	8	0	46	21	203	0	185	46	2,831
Pwani	0	26	33	0	56	0	0	0	0	0	0	39	0	0	8	0	0	0	0	0	38	200
Rukwa	87	62	0	0	0	0	0	0	0	0	0	17	0	0	0	0	0	0	0	0	0	166
Ruvuma	26	125	111	11	0	0	9	21	0	15	16	60	45	0	0	20	91	0	0	0	0	550
Shinyanga	199	575	0	2	5	0	0	0	0	125	0	31	0	97	0	0	22	223	9	0	15	1,303
Singida	35	571	0	7	0	0	15	0	0	0	3	0	0	73	0	0	0	58	23	27	0	812
Tabora	0	15	51	0	0	5	3	0	0	0	0	252	0	84	0	0	0	6	0	148	0	564
Tanga	486	658	478	166	41	304	378	0	8	0	9	20	0	350	41	0	2	39	4	0	0	2,984
Total	3,498	10,277	2,167	719	956	1,028	2,041	163	349	552	1,495	887	276	3,774	66	144	870	2,439	607	843	1,085	34,236

Source: JICA Study Team

(3)   Future Domestic Transport

Models were developed for forecasting the future regional freight movement OD table based on the OD table developed in the previous section, as follows. First, the relationship between the freight volume produced and attracted by each zone (region) and regional economic indicators such as population and GRDP was analyzed. The results are shown in Figure 1.13 with the left graph showing the relationship between the production/attraction and population, and the right graph, that with GRDP, which has a strong relationship with the generation and attraction of freight volume.
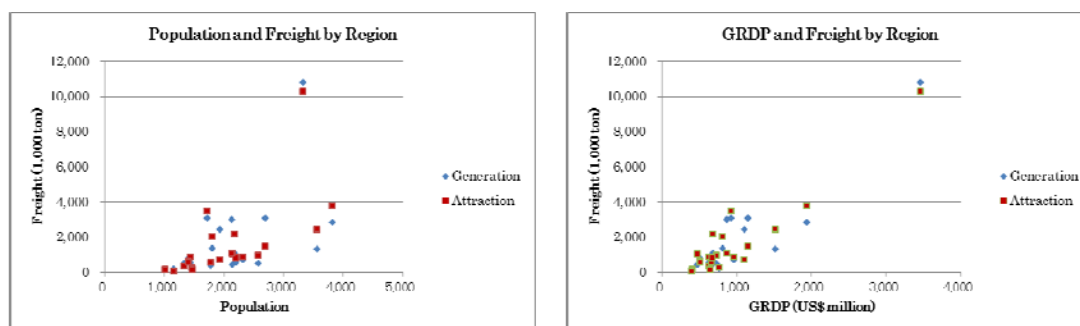
**Figure 1.13: Relationship between Generation/Attraction
and Regional Socio-Economic Indicators**

The following equations representing the models with the greatest explanatory power to estimate the future freight production and attraction of each zone were employed after the analysis above.

$$P_i = 3.1368 \cdot x_i - 1350 \quad \text{(r2 = 0.83)}$$
$$A_j = 3.0339 \cdot x_j - 1252 \quad \text{(r2 = 0.86)}$$

Where, P_i : Production of freight from i zone ('000 ton)

A_j : Attraction of freight to j zone ('000 ton)

x_i : GRDP of i zone (USD million)

The future freight production and attraction of each zone was estimated by inputting the future GRDP of each zone into the above models. Then, in order to estimate the element of the OD table, the Fratar method, which is a technique for distributing production and attraction in accordance with the rates of existing distribution pattern and balancing the total production and attraction, was used.

In addition, the estimation of regional GRDP, which is necessary for this task, was carried out as follows. First, per capita GRDP by region was calculated by dividing GRDP by the population of each region in 2002, the year when the last population census was conducted. It was assumed that the resulting figures will be same in the future as at present so that the current and future GRDP by region can be estimated by multiplying per capita GRDP with the current and future population of each region. The estimated current and future GRDP by region is shown in Table 1.16.

Table 1.16: Estimates of Present and Future GRDP by Region

Unit: USD million

Region	2010	2030 Target Growth Rate	2030 Conservative Growth Rate
Arusha	922	4,261	2,470
Dar es Salaam	3,463	22,064	12,789
Dodoma	686	2,973	1,723
Iringa	1,108	4,881	2,829
Kagera	730	3,088	1,790
Kigoma	480	2,077	1,204
Kilimanjaro	809	3,612	2,094
Lindi	406	1,779	1,031
Manyara	627	2,725	1,580
Mara	661	2,925	1,695
Mbeya	1,151	5,127	2,972
Morogoro	963	4,386	2,542
Mtwara	766	3,409	1,976
Mwanza	1,945	8,667	5,024
Pwani	400	1,786	1,035
Rukwa	641	2,827	1,639
Ruvuma	622	2,719	1,576
Shinyanga	1,519	6,497	3,766
Singida	510	2,216	1,284
Tabora	670	2,906	1,684
Tanga	873	3,863	2,239
Total	19,955	94,791	54,942

Source: JICA Study Team

Desire lines drawn with the estimated OD tables are illustrated in Figure 1.14 for 2010 and Figure 1.15 for 2030, and the OD table estimated with the conservative growth rate is shown in Table 1.17 and that with target growth rate in Table 1.18. In the OD table, the name of regions in the left column indicates the origin and the name on the top row indicates the destination of the freight movement.

According to the tables, the zone having the biggest freight production and attraction is Dar es Salaam, accounting for 20 million tonnes in 2010, 80 million tonnes in 2030 with the conservative growth rate, and 138 million tonnes in 2030, which is about seven times than the current value, with the target growth rate. The second biggest is Mwanza, whose freight production and attraction volume is about one-third of Dar es Salaam's. In addition to these areas, the Sinyanga, Arusha, and Mbeya regions may register large increases in freight volume in 2030.

Therefore, freight distribution can be estimated to register big increases between zones/regions. Especially, freight volume in 2030 between Dar es Salaam and the Mwanza region becomes 12.1 million tonnes with the conservative growth rate and 20.5 million tonnes with the target growth rate, compared to 3.6 million tonnes in 2010.
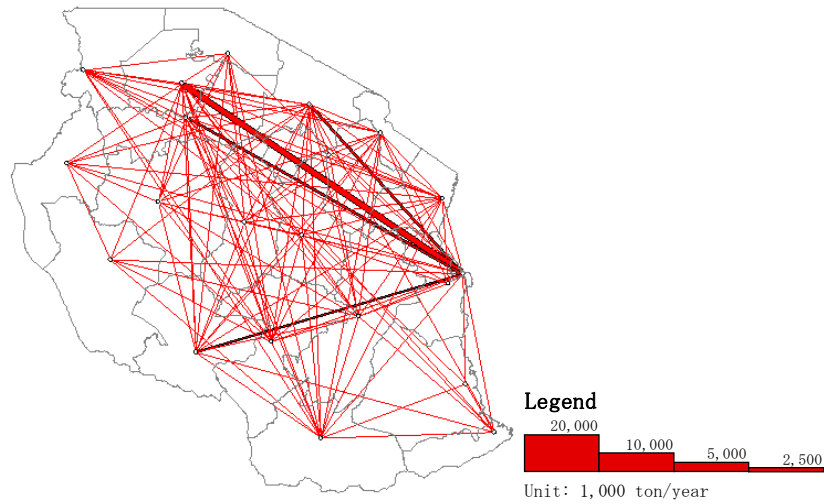
Figure 1.14: Freight Movement between Regions in 2010
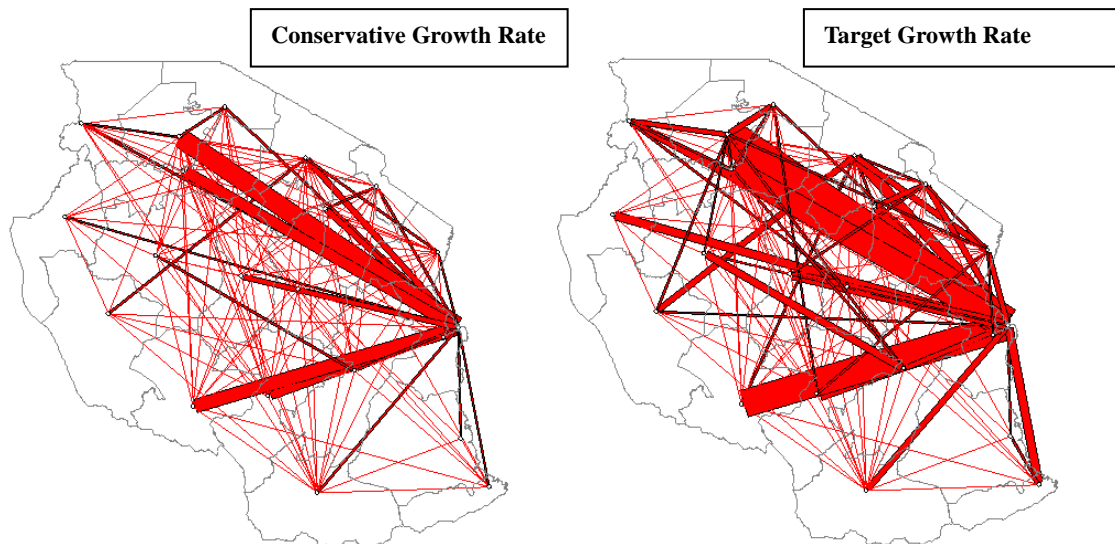
Figure 1.15: Freight Movement between Regions in 2030

Table 1.17: Estimated Transport Volume in 2030 (Conservative Growth Rate)

Unit: 1,000 tonnes

Origin \ Destination	Arusha	DSM	Dodoma	Iringa	Kagera	Kigoma	Kiliman-jaro	Lindi	Manyara	Mara	Mbeya	Morongo	Mwara	Mwanza	Pwani	Rukwa	Ruvuma	Shi-nyanga	Singida	Tabora	Tanga	Total
Arusha	175	1,858	0	469	11	175	1,315	0	852	0	260	79	44	262	0	622	0	24	163	2	1,646	7,956
DSM	2,931	106	2,504	2,344	1,753	1,596	1,205	920	1,435	508	4,886	767	1,148	7,018	220	0	2,170	4,292	1,531	1,424	1,307	40,064
Dodoma	341	2,173	99	297	452	0	776	0	0	0	0	136	42	0	0	0	17	0	0	0	0	4,334
Iringa	213	3,788	190	276	319	0	143	0	0	562	0	230	0	535	0	694	71	791	0	8	0	7,820
Kagera	0	1,412	398	0	0	0	0	0	0	189	0	0	0	1,013	0	0	95	723	0	0	0	3,831
Kigoma	18	1,647	0	11	0	481	0	0	0	0	0	0	0	412	0	28	0	114	0	0	0	2,711
Kilimanjaro	96	1,790	0	319	7	0	209	0	609	0	61	330	0	109	315	0	0	0	859	0	675	5,379
Lindi	0	787	0	0	0	0	0	258	0	0	0	0	642	0	0	0	237	206	0	0	0	2,131
Manyara	318	1,912	0	0	0	0	1,172	0	0	0	0	0	0	0	0	0	0	0	108	0	0	3,510
Mara	0	1,385	0	707	0	0	0	0	0	21	179	0	0	902	0	0	76	126	125	130	0	3,651
Mbeya	741	4,702	536	0	0	0	157	0	0	26	1,305	156	58	367	0	0	312	26	0	78	323	8,788
Morongo	148	2,019	123	405	0	0	183	0	365	0	0	0	0	719	0	0	0	701	0	503	502	5,669
Mtwara	0	1,634	0	0	0	0	0	703	0	0	0	98	1,431	0	0	0	154	0	0	0	0	4,021
Mwanza	526	5,125	62	69	1,115	337	0	0	0	1,078	354	397	161	29	0	1,277	96	752	0	809	302	12,488
Pwani	0	164	168	0	470	0	0	0	0	0	0	368	0	0	579	0	0	0	0	0	443	2,193
Rukwa	1,294	1,422	0	0	0	0	0	0	0	0	0	579	0	0	0	0	0	0	0	0	0	3,295
Ruvuma	69	512	369	129	0	0	38	233	0	104	109	362	524	0	0	630	464	0	0	0	0	3,543
Shinyanga	791	3,490	0	40	36	0	0	0	0	1,297	0	281	0	603	0	0	165	1,393	87	0	163	8,348
Singida	88	2,208	0	73	0	0	62	0	0	0	0	16	0	291	0	0	0	230	145	128	0	3,242
Tabora	0	80	215	0	0	30	18	0	0	0	0	0	1,976	454	0	0	0	33	0	939	0	3,745
Tanga	652	1,348	784	954	111	687	811	0	61	0	28	63	0	736	932	0	5	82	15	0	0	7,269
Total	8,401	39,563	5,449	6,093	4,276	3,307	6,089	2,114	3,323	3,786	7,196	5,823	4,050	13,451	2,045	3,251	3,862	9,493	3,033	4,022	5,364	143,988

Source: JICA Study Team

Table 1.18: Estimated Transport Volume in 2030 (Target Growth Rate)

Unit: 1,000 tonnes

Origin \ Destination	Arusha	DSM	Dodoma	Iringa	Kagera	Kigoma	Kiliman-jaro	Lindi	Manyara	Mara	Mbeya	Morongo	Mtwara	Mwanza	Pwani	Rukwa	Ruvuma	Shi-nyanga	Singida	Tabora	Tanga	Total
Arusha	253	2,663	0	894	20	301	2,100	0	1,701	0	485	133	79	443	0	1,171	0	41	300	3	2,988	13,575
DSM	4,220	152	3,981	4,443	3,086	2,727	1,912	1,694	2,845	851	9,068	1,283	2,062	11,789	440	0	3,817	7,195	2,792	2,443	2,358	69,158
Dodoma	607	3,841	195	694	985	0	1,518	0	0	0	0	284	94	0	0	0	37	0	0	0	0	8,255
Iringa	356	6,259	350	604	650	0	263	0	0	1,090	0	447	0	1,040	0	1,501	144	1,536	0	16	0	14,257
Kagera	0	2,636	826	0	0	0	0	0	0	416	0	0	0	2,222	0	0	219	1,584	0	0	0	7,902
Kigoma	34	3,090	0	27	0	1,074	0	0	0	0	0	0	0	908	0	68	0	250	0	0	0	5,450
Kilimanjaro	154	2,838	0	673	14	0	369	0	1,347	0	125	614	0	204	701	0	0	0	1,746	0	1,357	10,142
Lindi	0	1,434	0	0	0	0	0	603	0	0	0	0	1,462	0	0	0	534	444	0	0	0	4,477
Manyara	620	3,711	0	0	0	0	2,507	0	0	0	0	0	0	0	0	0	0	0	266	0	0	7,104
Mara	0	2,476	0	1,677	0	0	0	0	0	44	415	0	0	1,899	0	0	168	264	286	279	0	7,508
Mbeya	1,217	7,667	970	0	0	0	284	0	0	49	2,748	299	120	703	0	0	626	50	0	153	663	15,549
Morongo	264	3,578	242	952	0	0	361	0	897	0	0	0	0	1,500	0	0	0	1,461	0	1,074	1,124	11,452
Mtwara	0	3,008	0	0	0	0	0	1,660	0	0	0	211	3,285	0	0	0	352	0	0	0	0	8,517
Mwanza	904	8,718	118	156	2,342	687	0	0	0	2,154	783	793	345	57	0	2,847	201	1,504	0	1,658	650	23,917
Pwani	0	271	313	0	965	0	0	0	0	0	0	712	0	0	1,353	0	0	0	0	0	934	4,548
Rukwa	2,683	2,931	0	0	0	0	0	0	0	0	0	1,408	0	0	0	0	0	0	0	0	0	7,023
Ruvuma	117	856	694	290	0	0	72	501	0	205	239	709	1,095	0	0	1,388	962	0	0	0	0	7,129
Shinyanga	1,481	6,483	0	99	83	0	0	0	0	2,831	0	615	0	1,318	0	0	378	3,040	206	0	382	16,915
Singida	159	3,964	0	174	0	0	124	0	0	0	38	0	0	613	0	0	0	484	331	277	0	6,165
Tabora	0	138	415	0	0	63	35	0	0	0	0	3,987	0	924	0	0	0	66	0	1,948	0	7,577
Tanga	958	1,964	1,269	1,841	200	1,195	1,310	0	124	0	53	108	0	1,261	1,904	0	10	140	27	0	0	12,364
Total	14,026	68,680	9,373	12,524	8,346	6,047	10,855	4,458	6,913	7,640	13,955	11,603	8,542	24,881	4,398	6,975	7,447	18,059	5,954	7,852	10,456	268,982

Source: JICA Study Team

1.4   Corridor and Modal Competitiveness

1.4.1   Methodology and Tools for Analysis

Corridor analysis was performed as follows. The distribution of import and export freight from/to landlocked countries (Burundi, DRC, Malawi, Rwanda, Uganda, Zambia) with the possibility of being transported in Tanzania as transit freight was picked up from the OD table estimated in section 3.3. For the estimates of transit freight volume, corridor share was estimated by analyzing the level of service in alternative corridors for each landlocked country (e.g., the Northern Corridor to Mombasa and the Central Corridor to Dar es Salaam for Uganda), and the freight being transported along the corridor of Tanzania was divided into mode (road transport and railway) by applying a mode share model to estimate the probability of mode choice. Figure 1.16 summarizes the process.
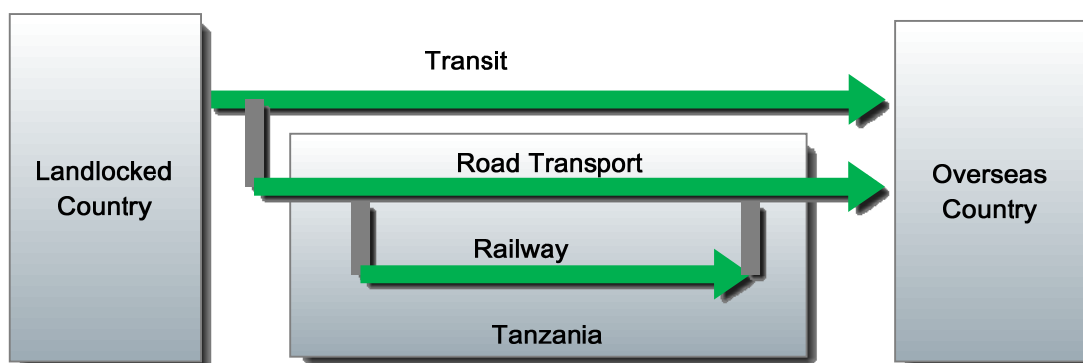
Figure 1.16: Target of Freight for Corridor Analysis

Corridor choice was carried out based on the corridor choice mode obtained from an analysis of the relationship between the level of service (e.g., transport time and cost) and the current corridor choice of each country. For the mode choice of transit freight in Tanzania, the modal choice model was built based on data collected in the cargo owner interview survey. This model is described in detail later.

1.4.2   Analysis of Existing Corridor Situation and Model Development

At first, the current situation regarding corridor share and mode choice of transit freight from/to the landlocked countries was analyzed.

(1)   Total Transit by Country

Table 1.19 shows the growth of transit freight handled at Dar es Salaam port over the last 10 years by each landlocked country. The total volume handled at Dar es Salaam port included 2.4 million tonnes of import traffic and 0.4 million tonnes of export traffic for a total of 2.8 million tonnes in 2010, which was about 3.5 times of the volumes in 2001. The equivalent annual average growth rate was about 15%. The country with the highest growth in transit freight from 2001 to 2010 was Malawi at about 40% per year, followed by the DRC at about 24%. However, the total volume of these countries is not especially large. Zambia had a relatively larger percentage share at 46% for imports and 58% for exports.

Table 1.19: Transit Traffic at Dar es Salaam Port

Unit: 1,000 tonnes

	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
Import	613.0	652.4	752.1	1,008.8	1,005.8	1,341.1	1,667.4	1,872.0	1,966.7	2,432.4
Zambia	300.9	371.5	464.9	608.0	538.4	645.5	851.5	821.6	927.0	1,112.3
DRC	83.4	99.6	113.6	151.6	164.4	326.9	458.2	535.9	430.2	567.3
Burundi	71.7	50.9	47.5	80.1	128.3	101.9	130.8	178.6	256.4	327.6
Rwanda	64.3	40.2	44.3	55.9	79.6	82.0	79.8	167.1	221.8	261.1
Malawi	5.7	66.2	28.8	22.0	26.7	132.3	112.5	104.8	104.1	131.5
Uganda	87.1	24.0	53.1	91.3	68.4	52.6	34.8	64.1	27.2	32.6
Export	206.5	143.0	174.7	230.7	233.1	263.8	310.5	324.1	279.6	398.3
Zambia	139.2	102.8	121.7	168.5	145.9	158.8	169.5	197.4	173.2	229.3
DRC	18.4	1.4	4.4	19.0	47.6	86.9	97.6	96.2	76.1	143.2
Burundi	17.4	14.0	25.4	12.6	18.7	10.0	25.1	14.5	18.8	13.7
Rwanda	6.6	8.1	6.4	7.5	3.9	4.9	8.8	10.2	8.0	11.4
Malawi	0.0	0.3	0.2	2.6	1.8	2.3	6.0	2.5	1.0	0.6
Uganda	24.8	16.5	16.7	20.5	15.2	0.8	3.5	3.2	2.5	0.1
Total	819.5	795.4	926.8	1,239.5	1,238.8	1,604.9	1,977.9	2,196.1	2,246.3	2,830.7
Zambia	440.1	474.3	586.6	776.5	684.3	804.3	1,021.0	1,019.0	1,100.2	1,341.6
DRC	101.8	101.0	117.9	170.6	212.0	413.8	555.8	632.2	506.3	710.5
Burundi	89.1	64.9	72.9	92.7	146.9	111.9	155.9	193.1	275.1	341.4
Rwanda	71.0	48.3	50.7	63.4	83.5	86.9	88.6	177.3	229.8	272.4
Malawi	5.7	66.5	29.0	24.6	28.5	134.6	118.4	107.3	105.1	132.1
Uganda	111.9	40.4	69.7	111.8	83.6	53.5	38.2	67.3	29.8	32.7

Source: Tanzania Ports Authority

(2)   Corridor Share

Table 1.20 shows the estimated current corridor share of transit freight from each landlocked country (i.e., how much of the freight volume is transported through the Tanzania corridors out of the total trade of each country going to and coming from the Indian Ocean).

The figures in the columns titled Overseas Freight, which is the total transit freight of each country, were obtained from the OD table estimated in the previous section, and the figures in the columns titled Transit at DSM port are based on the statistics in Table 1.19. By comparing these two figures, the share of DSM port can be estimated as the corridor share of Tanzania.

The highest share of Tanzania corridor usage is accounted for by the trade between Burundi and overseas, of which more than 90% is for imports and 38% for exports, followed by trade of Rwanda, Zambia, and the DRC. The corridor share of trade between some country pairs (e.g., Malawi and Uganda) is not high.

Table 1.20: Corridor Share of Transit Freight in 2010

Unit: 1,000 tonnes

Country	Overseas Freight *1)		Transit at DSM Port *2)		Share of DSM Port (%)	
	Import	Export	Import	Export	Import	Export
Burundi	363.7	36.6	327.6	13.7	90.1%	37.5%
DRC	3,070.2	2,258.9	567.3	143.2	18.5%	6.3%
Malawi	1,684.5	929.9	0.6	0.6	0.0%	0.1%
Rwanda	456.5	61.2	261.1	11.4	57.2%	18.6%
Uganda	4,514.5	689.8	32.6	0.1	0.7%	0.0%
Zambia	5,050.4	1,668.9	1,112.3	229.3	22.0%	13.7%
Total			2,301.5	398.3		

Source: *1) Estimated by JICA Study Team, *2) Tanzania Ports Authority Statistics

(3) Modal Share

Table 1.21 shows the estimated modal share for the transit freight of each landlocked country. The total volume of transit freight comes from the statistics of import/export volume indicated in Table 1.19 and the volume transported by railway was calculated based on TRL and TAZARA statistics.

The table shows that rail is used extensively for the imports of Malawi and Uganda, as the total amount is not large. In other countries, the share of railway use for both imports and exports is almost 20% and the rest (80%) is transported by road.

Table 1.21: Modal Share of Transit Freight in 2010

Country	Volume and Share	Import			Export		
		Road	Railway [*1)]	Total [*2)]	Road	Railway [*1)]	Total [*2)]
Burundi	Volume ('000 tonnes)	253	75	328	12	1	14
	Share (%)	77.1	22.9	100.0	89.2	10.8	100.0
DRC	Volume ('000 tonnes)	535	32	567	118	25	143
	Share (%)	94.4	5.6	100.0	82.3	17.7	100.0
Malawi	Volume ('000 tonnes)	74	58	132	1	0	1
	Share (%)	56.0	44.0	100.0	100.0	0.0	100.0
Rwanda	Volume ('000 tonnes)	199	62	261	11	0	11
	Share (%)	76.1	23.9	100.0	100.0	0.0	100.0
Uganda	Volume ('000 tonnes)	19	14	33	-	-	0
	Share (%)	56.8	43.2	100.0	-	-	100.0
Zambia	Volume ('000 tonnes)	974	138	1,112	28	202	229
	Share (%)	87.6	12.4	100.0	12.0	88.0	100.0

Source: JICA Study Team estimates based on *1) Railway OD data of TRL and TAZARA, and *2) Tanzania Ports Authority statistics

(4) Service Level by Corridor

The choice of corridor and mode tends to depend on the level of service of each corridor and modal characteristics. For example, transport time and cost (e.g., tariffs) can be important factors for transporters in selecting corridor and transport mode. Table 1.22 summarizes the alternative corridors and transport mode choice for each landlocked country. The source of data varies. Distance was measured with the network data based on the database discussed in section 3.1; waiting time and transport time were averages of the results of the interview surveys of transporters and cargo owners. The transport cost was the value discussed in Chapter 4.

Table 1.22: Existing Level of Service by Corridor and Mode

	Route No.	Mode	From	To	Distance (km)	Waiting Time (hrs)	Transport Time (hrs)	Transport Cost (USD/tonne)
Uganda	1	Road	Kampala	Mombasa	1,133	26	45	187
	2	Road	Kampala	DSM	1,747	24	51	289
	3	Lake +	Kampala	Mwanza	315	24	21	21
		TRL	Mwanza	DSM	1,218	144	90	113
		Total	Kampala	DSM	1,533	168	111	134
Rwanda	1	Road	Kigali	Mombasa	1,651	54	66	273
	2	Road	Kigali	DSM	1,471	48	41	243
	3	Road +	Kigali	Isaka	491	48	17	81
		TRL	Isaka	DSM	970	283	72	90
		Total	Kigali	DSM	1,461	331	89	171
Burundi	1	Road	Bujumbura	Mombasa	1,892	80	76	313
	2	Road	Bujumbura	DSM	1,553	30	45	257
	3	Lake +	Bujumbura	Kigoma	172	24	11	12
		TRL	Kigoma	DSM	1,251	246	93	116
		Total	Bujumbura	DSM	1,423	270	104	127
Zambia	1	Road	Lusaka	Beira	1,024	48	41	169
	2	Road	Lusaka	DSM	1,931	52	63	319
	3	TAZARA	Lusaka	DSM	2,076	224	117	192
Malawi	1	Road	Lilongwe	Beira	1,292	24	52	214
	2	Road	Lilongwe	DSM	1,541	52	47	255
	3	Road	Lilongwe	Mbeya	730	24	29	121
		TAZARA	Mbeya	DSM	855	224	48	79
		Total	Lilongwe	DSM	1,585	248	77	200
DRC	1	Road	Lubumbashi	Beira	1,556	24	41	257
	2	Road	Lubumbashi	DSM	2,030	52	67	336
	3	Road	Lubumbashi	Lusaka	315	24	13	52
		TAZARA	Lusaka	DSM	1,860	224	106	172
		Total	Lubumbashi	DSM	2,175	248	119	224

Source: JICA Study Team

(5) Model Development

The following models were constructed for corridor choice using the service level of each corridor described in Table 1.22 and the current share of corridor discussed in Table 1.20. The explanatory variables were transport cost and time, which can be measured from the assumed starting place, i.e., from capital city, to ports in the Indian Ocean. In addition, this model has different and separate parameters for imports and exports.

$$R_t = \frac{1}{e^{\alpha(C_t - C_o) + \beta(T_t - T_o) + \gamma}}$$

Where, R_t : Choice ratio of Tanzania corridor

C_t, C_o : Transport cost of Tanzania and alternative corridor (USD/ton)

T_t, T_o : Transport time of Tanzania and alternative corridor (hours)

α, β, γ : parameters.

Table 1.23: Parameters for Corridor Choice Model

Variable	Import	Export
Transport cost (USD)	0.005892	0.00684
Transport time (hours)	0.005069	0.0172
Constant	1.125984	0.743487

Source: JICA Study Team

The following is a mode choice model of transit freight through Tanzania. Table 1.24 presents the parameters of this model, which were calculated with preference answer data obtained from the interview survey of selected transporters and cargo owners.

$$P_n^{Road} = \frac{e^{\alpha W_n^{Road} + \beta T_n^{Road} + \gamma C_n^{Road}}}{e^{\alpha W_n^{Road} + \beta T_n^{Road} + \gamma C_n^{Road}} + e^{\alpha W_n^{Railway} + \beta T_n^{Railway} + \gamma C_n^{Railway}}}$$

Where,　　　P_n^{Road} : Probability of road transport choice on n corridor

$W_n^{Road}, W_n^{Railway}$: Waiting time for road and railway on n corridor

$T_n^{Road}, T_n^{Railway}$: Transport time for road and railway on n corridor

$C_n^{Road}, C_n^{Railway}$: Transport cost for road and railway on n corridor

α, β, γ : parameters

Table 1.24: Parameters for Modal Choice Model

Variable	Parameter	t-value
Waiting time (hrs.)	-4.46E-02	-6.2189
Transport time (hrs.)	-3.81E-02	-5.0646
Transport cost (USD)	-7.82E-04	-4.2871

Source: JICA Study Team

The absolute value of the coefficient for waiting time is greater than the coefficient of transport time, and thus it follows that reduction of waiting time affects mode choice more than does the reduction of transport time.

1.4.3　Corridor Analysis

In the corridor analysis, first, using the corridor choice model and the data indicating the current service level of each corridor, the current share of each corridor was estimated and calibrated as a baseline case. Second, the corridor share was changed from the baseline with a mechanism that reduces transport time and cost according to improvement in the level of service of corridors in Tanzania assuming implementation of this Master Plan, and then the freight volume was calculated based on the change in corridor shares.

Transit freight traffic was estimated for two modes, road transport and railway transport, applying the modal share model previously discussed. This estimate was separately prepared for the landlocked countries (Uganda, Rwanda, Burundi, Zambia, and DRC) as discussed below. However, transit freight for Malawi was excluded from this analysis considering that Nsanje World Inland Port was launched in 2011 to provide easy access for Malawian freight to Mozambican ports on the Indian Ocean, and the transit freight might be shifted to this corridor from the Dar es Salaam corridor in the future.

First, two routes by road transport and railway were used between a representative city of each country and Dar es Salaam. Second, existing conditions such as waiting time and transport time for each route were calibrated to represent the existing modal share (estimated in Table 1.21) and the future modal share was estimated after inputting into the model future conditions to be improved with implementation of the Master Plan. In this section, it was assumed that waiting time and transport time will be reduced with the improvement of railway service. The impact of cost improvement on modal share is discussed in subsection 3.4.5.

(1) Freight of Uganda

The total freight of Uganda in 2030 was estimated at 28 million tonnes for imports and 11 million tonnes for exports with the conservative growth rate and 38 million tonnes for imports and 13 million tonnes for exports with the target growth rate. Included in these estimates, the transit freight going to and coming from ports on the Indian Ocean was estimated at 18 million tonnes and 2 million tonnes in 2030 for imports and exports with the conservative growth rate, and 26 million tonnes and 3 million tonnes for imports and exports in 2030 in the case of the target growth rate. This includes transit freight that could possibly transit Tanzania. Table 1.25 presents the estimates.

Table 1.25: Trade Volume Estimates of Uganda

Unit: 1,000 tonnes

Year/Scenario	Import/ Export	Total Trade	Overseas Trade	Trade with Tanzania
2010	Import	6,785	4,515	119
	Export	2,630	690	39
2030 (Conservative Growth Rate)	Import	27,882	18,193	757
	Export	10,563	2,078	207
2030 (Target Growth Rate)	Import	37,937	26,248	1,170
	Export	13,257	3,274	328

Source: JICA Study Team

Uganda's transit freight may move along two possible corridors: the Northern Corridor to Mombasa port and the Central Corridor to Dar es Salaam port, as shown in Figure 1.17. When the starting point is Kampala, the capital of Uganda, the corridor lengths are 1,133 km along Northern Corridor and 1,747 km along the Central Corridor, referring to the database created in section 1.1. As shown in Table 1.26, current shares are 99.3% for the Northern Corridor and 0.7% for the Central Corridor. With the improvement of the transport network in Tanzania, the share of the Central Corridor becomes 4.8% for imports and 13.0% for exports. As a result, the volume of transit freight through Tanzania in 2030 can be estimated as follows: 878,000 tonnes for imports and 278,000 tonnes for exports with the conservative growth rate and 1,267,000 tonnes for imports and 437,000 tonnes for exports with the target growth rate.

As shown in Table 1.19, there are two principal routes of the Central Corridor in Tanzania: (i) the railway route from Kampala by inland waterway to Mwanza and TRL to Dar es Salaam and the road transport route through Bukoba, Isaka, Singida, Dodoma, and Dar es Salaam. As shown in Table 1.27, the current share of the corridor is estimated at 43% for imports by railway and none for exports. This is projected increase to 47% for imports and 9% for exports, with transit freight by railway in 2030 estimated at 413,000 tonnes for imports and 25,000 tonnes for exports with the conservative growth rate, and 596,000 for imports and 39,000 tonnes for exports with the target growth rate. The volume by commodity is shown in Table 1.28.
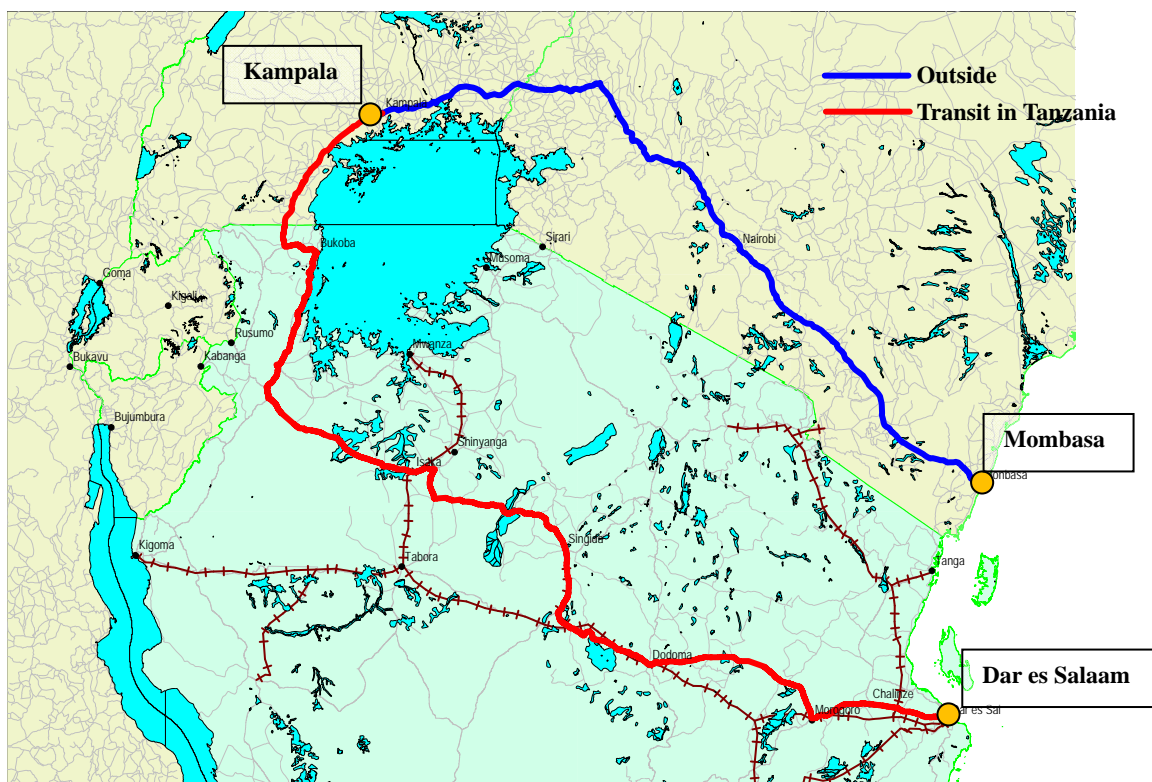
Figure 1.17: Routes for Uganda Trade

Table 1.26: Corridor Shares of Transit Freight from/to Uganda

			Baseline			Master Plan Network		
			Northern Corridor	Central Corridor	Total	Northern Corridor	Central Corridor	Total
2010	Import	Volume (000 ton)	4,482	33	4,515			
		(%)	99.3%	0.7%	100.0%			
	Export	Volume (000 ton)	690	0	690			
		(%)	100.0%	0.0%	100.0%			
2030Volume (Conservative Growth Rate)	Import	Volume (000 ton)	18,061	131	18,193	17,315	878	18,193
		(%)	99.3%	0.7%	100.0%	95.2%	4.8%	100.0%
	Export	Volume (000 ton)	2,078	0	2,078	2,079	278	2,078
		(%)	100.0%	0.0%	100.0%	86.6%	13.4%	100.0%
2030Volume (Target Growth Rate)	Import	Volume (000 ton)	26,058	190	26,248	24,981	1,267	26,248
		(%)	99.3%	0.7%	100.0%	95.2%	4.8%	100.0%
	Export	Volume (000 ton)	3,273	0	3,274	2,836	437	3,274
		(%)	100.0%	0.0%	100.0%	86.6%	13.4%	100.0%

Source: JICA Study Team
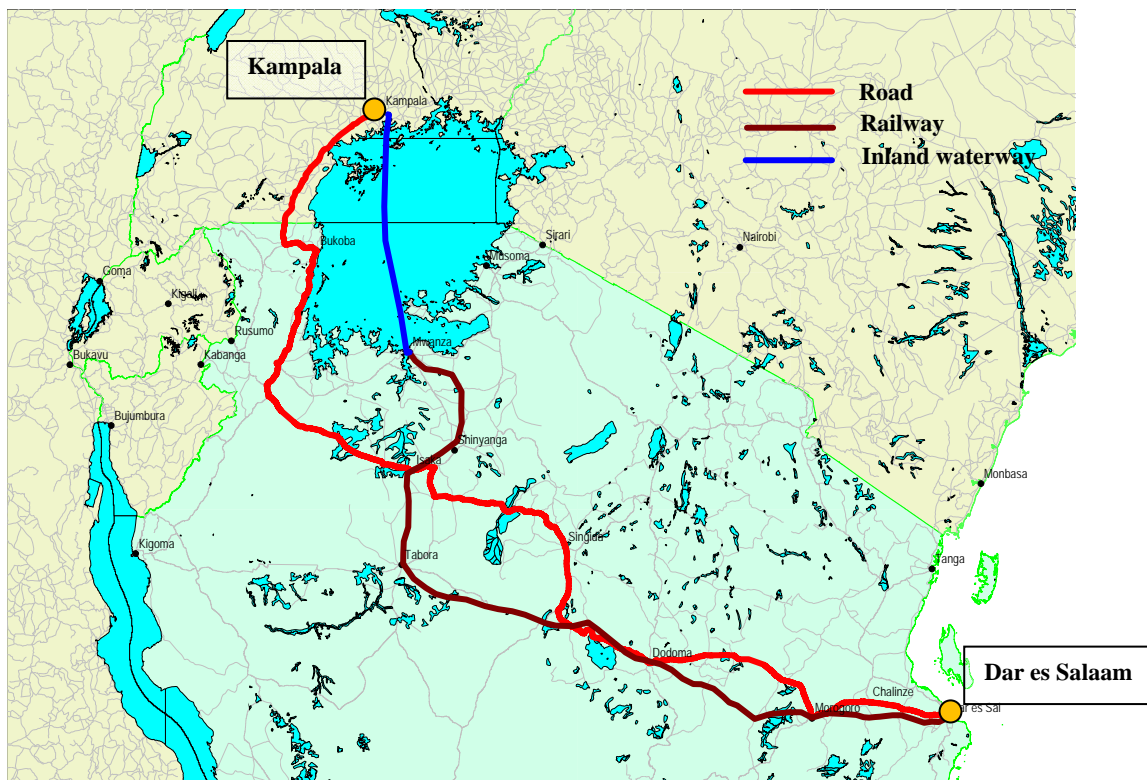
**Figure 1.18: Assumed Routes for Mode Choice between Uganda
and Dar es Salaam Port**

Table 1.27: Estimated Modal Share of Transit Freight from/to Uganda

Unit: 1,000 tonnes

Year	Import			Export		
	Road	**Railway**	**Total**	**Road**	**Railway**	**Total**
2010	19	14	33	0	0	0
	56.8%	43.2%	100.0%			
2030 (Conservative Growth Rate)	465	413	878	253	25	278
	53.0%	47.0%	100.0%	91.0%	9.0%	100.0%
2030 (Target Growth Rate)	671	596	1,267	398	39	437
	53.0%	47.0%	100.0%	91.0%	9.0%	100.0%

Source: JICA Study Team

Table 1.28: Estimated Demand by Railway[1] of Uganda Transit Freight by Commodity

Unit: 1,000 tonnes

Type of Commodity	2030 (Conservative Growth Rate)		2030 (Target Growth Rate)	
	Import	Export	Import	Export
Agricultural Products	77	12	112	18
Mineral Products	114	3	165	5
Fuel/Petroleum	149	5	215	8
Agricultural Processed Products	41	5	59	7
Industrial Products	30	1	44	1
Transportation	1	0	2	0
Total	413	25	596	39

Source: JICA Study Team

(2)   Freight of Rwanda

As shown in Table 1.29, the total freight of Rwanda in 2030 was estimated to be 5.7 million tonnes for imports and 0.8 million tonnes for exports with the conservative growth rate and 6.7 million tonnes for imports and 0.9 million tonnes for exports with the target growth rate. Transit freight in 2030 was estimated to be 1.7 million tonnes and 0.2 million tonnes for imports and exports, respectively, with the conservative growth rate, and 2.1 million tonnes and 0.2 million tonnes for imports and exports, respectively, with the target growth rate.

Table 1.29: Trade Volume Estimates of Rwanda

Unit: 1,000 tonnes

Year/Scenario	Import/ Export	Total Trade	Overseas Trade	Trade with Tanzania
2010	Import	1,399	456	131
	Export	200	61	3
2030 (Conservative Growth Rate)	Import	5,734	1,671	755
	Export	805	180	16
2030 (Target Growth Rate)	Import	6,748	2,081	1,008
	Export	882	242	22

Source: JICA Study Team

As shown in Figure 1.19, Rwanda's transit freight has the same two corridor options as Uganda's transit freight: the Northern Corridor and the Central Corridor. The current shares of the corridors for import freight are 43% for the Northern Corridor and 57% for the Central Corridor, while the shares for export freight are 81% for the Northern Corridor and 19% for the Central Corridor. The planned improvement of the transport network in Tanzania will slightly affect corridor shares, with the Central Corridor's share increasing in 2030 to 59% for imports and 31% for exports. As a result, the volume of transit freight through Tanzania in 2030 can be estimated for imports as 989,000 tonnes and for exports as 55,000 tonnes with the conservative growth rate, and for imports to be 1,231,000 tonnes and for exports to be 74,000 tonnes with the target growth rate (Table 1.30).

As shown in Figure 1.20, there are two principal routes of the Central Corridor in Tanzania: the road transport route via Kigali, Isaka, Singida, Dodoma, and Dar es Salaam, and the railway route from Kigali to Isaka by road transport and Isaka to Dar es Salaam by railway. As shown in Table 1.31, the current railway share is 24% for imports and 0% for exports. This is projected to

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[1] It was extremely difficult to collect more detailed data and annual freight pattern from the Roadside Study which had been held on maximum 3 days during this Master Plan, therefore it is only shown the estimated demand by railway by commodity in each country in this Chapter.

increase to 27% for imports and 3% for exports in 2030. Also as shown in Table 1.32, railway transit freight in 2030 was projected to be 269,000-335,000 tonnes for imports and 2,000 tonnes for exports. Table 1.32 presents transit freight volume by commodity class.
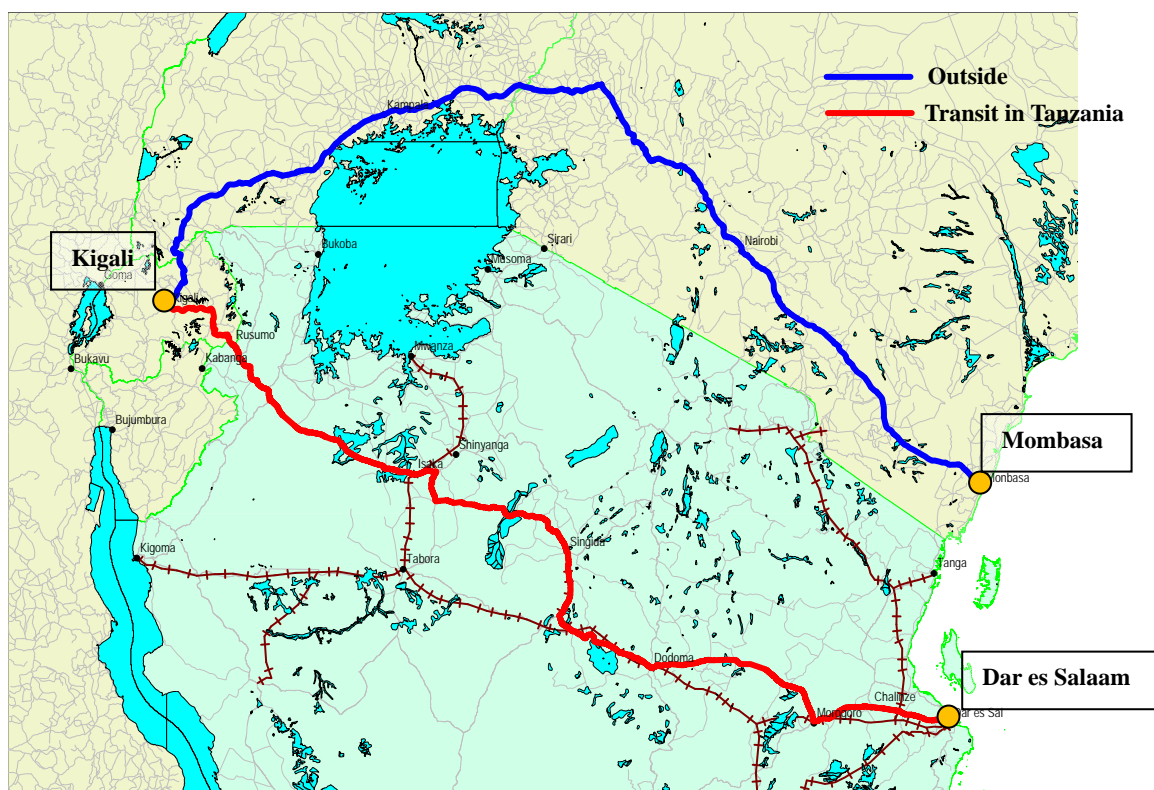
Figure 1.19: Routes for Rwandan Trade

Table 1.30: Corridor Share of Transit Freight from/to Rwanda

			Baseline			Master Plan Network		
			Northern Corridor	Central Corridor	Total	Northern Corridor	Central Corridor	Total
2010	Import	Volume (000 ton)	195	261	456			
		(%)	42.8%	57.2%	100.0%			
	Export	Volume (000 ton)	50	11	61			
		(%)	81.4%	18.6%	100.0%			
2030Volume (Conservative Growth Rate)	Import	Volume (000 ton)	715	956	1,671	682	989	1,671
		(%)	42.8%	57.2%	100.0%	40.8%	59.2%	100.0%
	Export	Volume (000 ton)	147	33	180	181	55	180
		(%)	81.4%	18.6%	100.0%	69.4%	30.6%	100.0%
2030Volume (Target Growth Rate)	Import	Volume (000 ton)	891	1,190	2,081	850	1,231	2,081
		(%)	42.8%	57.2%	100.0%	40.8%	59.2%	100.0%
	Export	Volume (000 ton)	197	45	242	168	74	242
		(%)	81.4%	18.6%	100.0%	69.4%	30.6%	100.0%

Source: JICA Study Team

**Figure 1.20: Assumed Routes for Mode Choice between Rwanda
and Dar es Salaam Port**

Table 1.31: Estimated Modal Share of Transit Freight from/to Rwanda

Unit: 1,000 tonnes

Year	Import			Export		
	Road	Railway	Total	Road	Railway	Total
2010	199	62	261	11	0	11
	76.1%	23.9%	100.0%	100.0%	0.0%	100.0%
2030 (Conservative Growth Rate)	719	269	989	54	2	55
	72.8%	27.2%	100.0%	97.0%	3.0%	100.0%
2030 (Target Growth Rate)	896	335	1,231	72	2	74
	72.8%	27.2%	100.0%	97.0%	3.0%	100.0%

Source: JICA Study Team

**Table 1.32: Estimated Demand by Railway of Rwanda Transit Freight
by Commodity**

Unit: 1,000 tonnes

Type of Commodity	2030 (Conservative Growth Rate)		2030 (Target Growth Rate)	
	Import	Export	Import	Export
Agricultural Products	145	0	181	0
Mineral Products	102	1	126	2
Fuel/Petroleum	3	0	4	0
Agricultural Processed Products	19	0	24	0
Industrial Products	0	0	0	0
Transportation	0	0	0	0
Total	269	2	335	2

Source: JICA Study Team

(3)   Freight of Burundi

The total volume of transit freight of Burundi was estimated at 3.2 million tonnes for imports and 0.3 million tonnes for exports with the conservative growth rate and 3.3 million tonnes for imports and 0.3 million tonnes for exports with the target growth rate. The transit freight in 2030 going out from ports on the Indian Ocean was estimated at 1.2 million tonnes and 0.1 million tonnes for imports and exports, respectively, with the conservative growth rate, and 1.2 million tonnes and 0.1 million tonnes for imports and exports, respectively, with the target growth rate. This includes transit freight that could possibly transit Tanzania. Table 1.33 presents the estimates.

Table 1.33: Trade Volume Estimates of Burundi

Unit: 1,000 tonnes

Year/Scenario	Import/ Export	Total Trade	Overseas Trade	Trade with Tanzania
2010	Import	786	364	216
	Export	80	37	2
2030 (Conservative Growth Rate)	Import	3,210	1,210	1,134
	Export	333	118	13
2030 (Target Growth Rate)	Import	3,277	1,231	1,237
	Export	312	127	14

Source: JICA Study Team

As is the case for Uganda and Rwanda, there are two possible corridors for Burundi's traffic: the Northern Corridor to Mombasa port and the Central Corridor to Dar es Salaam port, as shown in Figure 1.21. As shown in Table 1.34, shares in 2010 were 9.9% for the Northern Corridor and 90.1% for the Central Corridor for imports and 62.5% for the Northern Corridor and 37.5% for Central Corridor for exports. Assuming the planned improvement of transport network in Tanzania, the share of the Central Corridor in 2030 would increase to 90.7% for imports and 49.3% for exports. Transit freight volume in 2030 was then estimated as 1,097,000 tonnes for imports and 58,000 for exports with the conservative growth rate, and 1,116,000 for imports and 63,000 tonnes for exports with the target growth rate.

As shown in Figure 1.22, for Burundi's transit there are two routes in Central Corridor in Tanzania: the railway route from Bujumbura to Kigoma by inland waterway and Kigoma to Dar es Salaam by TRL and the road transport route through Kabanga, Isaka, Singida, Dodoma and Dar es Salaam. As shown in Table 1.35, the current railway share is 23% for imports and 11% for exports. This is projected to increase to 29% for imports and 11% for exports in 2030. Also as shown in Table 1.35, railway transit freight was estimated to be 322,000–328,000 tonnes for imports and 7,000 tonnes for exports in 2030. Table 1.36 presents transit freight volume by commodity class.

The model developed in this Study assumes one representative route for both railway and land transport. Therefore when this model is applied for forecasting future modal share of the freight between two cities, it is necessary to assume one representative route for railway and land transport in the future, respectively. For example, in the case of Bujumbra and DAR section, a route of Bujumbura – (water transport) – Kigoma - (TRL) – Dar es Salaam is a representative assumption for railway route and a route of Bujumbura – Isaka – Dar es Salaam is a representative assumed route for land transport.
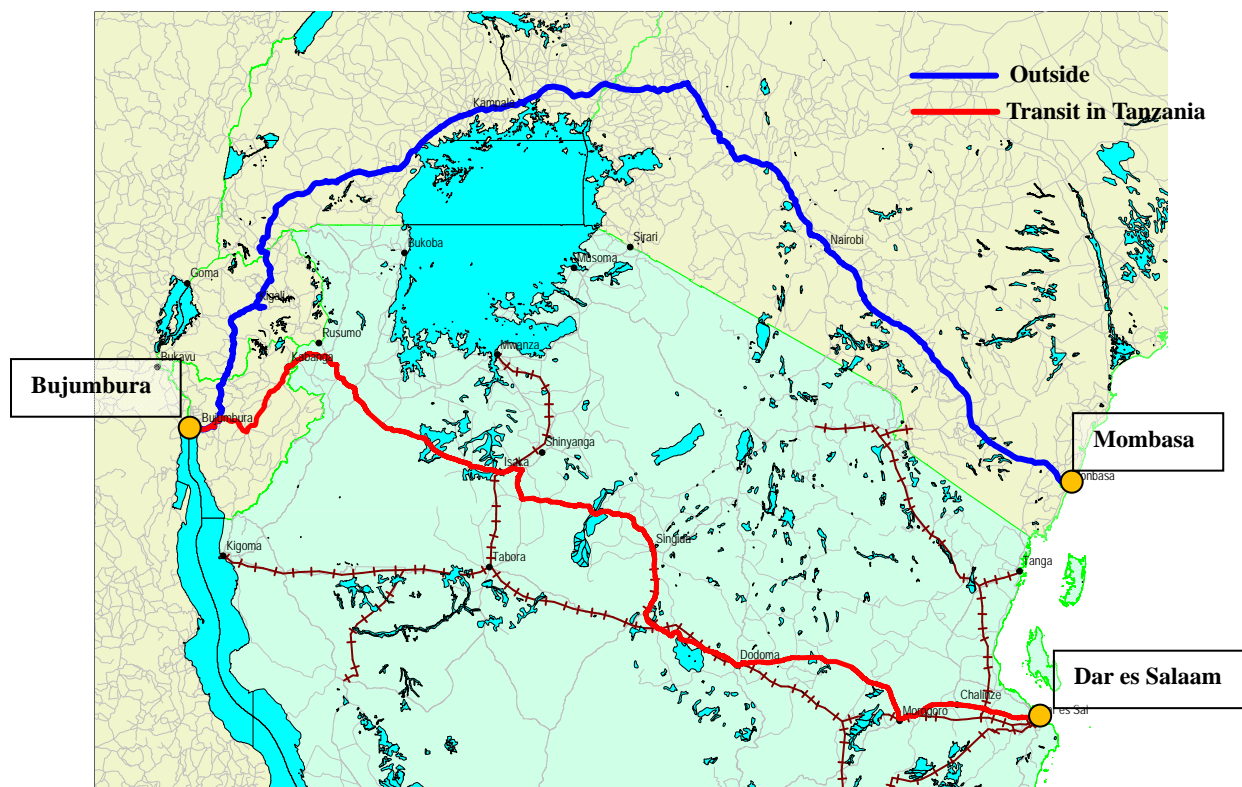
Figure 1.21: Assumed Routes for Corridor Choice of Burundi Trade

Table 1.34: Corridor Share of Transit Freight from/to Burundi

			Baseline			Master Plan Network		
			Northern Corridor	Central Corridor	Total	Northern Corridor	Central Corridor	Total
2010	Import	Volume (000 ton)	36	328	364			
		(%)	9.9%	90.1%	100.0%			
	Export	Volume (000 ton)	23	14	37			
		(%)	62.5%	37.5%	100.0%			
2030Volume (Conservative Growth Rate)	Import	Volume (000 ton)	120	1,090	1,210	113	1,097	1,210
		(%)	9.9%	90.1%	100.0%	9.3%	90.7%	100.0%
	Export	Volume (000 ton)	74	44	118	119	58	118
		(%)	62.5%	37.5%	100.0%	50.7%	49.3%	100.0%
2030Volume (Target Growth Rate)	Import	Volume (000 ton)	122	1,109	1,231	115	1,116	1,231
		(%)	9.9%	90.1%	100.0%	9.3%	90.7%	100.0%
	Export	Volume (000 ton)	80	48	127	65	63	127
		(%)	62.5%	37.5%	100.0%	50.7%	49.3%	100.0%

Source: JICA Study Team

**Figure 1.22: Assumed Routes for Mode Choice between Burundi
and Dar es Salaam Port**

Table 1.35: Estimated Modal Share of Transit Freight from/to Burundi

Unit: 1,000 tonnes

Year	Import			Export		
	Road	Railway	Total	Road	Railway	Total
2010	253	75	328	12	1.5	14
	77.1%	22.9%	100.0%	89.2%	10.8%	100.0%
2030 (Conservative Growth Rate)	775	322	1,097	52	6.5	58
	70.6%	29.4%	100.0%	88.8%	11.2%	100.0%
2030 (Target Growth Rate)	788	328	1,116	56	7.0	63
	70.6%	29.4%	100.0%	88.8%	11.2%	100.0%

Source: JICA Study Team

**Table 1.36: Estimated Demand by Railway of Burundi Transit Freight
by Commodity**

Unit: 1,000 tonnes

Type of Commodity	2030 (Conservative Growth Rate)		2030 (Target Growth Rate)	
	Import	Export	Import	Export
Agricultural Products	116	6	118	6
Mineral Products	66	0	67	0
Fuel/Petroleum	21	0	21	0
Agricultural Processed Products	58	0	59	1
Industrial Products	60	0	61	0
Transportation	3	0	3	0
Total	322	7	328	7

Source: JICA Study Team

(4)   Freight of Zambia

The total freight volume of Zambia was estimated and projected as summarized in Table 1.37. In 2030, total trade is projected to be in the range of 21.6 to 37.6 million tonnes for imports and between 13.1 to 19.1 million tonnes for exports. Transit volume that could possibly be transported along the Dar es Salaam Corridor was estimated between 18.3 and 33.1 million tonnes for imports and 6.4 and 10.9 million tonnes for exports.

Table 1.37: Trade Volume Estimates of Zambia

Unit: 1,000 tonnes

Year/Scenario	Import/ Export	Total Trade	Overseas Trade	Trade with Tanzania
2010	Import	5,695	5,050	54
	Export	2,936	1,669	32
2030 (Conservative Growth Rate)	Import	21,557	18,319	312
	Export	13,113	6,410	216
2030 (Target Growth Rate)	Import	37,565	33,086	604
	Export	19,114	10,872	369

Source: JICA Study Team

Figure 1.23 shows Zambia trade routes while Figure 1.24 shows mode selection between Zambia and Dar es Salaam port. The assumptions for future corridor share and modal share are shown in Tables 1.38 and 1.39, which refer to Zambian rail studies rather than applying the corridor choice model and modal choice model mentioned above. The results of the estimates are shown in Tables 1.38 to 1.40.
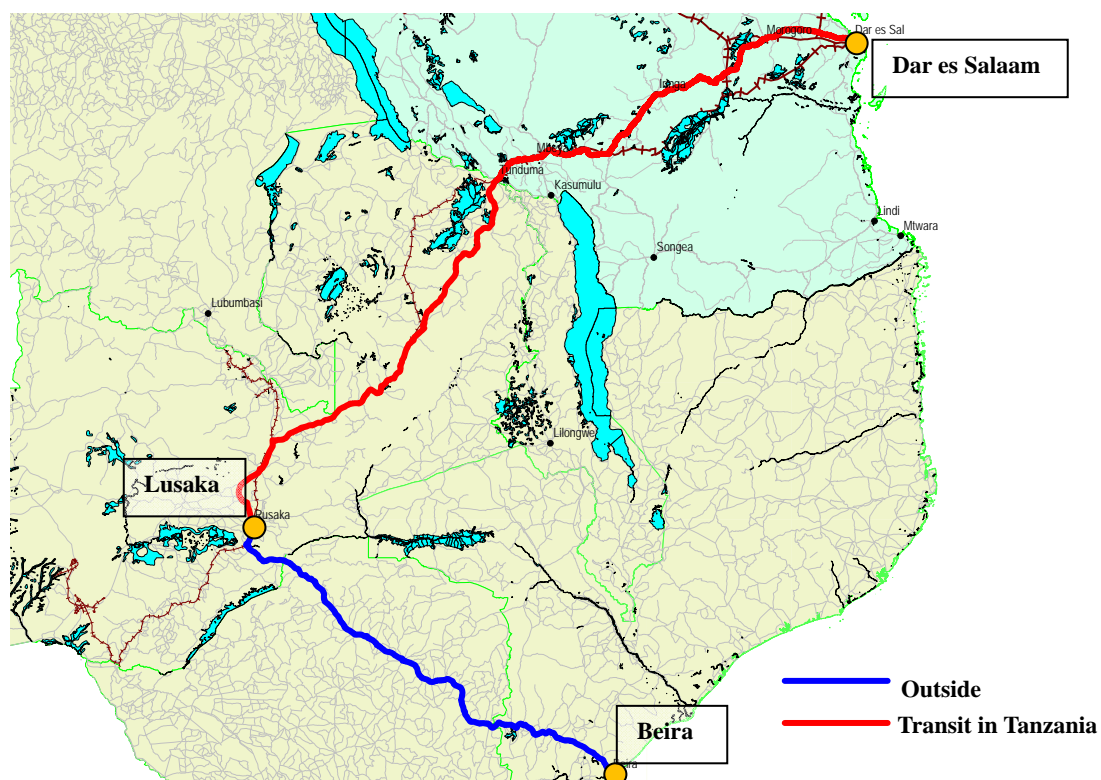
Figure 1.23: Zambian Trade Routes
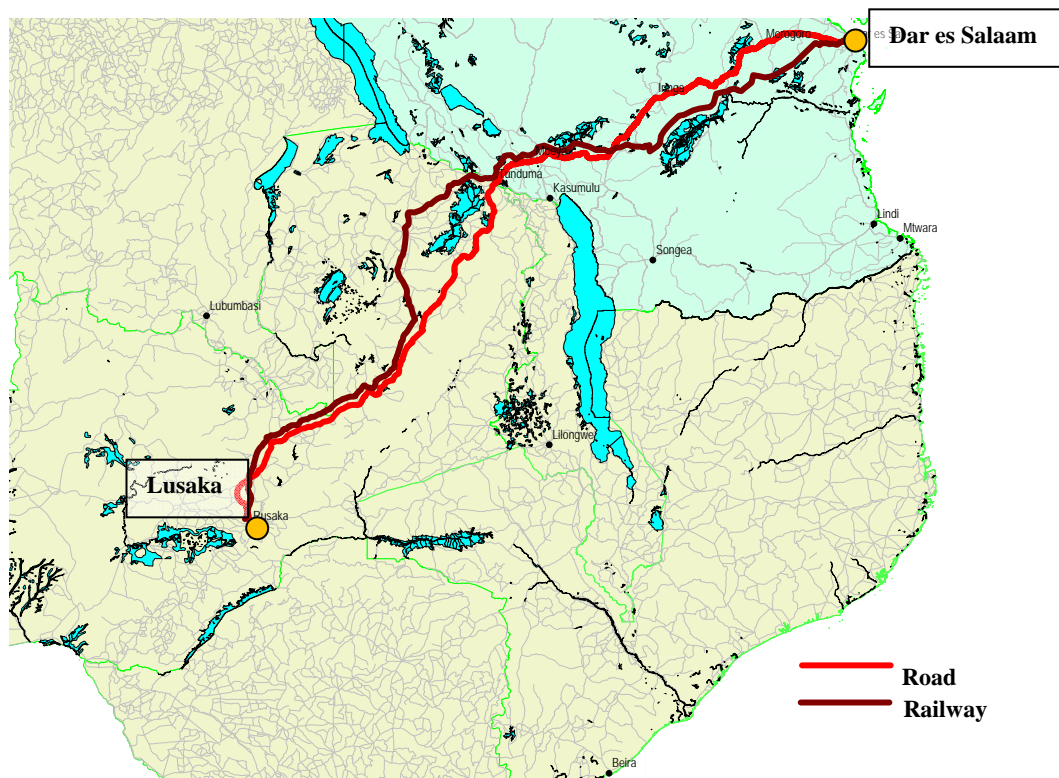
Figure 1.24: Mode Selection between Zambia and Dar es Salaam Port

Table 1.38: Corridor Share of Transit Freight from/to Zambia

			Baseline			Master Plan Network		
			Other Corridor	Dar es Salaam Corridor	Total	Other Corridor	Dar es Salaam Corridor	Total
2010	Import	Volume (000 ton)	3,938	1,112	5,050			
		(%)	78.0%	22.0%	100.0%			
	Export	Volume (000 ton)	1,440	229	1,669			
		(%)	86.3%	13.7%	100.0%			
2030Volume (Conservative Growth Rate)	Import	Volume (000 ton)	14,285	4,035	18,319	15,572	2,748	18,319
		(%)	78.0%	22.0%	100.0%	85.0%	15.0%	100.0%
	Export	Volume (000 ton)	5,530	881	6,410	6,411	641	6,410
		(%)	86.3%	13.7%	100.0%	90.0%	10.0%	100.0%
2030Volume (Target Growth Rate)	Import	Volume (000 ton)	25,800	7,287	33,086	28,124	4,963	33,086
		(%)	78.0%	22.0%	100.0%	85.0%	15.0%	100.0%
	Export	Volume (000 ton)	9,379	1,494	10,872	9,785	1,087	10,872
		(%)	86.3%	13.7%	100.0%	90.0%	10.0%	100.0%

Source: JICA Study Team

Table 1.39: Estimated Modal Share of Transit Freight from/to Zambia

Unit: 1,000 tonnes

Year	Import			Export		
	Road	Railway	Total	Road	Railway	Total
2010	974	138	1,112	28	202	229
	87.6%	12.4%	100.0%	12.0%	88.0%	100.0%
2030 (Conservative Growth Rate)	2,407	340	2,748	77	564	641
	87.6%	12.4%	100.0%	12.0%	88.0%	100.0%
2030 (Target Growth Rate)	4,348	615	4,963	131	956	1,087
	87.6%	12.4%	100.0%	12.0%	88.0%	100.0%

Source: JICA Study Team

**Table 1.40: Estimated Demand by Railway of Zambia Transit Freight
by Commodity**

Unit: 1,000 tonnes

Type of Commodity	2030 (Conservative Growth Rate)		2030 (Target Growth Rate)	
	Import	Export	Import	Export
Agricultural Products	13	39	23	66
Mineral Products	118	395	214	670
Fuel/Petroleum	96	1	173	1
Agricultural Processed Products	12	122	21	207
Industrial Products	101	7	183	13
Transportation	1	0	1	0
Total	340	564	615	956

Source: JICA Study Team

(5)   Freight of the DRC

According to the surveys for this Study, the existing east-west freight movement for the trading between DRC and Tanzania in the Lake Tanganyika consists of local trade between both side of coastal area by small ships. Besides, there is no magnitude of population and city in the hinterland of Kalemia port. Therefore, the Study team assumes that the east-west freight movement in the Lake Tanganyika is possibly small for taking into consider in the forecast.

For the DRC it was assumed that there are two independent economic centers where freight traffic is generated and attracted between the eastern part of the country and Tanzania: Bukavu and Lubumbashi. The total trade volume of the DRC was estimated based on the OD table (based on an analysis of ASYCUDA data), which may be divided with 52% for Bukavu and 48% for Lubumbashi.

Table 1.41 summarizes the total amount of freight including transit freight originating from and attracted to the northern part of eastern DRC (represented by Bukavu). Total trade in 2030 was estimated in the range of 10.6 to 13.8 million tonnes for imports and between 5.5 and 7.2 million tonnes for exports. The transit freight volume was estimated between 6.0 and 8.0 million tonnes for imports and 4.2 and 5.6 million tonnes for exports.

Table 1.41: Trade Volume Estimates of DRC (Bukavu)

Unit: 1,000 tonnes

Year/Scenario	Import/ Export	Total Trade	Overseas Trade	Trade with Tanzania
2010	Import	2,528	1,585	78
	Export	1,419	1,166	1
2030 (Conservative Growth Rate)	Import	10,574	5,956	467
	Export	5,509	4,241	7
2030 (Target Growth Rate)	Import	13,764	7,963	668
	Export	7,246	5,554	9

Source: JICA Study Team

Figure 1.25 shows routes for DRC (Bukavu) trade. As shown in Table 1.42, shares of import transit freight in 2010 were 81.5% for the Northern Corridor and 18.5% for Central Corridor. The share of export transit is 93.7% for Northern Corridor and 6.3% for the Central Corridor. Table 1.42 also shows how these corridor shares and the corresponding freight volume will change in 2030 assuming improvements in the service level of the Central Corridor with implementation of the Master Plan Network.
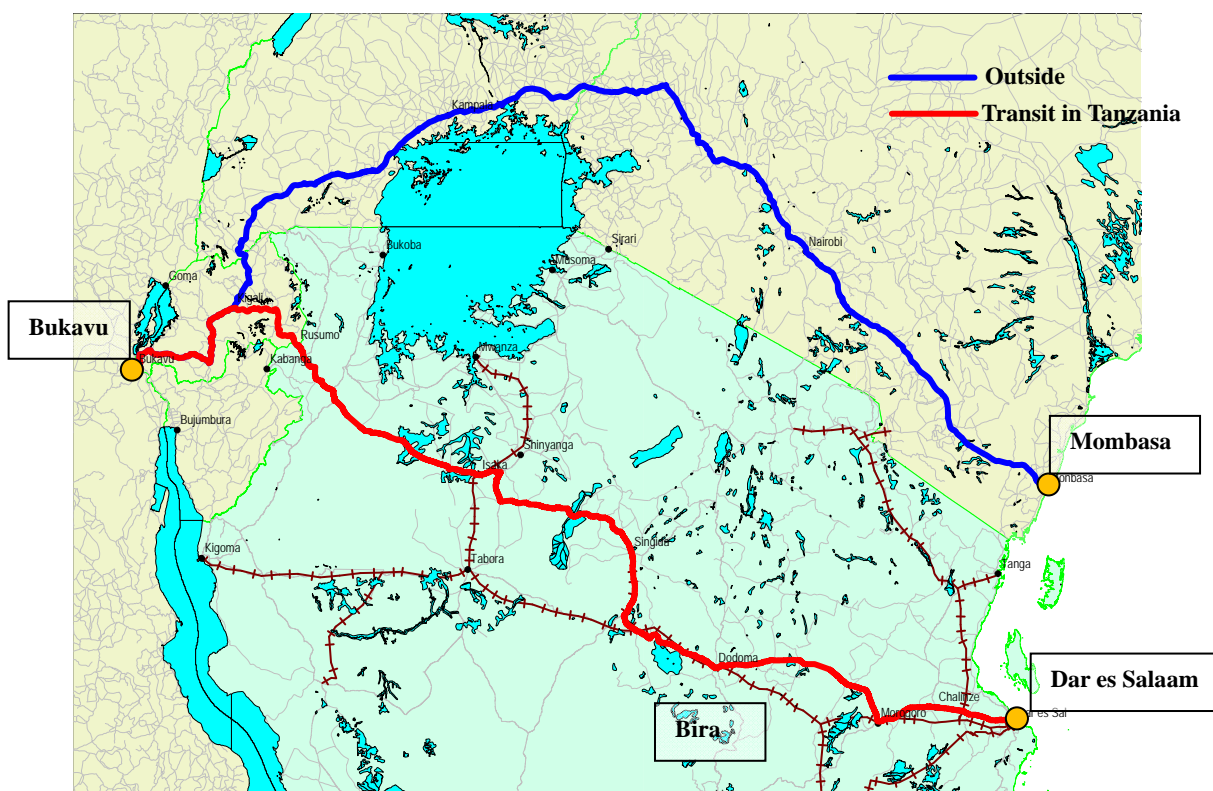
Figure 1.25: Routes for DRC (Bukavu) Trade

Table 1.42: Corridor Shares of Transit Freight from/to DRC (Bukavu)

			Baseline			Master Plan Network		
			Northern Corridor	Central Corridor	Total	Northern Corridor	Central Corridor	Total
2010	Import	Volume (000 tonnes)	1,292	293	1,585			
		(%)	81.5%	18.5%	100.0%			
	Export	Volume (000 tonnes)	1,092	74	1,166			
		(%)	93.7%	6.3%	100.0%			
2030Volume (Conservative Growth Rate)	Import	Volume (000 tonnes)	4,856	1,101	5,956	4,564	1,393	5,956
		(%)	81.5%	18.5%	100.0%	76.6%	23.4%	100.0%
	Export	Volume (000 tonnes)	3,972	269	4,241	4,242	808	4,241
		(%)	93.7%	6.3%	100.0%	81.0%	19.0%	100.0%
2030Volume (Target Growth Rate)	Import	Volume (000 tonnes)	6,492	1,471	7,963	6,101	1,862	7,963
		(%)	81.5%	18.5%	100.0%	76.6%	23.4%	100.0%
	Export	Volume (000 tonnes)	5,202	352	5,554	4,497	1,058	5,554
		(%)	93.7%	6.3%	100.0%	81.0%	19.0%	100.0%

Source: JICA Study Team

Figure 1.26 shows assumed routes for mode choice between the DRC (Bukavu) and Dar es Salaam port. As shown in Tables 1.43 and 1.44, modal shares and volumes transported by commodity between Bukavu and Dar es Salaam were estimated (assuming the same route condition as between Kigali and Dar es Salaam). .
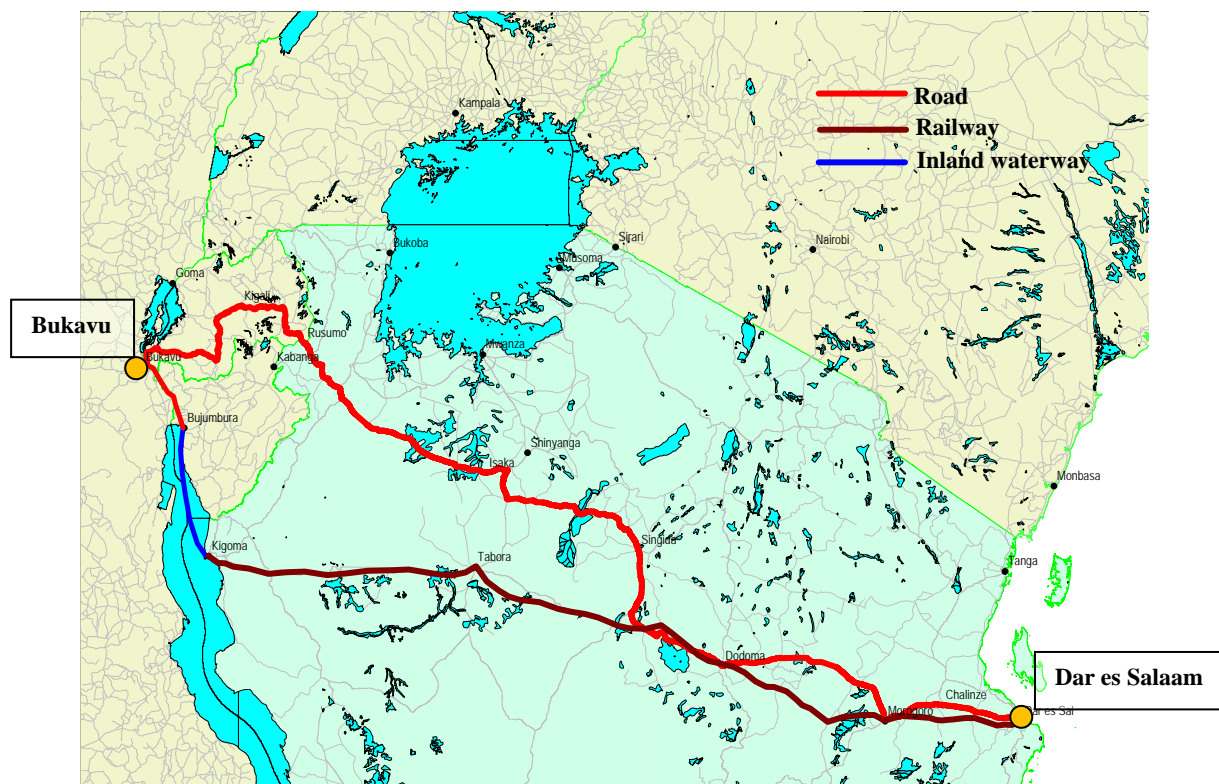
Figure 1.26: Assumed Routes for Mode Choice between DRC (Bukavu) and Dar es Salaam Port

Table 1.43: Estimated Modal Share of Transit Freight from/to DRC (Bukavu)

Unit: 1,000 tonnes

Year	Import			Export		
	Road	Railway	Total	Road	Railway	Total
2010	276	17	293	61	13	74
	94.4%	5.6%	100.0%	82.3%	17.7%	100.0%
2030 (Conservative Growth Rate)	1,309	84	1,393	662	145	808
	94.0%	6.0%	100.0%	82.0%	18.0%	100.0%
2030 (Target Growth Rate)	1,750	112	1,862	867	190	1,058
	94.0%	6.0%	100.0%	82.0%	18.0%	100.0%

Source: JICA Study Team

Table 1.44: Estimated Demand by Railway of DRC (Bukavu) Transit by Commodity

Unit: 1,000 tonnes

Type of Commodity	2030 (Conservative Growth Rate)		2030 (Target Growth Rate)	
	Import	Export	Import	Export
Agricultural Products	29	1	38	2
Mineral Products	22	47	29	61
Fuel/Petroleum	15	90	20	118
Agricultural Processed Products	10	7	13	9
Industrial Products	9	1	11	1
Transportation	0	0	0	0
Total	84	145	112	190

Source: JICA Study Team

Table 1.45 shows the total amount of freight including transit freight from and to the southern part of eastern DRC (represented by Lubumbashi). Total trade was estimated in the range of 9.9 and 12.9 million tonnes for imports and between 5.2 and 6.8 million tonnes for exports. Transit volume was estimated between 5.6 and 7.5 million tonnes for imports and between 4.0 and 5.2 million tonnes for exports.

Table 1.45: Trade Volume Estimates of DRC (Lubumbashi)

Unit: 1,000 tonnes

Year/Scenario	Import/ Export	Total Trade	Overseas Trade	Trade with Tanzania
2010	Import	2,370	1,486	74
	Export	1,330	1,093	1
2030 (Conservative Growth Rate)	Import	9,914	5,584	438
	Export	5,165	3,976	6
2030 (Target Growth Rate)	Import	12,904	7,465	626
	Export	6,793	5,207	8

Source: JICA Study Team

Figure 1.27 shows routes for DRC (Lubumbashi) trade. The estimated corridor shares of import and export transit freight and the volume transported along the Dar es Salaam Corridor are summarized in Table 1.46. The share of the corridor was estimated at 19.7% for imports and 11.2% for exports based on the future network master plan. Figure 1.28 shows assumed routes for mode choice between the DRC (Lubumbashi) and Dar es Salaam port. Table 1.47 presents estimates of the mode share of railway between Lubumbashi and Dar es Salaam (2010 and 2030), while Table 1.48 presents estimates of volumes transported by commodity between Lubumbashi and Dar es Salaam in 2030.
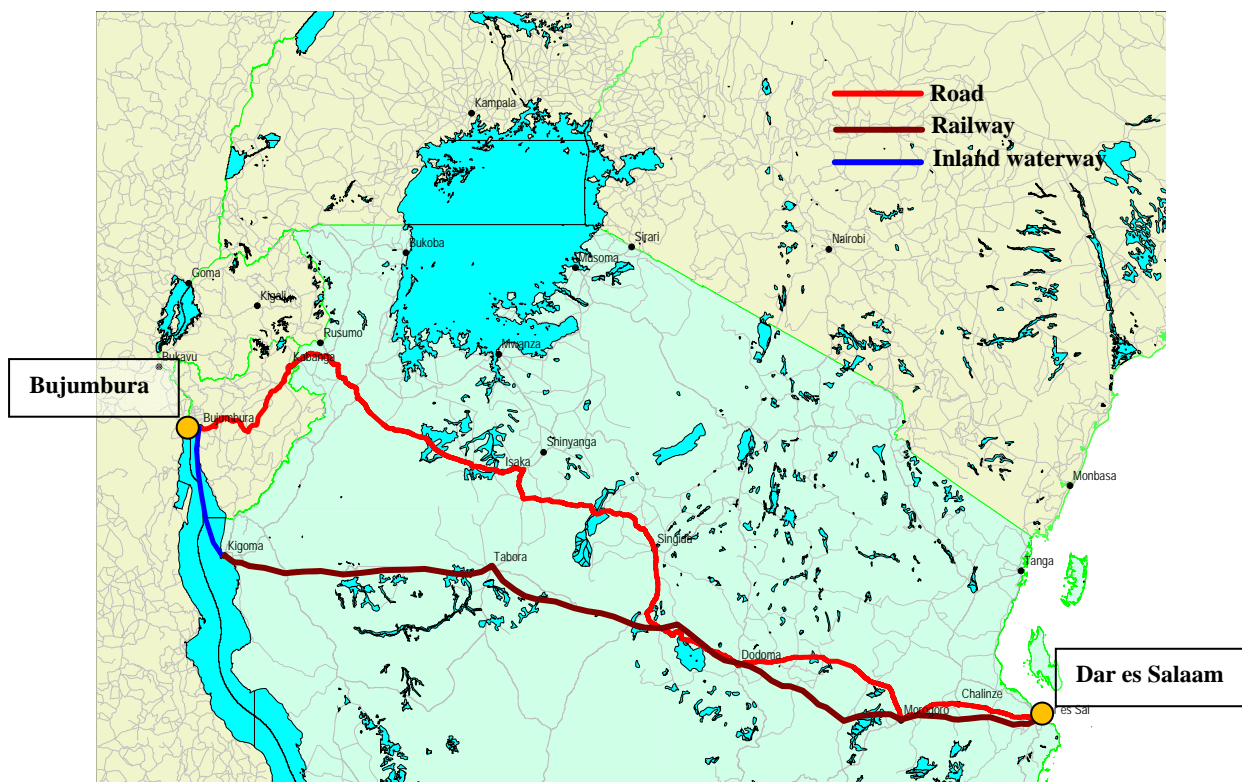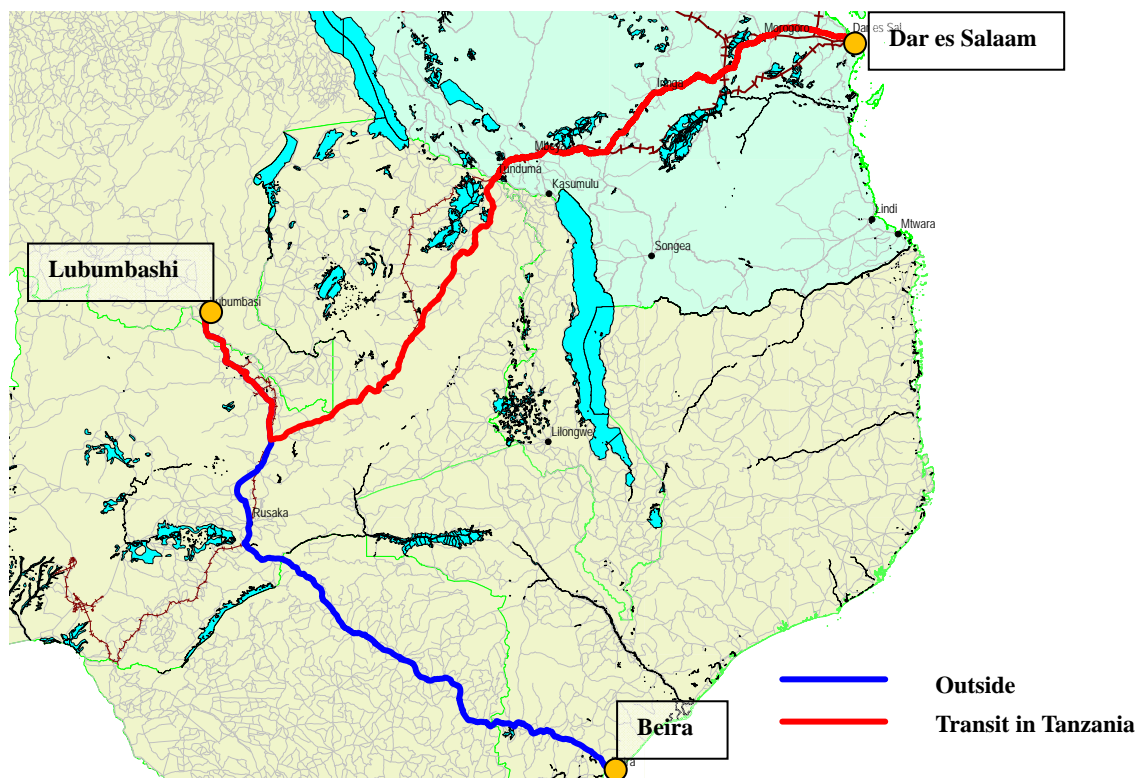
Figure 1.27: Routes for DRC (Lubumbashi) Trade

Table 1.46: Corridor Shares of Transit Freight from/to DRC (Lubumbashi)

			Baseline			Master Plan Network		
			Other Corridor	Dar es Salaam Corridor	Total	Other Corridor	Dar es Salaam Corridor	Total
2010	Import	Volume (000 ton)	1,211	275	1,486			
		(%)	81.5%	18.5%	100.0%			
	Export	Volume (000 ton)	1,024	69	1,093			
		(%)	93.7%	6.3%	100.0%			
2030Volume (Conservative Growth Rate)	Import	Volume (000 ton)	4,552	1,032	5,584	4,482	1,102	5,584
		(%)	81.5%	18.5%	100.0%	80.3%	19.7%	100.0%
	Export	Volume (000 ton)	3,724	252	3,976	3,977	444	3,976
		(%)	93.7%	6.3%	100.0%	88.8%	11.2%	100.0%
2030Volume (Target Growth Rate)	Import	Volume (000 ton)	6,086	1,379	7,465	5,992	1,474	7,465
		(%)	81.5%	18.5%	100.0%	80.3%	19.7%	100.0%
	Export	Volume (000 ton)	4,877	330	5,207	4,626	581	5,207
		(%)	93.7%	6.3%	100.0%	88.8%	11.2%	100.0%

Source: JICA Study Team
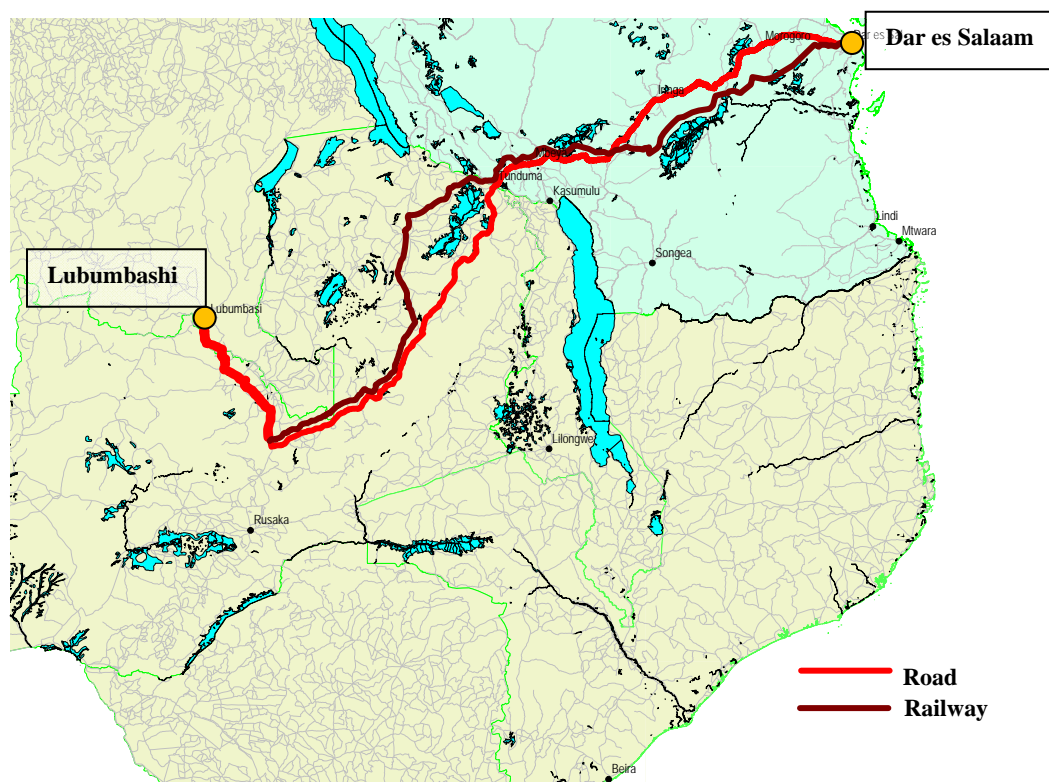
Figure 1.28: Assumed Routes for Mode Choice between DRC (Lubumbashi) and Dar es Salaam Port

Table 1.47: Estimated Modal Share of Transit Freight from/to DRC (Lubumbashi)

Unit: 1,000 tonnes

Year	Import			Export		
	Road	Railway	Total	Road	Railway	Total
2010	259	16	275	57	12	69
	94.4%	5.6%	100.0%	82.3%	17.7%	100.0%
2030 (Conservative Growth Rate)	1,036	66	1,102	364	80	444
	94.0%	6.0%	100.0%	82.0%	18.0%	100.0%
2030 (Target Growth Rate)	1,385	89	1,474	476	105	581
	94.0%	6.0%	100.0%	82.0%	18.0%	100.0%

Source: JICA Study Team

Table 1.48: Estimated Demand by Railway of DRC (Lubumbashi) Transit Freight by Commodity

Unit: 1,000 tonnes

Type of Commodity	2030 (Conservative Growth Rate)		2030 (Target Growth Rate)	
	Import	Export	Import	Export
Agricultural Products	23	1	30	1
Mineral Products	17	26	23	34
Fuel/Petroleum	12	49	16	65
Agricultural Processed Products	8	4	10	5
Industrial Products	7	0	9	0
Transportation	0	0	0	0
Total	66	80	89	105

Source: JICA Study Team

1.4.4 Traffic on the Network

In order to evaluate the performance of a network plan, OD tables were assigned on the transportation network and traffic volumes were estimated for each road section. The following cases were established to analyze the impact of the network plan by comparing the results of each case.

- Current Case: distributes the existing OD table estimated on the existing highway network.
- Without Case: distributes the future OD table estimated on the existing highway network.
- Master Plan Case: distributes the future OD matrix estimated on the master plan highway network, which includes future highway projects.

Figure 1.29 illustrates the freight volume of each road section, while Table 1.49 summarizes the estimated freight volume of representative road sections of the main corridors (Figure 1.30 shows the corridors analyzed).
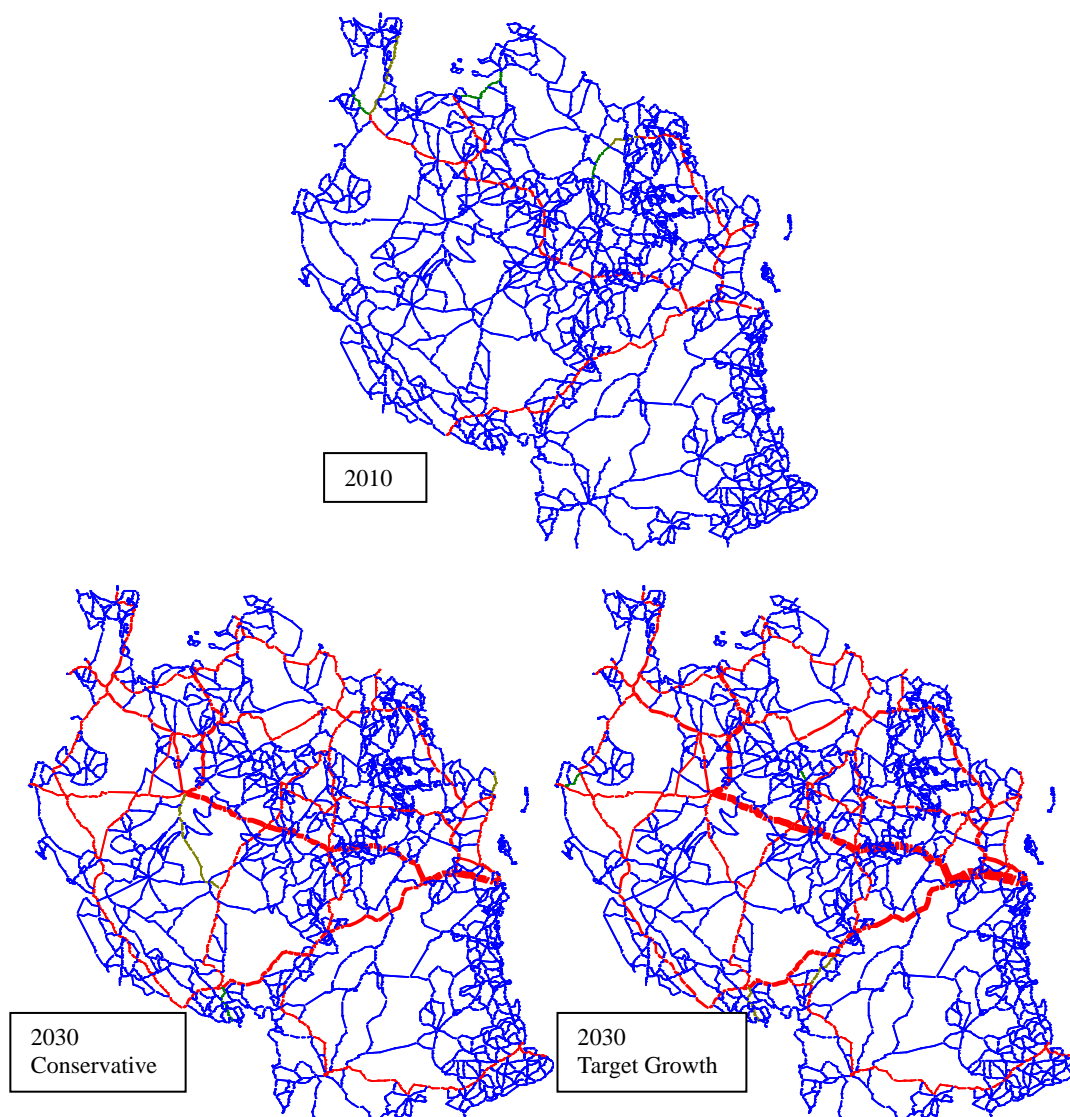
Figure 1.29: Estimated Freight Volumes on the Networks

Table 1.49: Estimated Freight Volumes by Corridor

Unit: million tonnes

			2010	Do Nothing (2030) Conservative Growth Rate	Master Plan (2030) Target Growth Rate
Arusha Corridor					
Lake Victoria	-	Arusha	-	1,500	10,400
Arusha	-	Tanga	7,900	26,600	40,300
Sirari Corridor					
Biharamulu	-	Sirari	1,800	10,600	9,200
Central Corridor					
Dar es Salaam	-	Dodoma	16,300	76,800	109,400
Dodoma	-	Nzega	15,800	70,200	101,700
Nzega	-	Rusumo	4,600	27,200	28,800
Dar es Salaam Corridor					
Morogoro	-	Iringa	9,500	49,200	66,400
Iringa	-	Tunduma	6,200	35,300	52,700
Coastal Corridor					
Mtwara	-	Dar es Salaam	-	-	-
Dar es Salaam	-	Tanga	6,600	21,200	52,900
Mtwara Corridor					
Mtwara	-	Masasi	100	1,100	10,000
Masasi	-	Mbamba Bay	-	-	-
Namanga Corridor					
Iringa	-	Dodoma	1,400	5,900	12,900
Dodoma	-	Manyara	1,800	8,400	21,500
Manyara	-	Namanga	300	2,000	8,500
Sumawanga Corridor					
Tunduma	-	Sumbawanga	600	7,200	17,600
Sumbawanga	-	Mpanda	100	1,500	14,500
Mpanda	-	Kasulu	0	200	7,300
Kasulu	-	Nyakanazi	1,300	6,500	8,800

Source: JICA Study Team
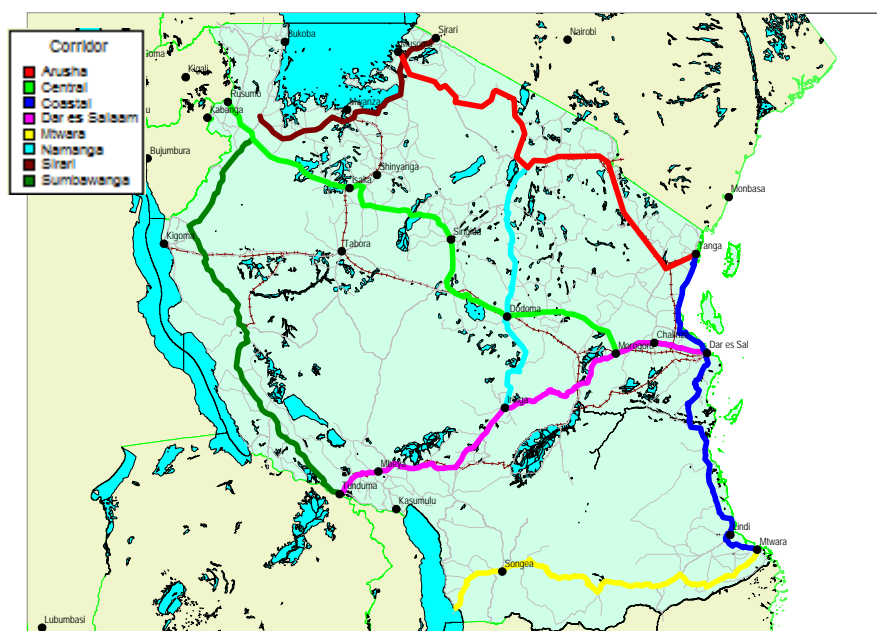
Figure 1.30: Corridors Analyzed

1.4.5   Estimates of Railway Freight Volume

The demand for railway transport was estimated based on the following considerations:

- Freight that can be transported by railway consists of long-distance domestic cargo transported between Dar es Salaam and major cities, and transit freight from/to neighbouring countries.
- The modal share model discussed in Section 1.4.1 was applied in the estimation, except for transit freight between Malawi and Zambia.
- Two different cases were employed in the estimation:
  Case 1: Transport time will be reduced with improvement of the railway operation system and transport cost would remain the same as at present. This case was analyzed in section 1.4.3.
  Case 2: Transport time will be reduced with the improvement of railway operation system as in Case 1, while transport cost is halved from the existing one.

Table 1.50 summarizes the results of the estimation, while Tables 1.51 to 1.53 present details of the estimation by corridor and origin and destination.

Table 1.50: Estimated Railway Freight Volume by Line

Unit: 1,000 tonnes

Year	Case		Item	TRL			TAZARA
				Mwanza Line	Kigoma Line	Total	
2010			Domestic	158	15	173	46
			Transit	77	104	181	427
			Total	235	119	354	473
			Railway Share (%)	4.0%	8.3%	4.8%	10.4%
2030	Conservative Growth Rate	Case 1	Domestic	1,074	102	1,176	488
			Transit	709	475	1,184	1,134
			Total	1,783	577	2,360	1,622
			Railway Share (%)	8.1%	9.7%	8. 4%	10.7%
		Case 2	Domestic	1,852	188	2,040	743
			Transit	799	520	1,319	1,164
			Total	2,650	708	3,359	1,907
			Railway Share (%)	12.0%	11.9%	12.0%	12.6%
	Target Growth Rate	Case 1	Domestic	1,802	191	1,993	906
			Transit	973	528	1,501	1,874
			Total	2,775	719	3,495	2,780
			Railway Share (%)	7.5%	7.9%	7. 6%	10.8%
		Case 2	Domestic	3,108	353	3,461	1,379
			Transit	1,100	584	1,684	1,914
			Total	4,208	937	5,144	3,293
			Railway Share (%)	11.3%	10. 4%	11. 1%	12.8%

Source: JICA Study Team

Table 1.51: Estimated Railway Freight Volume by Corridor, 2010

Unit: 1,000 tonnes

Corridor	Origin and Destination			Domestic		Transit		Total
				to DSM	from DSM	Import	Export	
Dar es Salaam Corridor	DSM	Mbeya	Total	1,705	992			2,697
			Road	1,705	946			2,651
			Railway		46			46
			Share (%)		4.6%			1.7%
	DSM	Zambia	Total			1,112	229	1,342
			Road			974	28	1,002
			Railway			138	202	340
			Share (%)			12.4%	88.0%	25.3%
	DSM	DRC	Total			293	74	367
			Road			276	61	337
			Railway			17	13	30
			Share (%)			5.6%	17.7%	8.1%
	DSM	Malawi	Total			132	1	132
			Road			74	1	74
			Railway			58	0	58
			Share (%)			44.0%	4.3%	43.8%
	Total		Total	1,705	992	1,537	304	4,537
			Road	1,705	946	1,324	89	4,064
			Railway	0	46	212	215	473
			Share (%)	0.0%	4.6%	13.8%	70.7%	10.4%
Kigoma Line	DSM	Kigoma	Total	473	276			749
			Road	473	261			734
			Railway		15			15
			Share (%)		5.4%			2.0%
	DSM	Burundi	Total			328	14	341
			Road			253	12	265
			Railway			75	1	77
			Share (%)			22.9%	10.8%	22.4%
	DSM	DRC	Total			275	69	344
			Road			259	57	316
			Railway			16	12	28
			Share (%)			5.6%	17.7%	8.1%
	Total		Total	473	276	602	83	1,434
			Road	473	261	512	69	1,315
			Railway	0	15	91	14	119
			Share (%)	0.0%	5.4%	15.0%	16.6%	8.3%
Central Corridor	DSM	Shinyanga	Total	575	1,364			1,940
			Road	575	1,302			1,878
			Railway		62			62
			Share (%)		4.5%			3.2%
	DSM	Rwanda	Total			261	11	272
			Road			199	11	210
			Railway			62	0	62
			Share (%)			23.9%	0.0%	22.9%
	Total		Total	575	1,364	261	11	2,212
			Road	575	1,302	199	11	2,088
			Railway	0	62	62	0	124
			Share (%)	0.0%	4.5%	23.9%	0.0%	5.6%
Central Corridor	DSM	Mwanza	Total	1,427	2,242			3,669
			Road	1,427	2,146			3,573
			Railway		96			96
			Share (%)		4.3%			2.6%
	DSM	Uganda	Total			33	0	33
			Road			19	0	19
			Railway			14	0	14
			Share (%)			43.2%	0.0%	43.0%
	Total		Total	1,427	2,242	33	0	3,702
			Road	1,427	2,146	19	0	3,592
			Railway	0	96	14	0	110
			Share (%)	0.0%	4.3%	43.2%	0.0%	3.0%

Source: JICA Study Team

Table 1.52: Estimated Railway Freight Volume by Corridor, 2030 (Conservative Growth Rate)

Unit: 1,000 tonnes

Corridor	Origin and Destination			Case 1					Case 2				
				Domestic		Transit			Domestic		Transit		
				to DSM	from DSM	Import	Export	Total	to DSM	from DSM	Import	Export	Total
Dar es Salaam Corridor	DSM	Mbeya	Total	4,702	4,886			9,588	4,702	4,886			9,588
			Road	4,702	4,398			9,100	4,702	4,143			8,845
			Railway		488			488		743			743
			Share (%)		10.0%			5.1%		15.2%			7.8%
	DSM	Zambia	Total			2,748	641	3,389			2,748	641	3,389
			Road			2,408	77	2,485			2,408	77	2,485
			Railway			340	564	904			340	564	904
			Share (%)			12.4%	88.0%	26.7%			12.4%	88.0%	26.7%
	DSM	DRC	Total			1,393	808	2,201			1,393	808	2,201
			Road			1,309	663	1,972			1,288	653	1,941
			Railway			84	145	229			105	155	260
			Share (%)			6.0%	18.0%	10.4%			7.5%	19.1%	11.8%
	DSM	Malawi	Total			0	0	0			0	0	0
			Road			0	0	0			0	0	0
			Railway			0	0	0			0	0	0
			Share (%)			0.0%	0.0%	-			0.0%	0.0%	-
	Total		Total	4,702	4,886	4,141	1,449	15,178	4,702	4,886	4,141	1,449	15,178
			Road	4,702	4,398	3,717	740	13,556	4,702	4,143	3,696	730	13,271
			Railway	0	488	424	709	1,622	0	743	445	719	1,907
			Share (%)	0.0%	10.0%	10.2%	49.0%	10.7%	0.0%	15.2%	10.8%	49.6%	12.6%
Kigoma Line	DSM	Kigoma	Total	1,596	1,647			3,243	1,596	1,647			3,243
			Road	1,596	1,545			3,141	1,596	1,459			3,055
			Railway		102			102		188			188
			Share (%)		6.2%			3.1%		11.4%			5.8%
	DSM	Burundi	Total			1,097	58	1,156			1,097	58	1,156
			Road			775	52	827			762	51	812
			Railway			322	7	329			336	8	343
			Share (%)			29.4%	11.2%	28.5%			30.6%	13.1%	29.7%
	DSM	DRC	Total			1,102	444	1,546			1,102	444	1,546
			Road			1,036	364	1,400			1,012	357	1,369
			Railway			66	80	146			90	87	177
			Share (%)			6.0%	18.0%	9.5%			8.2%	19.6%	11.5%

Corridor	Origin and Destination		Case 1					Case 2				
			Domestic		Transit			Domestic		Transit		
			to DSM	from DSM	Import	Export	Total	to DSM	from DSM	Import	Export	Total
	Total	Total	1,596	1,647	2,199	502	5,945	1,596	1,647	2,199	502	5,945
		Road	1,596	1,545	1,811	416	5,368	1,596	1,459	1,774	407	5,236
		Railway	0	102	389	86	577	0	188	426	95	708
		Share (%)	0.0%	6.2%	17.7%	17.2%	9.7%	0.0%	11.4%	19.3%	18.9%	11.9%
Central Corridor	DSM Shinyanga	Total	3,490	4,292			7,782	3,490	4,292			7,782
		Road	3,490	3,868			7,358	3,490	3,593			7,083
		Railway		424			424		699			699
		Share (%)		9.9%			5.4%		16.3%			9.0%
	DSM Rwanda	Total			989	55	1,044			989	55	1,044
		Road			720	53	773			703	53	756
		Railway			269	2	271			286	2	288
		Share (%)			27.2%	3.0%	26.0%			28.9%	3.2%	27.6%
	Total	Total	3,490	4,292	989	55	8,826	3,490	4,292	989	55	8,826
		Road	3,490	3,868	720	53	8,131	3,490	3,593	703	53	7,839
		Railway	0	424	269	2	695	0	699	286	2	987
		Share (%)	0.0%	9.9%	27.2%	3.0%	7.9%	0.0%	16.3%	28.9%	3.2%	11.2%
	DSM Mwanza	Total	5,125	7,018			12,143	5,125	7,018			12,143
		Road	5,125	6,368			11,493	5,125	5,866			10,991
		Railway		650			650		1,152			1,152
		Share (%)		9.3%			5.4%		16.4%			9.5%
	DSM Uganda	Total			878	278	1,156			878	278	1,156
		Road			465	253	718			396	249	645
		Railway			413	25	438			482	29	511
		Share (%)			47.0%	9.0%	37.9%			54.9%	10.4%	44.2%
	Total	Total	5,125	7,018	878	278	13,299	5,125	7,018	878	278	13,299
		Road	5,125	6,368	465	253	12,211	5,125	5,866	396	249	11,635
		Railway	0	650	413	25	1,088	0	1,152	482	29	1,663
		Share (%)	0.0%	9.3%	47.0%	9.0%	8.2%	0.0%	16.4%	54.9%	10.4%	12.5%

Source: JICA Study Team

Table 1.53: Estimated Railway Freight Volume by Corridor, 2030 (Target Growth Rate)

Unit: 1,000 tonnes

Corridor	Origin and Destination		Case 1 Domestic to DSM	Case 1 Domestic from DSM	Case 1 Transit Import	Case 1 Transit Export	Case 1 Total	Case 2 Domestic to DSM	Case 2 Domestic from DSM	Case 2 Transit Import	Case 2 Transit Export	Case 2 Total
Dar es Salaam Corridor	DSM Mbeya	Total	7,667	9,068			16,735	7,667	9,068			16,735
		Road	7,667	8,162			15,829	7,667	7,689			15,356
		Railway		906			906		1,379			1,379
		Share (%)		10.0%			5.4%		15.2%			8.2%
	DSM Zambia	Total			4,963	1,087	6,050			4,963	1,087	6,050
		Road			4,348	131	4,479			4,348	131	4,479
		Railway			615	956	1,571			615	956	1,571
		Share (%)			12.4%	88.0%	26.0%			12.4%	88.0%	26.0%
	DSM DRC	Total			1,862	1,058	2,920			1,862	1,058	2,920
		Road			1,750	868	2,618			1,722	855	2,577
		Railway			112	190	302			140	203	343
		Share (%)			6.0%	18.0%	10.4%			7.5%	19.1%	11.7%
	DSM Malawi	Total			0	0	0			0	0	0
		Road			0	0	0			0	0	0
		Railway			0	0	0			0	0	0
		Share (%)			0.0%	0.0%	-			0.0%	0.0%	-
	Total	Total	7,667	9,068	6,825	2,145	25,705	7,667	9,068	6,825	2,145	25,705
		Road	7,667	8,162	6,098	998	22,926	7,667	7,689	6,070	986	22,412
		Railway	0	906	727	1,147	2,780	0	1,379	755	1,159	3,293
		Share (%)	0.0%	10.0%	10.7%	53.5%	10.8%	0.0%	15.2%	11.1%	54.0%	12.8%
	DSM Kigoma	Total	2,727	3,090			5,817	2,727	3,090			5,817
		Road	2,727	2,899			5,626	2,727	2,737			5,464
		Railway		191			191		353			353
		Share (%)		6.2%			3.3%		11.4%			6.1%
	DSM Burundi	Total			1,116	63	1,179			1,116	63	1,179
		Road			788	56	844			775	55	830
		Railway			328	7	335			341	8	350

Corridor	Origin and Destination		Case 1 Domestic to DSM	Case 1 Domestic from DSM	Case 1 Transit Import	Case 1 Transit Export	Case 1 Total	Case 2 Domestic to DSM	Case 2 Domestic from DSM	Case 2 Transit Import	Case 2 Transit Export	Case 2 Total
Kigoma Line		Share (%)			29.4%	11.2%	28.4%			30.6%	13.1%	29.7%
	DSM – DRC	Total Road Railway			1,474 1,385 89	581 476 105	2,054 1,861 193			1,474 1,353 120	581 467 114	2,054 1,820 234
		Share (%)			6.0%	18.0%	9.4%			8.2%	19.6%	11.4%
	Total	Total Road Railway	2,727 2,727 0	3,090 2,899 191	2,590 2,173 417	644 532 112	9,051 8,332 719	2,727 2,727 0	3,090 2,737 353	2,590 2,128 462	644 522 122	9,051 8,114 937
		Share (%)	0.0%	6.2%	16.1%	17.3%	7.9%	0.0%	11.4%	17.8%	19.0%	10.4%
Central Corridor	DSM – Shinyanga	Total Road Railway	6,483 6,483	7,195 6,484 710			13,677 12,967 710	6,483 6,483	7,195 6,022 1,172			13,677 12,505 1,172
		Share (%)		9.9%			5.2%		16.3%			8.6%
	DSM – Rwanda	Total Road Railway			1,231 896 335	74 72 2	1,305 967 338			1,231 875 356	74 72 2	1,305 947 358
		Share (%)			27.2%	3.0%	25.9%			28.9%	3.2%	27.5%
	Total	Total Road Railway	6,483 6,483 0	7,195 6,484 710	1,231 896 335	74 72 2	14,982 13,934 1,048	6,483 6,483 0	7,195 6,022 1,172	1,231 875 356	74 72 2	14,982 13,452 1,531
		Share (%)	0.0%	9.9%	27.2%	3.0%	7.0%	0.0%	16.3%	28.9%	3.2%	10.2%
	DSM – Mwanza	Total Road Railway	8,718 8,718	11,789 10,697 1,092			20,508 19,416 1,092	8,718 8,718	11,789 9,854 1,936			20,508 18,572 1,936
		Share (%)		9.3%			5.3%		16.4%			9.4%

Corridor	Origin and Destination		Case 1 Domestic to DSM	from DSM	Transit Import	Export	Total	Case 2 Domestic to DSM	from DSM	Transit Import	Export	Total
Central Corridor	DSM Uganda	Total Road Railway			1,267 671 596	437 398 39	1,704 1,069 635			1,267 571 696	437 392 45	1,704 963 741
		Share (%)			47.0%	9.0%	37.3%			54.9%	10.4%	43.5%
	Total	Total Road Railway	8,718 8,718 0	11,789 10,697 1,092	1,267 671 596	437 398 39	22,212 20,484 1,727	8,718 8,718 0	11,789 9,854 1,936	1,267 571 696	437 392 45	22,212 19,534 2,677
		Share (%)	0.0%	9.3%	47.0%	9.0%	7.8%	0.0%	16.4%	54.9%	10.4%	12.1%

Source: JICA Study Team

Chapter 2   Moving from the Demand Forecasts to Corridor/ Sector Strategies

This chapter reviews the transport demand projections presented in Chapter 1 and allocates them to major corridors and modes. In that process, intermodality was taken into consideration. This process served as the basis for the strategies underlying the master plan (discussed in Chapter 3), and the specific projects for each mode identified to materialize these strategies (Chapters 4–7).

2.1   Demand Breakdown Procedures

As detailed in Chapter 1, growth in transport demand was projected based on the change in economic fundamentals in each region within Tanzania, as well as in countries neighbouring Tanzania. Overall demand was assigned to corridors and modes following the procedure explained in the following subsections. Figure 2.1 summarizes the demand forecasting and planning process undertaken. Various raw data and models were used to examine the master plan strategies and projects.
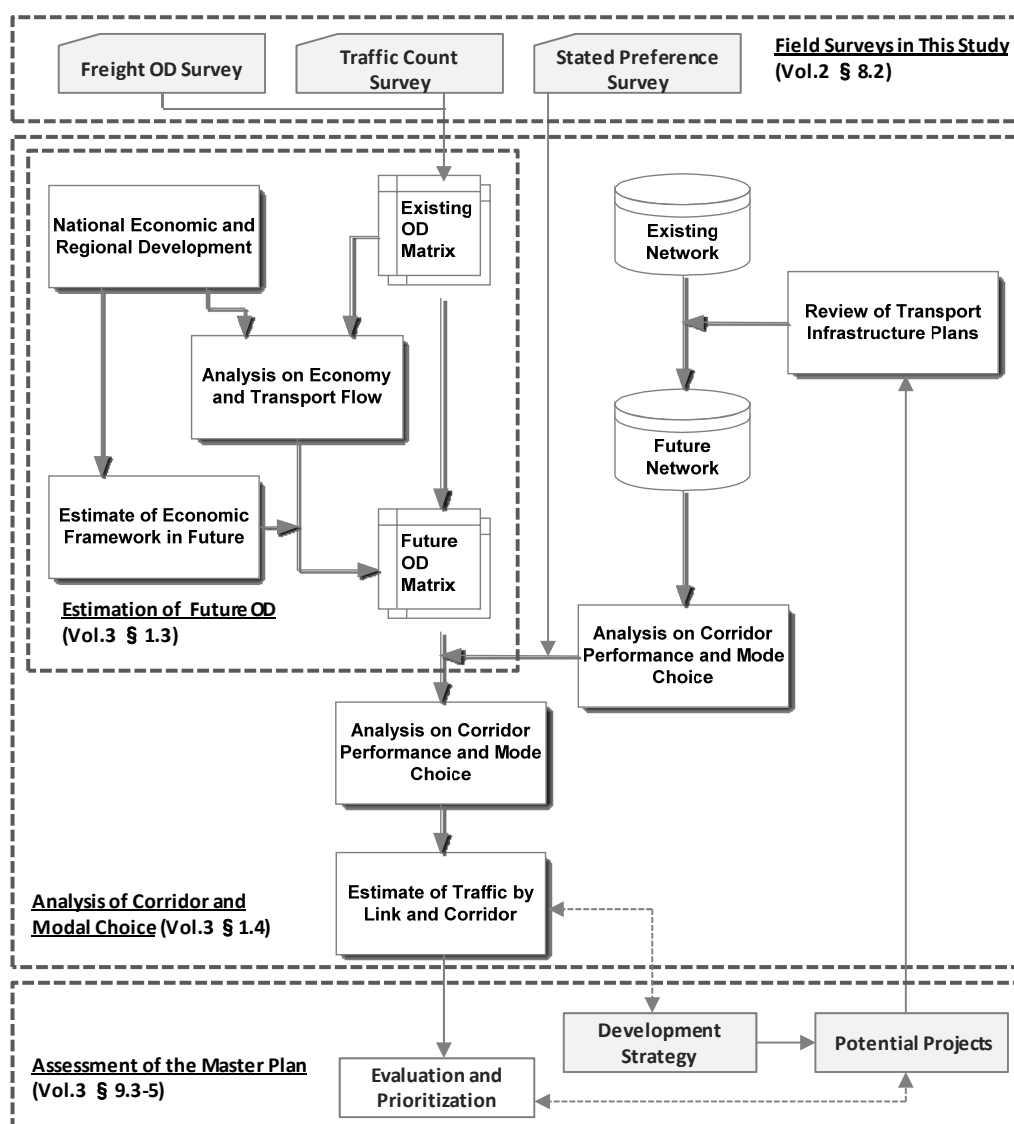

Figure 2.1: Demand Forecasting and Planning Process

2.1.1 Estimating the Overall Growth of Transport Demand

First, a model forecasting production and attraction of freight volume by zone, i.e., the sum of elements in the origin-destination (OD) matrix, was estimated based on the relationship between national and regional economic statistics and the volume of national imports, exports, regional production, and consumption. The model development process specified various parameters based on the data collected. The process and output (i.e., the OD matrix) were examined and calibrated to improve accuracy based from field surveys and existing statistics.

Future national and regional economic and regional development was projected based on the national economic plan and development projects, which was used as an input to the model to estimate of future OD matrices.

The future network was developed by improving and/or adding future projects onto the existing network. The following sector projects were considered to be included:

- New construction and improvement of road sections;
- Improvement of operational service level of existing railway lines;
- Improvement of handling capacity at existing seaports and lake ports;
- Construction of new international seaports; and
- Improvement of service levels of customs clearance at borders.

2.1.2 Demand Breakdown into Corridors

Figure 2.2 summarizes how corridor analysis was performed. The distribution of import and export freight to/from the landlocked countries (Uganda, Rwanda, Burundi, Zambia, Malawi, and the DRC) with the possibility of being transported in Tanzania as transit freight was picked up from the estimated OD table. For the projections of transit freight volume, corridor share was estimated by analyzing the level of service in alternative corridors for each landlocked country, e.g., the Northern Corridor to Mombasa, the Central Corridor to Dar es Salaam for Uganda.

In the corridor analysis, first, by using the corridor choice model and the data indicating the current service level of each corridor, the current share of each corridor was estimated and calibrated as a baseline case. Level of service data was the basis of corridor choice estimation and was composed of two indices: cost and the time of transport of competing corridor pairs.

Second, the corridor share was adjusted from the baseline with a mechanism that reduces transport time and cost based on improvement of the level of service of the corridors assuming implementation of the Master Plan, and then the freight volume was calculated based on the change of corridor share.
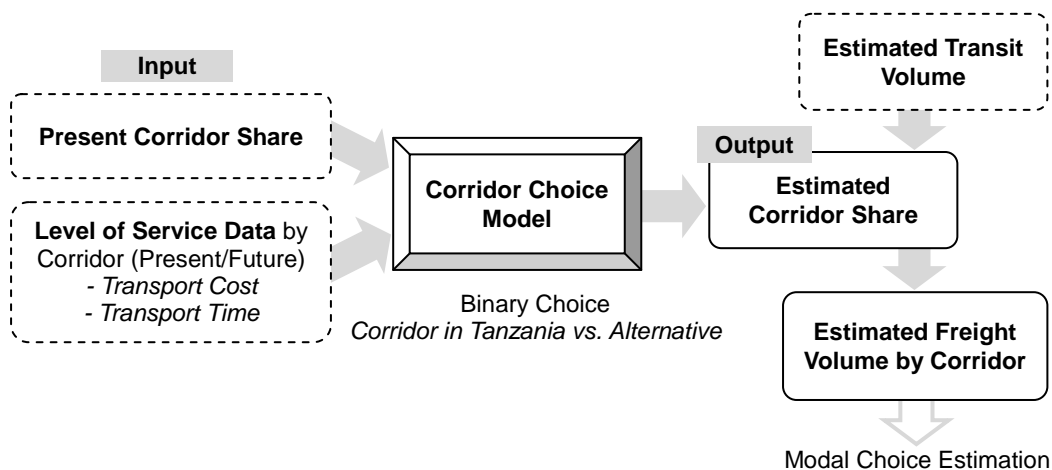
Figure 2.2: Process of Corridor Choice Estimation

2.1.3　Demand Breakdown into Modes by Strategic Corridor

Freight traffic to be transported in Tanzanian corridors was divided into mode chain route (e.g., road transport and railway) by applying the mode share model to estimate the probability of mode choice. This estimate was separately made for the landlocked countries (Uganda, Rwanda, Burundi, Zambia, and the DRC).

For the mode choice of transit freight in Tanzania, the modal choice model was constructed based on the data from the cargo owner interview survey. The interview survey asked "stated preference" of modal choice under hypothetical situations with improved railway service levels. Figure 2.3 presents an example of the stated preference question.

Figure 2.3: Example of the Stated Preference Question
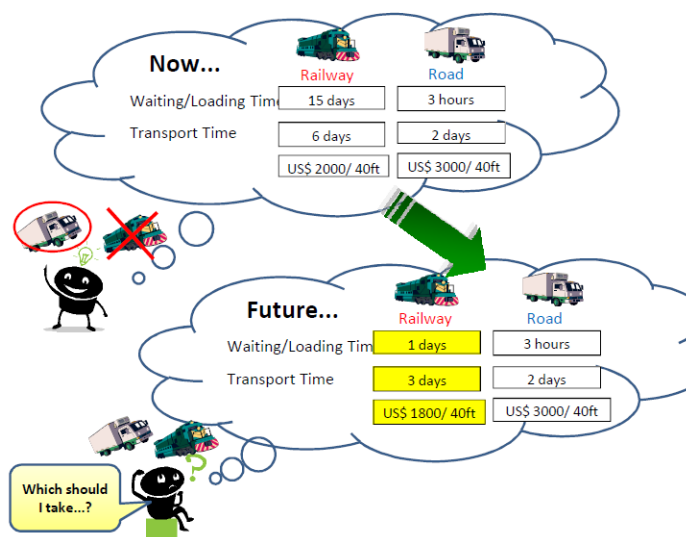
Figure 2.4 summarizes the process of modal choice estimation. In the first step, two routes (one by road and the other by railway) between a representative city of each country and Dar es Salaam were defined to compare the modes on specific. Second, the existing level of service (including waiting time, transport time, and the transport cost of each route) was calibrated to

reflect the existing modal share. Finally, future modal share was estimated by inputting into the model the future level of service assuming implementation of the Master Plan.
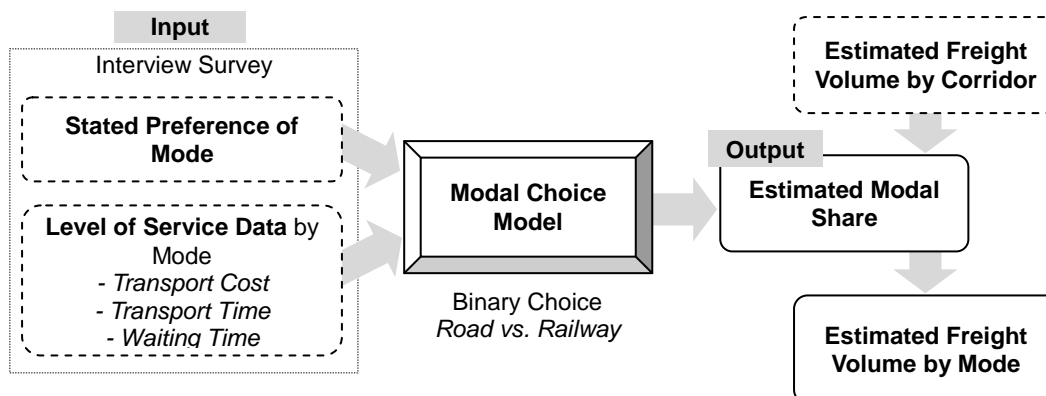

**Figure 2.4: Process of Modal Choice Estimation**

Figures 2.5 and 2.6 present breakdowns of transport demand in 2010 and 2030, respectively, based on these estimations.

Overall demand for land transport, including domestic and transit demand as defined in Chapter 1 (see Section 1.3) was estimated to increase from 37.07 million tonnes in 2010 to 284.19 million tonnes in 2030. This estimate for 2030 was allocated to two major corridors, the Central Corridor (36% of total) and the Dar es Salaam Corridor (16%), among others. Transport demand along these two corridors was further divided into road and rail, while demand among other corridors will only be for road transport.

The slight decrease in the shares of the two major corridors can partly be attributed to proposed road investments off the corridors (e.g., the north-south link in the west and other trunk roads). Also notable is relatively faster growth in the share of railway transport along these two corridors, reflecting the cost preferences of transporters.

Other than road and railway, an increase in demand of 204% was forecast for major ports (Dar es Salaam, Mwanza, and Kigoma), 370% for the three major international airports (Dar es Salaam, Kilimanjaro, and Mwanza), and 302% for two major oil refineries (in Dar es Salaam and Mwanza, as a proxy to measure pipeline capacity).

These are "order of magnitude" estimates of growth in transport demand, based primarily on the preference of transporters for cost savings. These estimates may be regarded as indicative of potential growth in transport demand, and were used as an input (together with other factors) in formulating infrastructure development strategies, as well as specific projects in each subsector.
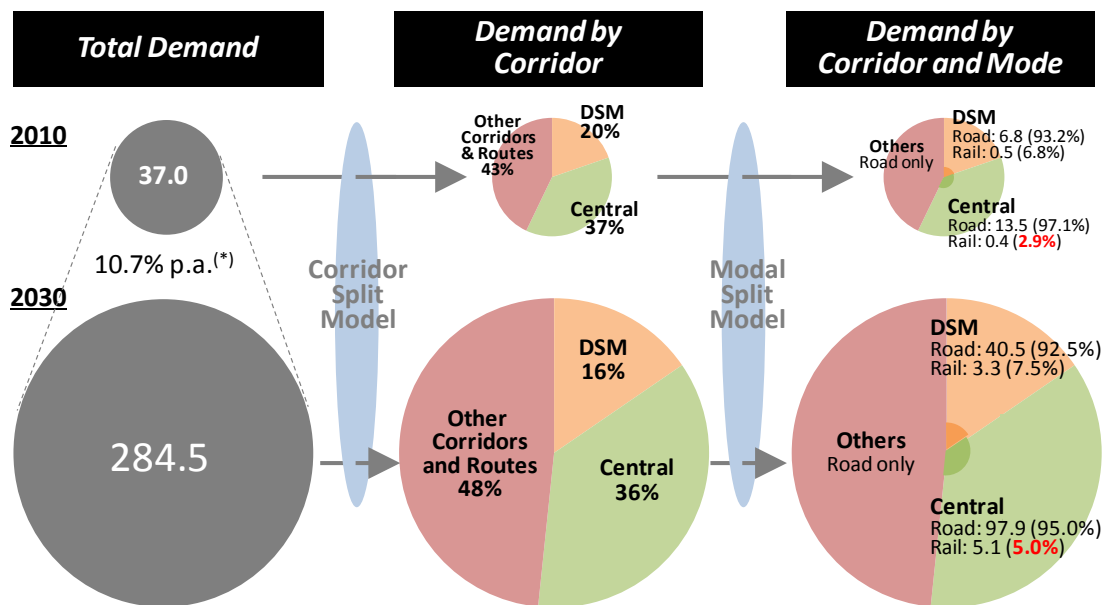
(*) A GDP growth of 8% p.a. and elasticities of 1.77 (imports) and 1.74 (exports) were assumed.
Unit: million tons
Source: JICA Study Team

Figure 2.5: Change in the Structure of Transport Demand
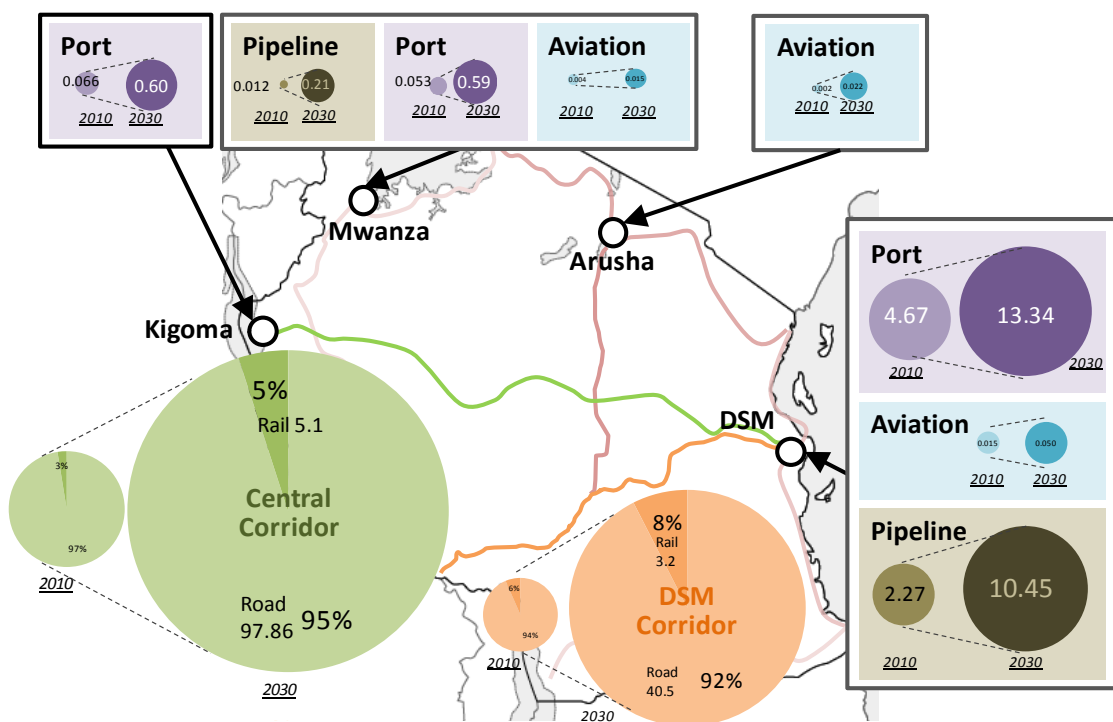
Note: Pipeline refers to the processing capacity of oil refineries, as a proxy for pipeline capacity.
Unit: million tons
Source: JICA Study Team

Figure 2.6: Overview of Potential Growth in Transport Demand

2.2 Intermodal Considerations by Cargo Type: Current Status and Implications

For Tanzania to serve the forecast demand growth as efficiently as possible, it will be important to optimize the combination/connection of different modes.

Each international corridor traversing Tanzania includes a variety of transport modes, i.e., road, railway, waterway, and pipeline. Therefore, transport costs may increase if transport intermodality is poor, or may decrease if there is effective transport intermodality. Therefore, it is important to assess effective means for transport intermodality in Tanzania. Figure 2.7 illustrates the concept of transport modes and their connections for intermodality in Tanzania and its neighbouring countries.
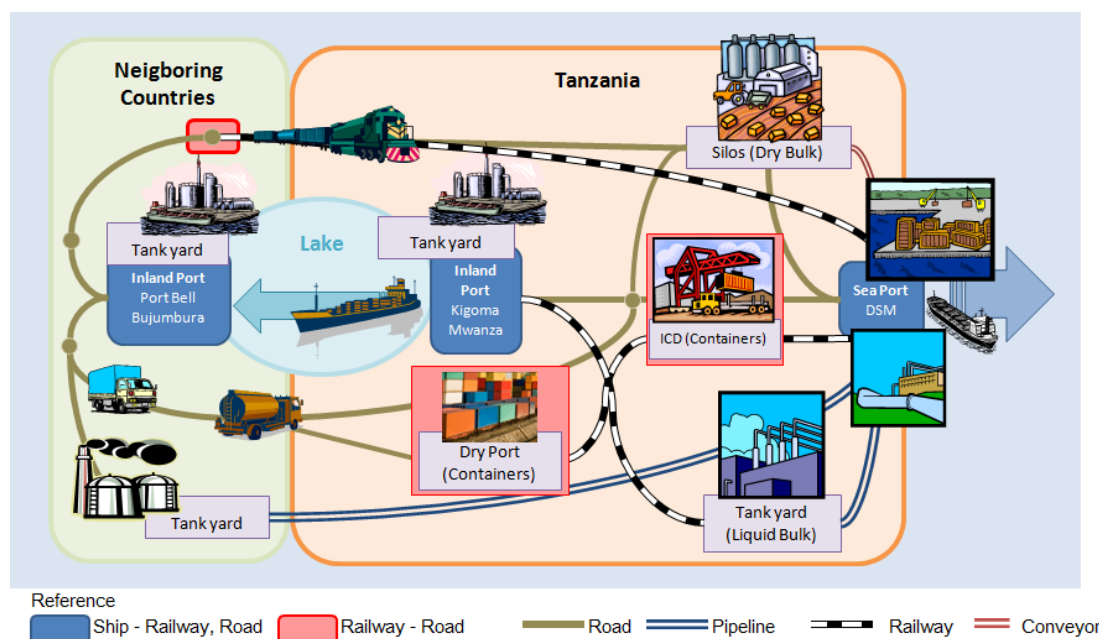

Figure 2.7: Transport Modes in Tanzania and Neighbouring Countries

2.2.1 Dry Bulk

Including transit cargo to and from the neighbouring countries, most dry bulk cargo (e.g., wheat) is imported at ***Dar es Salaam Port***, and stacked in silos or warehouses located at or near Dar es Salaam. In the case of wheat, the major dry bulk cargo in Tanzania, it is milled into flour in Dar es Salaam,[1] and then bagged and transported to the final destination by road or railway, without a change of mode. To reduce costs, containers can be transported by railway if the hauling distance is long or by road if the hauling distance is short.

After being transported along an international corridor, some of the bagged cargo will arrive at a lake port (e.g., ***Mwanza South Port***) by railway or road and then be transhipped to vessels plying between gateway ports (e.g., between Mwanza South Port and Port Bell Port in Uganda).

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[1] At Dar es Salaam Port, wheat is unloaded from the ship and transported by belt conveyors to silos located within the port premises. Some wheat is transported from the silos within the port premises to the silos of private industrial firms (e.g., flour mills and beer breweries) by road. From the silos of the private firms, some wheat is bagged and loaded on railway wagons and transported to Mwanza South Port, a lake port. Some is milled and bagged and then transported from the flour mill to distributors by road.

Effectively transhipping such bagged wheat or flour at the lake port is one of the keys for reducing transport cost as well as for assuring cargo owners of scheduled delivery.

2.2.2 Liquid Bulk

Liquid cargo (e.g., fuels) is imported at **Dar es Salaam** and unloaded by pipelines to nearby tank yards for storage. From the tank yards, some is transported by pipeline or road to consumers (e.g., power plants, fuel distributors), while others are transported by railway to tank yards located on the consumers' premises or at the lake ports (**Mwanza** and **Kigoma**) for re-export to the neighbouring countries (e.g., Burundi, the DRC).[2] From the lake ports in Tanzania oil tankers can transport fuel at low cost. In this regard, effective intermodality of liquid fuel from railway to ship is important to reduce fuel costs in neighbouring countries. Also, crude oil is unloaded by pipeline from seagoing crude oil carriers at Dar es Salaam and, after storage at the tank yard, pumped directly to Zambia through the Tanzania Zambia Mafuta Pipeline (TAZAMA) pipeline, which is the most economical mode for long-distance hauling on land.

Two measures may be employed to reduce fuel transport costs. One is to change the transport mode from road to railway between the two tank yards, which are far apart but are connected with railway, e.g., those at Dar es Salaam and Kigoma. The other is to encourage maritime transport on Lake Tanganyika for the re-export of fuel to Burundi and the DRC, and perhaps further to Rwanda through Bujumbura Port. To facilitate such a change, the Tanzania Railways Limited (TRL) railway between Dar es Salaam and Kigoma should be rehabilitated to ensure the security of cargo and time of delivery. The facilities needed for intermodal connectivity at the shunting yard for the tank yards and loading facilities for the oil jetties on Lake Tanganyika can be rehabilitated by the private sector once railway performance becomes more reliable.

2.2.3 Containers

Most transit containers are loaded onto or unloaded from oceangoing container vessels at Dar es Salaam Port. For imports, they are first stacked at the stacking yard in the container terminal of the port, from where some are transported to their final destinations by road, to inland container depots (ICDs) or dry ports by road or railway, or to the inland ports by railway. At the ICD or dry port they are transhipped from railway to road and at the lake ports they are transhipped from railway to ship.

Containerization is still at an early stage in Tanzania; within the country almost all containers are transported by road even though the hauling distance is not optimal for road transport (e.g., from Dar es Salaam to Kigoma, 1,000 km). **Isaka Inland Container Depot** and **Mbeya Dry Port**, which are located about 780 km and 850 km from Dar es Salaam, respectively, have been built as interchange points from railway to road. However, they have not yet erved this function effectively, partly due to institutional issues and poor railway performance of railways.[3] At **Kigoma Port**, there is a container gantry crane for loading/unloading containers to/from ships, but it has not been used for a long time, due to poor maintenance and railway performance.

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[2] From Kigoma Port, fuel is re-exported to the DRC by tanker vessel but re-exports to Burundi have been suspended for several years since it is not commercially viable. At Mwanza South Port, tanker vessels have not been used for a long time.

[3] For example, international multimodal transport is not allowed in Tanzania and multimodal transport operators cannot issue multimodal transport bills of lading. Consequently, the intermodality of containers between railway and road has not yet materialized even though an ICD and dry port were built for the purpose of facilitating the multimodal transport of containers within Tanzania.

In the case of container transport, there are several projects that have been formulated by the Government of Tanzania but have not yet progressed. If intermodal connectivity between railway and road at ICDs or dry ports is implemented as intended, transport costs and consequently the price of imported goods will be reduced, which in turn will improve the competitiveness of export goods.

The public sector should implement a number of measures to facilitate intermodality to reduce transport costs. One is deregulation to encourage multimodal transport operators to effectively use inland container depots and dry ports. Another is to provide efficient facilities at ICDs and dry port or to build efficient container terminals at lake ports as follows:

1) To upgrade ICDs and dry ports to facilitate the intermodal connectivity of containers between railway and road: Provision of cargo clearance and customs clearance at Isaka Inland Container Depot and Mbeya Dry Port and upgrading cargo handling facilities at the dry ports is considered effective to reduce container transport cost, since containers could then pass through Dar es Salaam Port without cargo and customs clearance, with a considerably shorter dwell time.

2) To provide container terminals at both Mwanza South Port and Kigoma Port: The container terminals should be equipped with proper container ship-to-shore (STS) cranes and other handling equipment. There should be a large container stacking yard and a railway container terminal of a proper size to meet container block trains.

2.2.4   Intermodal Implications for the Overall Strategy

From the above observations, it is apparent that there is relatively large scope for reducing costs for liquid bulk and containers. While the cost of transporting liquid fuels can be reduced most effectively through the pipelines programmed under the Energy Sector Master Plan, it will be necessary to further replace road transport with railway and lake transport. To increase containerization, not only the necessary physical infrastructure (e.g., ICDs, lake port facilities) are required, but also deregulation of carrier operations is needed so that they may make full use of such facilities. A new ICD is proposed at Kisarawe in order to increase storage capacity for containers outside of Dar es Salaam Port, with a link through the existing lines of TRL and the Tanzania Zambia Railway Authority (TAZARA). Also the capacity at Isaka ICD needs to be increased from the current track layout for 10-11 wagons to that for 30 wagons (see Chapter 4).

Figure 2.8 shows the modal composition of major cities and border points along the corridors. Considering the demand forecast results (Figures 2.5 and 2.6) and the assessment of modal implications, some key junctions where major modal connections take place can be identified. Such locations with strategic emphasis have been circled in pink in Figure 2.8. Their criticality will be further considered in the following chapters as a part of the overall strategy of this Master Plan and the specific subsector analyses, which detail additional potentials and constraints in the process of identifying specific projects.

Finally, Table 2.1 summarizes demand growth between 2010 and 2030 disaggregated by corridor and mode. Also, the budget allocation for the projects in each corridor and mode is shown in column on the far right of the table, with aggregates of the project amounts taken from Chapters 4–7. The allocation is not necessarily proportionate to the demand increase in a linear form since other critical factors have were also taken into account, as summarized in the chapters on each mode (subsector).
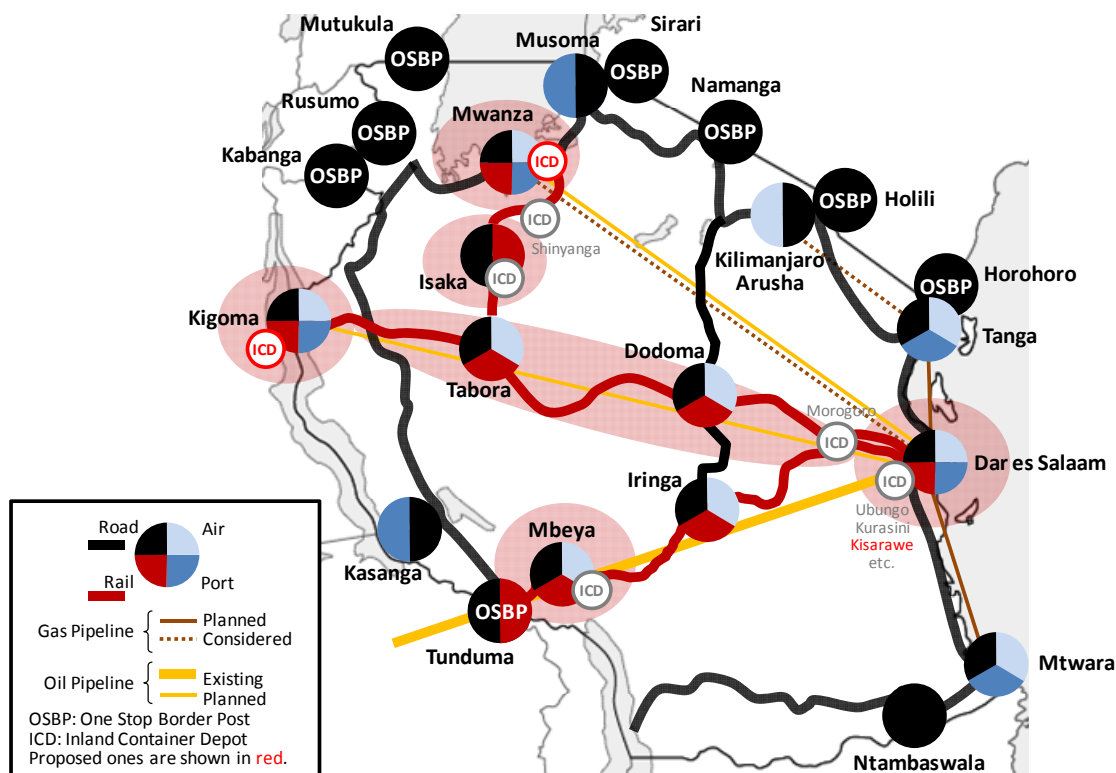
Source: JICA Study Team

Figure 2.8: Modal Composition at Major Locations

Table 2.1: Summary of Transport Demand Growth and Resource Allocation

Growth of Transport Demand							Tsh bn
		Mode	2010 (mn ton)	2030 (mn ton)	2010 ➜ 2030 (Change in mn ton)	2010 ➜ 2030 (% Change)	
Corridor	DSM	Road	6.82	40.51	33.68	494%	83.7
		Railway	0.47	3.29	2.82	595%	0
	Central	Road	13.52	97.86	84.34	624%	5,735.4
		Railway	0.35	5.14	4.79	1355%	1,382.5
	Others	Road	15.90	137.39	121.49	764%	15,444.3
City	DSM	Port	4.67	13.34	8.67	186%	1,064.9
		Aviation	0.02	0.05	0.04	234%	23.7
		Pipeline	2.27	10.45	8.18	360%	0
	Mtwara	Port	n.a.	n.a.	n.a.	n.a.	2,844.0
		Pipeline	n.a.	0.06	n.a.	n.a.	0
	Kigoma	Port	0.07	0.60	0.53	809%	39.5
	Arusha	Aviation	0.00	0.02	0.01	263%	15.8
	Mwanza	Aviation	0.00	0.02	0.02	783%	11.1
		Pipeline	0.01	0.21	0.20	1650%	0
		Port	0.05	0.59	0.54	1080%	52.8

Note: Investments for TAZARA have not been included, as they reflect the interest of, as well as the decisions by, the
countries other than Tanzania.
Source: JICA Study Team