No.

TRANSPORT PLANNING AUTHORITY
MINISTRY OF TRANSPORT
THE ARAB REPUBLIC OF EGYPT

MiNTS – MISR NATIONAL TRANSPORT STUDY

THE COMPREHENSIVE STUDY ON THE MASTER PLAN FOR NATIONWIDE TRANSPORT SYSTEM IN THE ARAB REPUBLIC OF EGYPT

FINAL REPORT

TECHNICAL REPORT 6

DEMAND SIMULATION AND SCENARIO TESTING

March 2012

JAPAN INTERNATIONAL COOPERATION AGENCY

ORIENTAL CONSULTANTS CO., LTD.
ALMEC CORPORATION
KATAHIRA & ENGINEERS INTERNATIONAL

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CHAPTER 1: INTRODUCTION

1.1 BACKGROUND

The Japan International Cooperation Agency (JICA) and the Transport Planning Authority of the Ministry of Transport are cooperating in the conduct of the *Comprehensive Study on The Master Plan for Nationwide Transport System in the Arab Republic of Egypt* (MiNTS – Misr National Transport Study), based upon agreements finalized during July, 2009[1]. Oriental Consultants Company Limited, headquartered in Tokyo, Japan, is the designated lead consultant for the study. Associated firms are Almec Corporation, Japan and Katahira & Engineers International, Japan. Technical efforts in Egypt were initiated during December, 2009.

1.2 THE MINTS FRAMEWORK

1.2.1 Study Scope and Objectives

A basic premise of all investigations is that the MiNTS shall be comprehensive in nature, that is, adopt approaches designed to mitigate transport problems and contribute to the sustainable development of the nation. Investigative efforts extend over the entirety of the Republic (Figure 1.2.1), with a particular focus being major corridors of movement for both persons and cargo. All major modes of transport are to be addressed including road, rail, maritime, inland waterway, air and pipeline. However, the practical master planning focus will be those modes falling under the jurisdiction of the Ministry of Transport; that is, the road, rail, maritime and inland waterway sectors.

Five key milestones form the foundation upon which planning efforts are based:

- Establish a nationwide, multi-modal database whose validity rests on a series of focused transport survey and data collection exercises;
- Formulate overall strategies and policies for development of the nationwide transport fabric;
- Develop an integrated, multi-modal transport master plan with years 2017, 2022 and 2027 being short, medium and ultimate planning horizons, respectively;
- Identification, within the master plan framework, of high-priority projects; and,
- Implementation of an effective and productive technology transfer program with Egyptian counterparts.

[1] *Scope of Work - Comprehensive Study on The Master Plan for Nationwide Transport System in the Arab Republic of Egypt*, as mutually agreed upon between the Japan International Cooperation Agency and the Ministry of Transport, Government of Egypt, July 16, 2009.

Source: JICA Study Team

Figure 1.2.1 MiNTS Study Area

The transport strategy embedded within MiNTS must concurrently contribute to an efficient economic structure, strengthen linkages within Egypt as well as with neighboring countries, and provide a base for market-oriented transport activity. Economic expansion within Egypt is well underway; continuing improvements in productivity and well-being are expected. As economic growth continues, changes in transport activities and behavior will follow suit. Thus, the foci of transport planning must gradually shift from alleviation of present deficiencies to realization of a transport system founded upon sustainable evolution and integrated, mutually supportive transport solutions. This strategy is particularly valid given the almost 20-year planning horizon adopted by MiNTS.

1.2.2 A Consultative Planning Process

The final structure of MiNTS, and the successful reception thereof, can only be achieved as a direct result of cooperative efforts and close liaison between the Study Team and local experts. Considerable efforts have, and are continuing to be, expended in gathering information, reviewing previous studies and holding numerous discussions to enhance knowledge of, and sensitivity to, local transport conditions, norms and practices.

The Study Team, housed in the offices of the Transport Planning Authority, Ministry of Transport, is being strongly assisted by its designated counterpart Special Working Group, Coordination Committee and Steering Committee. Thus, continuous and productive technical liaison is being maintained with a number of organizations including the Ministry of Transport and various entities thereof (Office of the Minister, Transport Planning Authority, Egypt National Railways, General Authority for Roads, Bridges and Land Transport, General Authority for River Transport, Maritime Transport Sector); the Ministry of Housing, Utilities and Urban Communities; Ministry of Civil Aviation; Ministry of Tourism; Ministry of Agriculture and

Land Reclamation; Ministry of Trade and Industry; Ministry of Industrial Development; Ministry of Interior; Ministry of Local Development; Ministry of Finance; State Ministry of Foreign Affairs, Sector of International Cooperation; Ministry of the Environment; CAPMAS (Central Agency for Public Mobilization and Statistics); as well as various Governorates and entities thereof. Close coordination has also been effected with Universities (University of Cairo, Ain Shams University) and various departments within those learned institutions.

Likewise, effective consultations are programmed with various international agencies, funding institutions, donors, and consultant groups in order to obtain an overview of previous, current, and likely future activities and/or involvement in Egypt.

1.3 REPORTING STRUCTURE

The *Final Report* consists of three elements: *The Master Plan* report, *Technical Reports* and *Appendix Reports*.

- *The Master Plan* report is seen as the main document whose intent is to present, in a synoptic sense, main findings of the MiNTS investigations;
- *Technical Reports* represent a series of sector-specific reports which document the technical underpinning of *The Master Plan* document (Table 1.3.1), and,
- *Appendix Reports* represent task-specific or activity-specific documents and other data summaries, some of which have been developed in response to client group requests.

Table 1.3.1 Technical Reporting Structure

Report Number	Subject
1	Road Sector
2	Rail Sector
3	Inland Waterway Transport Sector
4	Maritime Sector
5	Civil Aviation and Pipeline Sectors
6	Demand Simulation and Scenario Testing
7	Organizational and Functional Aspects of the Transport Sector
8	Private Sector Participation
9	Environmental Considerations
10	The MiNTS Vision, Policies and Strategies
11	Transport Survey Findings
12	Project Prioritization
13	Counterpart Training Program

Source: JICA Study Team

This technical report is also closely linked with Technical Report 13, *Counterpart Training Program* and the Appendix Report, Modeling Manual. Both of these reports include further details on the transport model that is discussed further in this technical report.

1.4 INTENT AND CONTENT OF THE CURRENT REPORT

Several core considerations underlie the rationale for this *Technical Report*, each of which is, in turn, seen as a core element within the framework of the project. A workshop, involving representatives of the Ministry of Transport, members of the Study Team, as well as other experts, had been completed on 29 September, 2011, in order to review, discuss and refine the topics documented in this *Technical Report* (refer Section 1.5). The *Technical Report* was completed following the workshop.

The document includes, in addition to this introductory Chapter 1, five additional chapters:

- A socio-economic framework was previously developed based on then-existing forecasts of national economic evolution. This framework was deemed as being acceptable by the MiNTS Steering Committee. Clearly, the January 2011 revolution has catalyzed a number of major impacts in this regard. The client group, to include Steering Committee, subsequently voiced a strong desire that the economic growth aspects of the socio-economic framework be reviewed in line with more recent, post-revolution realities. The main implications of this review are discussed in Chapter 2.

- The MiNTS transport model continues to expand and diversify. More comprehensive simulation approaches for both passenger and cargo flows are being developed. These reflect both technical evolution, as well as expressed wishes and comments by the client group. The current status of the model is summarized in Chapter 3.

- All parties have clearly accepted the vision that a more sustainable modal split among road, rail and inland waterway is necessary. Client group, including Ministerial, consultations have confirmed that, in light of the current modal performance of the Egyptian transport sector, achievement of intermodal cargo patterns, and refined passenger movement opportunities, will depend on a number of considerations in the humanware, hardware and software elements. Thus, a series of scenarios are explored which evaluate the potentials of achieving a series of modal shifts based as quantified by the MiNTS transport model. The transport scenarios, identified in consultation with the Steering Committee, are clarified in Chapter 4. The subsequent quantification of the scenarios, and follow-on conclusions as well as a discussion on the preferred scenario defined following the workshop, is documented in Chapter 5.

1.5 THE WORKSHOP ON TRANSPORT SCENARIOS

A workshop, chaired by HE The Minister of Transport, and involving representatives of the Ministry of Transport, members of the Study Team, as well as other experts, was undertaken, at the request of the client group, on 29 September, 2011. The workshop list of attendees is contained in Table 1.5.1. A PowerPoint presentation addressing the methodology, approach and findings of the scenario evaluation procedure was undertaken by Study Team representatives. This was followed by a robust and valuable exchange of information and ideas. Key discussion points are integrated, as practical and possible, into this *Discussion Paper* which was submitted to the client group about two weeks after the workshop.

The workshop discussion also gave rise to various considerations which should be employed during subsequent aspects of technical reviews, in particular detailing of the preferred scenario.

Table 1.5.1 Attendance at 29 September *Workshop on Transport Scenarios*

Name	Organization	Job Title
H.E. Dr. Ali Zein El-Abdeen Heikal		Minister of Transport
Mr. John E. Thompson	JICA Study Team	Acting Team Leader
Mr. Yoshikazu UMEKI		Deputy Team Leader
Mr. Len Johnstone		Modeling Specialist
Mr. Nobuo OSAWA		Railway Transport System
Mr. Makoto Ishikawa		Railway System
Dr. Ahmed El-Hakim		Privatization
Dr. Nabil Sehsah		Legal System / Finance
Mr. Yoshihisa ASADA		Economic Analysis / Project Evaluation
Ms. Hana Rady Mohamed		Project Support
Mr. Taro AZUMA	JICA Egypt Office	Senior Representative
Mr. Koichi MISUKUSA		Representative
Dr. Ashraf M. El-Abd		Chief Officer
Eng. Hassan Ahmed Selim	TPA	Vice Chairman
Mr. Mahmoud Ezzeldin	GARBLT	Chairman
Eng. Karim Abu El-Kheir	RTA	Chairman of RTA
Eng. Hany Hegab	ENR	Chaiman
Ms. Sameha Barakat	MIC	General manager of Japan's Administration
Mr. Samir Khamis	MTS	Director of Finance and investment
Eng. Mona Hassan Kotb	TPA	Senior Researcher
Ms. Azza Ahmed Mohamed Ghanem		Chairman of Central Administration for Economic Affairs
Eng. Asmaa Mohamed		Chairman of Central Administration for Technical Affairs
Dr. Amr Dawara		General Manager of Planning
Eng. Amgad Abdelaleem		Computer Researcher
Mr. Ahmed Abu El-Yazid		Secretary of vice chairman of TPA
Mr. Mahmoud Gamal El-Din	MOT	Advisor to Minister of Transport
Mr. Mohamed Abdel Sabour		Assistant Advisor for International Cooperation
Mr. Ali Ibraheem		Assistant Advisor to Minister
Mr. Anas nasr		Advisor of technical office
Ms. Yasmine Ramadan Mostafa	Ministry of International Cooperation (MIC)	Economic Researcher
Eng. Sami Abu Zeid	GOPP	Chairman of central administration
Eng. Abdelfattah Mohamed Anany	GARBLT	Chairman of Central Administration for Land Transport
Eng. Mohamed Hosny Mohamed		Chairman of Central Administratoin of Land Transport
Mr. El-Morsy Mohamed El-Helw		Chairman of General Administration for Roads Reserches
Eng. Khaled Hassona		Director of technical affairs
Eng. Ibraheem Fathy Ali		
Mr. General. Mohamed Saad Hassan	GALDP	Chairman of general administration for dry ports
Ms. Soheir Hassan Hamdy	RTA	
Mr. Hosny Ahmed El-Khatib	ENR	D.G. Marketing and Sales, Feight Sector
Mr. Nino Cinaolani		Co-Chairman Head Italian Team
Mr. Enrico Trapazzo		S.VC Passenger-Long Distance
Mr. Javier Casanas		S.Vice chairman SBU Freight
Eng. Rashad Mohamed Abdel-Hafez		Vice chairman Freight Sector
Mr. Khaled Abdel-Azim	ENIT	Chairman
Mr. Rene Q. Kist	EU Consultant - Logestic Centers	IMC / GOPA
Mr. Eisa Abdallah Sarhan	Ain Shams University	Faculty of Engineering, Professor
Dr. Khaled Adel El-Araby		Faculty of Engineering, Professor
Dr. Mohamed El-Faramawy AbdelRahman		Faculty of Engineering, Professor
Dr. Magdy Salah Noor El-Din		Faculty of Engineering, Professor
Dr. Hatem Mohamed Abdel-Latif		Faculty of Engineering, Professor
Dr. Mona Hussien Abdallah		Faculty of Engineering, Associate Professor
Mr. Moustafa Sabry		Professor
Mr. Rashad El-Mitiny	Cairo University	Professor
Dr. Ahmed Ibraheem Mosa	German University of Cairo (GUC)	Assistant Professor - ITS
Mr. Mohamed Ali Ibraheem	Arab Academy for Science, Technology & Maritime Transport (AAST)	Dean of Faculty of International Transport

CHAPTER 2: REFINING THE SOCIO-ECONOMIC FRAMEWORK

Considerable previous effort has been expended in the development of the MiNTS socio-economic framework. This has been documented in earlier reports, to include *Interim Report 2*. Key elements of the framework have, since that time and via the established consultative process, been reviewed between members of the client group, local experts and Study Team representatives. Furthermore, the January Revolution has clearly impacted both social and economic patterns of the Republic. Therefore, refinement of key elements of the socio-economic framework (that is, inputs to the MiNTS transport modeling process) is clearly called for, as described in this chapter.

2.1 AREAL STRATIFICATION

The analytical approaches embedded within MiNTS require that data be processed at varying levels of detail ranging from national totals to spatial (geo-based) analysis areas. The degree of detail, that is, zone size, is also influenced, in some instances, by a need to present data in a meaningful and understandable manner. Thus, a hierarchy of zones is required which retains a logical, interconnected structure. The zoning structure was previously presented in *Interim Report 2* and remains unchanged. However, a definitional recapitulation is included in the current report to enhance understanding.

The MiNTS zone structure stratifies the Republic at four levels of detail (Figure 2.1.1). This hierarchy is used consistently across all relevant MiNTS tasks. Zone systems include internal (domestic) zones and external (foreign) zones. The four zoning structures are the Regional Zones, Governorate Zones, Large Zones and Small Zones. The zoning systems are addressed in further detail in the Appendix Report, *Modeling Manual*.

Source: JICA Study Team

Figure 2.1.1 MiNTS Analysis Zone Hierarchy

The zoning hierarchy is defined as:

- The internal Small Zone boundaries, the most detailed building block for the entire zoning system, are patterned after Markaz[1] boundaries. A Markaz is sometimes divided geographically by, for instance, the Nile River. For the transport analysis, such sub-divided Markaz areas are considered as separate entities and uniquely defined as Small Zones. There are 385 internal Small Zones and 19 external zones, a total of 394 Small Zones.

[1] The Markaz level is the CAPMAS boundary which is a semi Governorate boundary. This is in fact the initial basis of the small zone boundaries.

- The Small Zones can be combined into 61 Large Zones, more specifically, 52 internal and 9 external zones. Large Zones, while representing an aggregation of Small Zones, may also be seen as subdivided Governorate Zones. This is particularly true in the Delta Region where Governorates were subdivided to ensure that no more than one major city be located in any Large Zone.

- Governorate Zones follow the Egyptian classification for 29 Governorates[2]. The Governorate Zones are aggregations of Large Zones.

- For the purpose of overall summary, the study area is also divided into eight internal regions (which mirror traditionally utilized terminology for Egyptian land areas) and one external region. Regional Zones are aggregations of Large Zones.

For purposes of current reporting, summaries are presented at the Regional Zone and Large Zone levels of detail. The regional zones, superimposed onto the large zone system, are depicted in Figure 2.1.2.

2.2 ECONOMIC EVOLUTION

The Economic Intelligence Unit (EIU), IMF Report during the June Group 8 Summit and the Ministry of Finance Economic Recovery Program suggest that GDP expansion will reduce from forecast pre-revolutionary levels, particularly so in the near-term future. Previous forecasts adopted by MiNTS suggest ranges of six to seven percent per annum over the extent of the planning horizon. While longer-term expansion is seen as again reaching such relative rates of growth, near term economic activity is forecast as being more sluggish, in particular the initial year following the Revolution when expected real GDP growth is in vicinity of one percent per annum (Table 2.2.1).

Table 2.2.1 MiNTS Gross Domestic Product (GDP) Forecasts

(Average annual change in percent, constant value)

Forecast	2011	2012	2013	2014-2017	2018-2022	2023-2027
Pre-revolution	6.0	7.0	7.0	7.0	6.5	6.5
Post-revolution	1.2	3.2	4.0	5.0	6.0	6.5

Source: JICA Study Team in consultation with Steering Committee. Data reflect Ministry of Finance, World Bank, EIU and IMF information.

The average annual compounded rate of growth over the planning horizon (years 2010 to 2027) will consequently reduce from some 6.65 percent to 5.34 percent. On a cumulative relative basis, GDP in year 2027 will, via-a-vis year 2010, increase by a factor of 2.4 under the post-revolution forecast as opposed to 3.0 under the pre-revolution forecast (Figure 2.2.1) – a reduction of some 20 percent. The implications in absolute terms is that year 2027 GDP has been downgraded from 3,263 billion LE to 2,644 billion LE (in constant year 2009 monetary terms). As previously, the Cairo Region remains a strong contributor towards national GDP, particularly within the tertiary (services) sector (Table 2.2.2). The reduced post-revolution GDP levels will not only impact the generation of transport movements but also the overall funds available to improve and or upgrade transport infrastructure. Nevertheless, as noted previously, the growth forecast for the Egyptian economy over the next 20 years is still averaging a robust 5.34 percent per annum.

[2] Following the Revolution, the number of governorates was reduced to 27. This new change has not been incorporated at the present time.

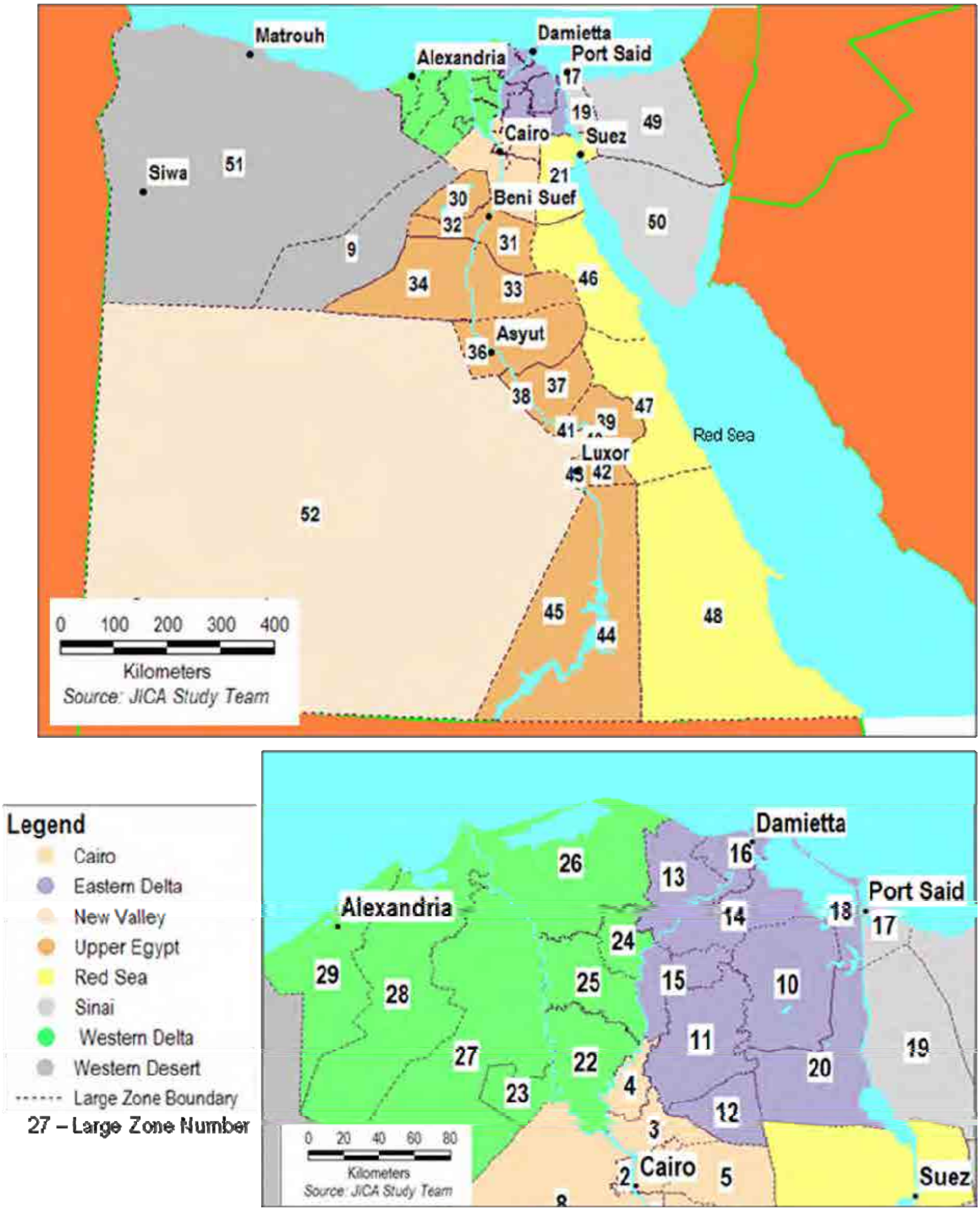
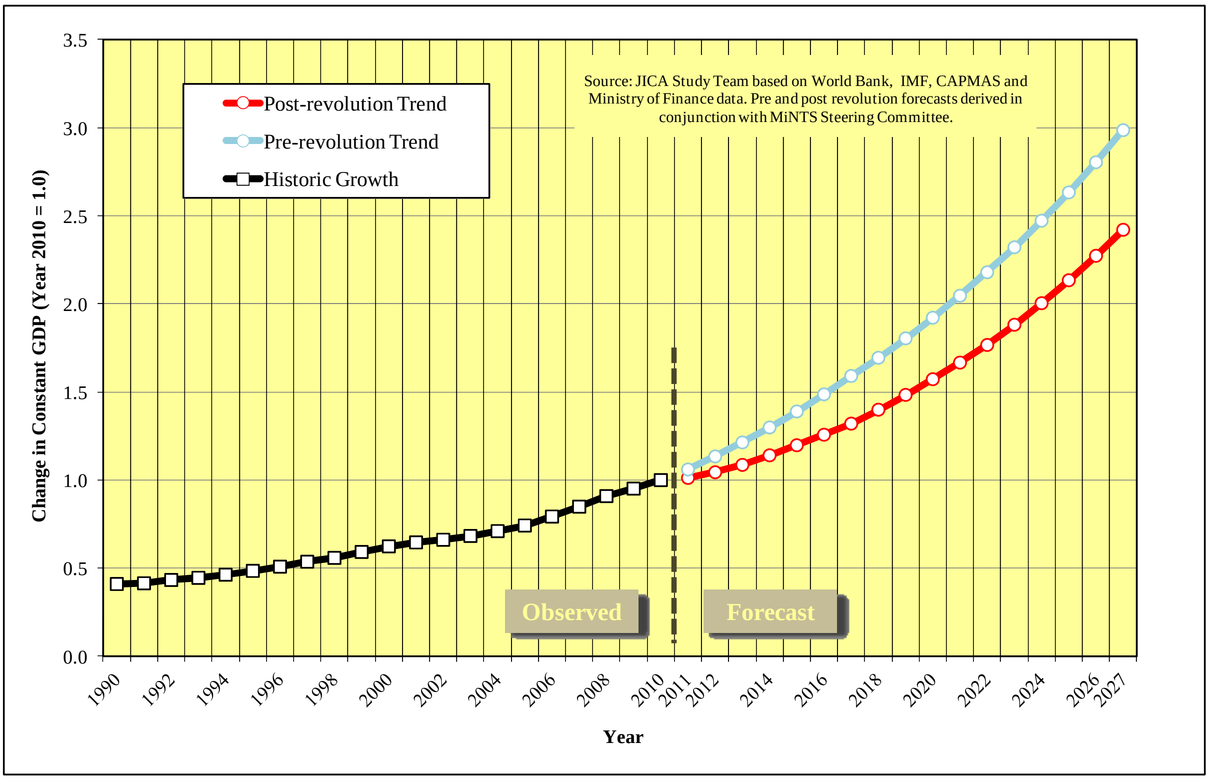


Figure 2.1.2 MiNTS Regional Zone and Large Zone Structure



Source: JICA Study Team

Figure 2.2.1 Historic and Forecast Relative Trend in National GDP

Table 2.2.2 Gross Regional Domestic Product

Region	Year 2010 (Thousand Constant Year 2009 LE)			Year 2027 (Thousand Constant Year 2009 LE)		
	Primary	Secondary	Tertiary	Primary	Secondary	Tertiary
Cairo	7,275,560	147,694,097	240,221,310	13,070,847	310,804,700	485,393,939
Eastern Delta	24,885,787	65,726,908	93,615,215	42,760,970	145,300,056	205,933,319
New Valley	801,807	226,220	2,227,063	3,691,113	2,160,227	18,606,273
Upper Egypt	56,032,096	80,227,826	87,543,873	96,052,034	191,557,328	359,322,732
Red Sea	249,707	5,013,285	8,488,364	2,013,796	13,510,791	46,134,281
Sinai	865,060	921,421	4,452,931	8,527,213	3,237,079	37,456,613
Western Delta	51,235,597	101,119,344	105,904,226	85,977,700	219,099,687	305,429,536
Western Desert	558,305	2,951,280	3,331,316	4,224,064	5,589,168	36,428,407
Total	141,903,918	403,880,382	545,784,300	256,317,737	891,259,035	1,494,705,098

Source: JICA Study Team. Refer Figure 2.1.2 for regional definition.

2.3 POPULATION AND EMPLOYMENT

MiNTS has estimated, as documented in *Interim Report 2*, that the population of Egypt will reach 107.3 million persons by year 2027. This represents an average annual rate of increase of some 1.9 percent vis-à-vis the year 2010 population of 78.4 million persons. This forecast remains unchanged.

The GOPP *Egypt Vision 2052* document has been enhanced to include an intermediate *Egypt Vision 2027* component. It is noted that forecasts of national population used within that document are virtually identical to MiNTS year 2027 forecasts. The *Vision* document envisages a shift in the population growth of the Cairo Delta agglomeration to the Western Desert, New Valley, Sinai and Red Sea Regions. These spatial strategies have been considered in the formation of the MiNTS demographic allocations.

In 2010, the Western Desert, New Valley, Sinai and Red Sea Regions housed nearly two million persons. By 2027, these regions are expected to have attracted a total additional population of 4.5 million people. (the detailed change in population across the Large Zones and Regions is shown in Figure 2.3.1). In 2010, the four above regions held 2.5 percent of the total population. By 2027, these same four regions are estimated to hold six percent of the national population. This is still a relatively small proportion of the population. As also seen in Figure 2.3.1, the large majority of population is concentrated in existing development areas.

In 2010, the employment across the primary, secondary and tertiary sectors was 22.3 million persons yielding a participation rate in 2010 of 0.28[3] employment opportunities per head of population. This participation rate is not expected to change appreciably in the foreseeable future.

Table 2.3.1 National Population and Employment – Year 2010

Region	Population	Employment[4]		
		Primary	Secondary	Tertiary
Cairo	19,774,423	301,798	1,573,256	4,409,662
Eastern Delta	13,965,295	1,154,864	813,650	2,046,792
New Valley	201,458	34,288	2,633	46,205
Upper Egypt	22,454,933	2,651,329	1,027,847	1,991,881
Red Sea	862,153	9,038	48,936	148,146
Sinai	535,465	35,607	10,371	89,291
Western Delta	20,180,281	2,420,167	1,178,651	2,240,652
Western Desert	384,822	22,910	34,656	67,371
Total	78,358,829	6,630,000	4,690,000	11,040,000

Source: JICA Study Team

[3] In some societies, this participation rate would be considered low. However as a result of the culture within Egypt, the female participation rate is low in comparison to other societies.

[4] Both employment and GDP are prepared in three categories of Primary, Secondary and Tertiary. In simple terms, primary refers to employment on the land such as farming whilst secondary is associated with the manufacturing sector. Tertiary is the service sector including the public sector.

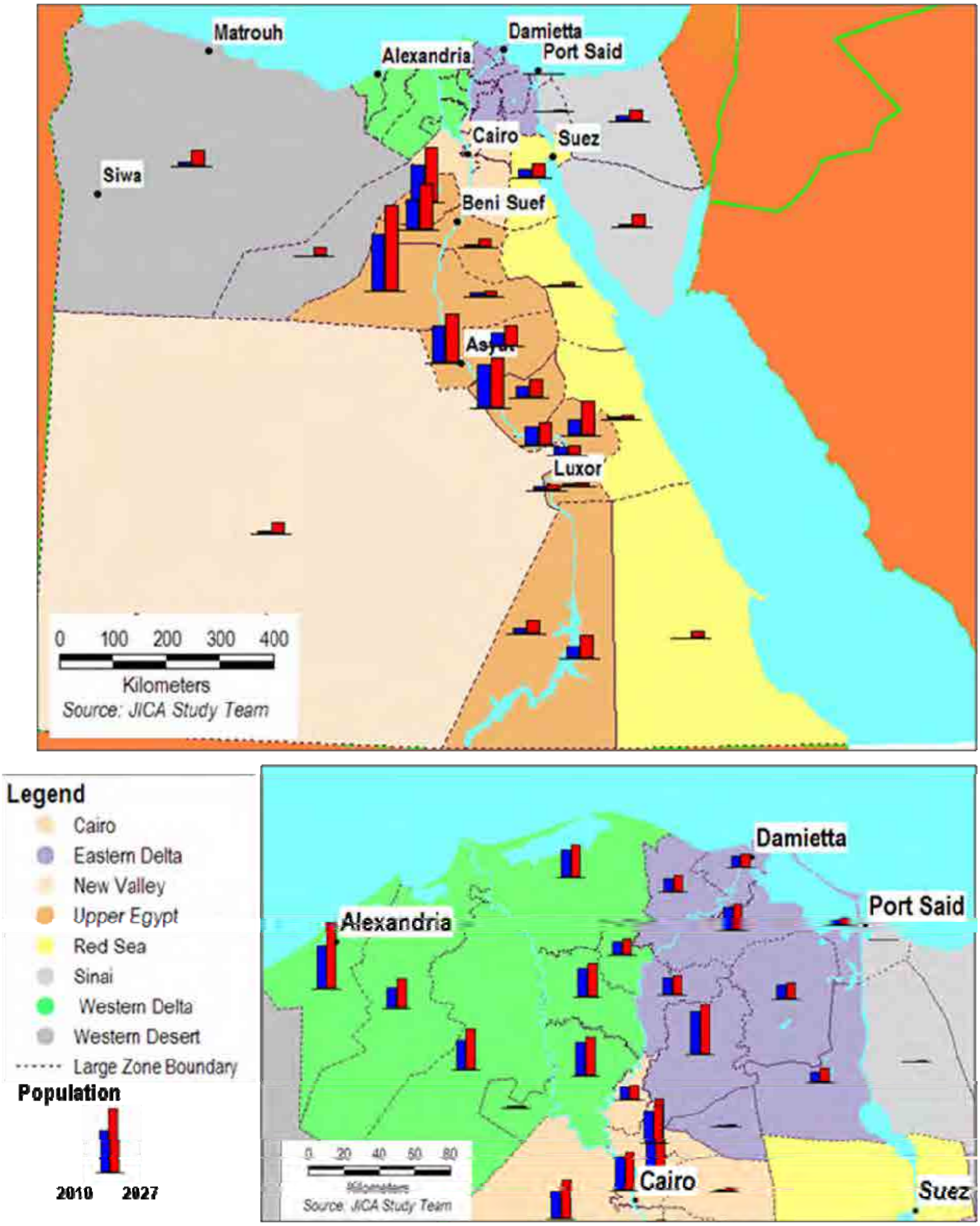


Figure 2.3.1 Distribution of National Population – Years 2010 and 2027

Table 2.3.2 National Population and Employment - Year 2027

Region	Population	Employment[5]		
		Primary	Secondary	Tertiary
Cairo	24,421,873	355,857	2,097,635	5,853,034
Eastern Delta	16,798,918	1,289,663	1,124,250	2,908,885
New Valley	849,769	102,920	15,754	249,915
Upper Egypt	33,197,082	2,958,161	1,538,372	5,284,808
Red Sea	2,066,255	47,481	82,574	522,732
Sinai	1,802,136	227,394	22,706	489,189
Western Delta	26,360,287	2,647,393	1,587,574	4,124,745
Western Desert	1,784,466	111,132	41,135	476,693
Total	107,280,786	7,740,000	6,510,000	19,910,000

Source: JICA Study Team

2.4 NATIONAL PRODUCTION AND CONSUMPTION

The evolution of national production and consumption was adjusted in line with changes in economic and demographic forecasts. The adjustment basis for productions and consumptions, on a commodity basis, is noted in Table 2.4.1. Further, impacts of the Revolution on the correlated imports and exports was considered. Post-revolution reviews suggest that, as is the case with GDP evolution, near-term activity is expected to be sharply reduced from historic norms (Figure 2.4.1).

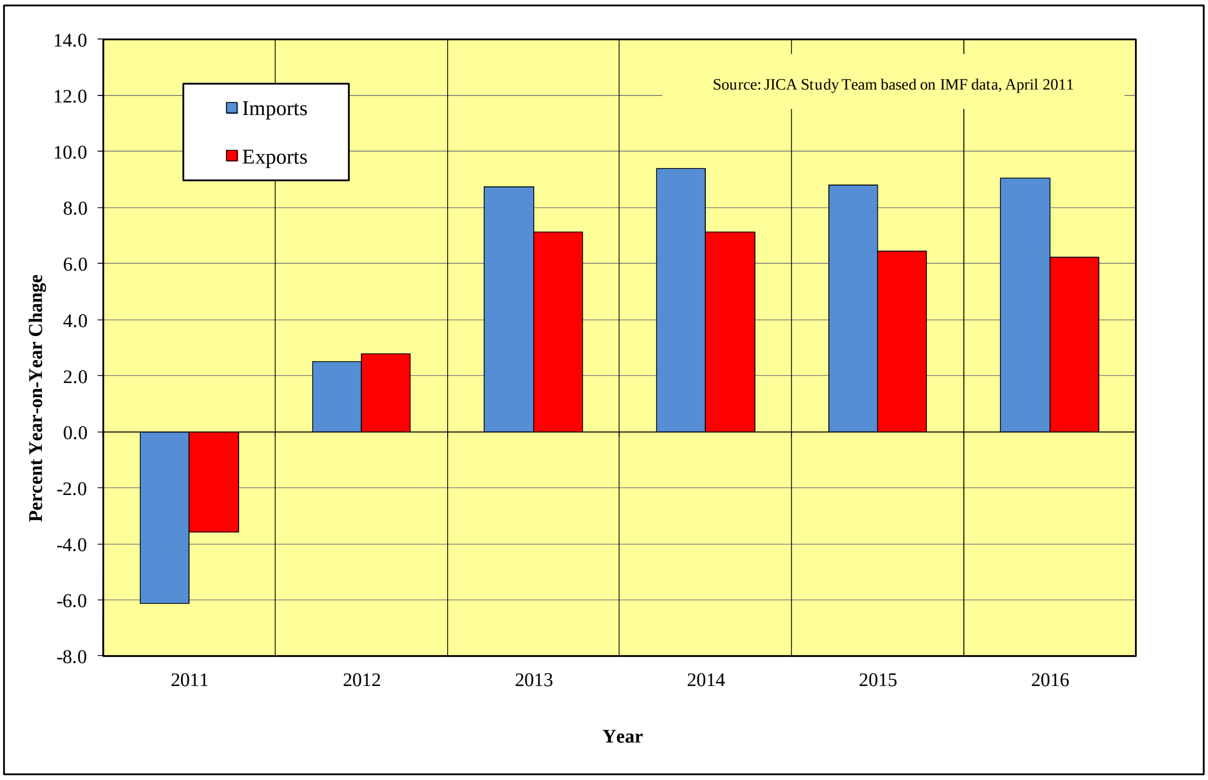


Figure 2.4.1 Near-term Trend: National Imports and Exports

Table 2.4.1 Methodology Structure: Commodity Groupings

MiNTS Code	MiNTS Commodity Group Name	Commodity Code	Commodity Name	Base of Elasticity[1]	Elasticity	Consumption Distribution	Trade Growth Rate (Percent per annum)			
							2010-2017		2017-2027	
							Import	Export	Import	Export
1	Agricultural products	6	Lumber and Timber	G	0.00	Population	8.52	-	10.00	-
1	Agricultural products	10	Barley	P	0.43	Population	-	-	-	-
1	Agricultural products	11	Corn	P	0.52	Population	5.68	-	5.68	-
1	Agricultural products	12	Maize	P	1.58	Population	-	-	-	-
1	Agricultural products	13	Rice	P	2.78	Population	2.84	2.84	2.84	2.84
1	Agricultural products	14	Broad Bean	P	1.00	Population	-	-	-	-
1	Agricultural products	15	Sorghum	P	0.77	Population	-	-	-	-
1	Agricultural products	16	Fruits	P	1.64	Population	5.68	2.84	5.68	2.84
1	Agricultural products	17	Vegetable	P	1.64	Population	2.84	2.84	2.84	2.84
1	Agricultural products	18	Greenhouse Vegetable	P	1.64	Population	-	-	-	-
1	Agricultural products	19	Onion	P	1.64	Population	-	-	-	-
1	Agricultural products	20	Garic	P	1.64	Population	-	-	-	-
1	Agricultural products	21	Potatoe	P	1.64	Population	-	2.84	-	2.84
1	Agricultural products	22	Sugar Cane	P	1.31	See Note 2	-	-	-	-
1	Agricultural products	23	Sugar Beat	P	1.31	Population	-	-	-	-
1	Agricultural products	24	Fiber Crop	P	1.00	Population	-	-	-	-
1	Agricultural products	25	Animal Fodder	P	0.27	See Note 3	-	-	-	-
1	Agricultural products	26	Poultry Fodder	P	1.64	See Note 4	10.00	-	10.00	-
1	Agricultural products	27	Oil Crops	P	5.99	See Note 5	-	-	-	-
2	Foodstuffs and animal fodder	9	Wheat	P	1.30	Population	7.10	-	7.10	-
2	Foodstuffs and animal fodder	29	Dairy Products	P	2.36	Population	-	-	-	-
2	Foodstuffs and animal fodder	32	Fishery	P	2.55	Population	2.84	-	3.41	-
2	Foodstuffs and animal fodder	33	Edible Oil	P	5.99	Population	8.52	2.84	10.00	2.84
2	Foodstuffs and animal fodder	34	Refined Sugar	P	1.31	Population	-	2.00	-	2.00
2	Foodstuffs and animal fodder	42	Beverage	P	1.10	Population	5.68	2.84	6.82	2.84
3	Solid mineral fuels	8	Coal and Coke	G	0.70	See Note 6	10.00	-	-	-
4	Petroleum products	1	Crude Oil	G	-1.51	See Note 7	-	-	-	-
4	Petroleum products	2	Natural Gas	G	1.05	See Note 8	-	6.82	-	8.18
4	Petroleum products	3	Petroleum Products	G	0.33	See Note 9	5.68	2.84	6.82	3.41
5	Ores and metal waste	7	Iron Ore	G	1.05	See Note 10	5.68	-	6.82	-
6	Metal products	35	Metal	G	1.49	Population	6.00	6.00	6.00	6.00
7	Crude and manufactured minerals, building materials	4	Cement	G	1.02	Population	2.84	4.26	3.41	5.11
7	Crude and manufactured minerals, building materials	5	Construction Material	G	0.96	See Note 11	2.84	2.84	3.41	3.41
8	Fertilizers	40	Fertilizer	G	1.20	See Note 12	5.68	2.84	6.82	2.84
9	Chemicals	41	Chemical Product	G	1.00	See Note 13	8.52	5.68	10.00	5.68
9	Chemicals	39	Paper	G	1.00	Population	8.52	2.84	10.00	2.84
10	Machinery, transport equipment, manufactured articles and miscellaneous articles	36	Textile	G	3.00	Population	10.00	2.84	10.00	2.84
10	Machinery, transport equipment, manufactured articles and miscellaneous articles	37	Soap	P	1.00	Population	-	-	-	-
10	Machinery, transport equipment, manufactured articles and miscellaneous articles	38	Industrial Products	G	1.10	Population	10.00	10.00	10.00	5.00
11	Live Animal	28	Animal Meat	P	0.27	Population	-	-	-	-
11	Live Animal	30	Poultry Meat	P	1.64	Population	5.68	2.84	5.68	2.84
11	Live Animal	31	Egg	P	1.64	Population	-	-	-	-

Source: JICA Study Team

Notes

1 : Commodity growth rate = Elasticity * (Growth rate of Population (P) or GDP (G) as specified in this column). Elasticity derived from 10 years historical record.
2 : Consumption distributions based on population and mill capacity
3 : Consumption distributions based on animal population (animal head)
4 : Consumption distributions based on poultry head
5 : Consumption distributions based on crushing capacity
6 : Consumption distributions based on coal & coke Consumption distribution volume
7 : Consumption distributions based on refinery capacity
8 : Consumption distributions based on LNG Trains and Power Plant Capacity
9 : Consumption distributions based on populatin, vehicle registration, airport, port
10 : Consumption distributions based on steel plant capacity
11 : Consumption distributions based on stone sand brick Consumption distribution volume
12 : Consumption distributions based on cropped area
13 : Consumption distributions based on industrial zone

The adjusted commodity volume (defined as productions plus imports or consumption plus exports) is consequently expected to increase from 1.51 million daily tonnes in year 2010 to 3.41 million daily tonnes in year 2027. In relative terms, imports and exports, despite reduced near-term demand, exhibit considerable greater long-term growth potential (Table 2.4.2).

Table 2.4.2 Total Volume of Major Commodities

Unit: Tonnes per day

Year	Production	Imports	Exports	Consumption
2010	1,333,930	175,962	84,339	1,425,554
2027	2,638,001	765,366	284,181	3,119,186

Source: JICA Study Team

The overall growth of commodity shipments, under post-revolution conditions, is expected to average near five percent per annum over the MiNTS planning horizon. Commodity grouping 10 (Machinery, Transport Equipment, Manufactured Articles and Miscellaneous Articles) represents a considerable proportion of both the absolute shipped tonnage as well as achieving highest relative growth (Table 2.4.3).

Table 2.4.3 Shipped Commodity Tonnage

Unit: Tonnes per day

Item	Product	2010	2027	Average Annual Change (%)
1	Agricultural Products	158,959	271,648	2.8
2	Food Stuffs and Animal Fodder	78,839	140,420	3.4
3	Solid Mineral Fuels	11,722	19,293	2.5
4	Petroleum Products	382,041	642,897	3.0
5	Ores and Metal Waste	50,129	89,292	3.4
6	Metal Products	9,177	33,093	7.8
7	Crude, Manufactured Minerals and Building Materials	514,601	997,197	4.0
8	Fertilizers	36,520	103,780	6.3
9	Chemicals	48,714	98,746	4.2
10	Machinery, Transport Equipment, Manufactured Articles and Miscellaneous Articles	206,931	990,796	9.0
11	Live Animal	12,262	16,200	1.6
	Total	1,509,892	3,403,367	4.9

Source: JICA Study Team. Tonnage by all modes. Defined as productions plus imports or consumption plus exports. Slightly over 80 percent of Commodity Group 4 (Petroleum Products) is shipped via pipeline.

2.5 THE GEODATABASE

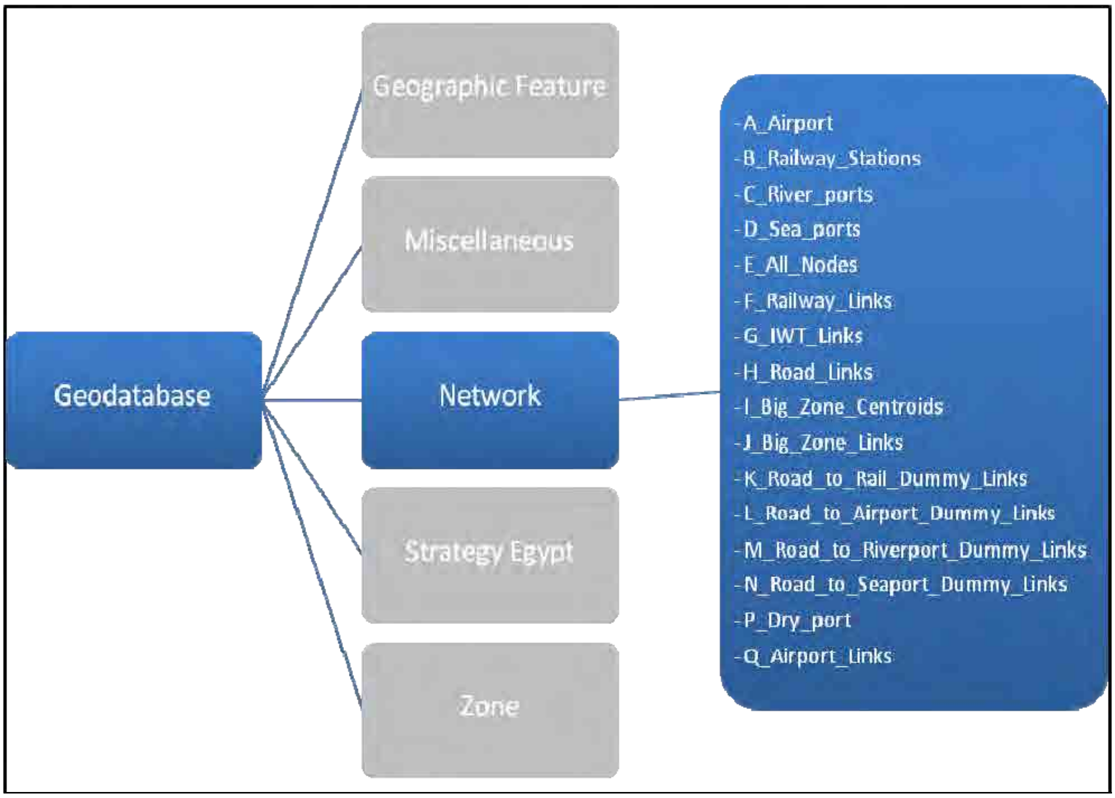
A critical input to the transport model is the geodatabase, that is, is a spatial database designed to store, query, and manipulate geographic information and spatial data. This has been described in previous reports. In the interim, the database continues to dynamically change as additional information is added and/or updated. The structure of the MiNTS geodatabase is separated into five categories namely:

- Geographic Feature ;
- Miscellaneous;
- Strategy Egypt ;
- Network; and,
- Zone.

The Geographic Feature category includes the mapping associated with natural features such as waterbodies and mountain ranges. The Miscellaneous category includes such varied geographical features as the details of the pipeline network and the locations of the capitals of the various governorates. The Strategy Egypt category includes the mapping associated with the *Egypt Vision 2052* document. The key categories[5] in the development of the transport model are the Network Category and Zone Category.

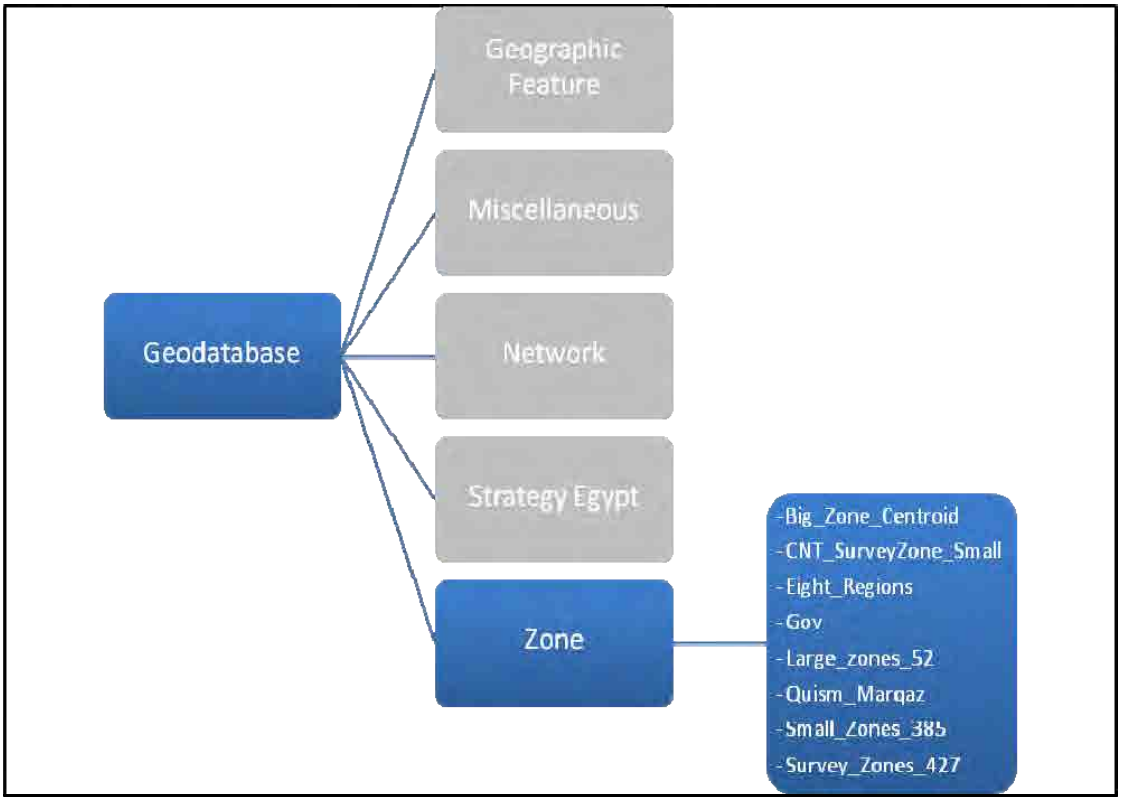
The main feature classes of the Network Category, at time of writing (October 2011), are shown in Figure 2.5.1. The details of each of the 16 feature classes in this category can be viewed within the transport model. The field within in each of the feature classes have been prepared in a cooperative effort between Study Team members and the various government agencies. The detail of these feature classes are then incorporated into the binary network of the transport model. The main feature classes of the Zone Category are shown in Figure 2.5.2. The details of each of the 8 feature classes in this category can be viewed within the model. The feature classes in this category essentially include the population, employment and GDP for the base year and the future year horizons of 2017, 2022 and 2027 together with the zonal equivalence tables.

[5] Other categories are described in detail elsewhere in particular within *Interim Report 2.*



Source: JICA Study Team

Figure 2.5.1 Feature Classes of the Network Category



Source: JICA Study Team

Figure 2.5.2 Feature Classes of the Zone Category

CHAPTER 3: THE SIMULATION PLATFORM AND SETTING THE BASE CASE

The evolution of a national transport strategy requires a robust numerical underpinning. Toward that end, MiNTS has completed a nationwide data collection effort consisting of surveys pertaining to road, rail, maritime, inland waterway and civil aviation transport. This information has, as practical and necessary, been supplemented via data and statistics acquired from local agencies. All relevant data were incorporated into the demand analysis process which has led to the development of a multi modal transport model, the MiNTS National Model or the MNAM model (the simulation platform).

This Chapter 3 provides a synopsis which, at time of writing, describes the status of the MNAM as well as the "base case" condition, that is, year 2010 numeric underpinnings of simulation procedures. The year 2010 condition represents the basis against which all future-year scenarios (as noted in following chapters) are compared.

3.1 OVERVIEW

The MNAM computerized simulation model includes three essential elements namely (a) model design; (b) data base; and, (c) modeling software (Figure 3.1.1). These elements represent a cascading and mutually supportive series of "building blocks" that define the analytical capabilities of MNAM.

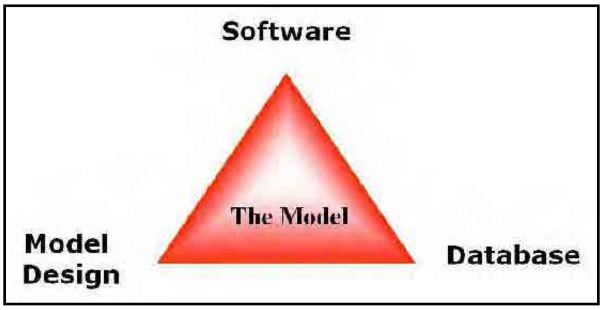


Figure 3.1.1 Model Components

- Model design is the set of equations that describe the transport model whether it be the modules for person travel or the transport of cargo. In the case of MNAM (being a four step transport model) the equations first link the start and end of trips with socio economic planning data, then secondly bind together the origin and destination of trips. Subsequently, the model splits the trips between the various private and public transport modes and finally assigns the private and public trips to the infrastructure networks. The form and structure of these equations is determined both by the database and the software.

- Database is the collection of base year (2010) and future year (through year 2027) datasets which, within the MNAM framework, are held in the form of a geodatabase (please refer Chapter 2, Section 2.5). As a recapitulation, data elements include:
    - Transport infrastructure inventory (highway, rail and the inland water transport networks);
    - Socio- demographic variables to include population, employment and GRDP;
    - Quantitative findings derived from the MiNTS national survey program and supplementary data sources; and,

- Economic data such as operating costs and value of time.

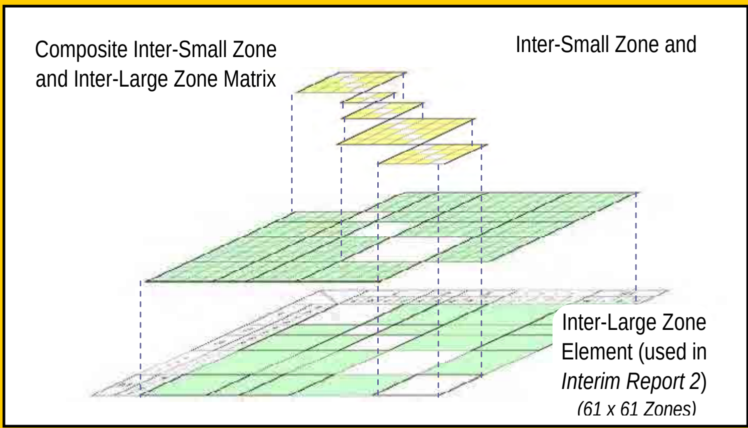
- Software is the technology that binds the database and the equations of the model design into a transport model. The MNAM is built using on the CUBE[1] software suite. This ensure a state-of-the-art simulation system linking geodata with both person and cargo movements.

Following sections represent additional details for core aspects; that is, the transport networks, the structure of the person as well as cargo models, and key year 2010 findings.

What trips are being used?

A trip refers to travel between an origin and a destination, for persons, vehicles or cargo. The MiNTS National Transport Model continues to evolve. Results discussed in the previous *Interim Report 2* reflected technical progress at that time. Demand was based on trips of longer distance, that is, journeys between pairs of the 61 unit national Large Zone system. However, in case of person trips, origins and destinations for the longer distance inter-Large Zone trips were geographically linked to the 394 unit Small Zone system.

Since that time modeling procedures have been refined and additional capabilities realized. This includes the addition of shorter distance person journeys to the then-existing trip tables. In other words, adding intra-Large Zone trips whose origins and destinations lie entirely within a single Large Zone but flow between pairs of Small Zones.



Thus, trips as used in this *report* have been expanded to their final extent; that is, consider both short and long distance journeys within the 394 zone hierarchy.

3.2 NETWORKS

All transport inventory datasets reside within a geodatabase feature class group titled Network. This includes both linkages and centroid connectors for land modes:

- Road inventory;

[1] CUBE software is a product of Citilabs.

- Railway inventory;
- Inland Water Transport facilities; and,
- Ports (dry and wet).

The inventory includes both existing and those planned/committed projects noted by the various providers of transport services. The planned/committed projects were defined in close consultation with ENR, GARBLT and RTA representatives during mid 2011. The network database thus contains an up-to-date record of proposals existing at that time.

The geodatabase includes a total length of some 19,800 road kilometers as presented in detail Table 3.2.1. The extent of the simulated rail network is 3,900 line kilometers, while the IWT network extends to 2,120 kilometers.

Table 3.2.1 Year 2010 MNAM Road Network

Number of Lanes (total both directions)	Road Length (kilometers)
2	15,740
4	3,010
6	970
>6 (including Motorways)	120

Source: JICA Study Team

Key elements of the network structure are depicted in Figure 3.2.1 (national system) and Figure 3.2.2 (system within the Delta Region).

3.3 ANALYTICAL STRUCTURE

The core MNAM analytical elements[2] include a person trip model and a cargo trip model. These demand aspects are built around the supply side of the transport equation. The supply side, that is, the modal networks, are described in the previous section, and are further clarified in the subsequent Chapter 4 as well as Appendix A.

3.3.1 Person Model

The person model is developed in a four step approach of trip generation, trip distribution, mode split and assignment. The person model[3] in its initial steps is divided into sub streams namely that for inter Large Zone[4] trips and intra Large Zone trips.

The equations for inter Large Zone person trip generation and distribution are derived directly from the extensive nationwide surveys whereas the intra Large Zone person trip generation are estimated from a more limited dataset.

[2] A more detailed description of the MNAM is provided in the *MNAM User Manual* currently under preparation.

[3] Even in a national model, it is desirable that the person trip model be divided into at least two categories such as discretionary and non discretionary. This distinction was not possible for all modes as dictated by the MiNTS survey database.

[4] All person trips are always developed at the level of Small Zones. Cargo trips are developed at the Large Zone basis.

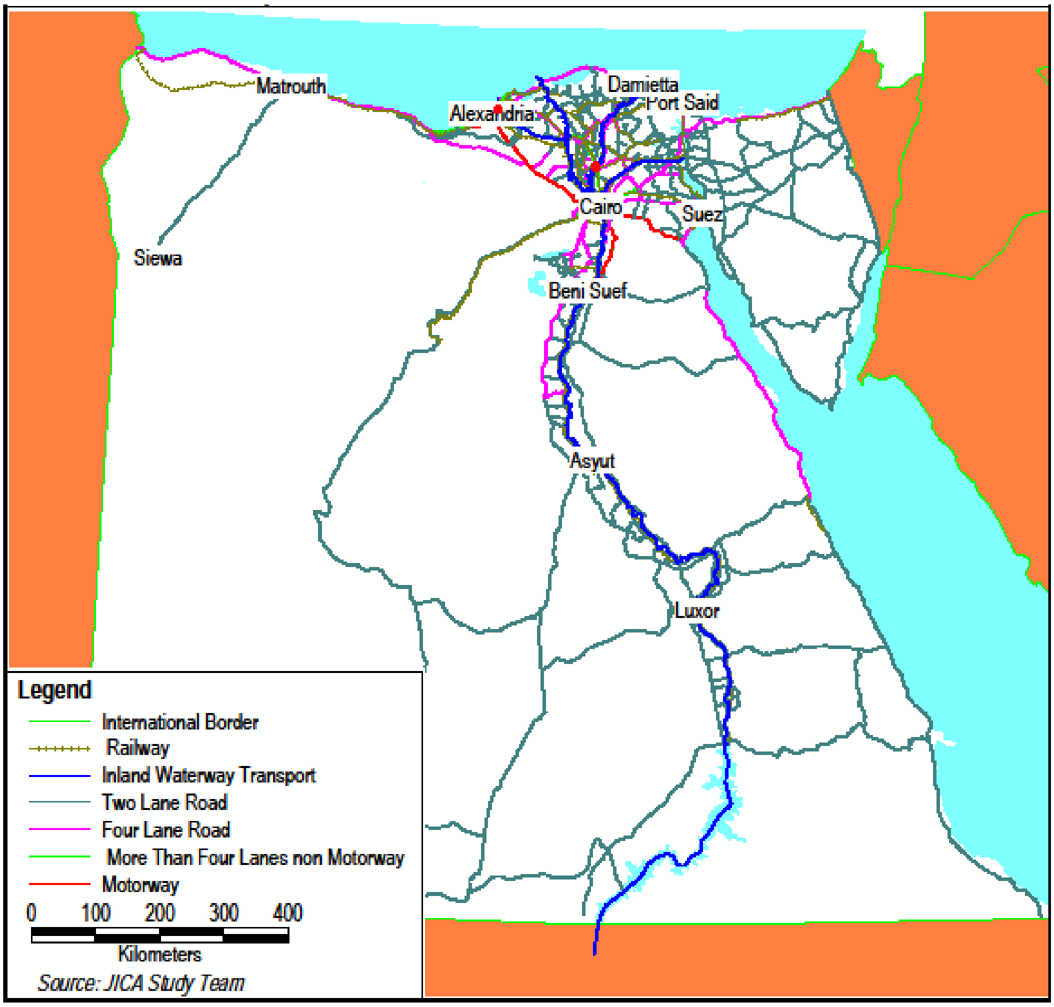


Figure 3.2.1 National Transport Network

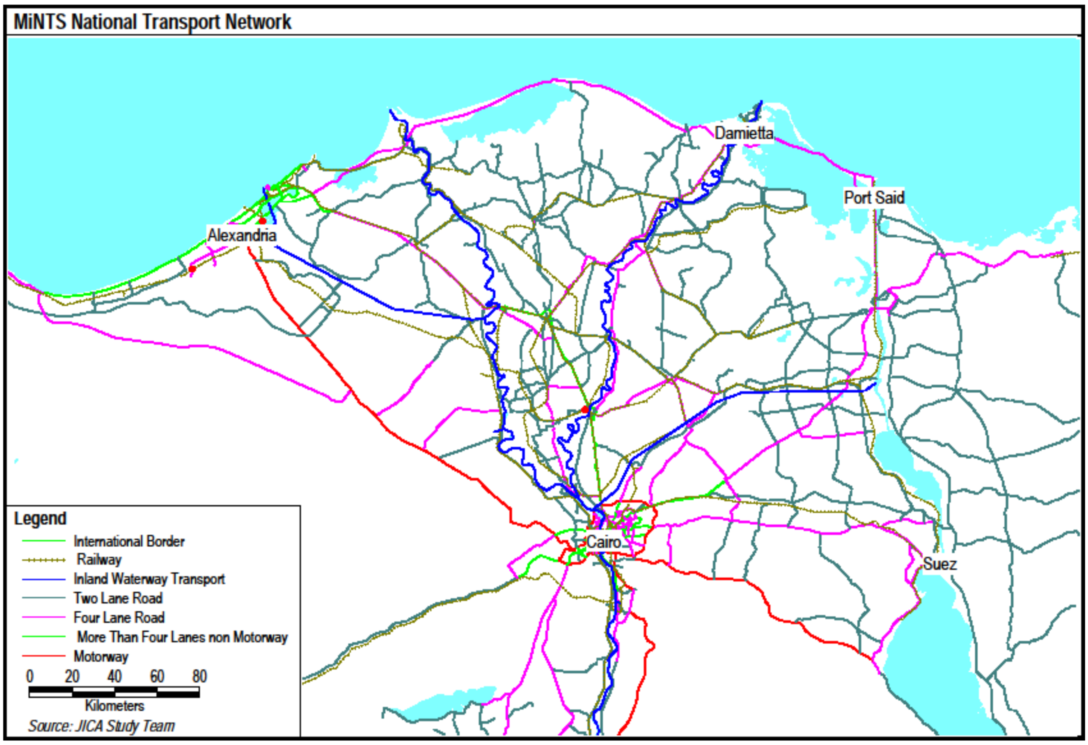


Figure 3.2.2 Delta Transport Network

The Inter Large Zone trip generation[5] equation is a function of population and car ownership and takes the following form:

Where: $G_I = a + \alpha P_I + \beta C_I$

G_I is the number of trips generations in a Large Zone I;

a is a constant;

α is a coefficient associated with the Population, P of a Large Zone I; and

β is a coefficient associated with the Car Ownership, C of a Large Zone I.

The parameter values associated with trip production and attraction are presented in Table 3.3.1.

Table 3.3.1 Trip Generation Parameters

Parameter	Production	Attraction
a	2640.7	2534.6
α	0.051	0.053
β	0.322	0.298

Source: JICA Study Team

The details associated with the development of Car Ownership model are discussed further in *Interim Report 2*[6]*.* Car ownership is a pseudo measure of the average zonal income. The variables adopted in the trip generation model were selected after a review of the statistical validity of alternative variables such as regional GDP and regional GDP per capita estimated at the level of large zone. The variables adopted for the Trip Generation equations must not only be measurable today but also be measurable in the future.

The trip generation equation for intra Large Zone trips is a function of population and GDP per capita and takes the following form:

$$G = k \frac{\exp(-\alpha * Population + Dummy)}{1 + \exp(-\beta * GDPperCapita + \gamma)}$$

Where:

G equals the number of trips generated per thousand people;

[5] It is not uncommon to use such an equation for trip generation. For example, in the study on the National Development Strategy in the Socialist Republic of Vietnam by JICA in July 2000 (VITRANSS), trip generation is derived as a function of regional urban population and regional GDP for a zoning system similar to the MiNTS large zones.

[6] The discussion on car ownership model is included in the Appendix Report, *Modeling Manual.*

α is a constant equal to 0.006;

β is a constant equal to 0.2060;

γ is a constant equal to -2.890;

Dummy is a variable ranging from -1 to 1 depending on the industrial and tourist characteristics of the small zone; and

k is a constant which is also a function of population and year ranging from 800 in 2010 to 1,500 in the year 2027.

The person trip distribution for inter Large Zone is developed around the Gamma Function as the friction factors for the Gravity Model in the estimate of distribution. The Gamma Function is as follows:

$$F(C_{ij})= C_{ij}X1 * \exp(X2*C_{ij})$$

Where

$F(C_{ij})$ is the cost deterrence for zone i to zone j;

C_{ij} is the generalized cost of travel between small zone i and j. In the case of MNAM, cost is measured as the distance between i and j; and

X1, X2 are constants namely 1 and -0.0184 respectively.

The person trip distribution for intra Large Zone is developed as follows:

$$T_{ij}=k \quad \frac{G_i^{\alpha} A_j^{\beta}}{e^{bd_{ij}} d_{ij}^{\ \gamma}}$$

Where:

G_i equals the number of trip generations;

A_j equals the number of trip attractions;

d_{ij} equals the distance between small zone i and j;

α is a constant equal to 1.1204;

B is a constant equal to 0.9551;

γ Is a constant equal to -4.3024;

b is a constant equal to 0.1742; and

k is a constant equal to 0.0042.

In the case of intra Large Zone travel, the trips estimated via the procedure above are then controlled to the trip generation and attractions via the Fratar Procedure.

The modal structure, that is, hierarchies of person trip types, associated with the person model is depicted in Figure 3.3.1.The person trips are distributed between five modes (air, high(er) speed rail, private car, rail, bus and shared taxi) via a series of binary logit mode splits. This is henceforth referred to as Hierarchical Binary mode split. In this case it is for five levels or five choices. The proportion of trips between any two zones, i and j that choose Choice 1 out of the subset of two choices is given as:

$$\frac{1}{1+\exp(-\lambda(C_{ij}^{2}-C_{ij}^{1}))}$$

Where:

λ is the scale parameter as defined in Table 3.3.2;

C_{ij}^{1} is the generalized cost of travel for hierarchical choice 1 between any two zones i and j; and

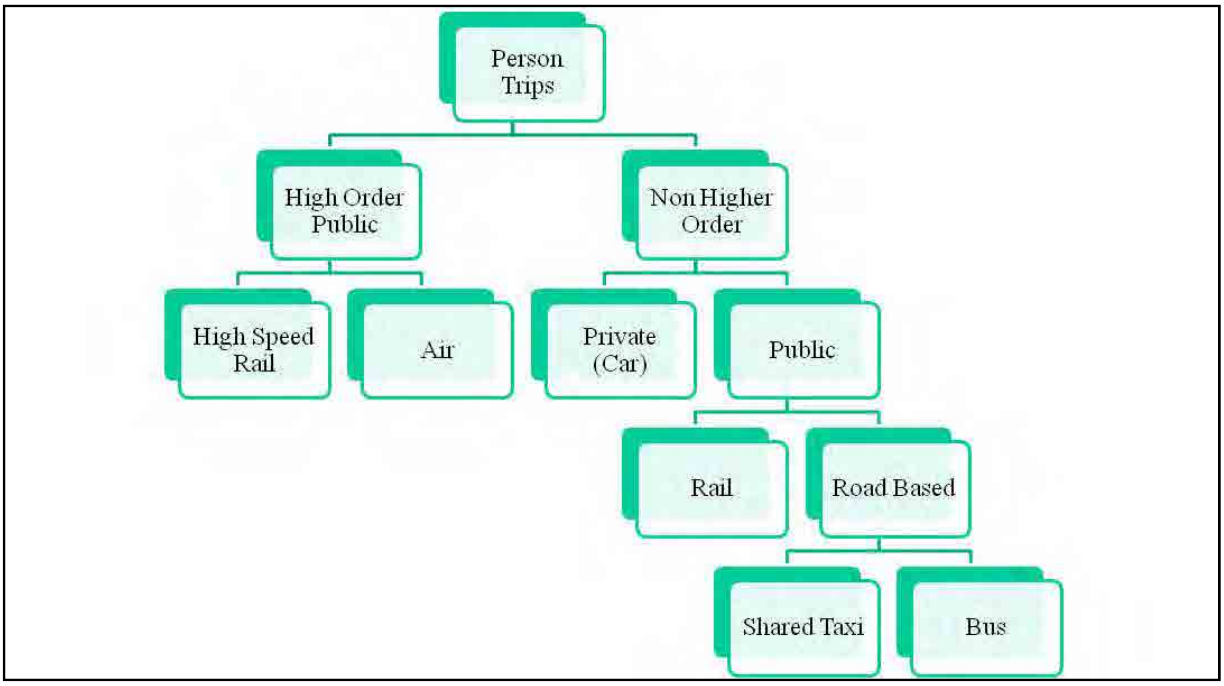
C_{ij}^{2} is the generalized cost of travel for hierarchical choice 2 between any two zones i and j.

The generalized cost of travel[7] is defined to include all perceived costs of travelling between any origin and destination in Egypt. In the case of travel by car, this cost will include time, any road tolls and the perceived vehicle operating costs. In the case of non car travel, the generalized cost includes fare, travel and waiting fare. There is also a relative bias[8] associated with each mode of travel.

In the mode split, the choice probabilities are calculated by starting at the bottom of the tree and moving up the hierarchy, calculating the choice probabilities and the composite costs in each nest. In this model the process begins in the bottom level.

[7] This perceived cost is in the form of equivalent minutes. Each mode of travel in this case is associated with a value of time in Egyptian Pounds per minute.

[8] In the mode split analysis, the mode bias is defined for Air, High(er) Speed Rail, Car, Rail, Shared Taxi and Bus as 50, 50, 107, 13, 0 and 32. These bias values are in effect the final calibration parameters of the mode split analysis.



Source: JICA Study Team

Figure 3.3.1 Hierarchy Nest of Modal Person Trips

Table 3.3.2 Hierarchical Logit Model Scale Parameters

Modal Split Equation Level	Choice 1	Choice 2	Scale Parameter
1	Higher Order	Non Higher Order	0.012
2	High(er) Speed Rail	Air	0.020
3	Private Car	Public Transport	0.029
4	Rail Public Transport	Road based Public transport	0.034
5	Shared Taxi	Bus	0.04

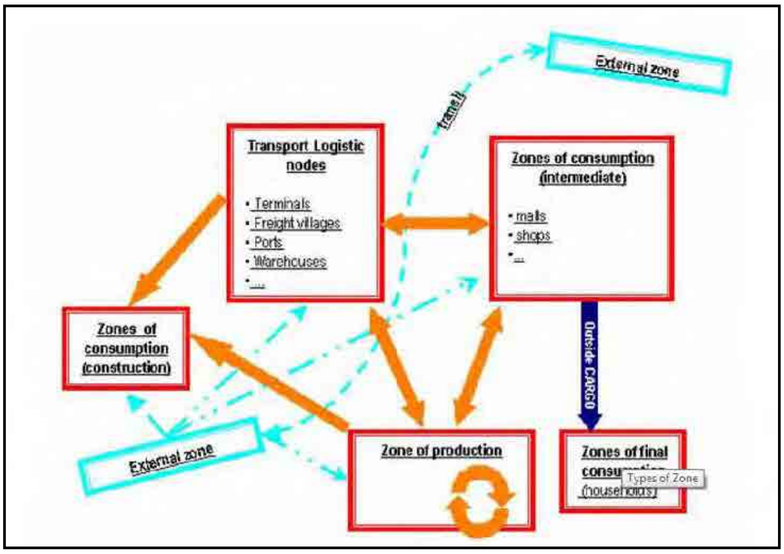
Source: JICA Study Team

Firstly, conditional probabilities for each of the two choices at Level 5 namely bus and shared taxi are calculated and then the composite road based public transport cost are calculated within the lowest level. The composite road based public transport cost will be used next to represent the cost associated with the combined choice. The costs associated with the level above are calculated in the same way until you reach the top level. It is then necessary to move back down the hierarchy forecasting demand for each mode with the information derived above, so that: this then becomes an iterative procedure.

In the case of assignment, rail trips (including high(er) speed rail) are assigned to the rail network separately whereas the person trips are converted into vehicle trips and assigned to the network jointly with the trips from the cargo demand analysis.

3.3.2 Cargo Model

The national transport model has, as noted, two distinct streams of development; namely, for person or passenger transport and freight or cargo transport. There exists two primary data sources for cargo flows: the MiNTS survey program and the Production - Consumption Analysis. Hence the stipulation that cargo trip modeling is focused on Large Zone trips as this is the geographical region of data collection for the production consumption analysis. Outputs of the person trip model, as described in the previous sub-section, are in terms of people or vehicles, to be followed by the assignment step. In the cargo modeling context, the results are a matrix of commodity-type tonnes (Figure 3.3.2) and additional analysis is required to determine how those tonnes are moved and by what means.



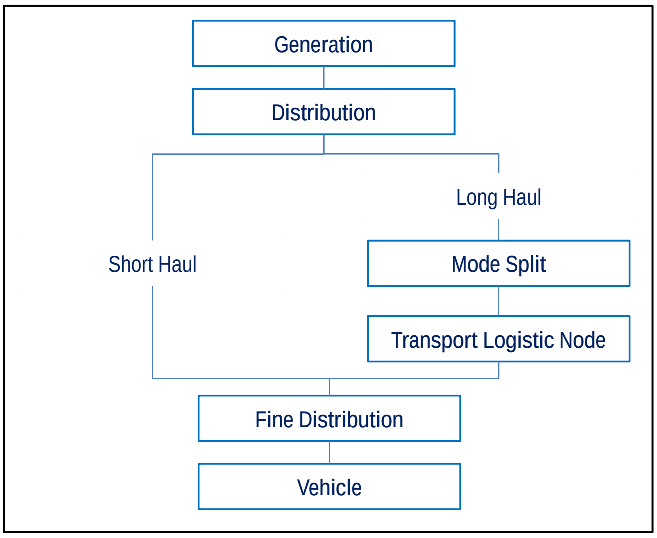
Source: JICA Study Team

Figure 3.3.2 Cargo Trip Chain Topology

The MiNTS commodity classifications are given in Table 3.3.3. These represent the “building blocks” of the cargo model in that trip (tonne) matrixes are built initially at the individual commodity level, then aggregated to commodity group prior to further analysis and, ultimately, assignment.

There are six steps to estimate freight movement as shown in Figure 3.3.3. These steps are not so different to the person trip analysis and similarities are seen in generation, distribution and mode split. In the flowchart, there is distinguishing between the long and short haul freight.

The generation model forecasts the trip ends as well as the number of tonnes of each commodity group produced and consumed in each internal Large Zone. The productions are divided into internal productions, which are to be transported to an internal zone, or exports, which are sent to external zones. Similarly, the attractions are classified as internal, that is, from internal zones, or as imports, which come from external zones.



Source: JICA Study Team

Figure 3.3.3 Freight Movement Structure

The procedure for the estimation of production and consumption for the 42 commodities identified in Table 3.3.3. The commodity produced is linked to the elasticity associated with that commodity and the changes in the associated socio economic parameter either population or GDP

Table 3.3.3 Cargo Model Commodity Groupings

Commodity Group	Group Name	Commodity Code	Commodity Name
1	Agricultural Products	6	Lumber and Timber
		10	Barley
		11	Corn
		12	Maize
		13	Rice
		14	Broad Bean
		15	Sorghum
		16	Fruits
		17	Vegetable
		18	Greenhouse Vegetable
		19	Onion
		20	Garlic
		21	Potato
		22	Sugar Cane
		23	Sugar Beet
		24	Fiber Crop
		25	Animal Fodder
		26	Poultry Fodder
		27	Oil Crops
2	Food Stuffs and Animal Fodder	9	Wheat
		29	Dairy Products
		32	Fishery
		33	Edible Oil
		34	Refined Sugar
		42	Beverage
3	Solid Mineral Fuels	8	Coal and Coke
4	Petroleum Products	1	Crude Oil
		2	Natural Gas
		3	Petroleum Products
5	Ores and Metal Waste	7	Iron ore
6	Metal Products	35	Metal
7	Crude and Manufactured Minerals, Building Materials	4	Cement
		5	Construction Material
8	Fertilizers	40	Fertilizer
9	Chemicals	41	Chemical Product
		39	Paper
10	Machinery, Transport Equipment, Manufactured Articles and Miscellaneous Articles	36	Textile
		37	Soap
		38	Industrial Product
11	Live Animal	28	Animal Meat
		30	Poultry Meat
		31	Egg

Source: JICA Study Team

The distribution model calculates the total trip ends for all the internal (within Egypt) zones in the Large Zone system and partitions them between internal (domestic) trips and import/export trips. Mode distribution allocates these trips to individual matrix cells. These procedures are estimated for the 11 commodity groups rather than the 42[9] commodities.

The first step in the distribution model is to partition the internal trips into "short-haul" and "long-haul" trips. The proportion of short haul trips is given in Table 3.3.4[10]. The distinction between long- and short-haul trips is as much about journey purpose as about trip length.The "short" trips are distributed using a gravity model with a negative exponential deterrence function. The function is applied to the square of the distance.

The deterrence function for short haul gravity model is:

$$F_c(d) = e^{\left(\frac{-d^2}{2p_c^2}\right)}$$

where

- c refers to the commodity group;
- e is the base of the natural logarithm function (approximately 2.718282);
- d is the travel distance;
- $F_c(d)$ refers to the deterrence function of distance used in the gravity model; and
- Pc is a calibration parameter. For short haul trips, this is set at 15 for all commodities.

Table 3.3.4 Short Haul Proportion

Commodity	Short Haul Proportion
1	0.074
2	0.096
3	0.117
4	0.063
5	0.033
6	0.096
7	0.067
8	0.052
9	0.041
10	0.051
11	0.082

Source :JICA Study Team based on MiNTS Surveys

[9] The commodities are combined into 11 groups because there is insufficient data available for the analysis of 42 commodities.

[10] The initial definition of short haul trips are those trips with an origin and destination within the same governorate.

A generalized cost function for the long haul trips is next calculated. This cost is a linear combination of the supplied time, distance, and cost matrices. The coefficients of these generalized cost components are taken from Table 3.3.3. It is noted that these parameters are provided separately by mode but, since they will be used in a multinomial logit model, the calculation of a composite cost is straightforward.

The internal, import, and export long trips are distributed using a gravity model with a negative exponential deterrence function. The function is applied to the generalized cost.

The deterrence function for long haul gravity model

$$\Phi_c(G_c) = e^{-P_c\left(1+\frac{\Gamma_c}{100}\right)^y G_c}$$

Where:

c	refers to the commodity group;
e	is the base of the natural logarithm function (approximately 2.718282);
Gc	is the generalized cost for commodity group c. This is the composite cost derived from the logit model used for modal split;
Φc(Gc)	is the deterrence function of generalized cost used in the gravity model;
Pc	The calibration parameter for commodity group c;
Γc	The growth factor for the calibration parameter for commodity group c;
y	The time, in years, from the base year to the year for which MNAM is being run. This is found by subtracting the two control data parameter values.

The outputs from distribution model are total large zone to large zone movements for all modes. The modal split model is run on the long-haul trips; all short-haul trips are assumed to travel by road. The generalized cost function is defined for each combination of commodity group and mode. There are three independent variables, time, distance and generalized cost. The functions each involve four coefficients: one for each of the independent variables and one for the constant term. For each commodity group, the modal split is a simple multinomial logit model.

The composite costs of the multinomial logit models are used in the long-haul distribution model. The model split proportions are defined in the following equation:

$$\zeta_{cm}(d,\tau,\chi) = \frac{e^{-\Gamma_{cm}(d,\tau,\chi)}}{\sum_m e^{-\Gamma_{cm}(d,\tau,\chi)}}$$

where:

c	refers to a commodity group;
m	refers to mode, m;
d	is the travel distance;
τ	is the travel time;

χ	is the generalized cost of travel;
$\zeta cm(d,\tau,\chi)$	is the proportion of tonnes of commodity group c that will travel by mode m;
e	is the base of the natural logarithm function (approximately 2.718282); and
$\Gamma cm(d,\tau,\chi)$	is the internal Cargo generalized cost function for commodity group c and mode m.

The internal Cargo generalized cost function takes the following form:

$$\Gamma_{cm}(d,\tau,\chi) = \kappa_{0cm} + \kappa_{1cm}d + \kappa_{2cm}\tau + \kappa_{3cm}\chi$$

where:

c	refers to a commodity group;
m	refers to mode, m;
d	is the total journey length in kilometers. For rail and IWT trips, this distance includes the lengths of the road trips to and from the port or station;
τ	is the total journey time in minutes. For rail and IWT trips, this includes the time spent travelling by train or barge, the time spent travelling by road to and from the port or station, any time required for loading and unloading, and any associated waiting time;
χ	is the direct monetary cost. For road trips, and for the road legs of rail and IWT journeys, this includes (fuel and non-fuel) vehicle operating costs and tolls. Rail and IWT journeys also incur the tariff charged by the boat or train operators, charges for loading and unloading, and for temporary storage if appropriate;
$\Gamma cm(d,\tau,\chi)$	is the internal Cargo generalized cost function for commodity group c and mode m;

κ_{0cm}	is the constant term;
κ_{1cm}	is the coefficient for distance;
κ_{2cm}	is the coefficient for time; and
κ_{3cm}	is the coefficient for cost.

The parameters for each mode are presented in Table 3.3.5.

The outputs from modal split are Large Zone to Large Zone freight movement in tonnes for each mode of transport. Following the mode split analysis with reference to Figure 3.3.3, consideration is given to the Transport Logistic Nodes (TLNs). These are places such as major goods yards, multimodal terminals, railway stations, and ports, where trip chaining occurs.

The TLNs are located in zones in the Small Zone system. Table 3.3.6 defines which Small Zones contain TLNs. They “serve” zones in the Large Zone system.

Table 3.3.5 Parameters for Generalized Cost Function

Commodity Group	Pc	Mode	κ_{2cm}	κ_{3cm}
1	0.000043	Truck	-0.03	-0.105
		Rail	-0.033	-0. 05
		IWT	-0.0 3	-0.105
2	0.003620	Truck	-0.027	-0.034
		Rail	-0.027	-0.034
		IWT	-0.027	-0.034
3	0.004150	Truck	-0.008	-0.011
		Rail	-0.008	-0.011
		IWT	-0.008	-0.011
4	0.004250	Truck	-0.026	-0.028
		Rail	-0.026	-0.028
		IWT	-0.026	-0.028
5	0.000098	Truck	-0.062	-0.109
		Rail	-0.062	-0.109
		IWT	-0.062	-0.109
6	0.002550	Truck	-0.013	-0.027
		Rail	-0.013	-0.027
		IWT	-0.013	-0.027
7	0.000084	Truck	-0.047	-0.053
		Rail	-0.047	-0.053
		IWT	-0.047	-0.053
8	0.000036	Truck	-0.037	-0.065
		Rail	-0.037	-0.065
		IWT	-0.037	-0.065
9	0.000031	Truck	-0.059	-0.067
		Rail	-0.059	-0.067
		IWT	-0.059	-0.067
10	0.000038	Truck	-0.055	-0.085
		Rail	-0.055	-0.085
		IWT	-0.055	-0.085
11	0.000049	Truck	-0.042	-0.061
		Rail	-0.042	-0.061
		IWT	-0.042	-0.061

Source: JICA Study Team. These are the calibrated coefficients that replicate the existing data. The value of : κ_{0cm} and κ_{1cm} is zero for all modes and all commodities

Table 3.3.6 Transport Logistic Node (TLN) Locations

TLN Code	Name	Small Zone
1	West Port Said	143
2	Damietta Port	130
3	East Port Said	136
4	Suez Port	152
5	Adabiya Port	153
6	El Dekeila port	223
7	Alexandria Port	226
8	Safaga Port	351
9	Al Arish Port	355
10	Sokhna Port	154
11	Nuwaiba Port	372
12	Hamrawein Port	351
13	Abu Ghosoun Port	352
14	6th of October Dry Port	76
15	SOSDI Dry Port	79
16	10 th of Ramadan Dry Port	100
17	El-Ragab Dry Port	224

Source: JICA Study Team. TLN's include places such as major goods yards, multimodal terminals, railway stations, and ports, where trip chaining occurs

The logistic nodes model examines the matrices created by the long-haul modal split model and partitions them into "direct transport" and "transport chain matrices." The goods in the direct transport matrices will be transported directly from their initial origins to their final destinations. The goods in the "transport chain matrices" will travel via TLNs. These trips must be divided into two sections: from origin to TLN and from TLN to destination. Of these two sections, one will be classified as long-haul and the other will be classified as short-haul. This prompts a modified interpretation of "direction": distribution trips, where the trip to the TLN is long-haul (and the trip from the TLN is short-haul), are considered as "production" and collection trips, where the trip to the TLN is short-haul (and the trip from the TLN is long-haul), are considered as "consumption."

At the end of this process, there are four matrices per mode per commodity group. These are short-haul direct, long-haul direct, long-haul to or from TLN, and short-haul to or from a TLN. Logistic nodes model outputs are the matrices generated by the logistic nodes module contain the direct flows between the production zones and the final destination zones and the trips going through the logistic nodes.

For each combination of mode and commodity group, the movement is estimated in tonne, for direct long- and short-haul trips, relative to the Large Zone system.

The final step is to uses all this flow information to produce matrices of flows, in tonnes, in the Small Zone system. The distribution from the Large Zone to the Small Zone is based on calculating a weight for each Small Zone. The weights are based on the Small Zone socio-economic data.

The demand analysis has been estimated in tonnes. The vehicle model estimate the number of vehicle trips per day. The vehicles are divided into heavy trucks and light trucks[11]. All long-haul trips are made by heavy trucks by using the average loading per truck as shown in Table 3.3.7.All the matrices for a given mode and commodity group are combined to give a single vehicle from Small Zone to Small Zone matrix, relative to the Small Zone system (that is, trips to or from a TLN are now assumed to run to or from the Small Zone containing the TLN), in vehicles per day.

Table 3.3.7 Average Vehicle Load (Tonnes)

Commodity Group	Long Haul	Short Haul (Light Vehicle)	Short Haul (Heavy Vehicle)
1	5.30	0.87	1.20
2	6.00	0.77	1.09
3	11.29	4.69	8.14
4	11.76	3.30	6.82
5	12.97	2.26	6.83
6	3.84	0.76	1.17
7	13.53	4.64	7.07
8	5.75	1.09	1.78
9	5.45	0.75	1.06
10	5.93	0.73	1.13
11	5.30	0.87	1.20

Source: JICA Study Team derived from MiNTS Survey

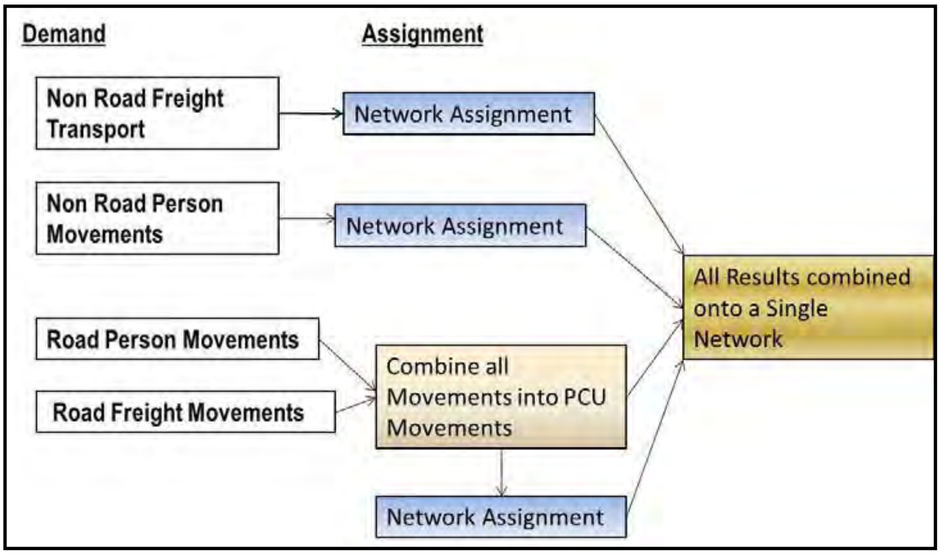
The truck vehicle matrix and the person vehicle matrix discussed earlier are combined in the assignment to the road network.

3.3.3 Network Assignment

The demand matrices are then assigned to the infrastructure network as depicted in Figure 3.3.4. The non road orientated demand matrices for both person and cargo are first assigned to their respective rail and IWT networks. The road orientated demand matrices for both person and cargo are first converted into equivalent passenger car units (PCU) prior to a capacity restraint assignment.

After completion of both assignment procedures, the assignment results are combined into a single network.

[11] The proportional split between medium and heavy trucks in the long haul category is developed from the MiNTS survey database as is the back loading factor. Over time, MNAM has an input key that allows for improved efficiency. This is further discussed in the *MNAM User Manual*.



Source: JICA Study Team

Figure 3.3.4 Network Assignment

3.4 YEAR 2010 CONDITIONS

The base year (2010) trip characteristics, as simulated via application of the MNAM, are presented in this section.

3.4.1 Person Trips

Approximately 18.53 million national person trips were generated throughout Egypt during a representative year 2010 day (Table 3.4.1). These include journeys by all modes of travel between the MiNTS analysis zones. Thus, by definition, trip totals within zones (i.e. inside of urban areas) are excluded. As expected, the Cairo Region generates the highest number of trips. Upper Egypt also accounts for sizable activity, however, spatially speaking, the Upper Egypt Region is considerably larger than either Cairo or the Delta Regions.

Table 3.4.1 Year 2010 Daily Person Trip Generation

Region Number	Region Name	Daily Trips
1	Cairo	5,959,784
2	Western Delta	3,576,573
3	Eastern Delta	2,817,112
4	Upper Egypt	4,796,241
5	Red Sea	491,217
6	Western Desert	387,775
7	New Valley	109,872
8	Sinai	393,124
Total		18,531,698

Source: JICA Study Team. Notes: Refer Figure 2.1.2 for regional boundaries. Refer Table 2.2.2 for Regional GDP as well as Table 2.3.1 for regional population and employment.

The road mode is dominant accounting for some 93 percent of passenger trips. The largest single passenger mode is shared taxi, carrying roughly two-thirds of all passenger trips and catalyzing near half of national passenger kilometers (Table 3.4.2).

Table 3.4.2 Modal Share of Year 2010 Daily Person Trips

Major Mode	Mode	Number of Trips	Percentage	Person Kilometers	Percentage Distribution
Road	Car	2,114,553	11.4	255,400,503	24.6
	Shared Taxi	12,561,223	67.8	490,213,310	47.3
	Bus	2,551,297	13.8	221,722,456	21.4
	Subtotal	17,227,073	93.0	967,336,269	93.4
Non Road	Rail	1,226,864	6.6	54,282,451	5.2
	Air	77,760	0.4	14,591,216	1.4
	Subtotal	1,304,624	7.0	68,873,667	6.6
Total		18,531,698	100.0	1,036,209,936	100.0

Source: JICA Study Team. Air passengers exclude international arrivals and departures.

The previous table includes all trips, including those between Small Zones (refer Section 2.1 for discussion of zonal hierarchy). Such trips can, especially within built-up regions such as the Delta, contain substantial numbers of very short distance journeys for which the use of shared taxis is expected to dominate. It is, given the national perspective of MiNTS, of interest to also examine longer distance trips, that is, journeys of more than 100 kilometers. While the road mode retains its dominancy, the modal share of passengers cars is more pronounced accounting for almost one-fourth of journeys and one-third of passenger kilometers. Shared taxis, while still retaining the largest absolute share, have seen relative share decrease to under 40 percent (Table 3.4.3).

Table 3.4.3 Modal Share of Long-distance Year 2010 Daily Person Trips

Major Mode	Mode	Number of Trips	Percentage	Person Kilometers	Percentage Distribution
Road	Car	856,239	24.4	202,707,805	33.0
	Shared Taxi	1,367,846	38.9	192,668,731	31.4
	Bus	948,062	27.0	163,467,048	26.6
	Subtotal	3,172,147	90.3	558,843,584	91.1
Non Road	Rail	262,854	7.5	40,257,080	6.6
	Air	77,760	2.2	14,591,216	2.4
	Subtotal	340,614	9.7	54,848,296	8.9
Total		3,512,760	100.0	613,691,880	100.0

Source: JICA Study Team. Air passengers exclude international arrivals and departures. Longer distance trips defined as being more than 100 kilometers in length.

The person trip origin-destination pattern for the highest-generator precinct (Cairo Region) confirms that the highest absolute number of trips lie within the Cairo Region; that is, between zones comprising the Cairo metropolitan area. This is followed by trips linking the Cairo Region with the Western Delta and Eastern Delta Regions, respectively (Table 3.4.4). The composite national trip origin-destination pattern, on a Large Zone basis, is depicted in Figure 3.4.1.

Table 3.4.4 Regional Travel Pattern: Year 2010 Daily Person Trips

Region Name	Region Number	Region Number								
		1	2	3	4	5	6	7	8	Total
Cairo	1	4,821,003	444,343	349,665	295,870	31,778	10,649	1,817	4,659	5,959,784
Western Delta	2	437,409	2,815,006	241,098	40,661	4,910	36,083	204	1,203	3,576,573
Eastern Delta	3	343,867	242,874	2,183,314	31,017	10,125	1,554	141	4,218	2,817,112
Upper Egypt	4	283,610	39,752	30,347	4,402,934	28,823	946	9,576	254	4,796,241
Red Sea	5	31,931	5,030	10,337	30,186	411,234	69	116	2,314	491,217
Western Desert	6	10,781	36,797	1,602	995	70	332,091	5,434	*	387,775
New Valley	7	1,818	208	144	9,826	114	5,308	92,454	*	109,872
Sinai	8	4,806	1,282	4,391	272	2,369	*	*	379,997	393,124
Total		5,935,224	3,585,291	2,820,898	4,811,761	489,422	386,707	109,741	392,653	18,531,698

Source: JICA Study Team. Note: * denotes less than 20 trips.

3.4.2 Cargo Trips

Numerous studies have, in past, examined the demand on road, rail and inland waterway modes. In addition, MiNTS has conducted a comprehensive series of national surveys. Modal data (as presented in earlier reports) contain various information, although not necessarily according to similar formats. Nevertheless, several clear cargo patterns appear to be emerging on a tonne basis (Table 3.4.5):

- The role of the road mode is absolutely dominant, and growing.
- The rail mode is second to the road mode in terms of use, however, both relative and absolute shares of total cargo carried are decreasing quite rapidly.
- Inland waterway transport (IWT) activity has experienced a drop in relative share over the last decade. However, absolute cargo carried appears to have stabilized.

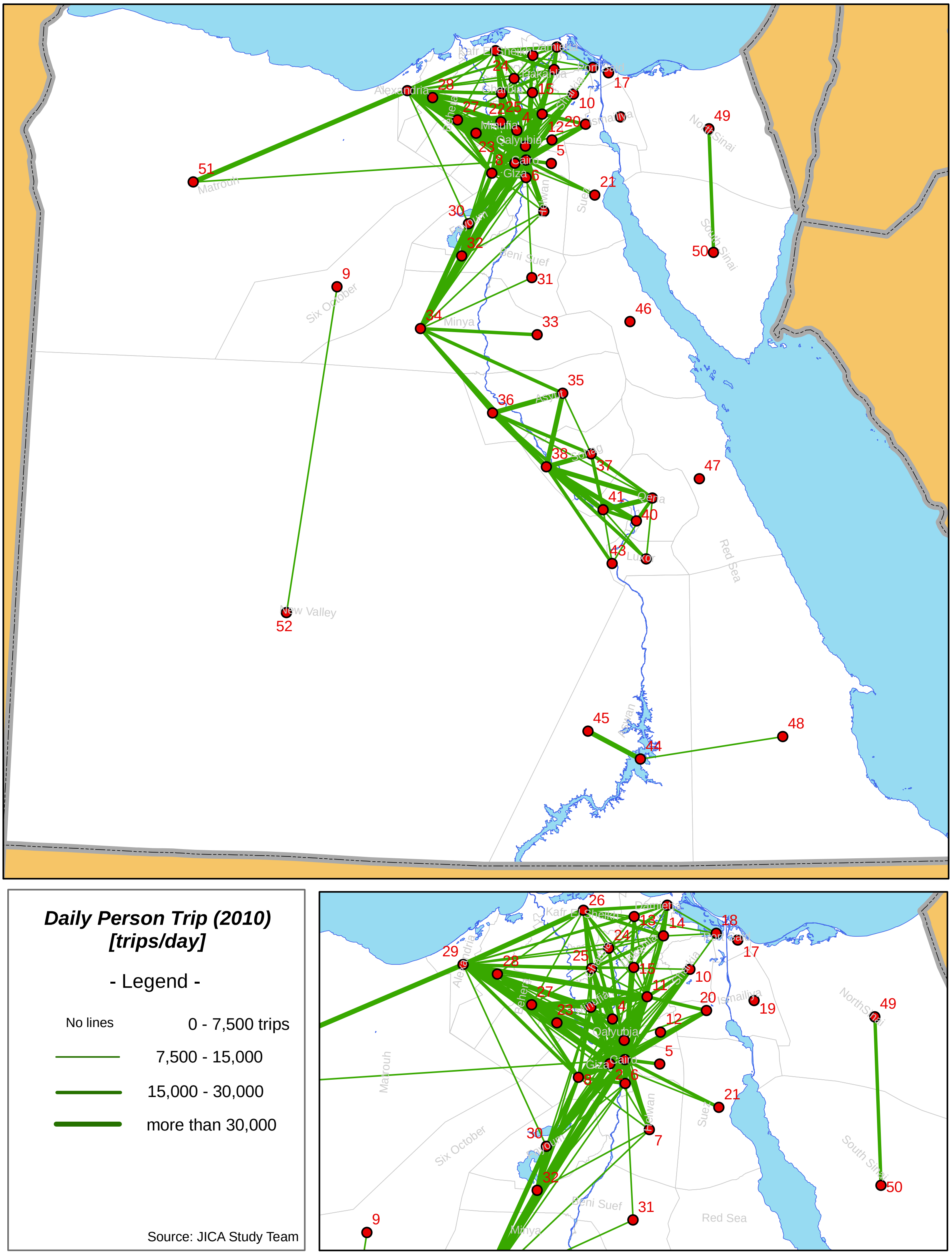


Figure 3.4.1 Year 2010 Passenger Trip Origin-Destination Pattern

- Civil aviation (not included in Table 3.4.5) transported about 300,000 tonnes of cargo during year 2010, about 0.1 percent of the national total.

Table 3.4.5 Trend in Modal Share: Annual National Freight Movement

Year	Annual Cargo Volume (000 tonne)				Modal Share (Percent)			
	Road	Railway	IWT	Total	Road	Railway	IWT	Total
1979	73,700	5,000	4,300	83,000	88.7	6.1	5.2	100.0
1992	165,495	9,642	3,214	178,351	92.8	5.4	1.8	100.0
2000	242,000	11,812	2,161	256,000	94.5	4.6	0.8	100.0
2010	433,361	4,042	2,226	439,630	98.6	0.9	0.5	100.0

Source: JICA Study Team based on (a) 1979 and 1992 data from *The Study on the Transportation System and the National Road Transportation Master Plan* (1993), JICA (b) 2000 data from *Development Study on the Inland Waterway System in the Arab Republic of Egypt*, (2003), JICA; and (c) 2010 information from MiNTS data surveys. Excludes pipeline transport (115 million tonnes in year 2010). Inland water transport (IWT) excludes short distance cross-Nile ferry traffic.

The aggregate year 2010 daily total of 1.51 million shipped tonnes (shipments between MiNTS Large Zones) includes some 0.32 million tonnes of pipeline product, roughly 21 percent of shipped tonnes and 31 percent of tonne kilometers (Table 3.4.6).

The exclusion of pipeline transport confirms that some 62 percent of tonne cargo is carried by heavy commercial vehicles (large trucks) (Table 3.4.7). The modal split on a tonne kilometer basis confirms that:

- The role of large trucks becomes even more dominant account for near 72 percent of expended national tonne kilometers (and all trucks near 97 percent of tonne kilometers).

- Rail and inland waterway carry predominately large, bulky cargoes. Thus, in case of rail, the relative national tonne kilometer share increases considerably over tonne share. Tonne kilometer impacts of IWT are reduced due to very short distance cross-Nile ferry services. However, the tonne kilometer share remains minor compared to the road mode given the modest absolute totals carried by those two modes.

- The highest volume commodity shipments by road are represented by Commodity Group 7, Manufactured Material and Building Materials. In case of rail and IWT, highest volume commodities are Group 1, Agricultural Products, and Group 10, Machinery, Transport Equipment and Manufactured Articles, respectively (Table 3.4.8).

Table 3.4.6 Modal Share of Year 2010 Daily Cargo Trips

Major Mode	Mode	Number of Tonnes	Percentage	Tonne Kilometers	Percentage Distribution
Road	Light Truck	213,500	14.1	22,426,200	7.3
	Medium Truck	216,200	14.3	29,716,100	9.7
	Heavy Truck	734,512	48.6	152,234,900	49.7
	Subtotal	1,164,212	77.1	204,377,200	66.7
Non Road	Rail	9,080	0.6	3,963,668	1.3
	IWT	21,600	1.4	3,523,204	1.1
	Pipeline	315,000	20.9	94,520,500	30.9
	Subtotal	345,680	22.9	102,007,372	33.3
Total		1,509,892	100.0	306,384,572	100.0

Source: JICA Study Team. Assumes 300 kilometer average distance for pipeline transport. Inland water transport (IWT) includes cross-Nile ferry traffic.

Table 3.4.7 Modal Share of Year 2010 Daily Cargo Trips (Excluding Pipeline)

Major Mode	Mode	Number of Tonnes	Percentage	Tonne Kilometers	Percentage Distribution
Road	Light Truck	213,500	17.9	22,426,200	10.6
	Medium Truck	216,200	18.1	29,716,100	14.0
	Heavy Truck	734,512	61.5	152,234,900	71.9
	Subtotal	1,164,212	97.4	204,377,200	96.5
Non Road	Rail	9,080	0.8	3,963,668	1.9
	IWT	21,600	1.8	3,523,204	1.7
	Subtotal	30,680	2.6	7,486,872	3.5
Total		1,194,892	100.0	211,864,072	100.0

Source: JICA Study Team. Assumes average distance for pipeline transport of 300 kilometers. Inland water transport (IWT) includes cross-Nile ferry traffic.

Table 3.4.8 Year 2010 Cargo Shipment by Mode of Transport

Commodity Group	Description	Mode of Transport (tonnes per day)					Percent of Total
		Road	Rail	IWT	Pipeline	Total	
1	Agricultural Products	155,775	2,811	374	-	158,959	10.5
2	Foodstuffs and Animal Fodder	78,270	36	533	-	78,839	5.2
3	Solid Mineral Fuels	9,949	1,723	50	-	11,722	0.8
4	Petroleum Products	64,071	1,461	1,409	315,100	382,041	25.3
5	Ores and Metal Waste	48,628	1,425	77	-	50,129	3.3
6	Metal Products	8,680	493	4	-	9,177	0.6
7	Manufactured Minerals and Building Materials	510,732	857	3,013	-	514,601	34.1
8	Fertilizers	35,530	60	931	-	36,520	2.4
9	Chemicals	48,714	-	-	-	48,714	3.2
10	Machinery, Transport Equipment and Manufactured Articles	191,579	166	15,185	-	206,931	13.7
11	Live Animals	12,189	48	26	-	12,262	0.8
Total		1,164,116	9,080	21,600	315,100	1,509,892	100.0

Source: JICA Study Team. Inland water transport (IWT) includes cross-Nile ferry traffic.

The tonne trip origin-destination pattern confirms important differences from the passenger trip pattern. The highest volume of tonne trips is linked with the Western Delta Region, followed by the Cairo Region. Strong activity is noted for the Eastern Delta, Red Sea and Upper Egypt Regions (Table 3.4.9).

Table 3.4.9 Regional Travel Pattern: Year 2010 Daily Tonne Shipments

Region Name	Region Number	Region Number								
		1	2	3	4	5	6	7	8	Total
Cairo	1	98,715	90,792	40,516	15,447	12,898	3,146	445	3,446	265,407
Western Delta	2	81,352	261,564	33,218	7,676	5,751	3,487	*	1,407	394,463
Eastern Delta	3	38,200	25,259	96,934	3,618	5,514	175	44	2,651	172,395
Upper Egypt	4	22,584	8,717	8,692	109,578	6,130	212	1,516	220	157,648
Red Sea	5	59,776	51,729	40,950	10,900	6,301	643	140	1,700	172,139
Western Desert	6	2,936	12,080	134	48	42	1,045	*	*	16,300
New Valley	7	161	27	504	1,162	100	33	*	*	1,999
Sinai	8	5,347	619	4,409	453	1,198	*	*	2,358	14,386
Total		309,070	450,788	225,357	148,883	37,935	8,741	2,173	11,791	1,194,892

Source: JICA Study Team. Excludes Pipeline . Inland water transport (IWT) includes cross-Nile ferry traffic. * denotes less than 20 tonnes.

CHAPTER 4: SCENARIO FORMULATION

Future scenarios represent, in principle, a series of alternative developmental scenarios involving changes in transport network, trips and the parameters which guide the assignment procedures.

4.1. THE STEPWISE APPROACH

The current approach, as documented in this report, relies on several logical components:

- The base case (as presented in the previous Section 3.4) represents the year 2010 condition. That is, "existing" transport networks, simulated trip demand and current assignment conditions (for example, fuel costs reflect the existing price, in year 2010 terms[1]). This condition can also be referenced as a "do nothing" scenario; that is, no new investment in infrastructure.

- However, the "do nothing" scenario is not a realistic condition against which to assess future scenarios since existing (base case) transport networks are expected to be enhanced via the inclusion of currently committed projects[2]. This "existing plus committed" condition can be referenced as the "do minimum" scenario whose operational parameters represent performances against which any future changes are weighed.

- Alternative future scenarios represent the logical follow-on of the vision, policy and strategy chain noted in *Interim Report 2*. These account for a linking of transport demand with land use, modern – yet affordable and sustainable – transport systems, increasing reliability on free market (fuel) pricing mechanisms, and capability of enhancing societal quality of life.

Scenario building can involve a large number of permutations and combinations of events and procedures. These were previously discussed with the MiNTS Steering Committee. The primary vehicle for scenario discussion was, in addition to Committee consultations, the previously-referenced Transport Scenario Workshop of 29 September, 2011, and comments received there from.

4.2. THE "USER PAYS" PRINCIPLE

Generalized cost, as noted in the previous chapter, is a key determinant of MNAM modal choice relationships. Fuel price is a variable in this relationship. In Egypt, the cost of fuel is heavily subsidized. The Steering Committee had earlier confirmed the relevance of the subsidy, not only from a perspective of

[1] The existing price reflects the current levels of fuel subsidy on gasoline and diesel.

[2] Committed transport projects were defined in consultation with the ENR, GARBLT, RTA and maritime authorities during early/mid-2011. Project information, obtained in spreadsheet and pictorial formats, includes location and cost, among other items. For purposes of scenario testing, road, rail and inland waterway projects form the basis of network configurations.

financial "cost at the pump", but also in terms of impacts upon the national budget. Year 2009/2010 conditions, for example, confirm that the average pump price of gasoline (across all octane ranges) accounts for near half of the market cost of the fuel. The situation in case of diesel fuel is more pronounced. Annual national fuel (gasoline plus diesel) subsidy outlays are escalating and (then) accounted for some 34.05 billion LE. Of course, not all of these subsidies can be linked directly to transport; nevertheless, the indicated totals represent some 3 percent of GDP – a sizable impact.

A variety of initiatives have been considered in past for reducing and/or eliminating the subsidy in some form. Clearly, societal pressure continues to grow with the recognition that unbridled subsidies represent a threat to economic sustainability. As noted in a recent Reuters News Service article[3] "*……The government has said it wants to better target subsidies to the most needy in a country where a fifth of its 78 million people live on less than $1 a day. Economists say targeting subsidies would help cut the budget burden and reduce waste….*".

A View on Fuel Subsidies

> *… Governments should look for opportunities to move away from fuel price subsidies as rapidly as possible and replace them with targeted assistance to the poor. Preparatory work to identify beneficiaries and design efficient ways to deliver assistance should be given high priority, especially since high oil prices are likely to continue in the coming years...*
>
> Source: *Phasing Out Subsidies: Public Policies for the Private Sector*, by R. Bacon and M. Kojima, Note 310, The World Bank, 2006.

The impact of the reduced fuel price (due to subsidy) is substantial in terms of trip making. The observed base year modal split for passenger cars is, for trips in excess of 100 kilometers, near 25 percent (the remainder being allocated to shared taxi, bus and rail modes). The impact of roughly doubling the price of fuel (the equivalent of removing subsidy) can be substantial. For example, if pump price equals unsubsidized market cost the modal share of passenger cars would decrease by roughly one-third to slightly over 16 percent (Figure 4.2.1). This implication of adjusting fuel prices (year 2027 in constant year 2010 terms) is fully integrated with the testing of future scenarios.

Considerable financial resources will be required to finance the MiNTS Transport Master Plan. Thus, de-facto adjustments/elimination of the fuel subsidy will "free up" considerable national financial assets for investment in other sectors of society, including transport. An additional source of revenue is levying a fuel tax (or carbon tax). "At the pump" taxes are common in other countries, where their use is justified on a variety of grounds, to include funding for transport projects and/or maintenance of transport facilities and/or systems; input to general revenues; encourage energy conservation; catalyst for transportation demand management; revenue-neutral tax shift (fuel tax revenues take the place of other, more economically negative, taxes); internalize the external costs of fuel production and consumption; and, fund vehicle insurance pool.

[3] Online at http://af.reuters.com/article/investingNews/idAFJOE6180FQ20100209

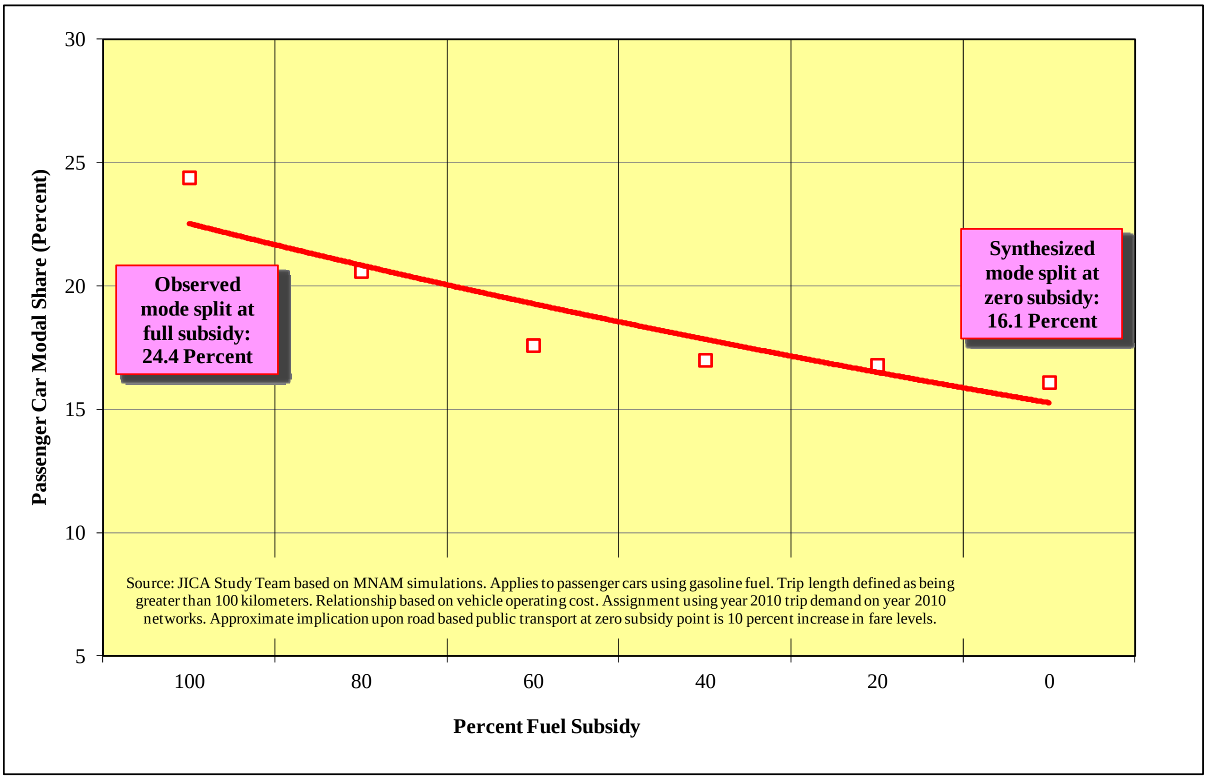


Figure 4.2.1 Simulated Impact of Fuel Subsidy on Year 2010 Passenger Car Mode Split

What are representative applications of an “at the pump” tax?

- March, 2011 prices for regular gasoline in the United States averaged $3.56 per gallon (about 5.50 LE per liter). The unit cost breakdown was crude oil 68 percent; refining 13 percent, distribution/marketing 7 percent and taxes 12 percent.

- Taxes on fuel sold within the European Union generally represent 40-60 percent of per liter cost. Thus, taxes yield some 5 - 6 LE per liter.

- Recent prices for gasoline in Japan reached 151 Yen per liter (about 11.5 LE) including a five percent Value Added Tax. Also included are two fixed taxes totalling 53.8 Yen for national and regional authorities. These taxes (about 4.1 LE per liter) have historically been earmarked for road construction and maintenance, although some recent use for public transport activity has been approved.

- Fuel taxes are typically collected “at the pump” from motorists. Other forms of fuel, such as cooking and heating fuel, tend to have different tax structures and collection mechanisms.

It is therefore of interest that the application of a tax, levied “at the pump” in the form of increased fuel price, be considered in the testing of MNAM scenarios. This could be considered an environmental tax.

What is an Environmental Tax?

Environmental taxes are taxes based on fossil fuel carbon content, and therefore a tax on carbon dioxide emissions. Because such a tax is intended primarily to internalize the environmental costs of fuel consumption and encourage energy conservation, there is no particular requirement for how their revenues should be used. Revenues can be used to reduce taxes, provide rebates, or finance new public services. Such taxes can be applied at the point of production, distribution or sales.

Source: JICA Study Team drawing on Victoria Transport Policy Institute, Melbourne, Australia.

4.3. SETTING THE SCENARIOS

In the first instance, Scenario A and Scenario B represent the "do minimum" and "do nothing" cases.

- Scenario A: "Do Minimum" scenario, embodies future (year 2027) demand on the existing plus committed transport network. That is, the transport networks include the year 2010 facilities plus those committed for implementation by the road, rail and inland waterway sectors. Assignment reflects modal split under current transport costing conditions to include fuel prices. The findings of Scenario A represent the case against which evaluations of more elaborate future scenarios are compared.

- Scenario B: "Do Nothing" scenario is driven by future demand on the existing network. The assignment operates under identical conditions as Scenario A, with the major difference being that committed transport projects are excluded from consideration. This provides a more direct comparison to observed year 2010 conditions; that is, how existing networks cope with future (year 2027) demand.

Scenario C contains variants of future scenarios.

- Scenario C-1: "Maximum infrastructure" scenario. The "existing plus committed" transport network is enhanced by the inclusion of (a) some elements of the strategic MiNTS corridors; (b) additional projects proposed (but not committed) by transport service providers, and (c) transport linkages contained in the *Egypt Vision 2052* document. The rail network includes provision for "high speed" (TGV/Shinkansen-class) services in some corridors. The assignment reflects a more market oriented approach in that fuel prices are roughly doubled in real terms[4].

- Scenario C-2: "Reduced infrastructure" scenario evolves towards a less complex/expensive network vis-à-vis that of Scenario C-1. For example, high speed rail is replaced by "high speed rail" (operating speed 200 km/hr) in appropriate corridors. Fuel price increases are less than Scenario C-1, on the order of 50 percent.

- Scenario C-3: "Revenue generation" scenario builds upon previous tests by utilizing reduced infrastructure (as per Scenario C-2). In addition, the Scenario C-1 fuel pricing structure is

[4] Approximately simulates the full removal of the current fuel subsidy.

increased by some 20 percent of per-liter costs. The intent is to simulate possible revenues which can be derived from levying an “at the pump” fuel tax.

The scenarios are summarized in Tab le 4.3.1.

Table 4.3.1 Overview of Transport Scenarios

Scenario	Scenario Reference	Fuel Price(1)	Input Network	Modal Focus
A	Do Minimum	Current	Existing plus Committed	Road
B	Do Nothing	Current	Existing	Road
C-1	Maximum Infrastructure	Market Price	Existing plus Committed plus All New	Non Road
C-2	Reduced Infrastructure	Less than Market Price but higher than Existing Price	Existing plus Committed plus Most New	Non Road-Passenger Road-Cargo
C-3	Revenue Generation(2)	Market Price plus “at the pump” tax	Existing plus Committed plus Most New	Maximum Non Road

Source: JICA Study Team.

(1) Fuel price expressed in constant year 2010 terms. Increase percentages are approximate for presentation and discussion purposes. One hundred percent increase in fuel prices approximates removal of all fuel subsidy. More than 100 percent increase in fuel price includes additional “at the pump” carbon tax approximately equal to 20 percent of per liter cost. In scenario C2, the overall fuel price increase approximates to the removal of the fuel subsidy on person transport only.

(2) Revenue generated via imposition of “at the pump” per-liter carbon tax.