CHAPTER 3: THE TRANSPORT MODEL

3.1 EXISTING ISSUES, OPPORTUNITIES AND CONSTRAINTS

The objective of this chapter is to discuss the transport model, its development, calibration and application, as used to define trip activity, modal characteristics and origin destination patterns. The model initially synthesizes representative travel patterns as quantified by 14.5 million people residing in 3.5 million households within the study area. Also presented in this chapter are representative findings of demand forecasting procedures which extend over the adopted planning horizon to year 2022. While the application of these forecasts in the screening, evaluation and fine-tuning of the proposed transport master plan, referenced in subsequent sections as Scenario D, is summarized in this chapter, more detailed and sectorially focused quantification is documented in other chapters, particularly Chapter 4, *Public Transport System*, Chapter 5, *Urban Road System*, Chapter 6, *Cargo Transport* and Chapter 7, *Intermodality*.

3.1.1 Background

CREATS successfully completed a series of eleven comprehensive transport surveys during latter 2001[1]. In a technical sense, the main purposes of the surveys are to (a) assist in the development and calibration of a computerized transport demand model; (b) provide up-to-date information so that accurate engineering and planning analyses may proceed; (c) document current transport demand among the various transport modes and facilities existing in Cairo; (d) establish quantitative as well as qualitative interactions among transport, planning, economic, social and environmental sectors associated with CREATS; and, (e) provide input to a growing GIS data base for Greater Cairo. In terms of the initial objective, that is, development and calibration of the transport model, principal survey groupings are:

- *Household Interview Survey.* The HIS is seen as the "backbone" of model development and consisted of interviews involving some 57,000 households within the study area. Each member of the household was asked a series of questions relating to household characteristics, persons characteristics and trip

[1] For full detailing of survey approaches, methodologies, and findings, please refer *Progress Report (2) - Transportation Master Plan and Feasibility Study of Urban Transport Projects in Greater Cairo Region in the Arab Republic of Egypt, Volume I (Current Urban Transport Status) and Volume II (Results of Transport and Traffic Surveys)*, op. cit.

characteristics. In addition, subsidiary surveys were conducted with additional, focused questions relating to trip preferences, environmental concerns and opinions on transportation problems, possible solutions and policies.

- *Roadside Interview and Traffic Counting Surveys.* The monitoring of trip demand is an important element of the model building process, thus, a series of interrelated and mutually supportive surveys were conducted. A cordon survey, whose purpose is to ascertain trip patterns of external trip makers, that is, movements between the study area and other parts of Egypt, as well as between other parts of Egypt but passing through the study area. Interviews and traffic counts were conducted along all major roads crossing the study area boundary and at select public transport terminals/stations. The Nile River is adopted as a primary screen line bisecting the study area. Thus, 16 or 24 hour traffic counts were conducted on all bridges, stratified by direction and vehicle types. It is noted traffic counts involve the counting of both vehicles and vehicle occupants. A traffic count survey incorporating two elements. Firstly, some 60 locations were counted along the Cairo Ring Road, major arterials in Cairo, near major generators as well as along central area and CBD cordons. In addition, about 30 intersections and squares were selected for peak periods directional turning movement counts, again stratified by time period, direction and vehicle types.

- *Public Transport Passenger Survey.* Modal patterns, preferences and trip relationships for public transport users were ascertained via interviews conducted at selected terminals/stations involving CTA, metro, ENR, shared taxi and other services.

- *Freight Vehicle Survey.* The flow of cargo to/from Cairo, as well as within Cairo, is of vital importance to any strategy involving commercial vehicles and the facilities used in cargo processing. Thus, in addition to analysis of available data, interviews were conducted which focus on truck owner characteristics, trip patterns as well as opportunities and constraints.

- *Vehicle Travel Speed Survey.* A series of arterials were identified, and vehicle operating speeds determined. These surveys, conducted during varying periods of the day, measure speeds of vehicles operating in mixed traffic.

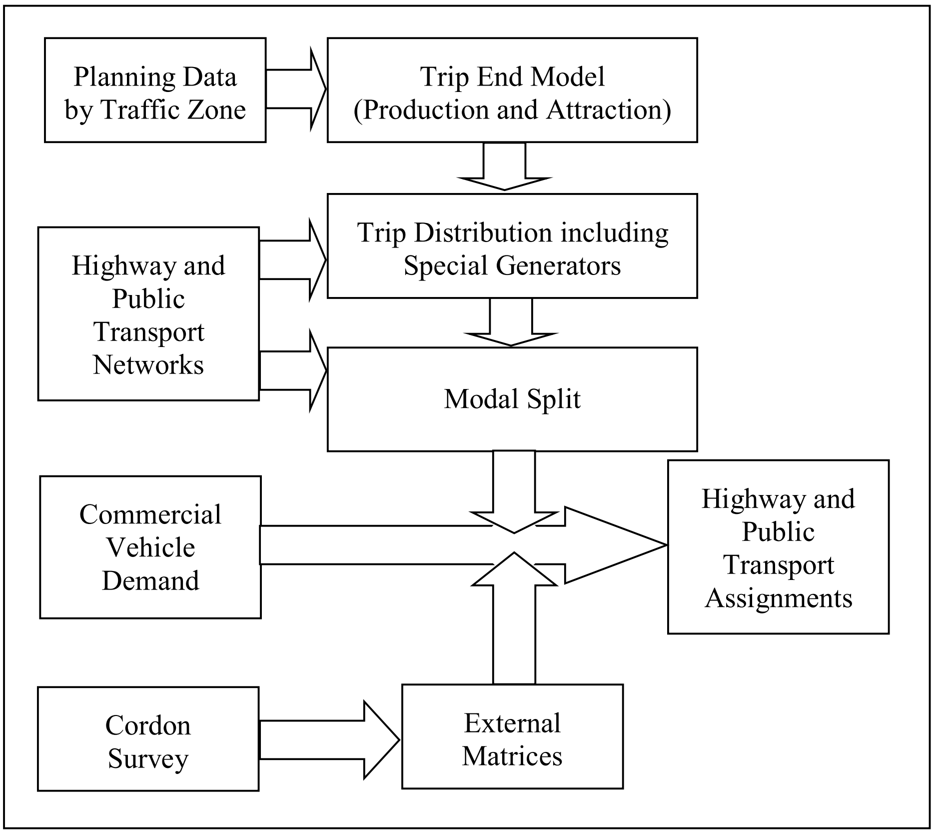
- *Road Condition Survey*. The general content of major roads (such as number of lanes, carriageway width, roadside friction, traffic signal control, etc) was ascertained via a review of available records, plus focused field investigations.

- *Transport Network Survey.* As a sister-survey to the road condition survey, the network survey focuses on public transport systems. Following a compilation of records available from formal (CTA, CMO, ENR) operators (such as route structure, service patterns, service frequency, etc), the network survey addressed gaps in available information with a focus on the shared taxi and cooperative minibus modes. Results of both the road condition and transport network surveys provide considerable inputs toward the development of road and public transport networks within the framework of the transport model.

As stated, this chapter presents the transport model, its development, calibration and application, as used to define trip activity, modal characteristics and origin destination patterns[2]. Considerable challenges were overcome in the development of a complete four-step CREATS model within a limited time period. Overall this model provides a good technical tool for the evaluation of strategic network infrastructure projects or major transport policy issues in the CREATS study area.

3.1.2 Model Structure

The framework of the CREATS Transport Model framework is shown in Figure 3.1.1. It follows the conventional 4-stage approach which has been well-tried and found to be effective in many cities of the world.



Source: JICA Study Team

Figure 3.1.1 CREATS Transport Model Framework

The four stage approach consists of a series of nested and cascading sub-modals:

- Trip End Models - Estimating the "amount" of travel and where it begins and finishes;
- Trip Distribution - Linking the trip ends together to form trips between the origins and destinations;

[2] Refer also *Technical Report (2): Framework of the Transport Model*, op. cit.

- Modal Split - Accessing the modal shares of the available travel modes; and,
- Assignment - Usage of each segment of the highway and public transport networks.

The main thrust of the model is targeted at the representation of the travel demand of the residents of the Greater Cairo Region, and their usage of private and public transport. Goods vehicles and the travel which crosses the boundary of the study area (external travel) are "added-in" prior to the traffic assignment.

The external travel is derived in base year from the cordon of roadside interview stations which were located adjacent to the Study Area boundary.

Estimates of goods vehicle travel were derived from the survey data adjusted to reflect the observed travel patterns obtained from the traffic counts undertaken at many locations throughout the city. Forecasts of future goods vehicle traffic have been based on general growth and the assumed employment distribution.

3.1.3 Model Approach

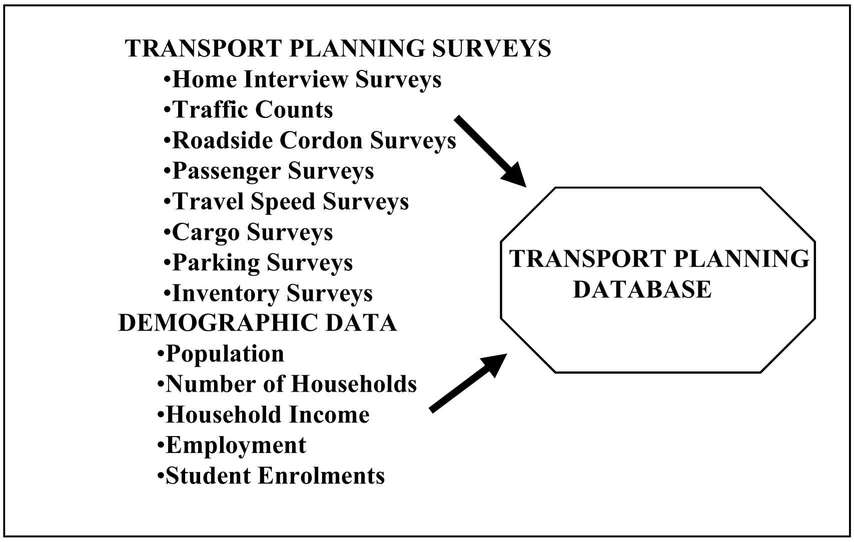
The development of the transport model required the assembly of data describing the transport supply (i.e. networks) and transport demand (population, jobs, school places etc., their spatial location, and the pattern of movements). This had to be assembled in a coordinated manner with the data cross-checked against other sources. There were many different sources of data which have been assembled over the years by different authorities and organizations. These were reviewed and corroborated to form, in conjunction with CREATS surveys, the database for model development (Figure 3.1.2).

The starting point for the model development was:

- Collection of socio-economic and network data;
- Conduct of major surveys as listed in Section 3.1.1; and
- Compilation of data for corroborative purposes from other sources.

In building the model, travel characteristics were taken from the CREATS database[3], primarily from the Home Interview Survey and the Roadside Interview Survey data. However, one of the main final checks on the model was the comparison with the observed Nile River screenline crossings of actual traffic flows, by vehicle type and time of day. Some considerable emphasis in calibration was placed on matching the observed and modeled screenline crossings as this illustrates the replication of the current traffic volumes and travel characteristics.

[3] Refer to *Volume IV: CREATS Urban Transport Database*, of this *Phase I Final Report*, which categorizes the extensive numeric database collected and generated as part of CREATS technical procedures, and contains explanatory documentation regarding database content



Source: JICA Study Team

Figure 3.1.2 The Transport Planning Database

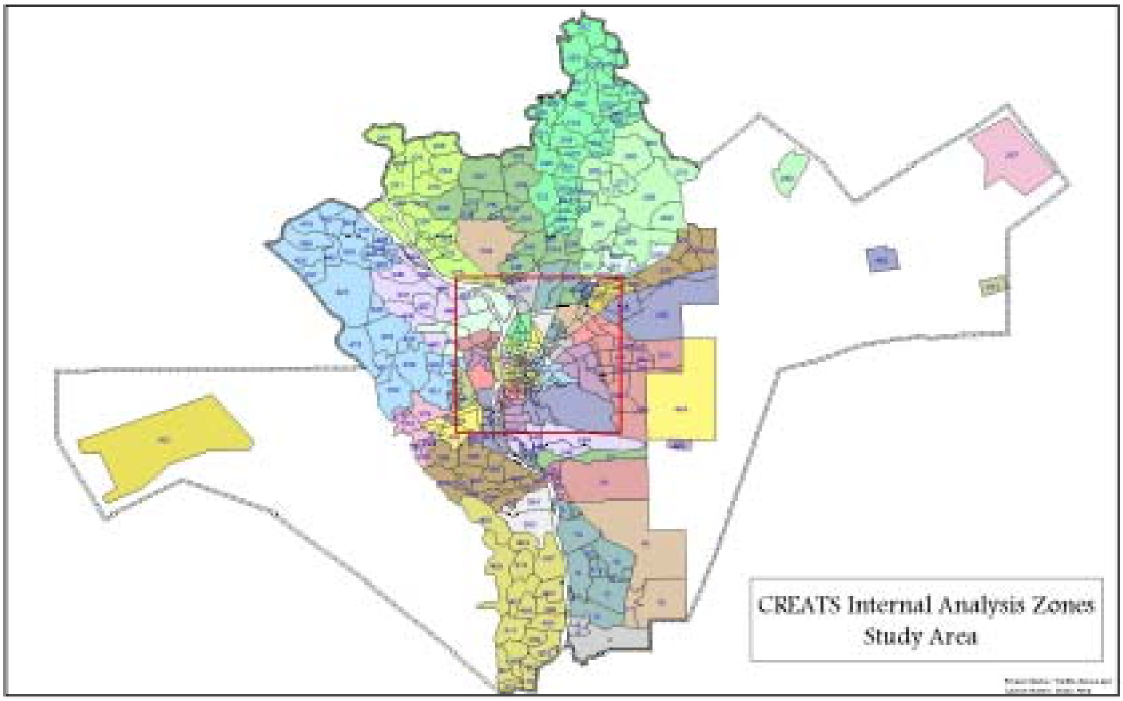
3.2 NETWORK DEVELOPMENT AND REPRESENTATION

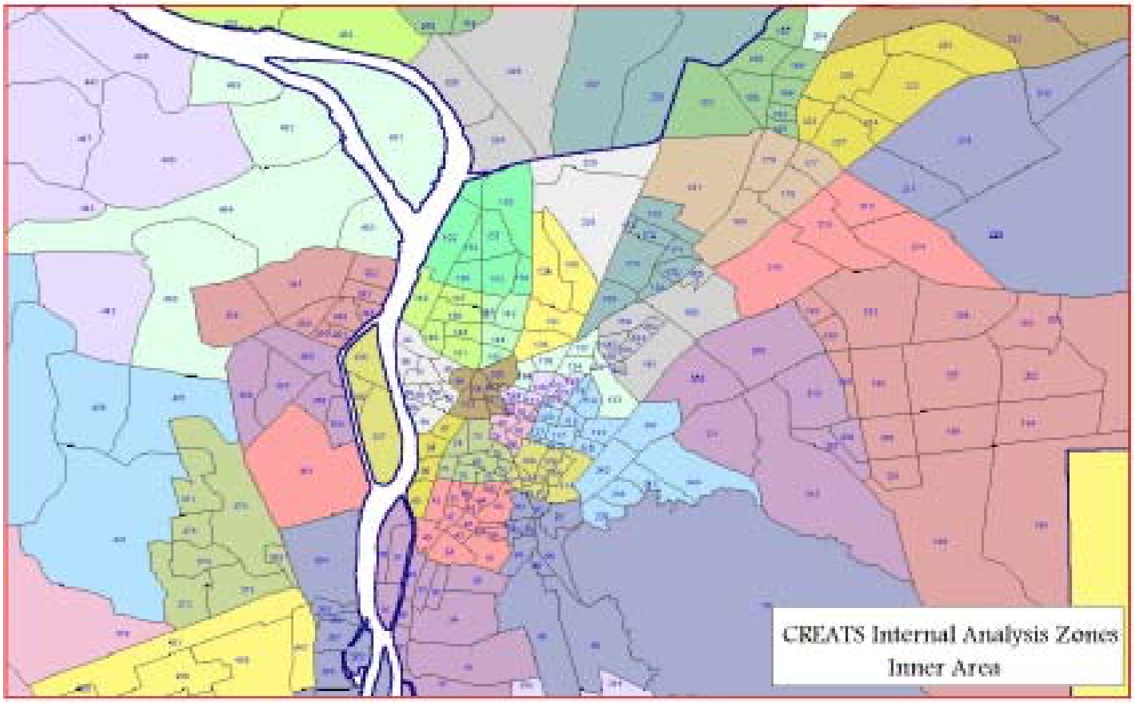
3.2.1 Development of the Traffic Zoning System

It is a standard requirement of any transport model to have a set of spatial data units, known as traffic zones, which apply to the model study area. They should be designed to classify data at the most appropriate level for transport model development.

The model study area for the transport model comprises parts of the Governorates of Cairo, Giza, Qalyobeya and Sharqeya. In essence there are 503 traffic zones, 464 internal traffic zones, 9 special generators, 20 external stations and ten zones reserved for future development. In the future horizon year of 2022, some of these reserved traffic zones have been deployed as special generators along the corridor linking the 6th of October and the 10th of Ramadan cities.

The detailed description of traffic zone system is provided in Chapter 2, *Urbanization Structure and Socio-Economic Framework*. The 464 internal traffic zoning system is presented in Figure 3.2.1 showing the study area and the inner area. The internal zone and sector system are linked to the network via a GIS shape file.





Source: JICA Study Team

Figure 3.2.1 The CREATS Traffic Zone System

3.2.2 Road Network Content

This section presents detail regarding development of the base year (2001) highway network within the overall framework of the CREATS transport modeling process[4]. It is noted that the analyses focus on the unique needs of CREATS and should not be interpreted as having broader implications, although the Study Team strongly supports the need for post-CREATS efforts leading to development of an Egyptian *Highway Capacity Manual*.

Several surveys and data collection efforts, augmented by on-going technical liaison with local experts, provided input to the formulation of the highway network:

- The "beginning point" of network development is defined as the simulated highway network created as part of previous transport planning efforts in Cairo. This network was housed in, and maintained by, the Development Research and Technological Planning Center (DRTPC) of the University of Cairo.
- The Road Inventory Survey, during which some 20 corridors were investigated. Inventory data include surface type and condition, type of traffic operation, parking practices, road cross-section, side friction, chainage and intersection types.
- Field inspections by members of the Study Team.
- Review of previous studies in Cairo pertaining to network development, or elements thereof, as well as technical discussions with representatives of ENIT (Egyptian National Institute of Transport) and the University of Cairo to further clarify related issues, and to assist in the derivation of speed and capacity relationships at a level of detail appropriate to the modeling and analytical needs of CREATS[5].

The simulated road system must include all roads required to achieve modeling of inter-zonal trip demand. The level of detail to which the zone structure and highway network are built must be in balance; thus, not all existing roads need be included since zonal stratification extends to a 503-zone level of detail. The road network is a computerized simulation of highways located within the CREATS study area and consists of numerous links (road segments) and nodes (intersection points), with each link being embedded with a unique set of indexes describing its operating capabilities. Parameters for each link include:

- A and B nodes, which are numeric values that identify the "from" and "to" ends of a link. Node locations are defined by their X and Y coordinates and thus permit monitor displays of network content, performance and operation. The network is also linked to the CREATS GIS (Graphic Information System).

[4] A more complete discussion of road capacity considerations which underlie road network formulation is contained in Chapter 6, Volume I of *Progress Report (2)*, to include procedural approaches, background data, local practices and CREATS methodologies.

[5] The Study Team is particularly indebted to the guidance and advice received from Prof. Dr. Ali S. Huzayyin and Prof. Dr. Mohamed Rashad El Mitainy, Faculty of Civil Engineering, University of Cairo, in this regard.

- Link distance defining the length of a link in kilometers.
- Free flow speed, which is defined as the safe speed at which a vehicle would travel on a link in the absence of other traffic. Free flow speed is further discussed in the following section.
- Link (assignment) capacity, as discussed in the following text.
  i. Capacity (road) type code is used to identify links to which a common capacity restraint function is to be applied, that is, link speed is reduced by a pre-determined function as the link volume to capacity ratio increases. Conditions are:
  ii. Link type groupings are in accordance with facility type.
  iii. Free flow speed represents the V/C = 0.0 condition, while V/C = 1.0 simulates full utilization of assignment capacity.
  iv. A V/C of approximately 1.4 represents very congested flow prior to operational breakdown. (This ratio indicating, "very congested flow" takes typically the value of 1.3 to 1.5, and the value of 1.4 is a median value for representing such condition. While it is technically very difficult to define one representative number for this purpose, the value of 1.4 is a reasonable value.)

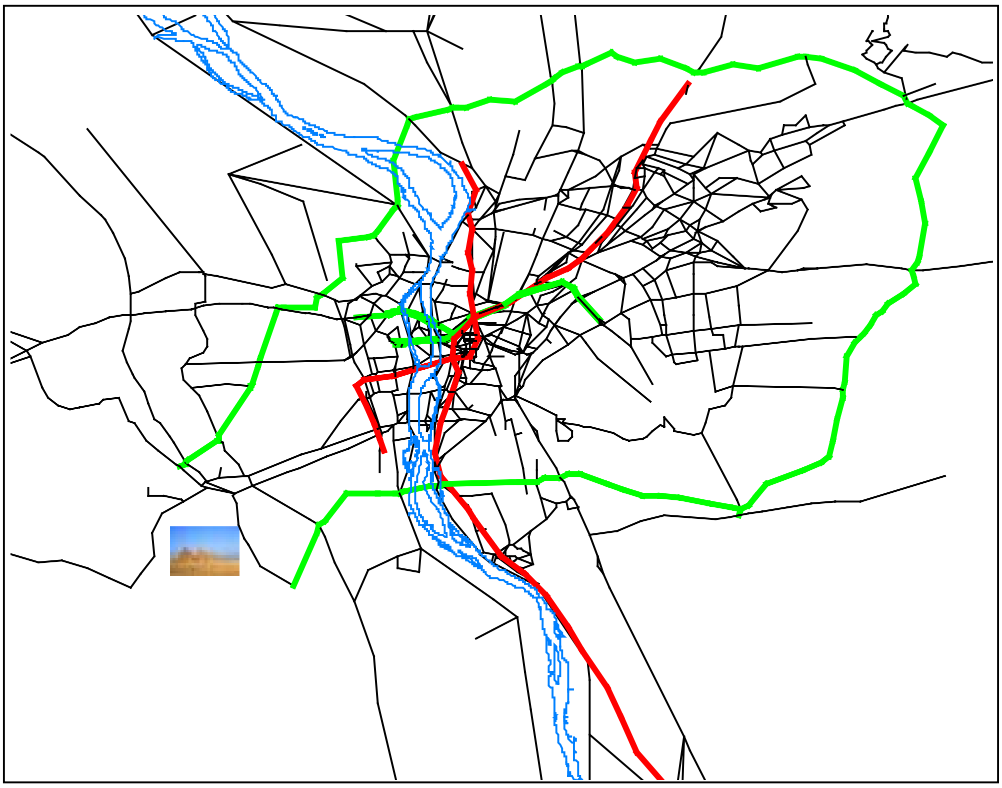
The highway network includes most, if not all, main roads and streets located in Greater Cairo. It incorporates 503 centroids (simulated connections to zonal centers of transport activity) of which 464 represent links with zones located within the study area (Figure 3.2.2). This figure shows the basic road network in the central area. The completed ring road and the metro lines are high lighted for this presentation.

The total network contains nearly 4,900 links, extending over roughly 4,500 link kilometers. Average free flow speed varies depending on facility type ranging from 20 to 99 kilometers per hour (Table 3.2.1).

Table 3.2.1 Averaged Link Parameters CREATS Year 2001 Roadway Network

Facility Type[1]	Number Of Links	Distance (km) [2]	Speed (km/hr) [3]	Capacity (pcu/hr) [4]	Number Of Lanes[5]	Capacity per Effective Lane
Expressway[6]	261	191.1	99	4,200	2.8	1,500
Arterial, > Four Lanes	1,273	866.7	80	2,500	3.1	800
Arterial, Four Lanes	1,767	1,398.0	75	1,600	2.0	800
Arterial, Two Lanes	510	418.5	60	500	1.0	500
Total Network	3,811	2,874.3	*[7]	*	*	*

1 For entire carriageway. Arterial, four lanes represents, for example, interrupted flow conditions with two nominal traffic lanes in each direction.
2. Directional link distance in kilometers.
3 Link free flow speed, or the safe speed at which a vehicle would travel in the absence of other traffic.
4 Link assignment capacity of simulated (intersection) approach in pcu per hour, weighted by link length.
5 Number of lanes per simulated (intersection) link approach, weighted by link length.
6 Mainline portions only.
*7 * means not applicable.*



Source: JICA Study Team

Figure 3.2.2 CREATS Year 2001 Simplified Roadway Network

There does not, at present, exist a comprehensive *Highway Capacity Manual* which quantitatively describes the interplay of speed, volume and capacity under Egyptian conditions. The *Egyptian Road Code*[6] represents the first effort in this regard, although procedures and techniques are focused on the design of inter-urban road facilities. Urban conditions, that is, interrupted and semi-interrupted flow, have not been quantified or codified to any formal extent, although some project or site specific investigations have been conducted by consultants or institutions such as CAPMAS and the DRTPC, among others. CREATS speed and capacity relationships, which form an important element of link content, are consequently derived for CREATS based on a synthesis of local experience and overseas documentation, among then the *US Highway Capacity Manual*[7] and the *Indonesian Highway Capacity Manual*[8]. A more comprehensive discussion of urban road speed

[6] *Egyptian Code for Roads*, authored by the Ministry of Housing, Building Research Center, 1998; in particular, *Volume 2: Traffic Studies* and *Volume 3: Geometric Design*.

[7] *Highway Capacity Manual*, *Special Report 209*; Transportation Research Board, National Research Council, 1998

[8] *Indonesian Highway Capacity Manual; Part II - Interurban Highways*, for Government of Indonesia, Directorate General of Highways, by SweRoad, et. al, 1996; and, *Part I – Urban Roads*, for Government

and capacity relationships was previously presented in Chapter 6, *Urban Road System*, Volume I of *Progress Report (2).* Only highlights are, in the interests of brevity, repeated here.

Capacity techniques used by CREATS rely on various terminologies. The following introductory descriptions are provided so that a more accurate and complete appreciation of procedures may be obtained.

- The roadway network, either existing or proposed, is divided into links (road segments) separated by nodes (junctions), with each link described by a unique set of operating conditions (speed, capacity, chainage, physical content).
- Vehicle demand/capacity is expressed in terms of passenger car units (pcu's). This stratification accepts that vehicle types exert differing impacts upon the traffic stream in which they operate due to both size and engine capabilities. Utilized pcu vis-à-vis vehicle equivalents for urban conditions are: motorcycle – 0.33; light vehicle (car, pick-up, taxi, van) - 1.0; small truck (two axles) - 2.0; medium truck (three axles) – 2.5; large truck (more than three axles) – 3.0; micro bus (shared taxi) – 1.5; mini bus – 2.0; and, standard bus – 2.5. These are estimated by the Study Team.
- Link capacity can be expressed in terms of practical capacity and assignment capacity.
- Practical capacity represents an absolute limit regarding the number of pcu's which can be accommodated on a given road section under realistic operating conditions and within physical parameters associated with the link.
- Assignment capacity represents a trip-making threshold at which alternative route choices are likely. Assignment capacity, free flow speed and traffic loading are integrated via speed-decay relationships which dynamically decrease link attractiveness (speed) as the volume to capacity ratio (v/c) increases.

Capacity, as used in CREATS modeling, is assignment capacity; that is, values which can intuitively be associated with a Level of Service C/D concept. Link free flow speed is the safe speed at which a vehicle (pcu) would travel along a road segment in the absence of other traffic and within the physical conditions unique to that particular segment.

Due to the massive size of the simulated study area road network (some 4,900 links extending over approximately 4,500 link kilometers), evaluations require the adoption of a generalized procedure to estimate capacity and speed for each link in the road network. These and other parameters determine generic link class and function within the overall road hierarchy. Such generalized approaches have proven successful during previous modeling efforts conducted on a city-wide or regional scales. It is noted that while such procedures are appropriate for most network links, supplementary capacity/speed analyses may still required on a site-specific basis for roads which do not conform to typical norms or perform unique functions (such as ramps or merging sections).

of Indonesia, Directorate General of Highways, by SweRoad, et. al, 1994.

Analyses have been stratified under four broad geographic headings:

- Core area, a designation which, in the CREATS context, is associated with the CBD's of Cairo and Giza. Heavy traffic volumes, considerable roadside friction, extensive parking, constrained road facilities, pronounced pockets of public transport concentrations and heavy pedestrian volumes, characterize Road operations.
- Urban area, or what could, in general terms, be designated as the area inside of the Cairo Ring Road. Traffic flows are likely less concentrated, and more diffuse, than those found in the core area. Public transport activities are likely to be more corridor oriented, and pedestrian activities less intense. Road facilities would likely be more expansive, to include the presence of higher-order facilities.
- Suburban area, or the area generally outside of the Ring Road. Roadside activities would become more radial in nature, and the frequency of intersecting movements decline. While the content of public transport vehicles in the traffic stream is less, considerably more heavy commercial vehicles (which are banned from central area streets) are likely to be found.
- Rural area, or road operations which approximate inter-urban, uninterrupted flow conditions. Capacities under rural conditions would likely be the maximum available for LOS (Level of Service) C/D conditions. In the case of CREATS, few links are seen as experiencing rural flow. Only near the periphery of the study area, or along higher-order roads, are inter-urban flow conditions observed to any consistent degree.

Under uninterrupted (mid-block) conditions, a two-way, four lane (two lanes in each direction) undivided urban facility is shown as achieving an assignment capacity of some 3,950 pcu/hour (without curb parking lane) and 3,440 pcu/hour (with parking lane), total both directions of travel (Table 3.2.2). The flow values are derived from several sources, with considerable guidance from the *US Highway Capacity Manual*.

In the case of interrupted flow conditions, capacity is further impacted by the ability of links to discharge traffic through a node, given that "competition" for nodal discharge opportunity exists among intersecting flows, and that this "competition" is often regulated by traffic signals, the police or other forms of traffic control devices. For the purposes of CREATS, it is assumed that at all nodes experiencing interrupted flow conditions, discharge (flow) opportunity is governed by a ratio similar to the "green time" relationship associated with signal operations. Such discharge ratios at nodes are simulated as being a function of the number of legs on each intersection approach. Average relationships were calculated for each of the four geographic precincts, with the overview result being an approximate 40 percent reduction of mid-block capacities for roads experiencing interrupted flow. This is in fact saying that the mid block flows cannot be maintained through the intersections. The nodes rather than the road links are likely the critical points in the network.

Table 3.2.2 Mid-block Road Capacity-CREATS Roadway Network

Facility Type (1)	Road(2) Condition	Curb Parking	Capacity (pcu/hour/direction)(3)			
			Core	Urban	Suburban	Rural
Two-way, two lanes	Wide	No	770	870	880	950
		Yes	540	650	700	*(4)
	Standard	No	600	680	690	740
		Yes	420	510	550	*
	Narrow	No	450	510	520	560
		Yes	320	380	410	*
One-way, two lanes	Standard	No	1,690	2,090	2,310	*
		Yes	1,440	1,830	2,080	*
One-way, four lanes	Standard	No	3,580	4,320	4,720	*
		Yes	3,220	3,970	4,430	*
Two-way, four lanes	Undivided	No	1,580	1,970	2,190	2,280
		Yes	1,340	1,720	1,970	*
	Divided	No	1,780	2,200	2,430	2,540
		Yes	1,510	1,930	2,190	*
Two-way, six lanes	Undivided	No	2,500	3,050	3,350	3,420
		Yes	2,250	2,800	3,150	*
	Divided	No	2,820	3,410	3,730	3,800
		Yes	2,540	3,140	3,500	*
Expressway	Four lanes	No	2,990	2,990	2,990	2,990
	Six lanes	No	4,490	4,490	4,490	4,490

(1) For entire carriageway. Two way, six lanes represents for example, two-way flow with three lanes per direction.

(2) Standard refers to typical lane width of 3.5-3.6 meters.

(3) Assignment capacity, pcu per hour in one direction for two-way roads and total flow for one-way roads.

(4) There are no network links in this category.

(5) Capacity calculations reflect an average system-wide 25 percent heavy vehicle traffic stream content.

Free-flow speeds of roads[9] vary depending on facility type and urban environment, ranging from under 30 km/hour for two-lane CBD roads to some 80 km/hour for multi-lane roads situated in rural or outlying areas. Urban expressways, whose design criteria remain consistent, are shown as possessing free flow speed profiles of up to 100 km/hour (Table 3.2.3). It is noted that actual operating speeds will lie below free flow speeds.

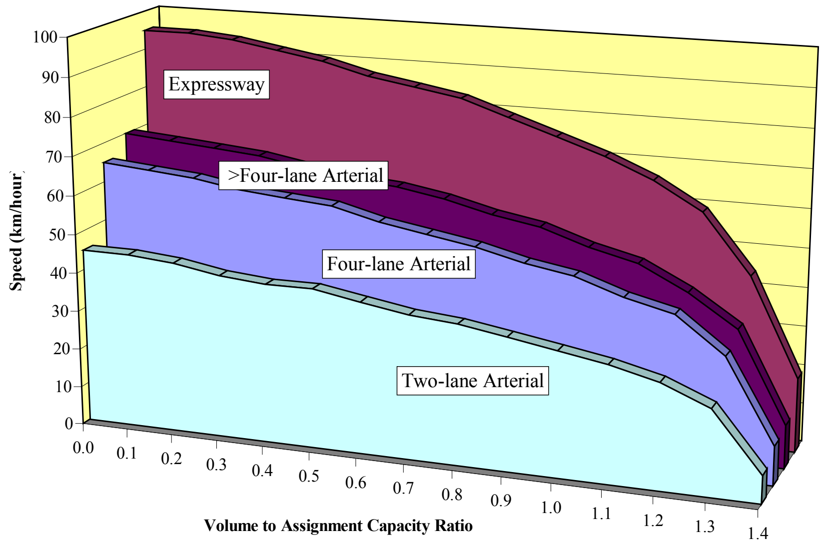
It is important to note that speed and capacity of all types of road segments (links) are inexorably inter-related: as speed decreases, capacity increases and as the volume to capacity ratio (v/c) ratio increases, speed decreases. The speed decrease with unit flow increase is small at low flows but becomes larger as flows get higher. In modeling terms, assignment capacity, free flow speed and traffic loadings are integrated via speed-decay curves which dynamically decrease link attractiveness (speed) as the v/c ratio increases. A typical family of speed-decay curves for suburban road conditions used in modeling processes is depicted in Figure 2.2.3.

[9] Free flow speed of any link refers to a profile speed of all motorized road users.

Table 3.2.3 Link Free Flow Speeds: CREATS Roadway Network

Road Operation[1]	Free Flow Speed by Environment (km/hr)[2]			
	Core	Urban	Suburban	Rural
Two-way, Two Lanes	25-30	30-40	40-50	50-60
Two-way, Four Lanes	35-45	45-60	60-70	70-80
Two-way, > 4 Lanes	45-55	55-65	65-75	75-85
Expressway	80-90	80-90	90-100	90-100

1 *For entire carriageway. Two way, six lanes represents, for example, two-way flow with three lanes in each direction.*
2 *Ranges in speed based on reasonable variation in lane width.*



Source: JICA Study Team

Figure 3.2.3 Speed Decay Function CREATS Roadway Network - Suburban Facilities

3.2.3 Public Transport Network Content

The model uses networks and line files, respectively, to represent the underlying network structure and the routes that operate across the network. The network file is the same link file as for the road network with the addition of public transport operating on dedicated right of way such as tram, metro, train and ferry.

The starting point of the public transport network development was the inventory undertaken of bus and shared taxi route during the CREATS surveys. Some 550 bus routes including all types of bus as well as over 500 shared taxi routes were identified and coded into the public transport lines file. Other service information such as service frequency and fares were also coded into the lines file format.

It is assumed that public transport travelers may walk some way along existing road links before finding an appropriate service. Rather than explicitly code a comprehensive walk network which parallels the highway network the modeling software calculates such a walk network internally. It is controlled by classifying each link type into either a walk only, transit only or transit and walk link. The link description for the network including future link designations is shown in Table 3.2.4. Walk only links do not allow transit routes to pass along them; transit only links do not allow walking along them (e.g. expressway) whilst those classified as both allow walking along and riding buses or shared taxi along the link.

The modeling software requires public transport routes or lines (as they are know in the terminology of the modeling software) to be classified by two attributes which are mode and company. Company is a report summary classification, whilst mode is a behavioral classification. For the base year the mode and company codes are the same. In addition, every route is allocated a fare table which defines how the fare table is calculated for each route. In the case of this study an individual fare table for the many routes in particular the road based public transport was obtained for each route. The mode and company codes are the same in the base year and these are presented in Table 3.2.5.

3.3 TRIP GENERATION

3.3.1 Overview

The first step in the model is to categorize households in each traffic zone into various socio-economic bins or groupings. Often this is done using vehicle ownership categories which are also a pseudo measure of household income and economic activity within a household. However in the case of this study area some 70% of households did not have access to a private car. For this reason household income is used as the indicator of economic activity.

The households within the zone are split into five classes of economic activity and then further distributed between seven household size categories. Thence the two are combined to develop a matrix of households within each traffic zone by size and economic activity. A trip generation rate is linked to each element of the matrix to estimate the trip productions. The trips attracted to a zone are estimated using zonal attributes such as employment.

Table 3.2.4 Network Link Description

Link Type	Description
1	Road
2	Elevated Road and Tunnels
3	Ring Road
4	Metro
5	ENR
6	Tram & Heliopolis Tram
7	Ferry
8	Transit Connector Metro to Road
9	Centroid Connector
10	Transit Connector Tram to Road
11	Transit Connector ENR to Road
12	Transit Connector Ferry to Road
13	Transit Connector Metro to Metro
14	Transit Connector Metro to Tram
15	Transit Connector Metro to ENR
16	Transit Connector Metro to Ferry
17	New Metro Line
18	Transit Connector ENR to ENR
19	Dangling, Connected to Centroid
20	Access Link to Ring Road
21	PT Links under Ring road
22	Major New Links >1 Lane per Direction
23	Minor New Links 1 Lane per Direction
24	6th October
25	Tunnel
26	Connectors to Metro
27	Express ENR line
28	Expressway-TollRoad
29	New or Upgraded Urban Street
30	New Tram Links
31	Super Tram
32	Not Used

Source: JICA Study Team

Table 3.2.5 Mode/Company Definitions for Public Transport Lines Files

Mode	Public Bus-CTA
1	Public Bus-GCBC
2	A/C Bus
3	Ferry
4	Tram
5	H-Tram
6	Metro 1
7	Metro 2
8	ENR Suburban Rail
9	Shared Taxi
10	CTA Minibus
11	Cooperatives Minibus

Source: JICA Study Team

3.3.2 Household Distribution Model

The household economic activity model uses five levels of economic activity namely:

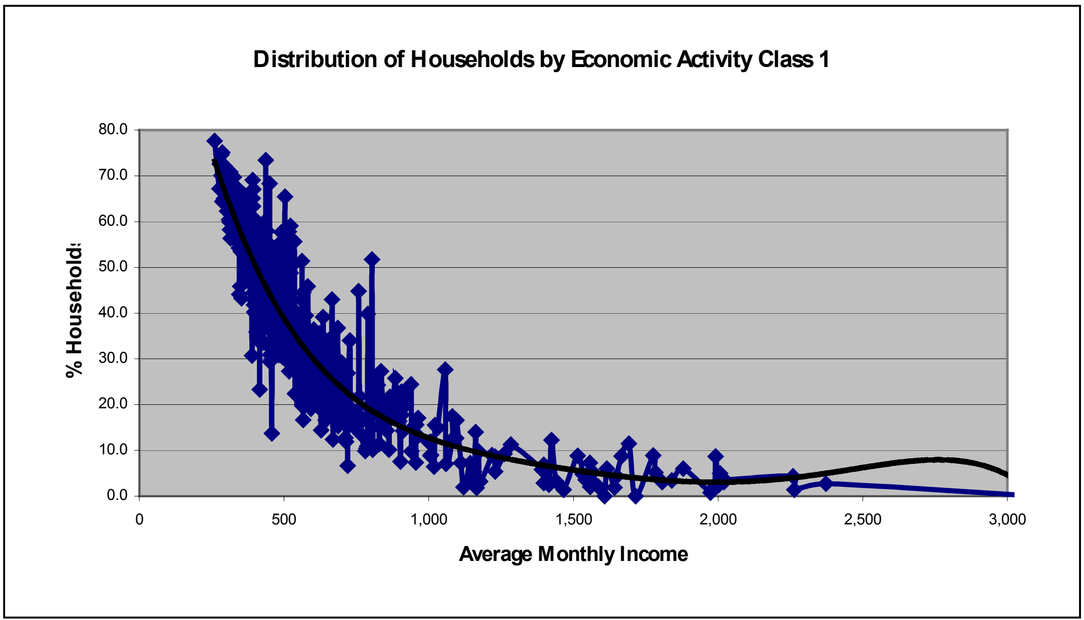
- Class 1~Low;
- Class 2~Low-Medium;
- Class 3~Medium;
- Class 4~High-medium; and
- Class 5~High.

These classes of economic activity correspond to monthly household income levels of less than 300 LE per month, 300-500 LE per month; 500-1,000 LE per month; 1,000-3,000 LE per month and greater than 3,000 LE per month.

These levels of economic activity were verified against the two household expenditure items namely the household monthly electricity and telephone bills. For example in the case of economic activity Class 1 and 2 combined, the average monthly expenditure on electricity and telephone is 18 and 19 LE per month respectively. At the other end of the scale for the Class 5 level, the average monthly expenditure on electricity and telephone is 84 and 108 LE per month respectively. These household expenditure items verified the breakdown of the households into classes of economic activity.

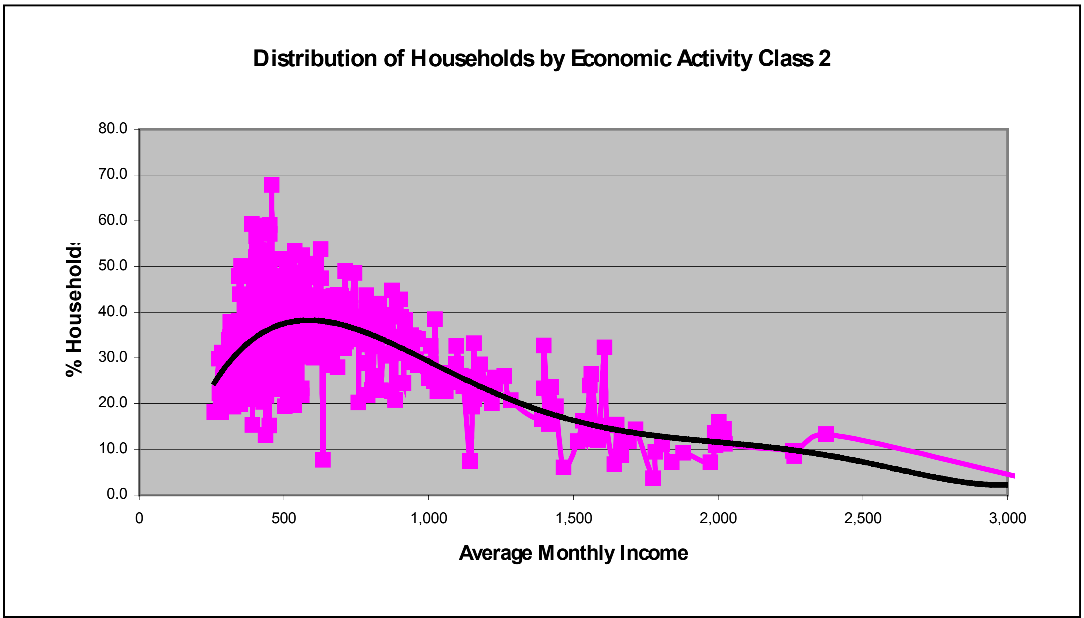
From the analysis of the CREATS home interview survey income class based curves were developed with the input variable being the average household income. These curves are shown for the five income classes in Figures 3.3.1 through to 3.3.5 whilst all curves are combined together in Figure 3.3.6.

For each traffic zone a distribution of households by size into seven categories (1,2,3,4,5,6 and 7+ person households) is also derived from the home interview survey. These curves are shown for each household size group in Figures 3.3.7 through to 3.3.13 whilst all curves are combined together in Figure 3.3.14.



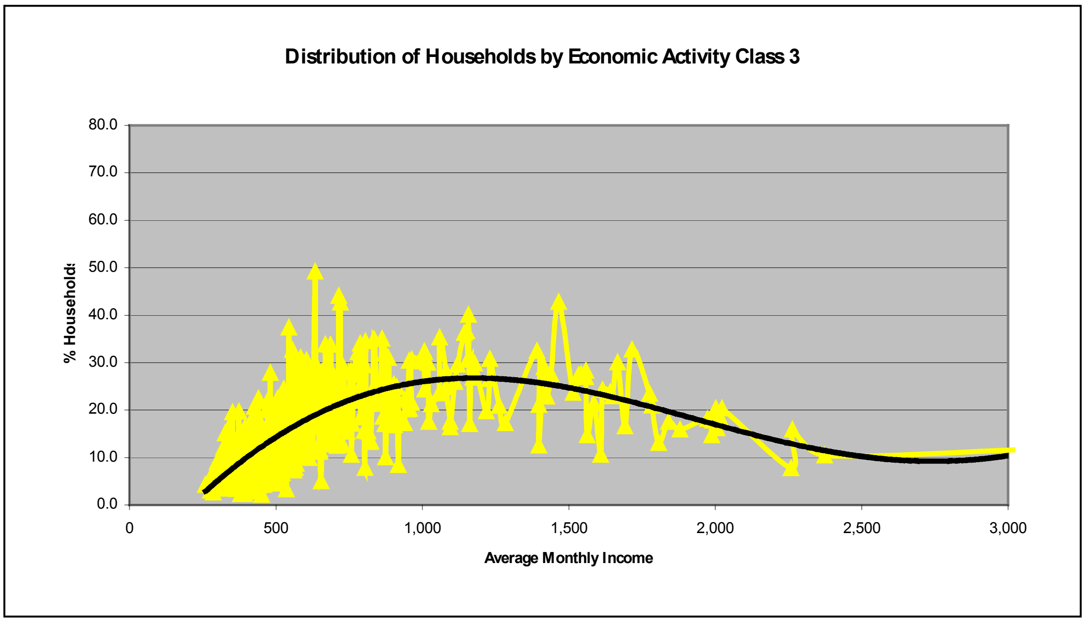
Source: JICA Study Team

Figure 3.3.1 Household Distribution for Economic Activity Class 1



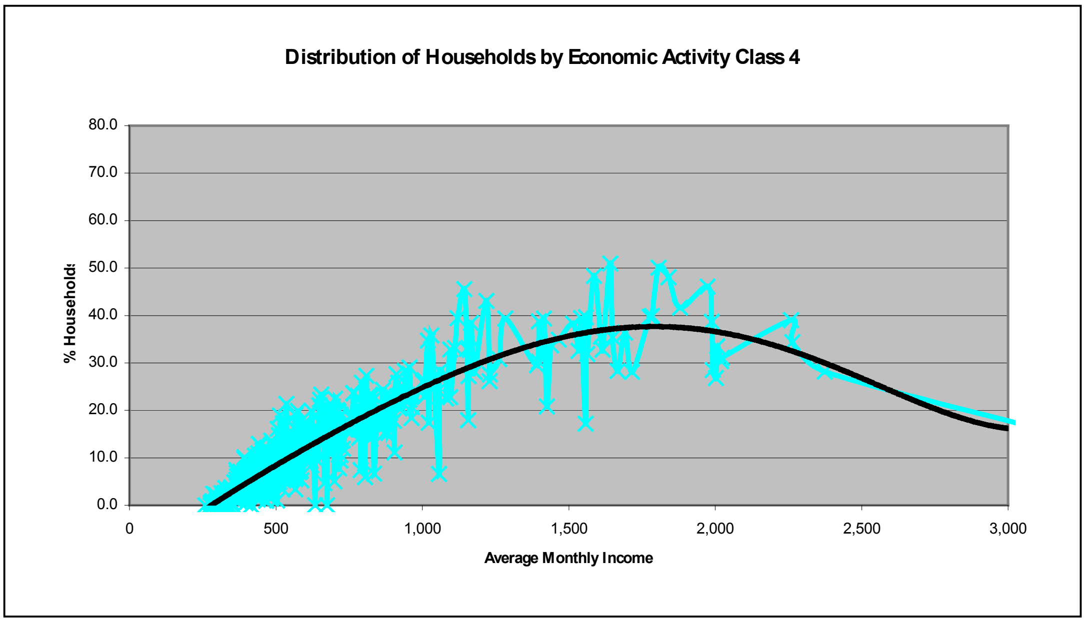
Source: JICA Study Team

Figure 3.3.2 Household Distribution for Economic Activity Class 2



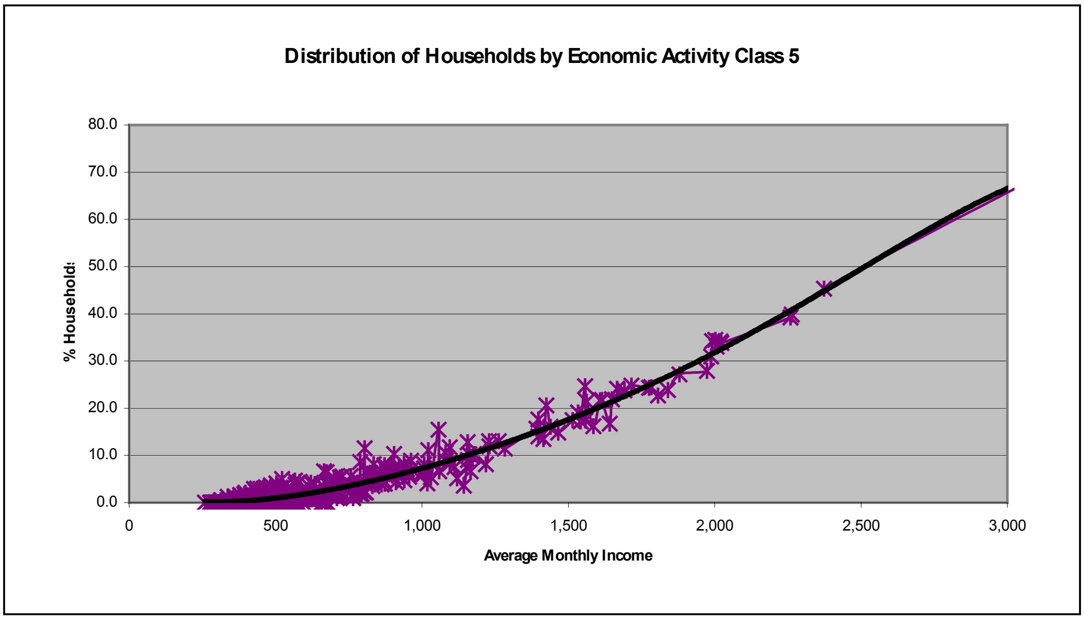
Source: JICA Study Team

Figure 3.3.3 Household Distribution for Economic Activity Class 3



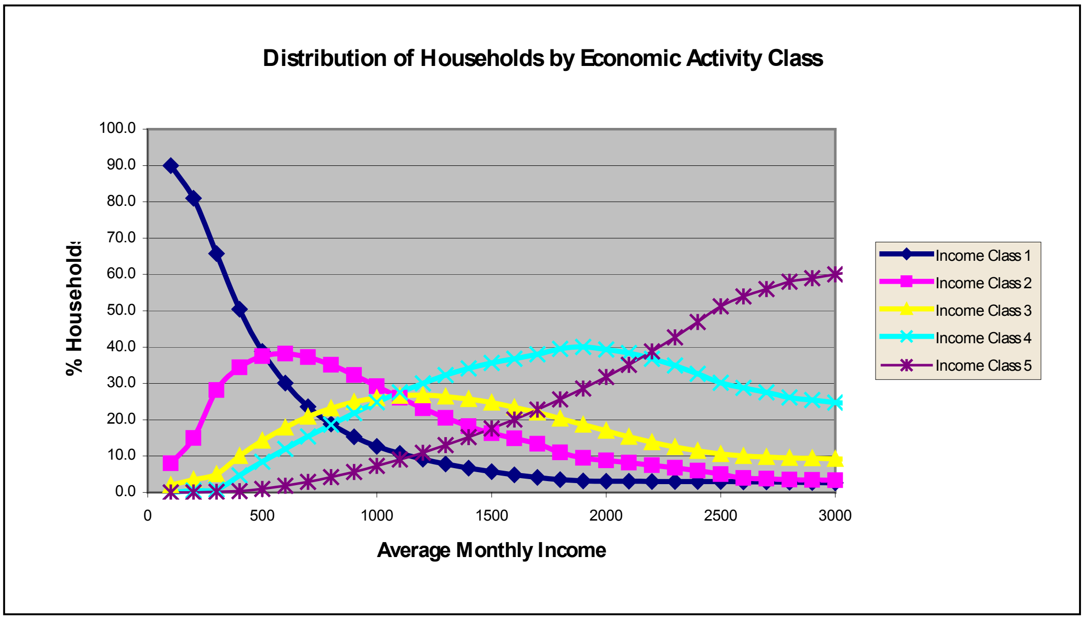
Source: JICA Study Team

Figure 3.3.4 Household Distribution for Economic Activity Class 4



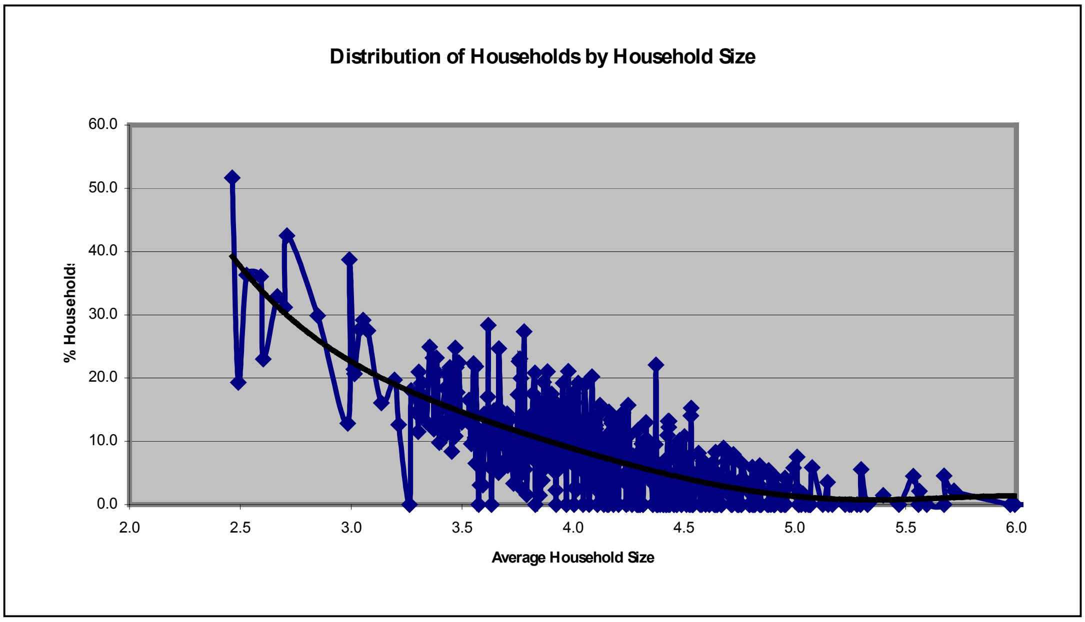
Source: JICA Study Team

Figure 3.3.5 Household Distribution for Economic Activity Class 5



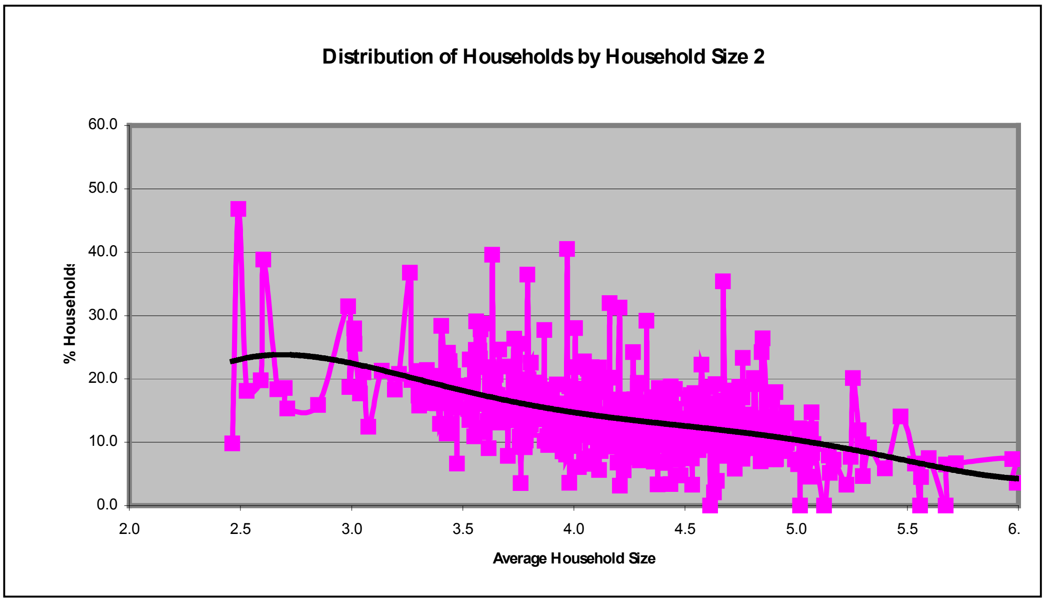
Source: JICA Study Team

Figure 3.3.6 Household Distribution for all Economic Activity Classes



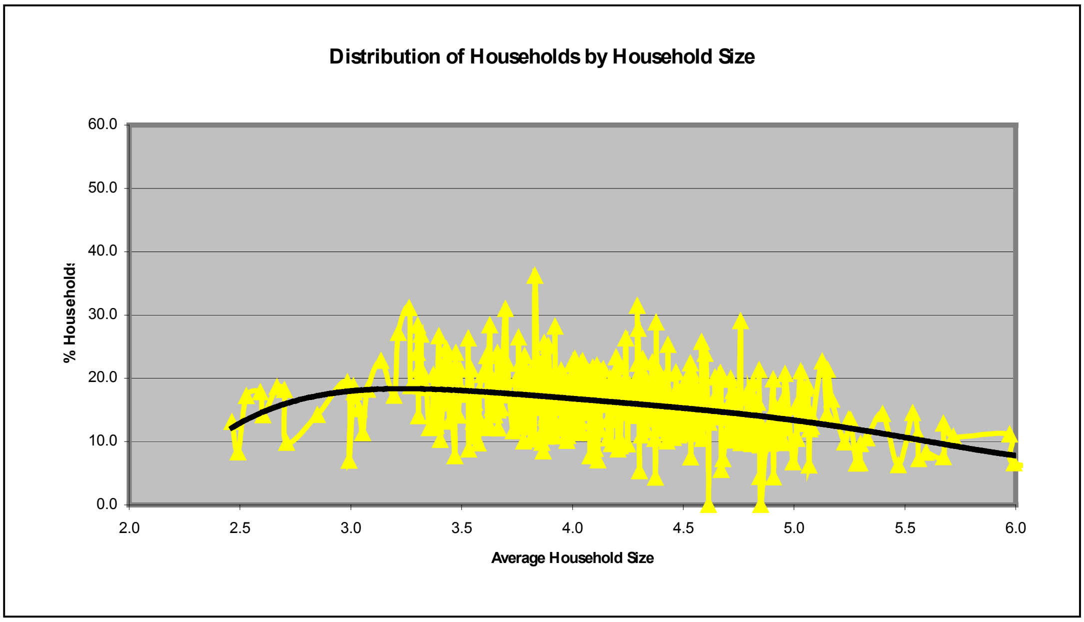
Source: JICA Study Team

Figure 3.3.7 Household Distribution for Household Size 1



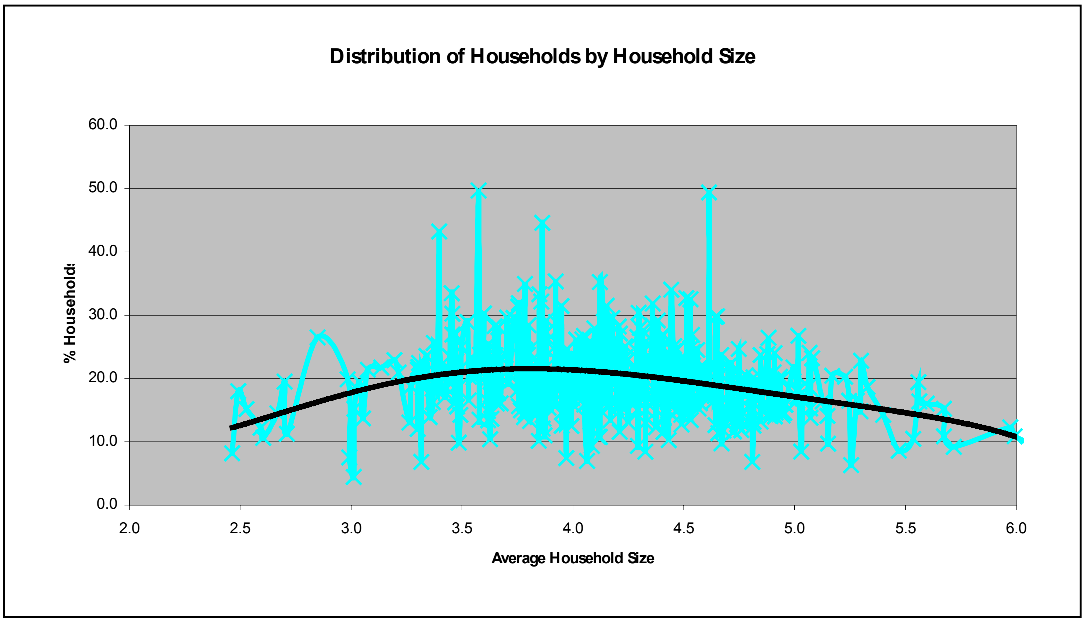
Source: JICA Study Team

Figure 3.3.8 Household Distribution for Household Size 2



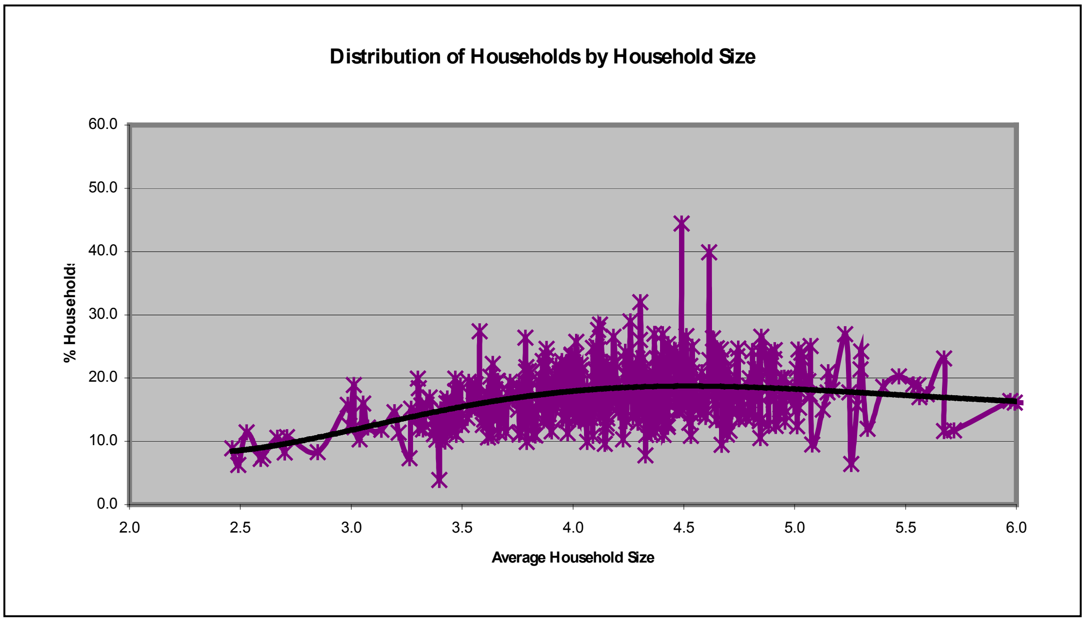
Source: JICA Study Team

Figure 3.3.9 Household Distribution for Household Size 3



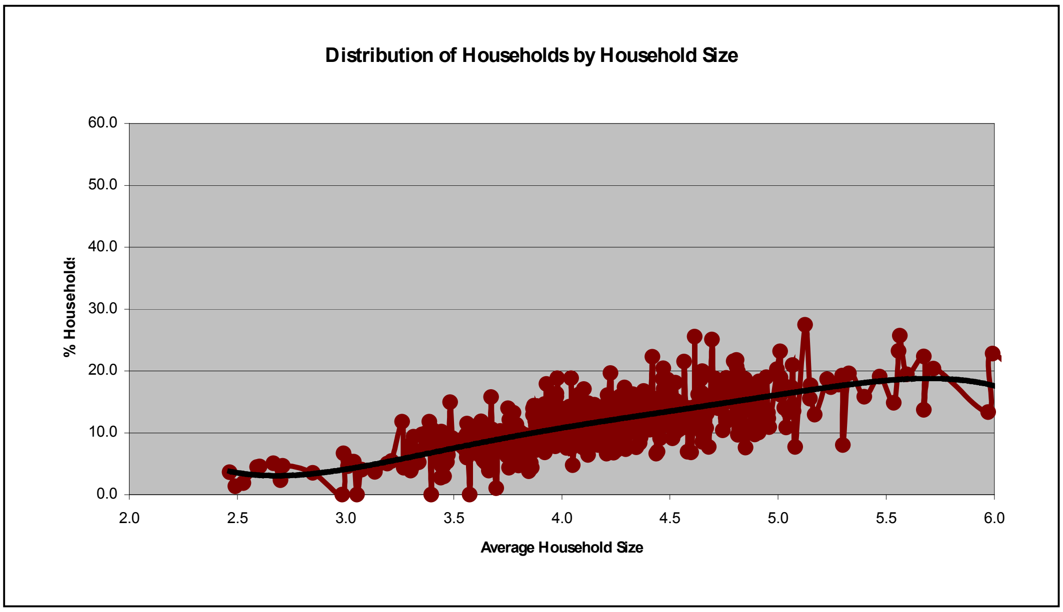
Source: JICA Study Team

Figure 3.3.10 Household Distribution for Household Size 4



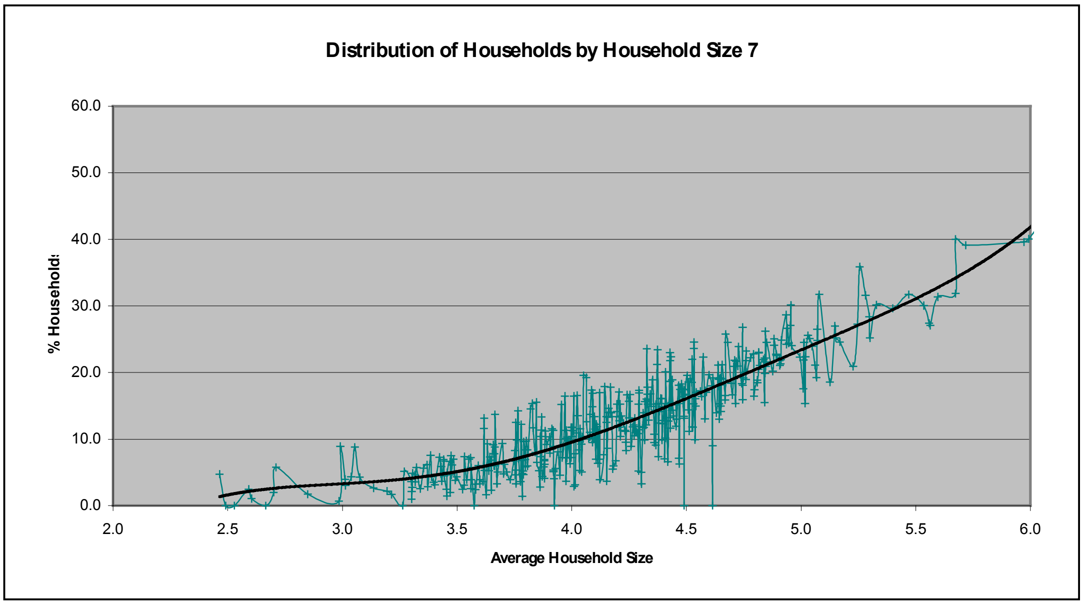
Source: JICA Study Team

Figure 3.3.11 Household Distribution for Household Size 5



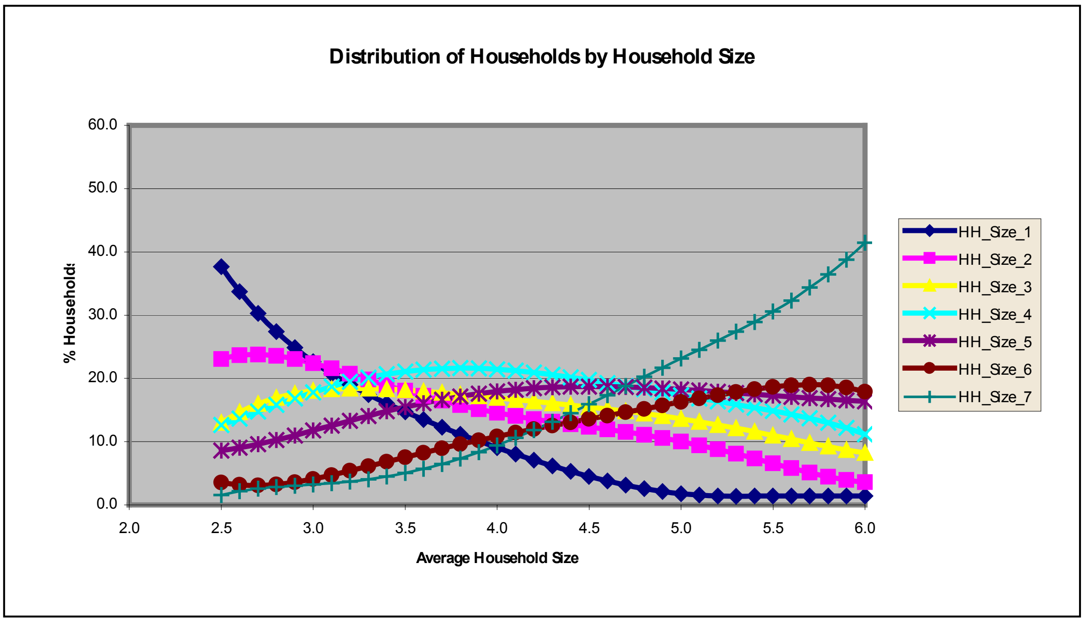
Source: JICA Study Team

Figure 3.3.12 Household Distribution for Household Size 6



Source: JICA Study Team

Figure 3.3.13 Household Distribution for Household Size 7



Source: JICA Study Team

Figure 3.3.14 Household Distribution for all Household Sizes

All of the economic and household size distribution curves presented in Figures 3.3.1 through to Figure 3.3.14 take the form of polynomial best-fit curves of the order of 5. In an initial review of the data different types of curves were fitted to the data such as logarithmic, power, exponential as well as lower order polynomial curves, the high order polynomial curve provided a good fit for most of the curves. In some cases as is seen in the previous figures there is a lot of scatter in the plotted data. The curves take the following form:

$$y = ax^5 + bx^4 + cx^3 + dx^2 + ex + f \quad \text{…….. Equation 3.1}$$

where:

y is the percentage of households in a given grouping;

x is the zonal average of household income or household size; and

a, b, c, d, e, and f are calibration constants.

For the curves in Figures 3.3.1 through to Figures 3.3.14, the Co-efficient of Determination is present in Tables 3.3.1 and 3.3.2. The results from the Economic Activity Class analysis range from 0.45 to 0.96 whilst for the Household Size analysis the range is from 0.14 to 0.96. In the latter case the lower value of the statistical fit is the result of the large scatter of the results. This scatter is reflected in the graphical presentations.

To ensure that the traffic zones were cohesive in terms of economic activity, the co-efficient of variation of household income was calculated for each traffic zone. The maximum value was 0.24 with 95% of the values less than 0.1.

Table 3.3.1 Co-efficient of Determination
Households by Economic Activity Class

Economic Activity Class	R^2
1	0.83
2	0.45
3	0.52
4	0.84
5	0.96

Source: JICA Study Team

3.3.3 Trip Production Model

The Trip Generation Models is developed based on households as a unit. Trips are a function of household characteristics. For example a non-working person from a household with low economic activity will behave completely differently to a similar person from a high activity class.

Table 3.3.2 Co-efficient of Determination for Households by Household Size

Economic Activity Class	R^2
1	0.60
2	0.27
3	0.14
4	0.14
5	0.16
6	0.51
7	0.79

Source: JICA Study Team

In both trip production and trip attraction models, the model is disaggregated into four trip purpose categories, the purposes being:

- Home Based Work (HBW)
- Home Based Education (HBE)
- Home Based Other (HBO)
- Non Home Based.

The definition of a Home Based Trip is that the production part is always at the Home End. Thus a trip from home to work and then the reverse trip from work to home have two productions in the home traffic zone and two attractions in the work traffic zones. In contrast a Non Home Based Trip, for example from work to a school and then back to school has one production and one attraction in each of the work and school traffic zones. This is often referred to a trip in production attraction format.

The trip rates are derived from the CREATS Home Interview Survey data are shown in Table 3.3.3. for motorized trips. The main trip production model estimates motorized trips only. The walk trip rates are estimated separately and discussed further in Section 3.6.6. The walk trip rates are presented in Table 3.3.4.

A modification of the model was made to allow for the impact of population density. The model was found to over and under predict at various population densities. It was therefore decided to apply an adjustment factors to the zonal trip production based on four population density categories and these are recorded in Table 3.3.5.

Table 3.3.3 Daily Production Rates Motorized Trips by Household Category

Trip Purpose and Household Size	Economic Activity Class				
	1	2	3	4	5
HBW					
1	0.442	0.417	1.102	1.239	1.247
2	0.961	1.376	1.880	2.188	2.158
3	1.471	1.742	2.275	3.002	3.416
4	1.428	2.014	2.634	3.066	3.759
5	1.484	1.964	2.527	3.217	3.493
6	1.408	1.903	2.344	2.789	3.673
7+	1.437	1.894	2.298	2.701	3.445
HBE					
1	0.038	0.076	0.102	0.000	0.146
2	0.171	0.183	0.087	0.186	0.278
3	0.535	0.797	0.911	0.944	1.135
4	1.030	1.508	2.066	2.168	2.913
5	1.724	2.266	2.797	3.011	3.528
6	2.093	2.512	2.893	2.994	4.215
7+	2.344	2.967	3.101	3.738	3.910
HBO					
1	0.276	0.333	0.546	0.611	0.336
2	0.189	0.287	0.432	0.532	0.619
3	0.262	0.270	0.477	0.531	0.507
4	0.209	0.202	0.312	0.352	0.428
5	0.144	0.238	0.303	0.312	0.500
6	0.153	0.174	0.261	0.248	0.366
7+	0.157	0.219	0.293	0.331	0.543
NHB					
1	0.028	0.043	1.125	0.127	0.130
2	0.014	0.072	0.093	0.036	0.277
3	0.033	0.053	0.118	0.361	0.348
4	0.041	0.110	0.141	0.253	0.250
5	0.046	0.051	0.119	0.155	0.160
6	0.040	0.073	0.148	0.148	0.489
7+	0.019	0.034	0.048	0.150	0.489

Source: JICA Study Team

Table 3.3.4 Daily Production Rates Walk Trips by Household Category

Trip Purpose and Household Size	Economic Activity Class 1	2	3	4	5
HBW					
1	0.114	0.141	0.063	0.068	0.000
2	0.322	0.346	0.266	0.273	0.200
3	0.406	0.478	0.404	0.357	0.280
4	0.508	0.457	0.392	0.427	0.500
5	0.470	0.502	0.546	0.435	0.349
6	0.557	0.560	0.504	0.521	0.381
7+	0.666	0.620	0.660	0.643	0.463
HBE					
1	0.000	0.000	0.002	0.000	0.000
2	0.069	0.020	0.012	0.006	0.000
3	0.784	0.578	0.423	0.290	0.108
4	1.846	1.355	1.039	0.765	0.487
5	2.739	2.294	1.764	1.570	0.917
6	3.301	2.874	2.278	2.402	1.260
7+	3.886	3.286	3.206	2.877	2.055
HBO					
1	0.042	0.073	0.093	0.055	0.130
2	0.076	0.063	0.071	0.100	0.013
3	0.092	0.087	0.064	0.108	0.119
4	0.067	0.066	0.066	0.084	0.137
5	0.052	0.042	0.054	0.073	0.066
6	0.042	0.055	0.053	0.117	0.043
7+	0.053	0.047	0.068	0.068	0.038
NHB					
1	0.000	0.000	0.000	0.137	0.000
2	0.001	0.028	0.011	0.010	0.000
3	0.001	0.033	0.006	0.006	0.053
4	0.009	0.009	0.018	0.016	0.080
5	0.007	0.020	0.034	0.058	0.039
6	0.001	0.003	0.011	0.047	0.000
7+	0.010	0.000	0.029	0.006	0.000

Source: JICA Study Team

Table 3.3.5 Trip Production Adjustment for Population Density

Zonal Trip Production Adjustment Factors					
Density Group	Density (Pop/Sq. Km)	HBW	HBE	HBO	NHB
1	0 to 10,000	0.88	0.82	0.72	1.21
2	10,000 to 20,000	1.18	1.23	1.14	1.66
3	20,000 to 30,000	1.19	1.27	1.35	1.13
4	30,000 and above	0.98	1.00	1.02	0.5

Source: JICA Study Team

The density of the population in a traffic zone will also have an impact on the number of trip productions in that zone. This has been found to be an important correction factor in Asia with varying population density.

Trip productions by percentage distribution in the 2001 model run are shown in Table 3.3.6 in comparison with the observed trip productions by household category. The comparison between the two distribution reflects similar distributions for trip productions between the observed and the model.

Table 3.3.6 Trip Production Distribution Comparison

Observed Percentage Distribution							
Income Class	Household Size						
	1	**2**	**3**	**4**	**5**	**6**	**7**
1	2.5	5.1	5.2	5.5	5.0	3.6	4.1
2	3.0	4.2	5.2	6.7	6.5	4.2	4.7
3	0.8	2.1	2.4	4.0	3.2	2.1	2.1
4	0.4	1.4	2.1	3.4	2.7	1.9	1.8
5	0.1	0.4	0.7	1.1	0.8	0.5	0.4
Model Percentage Distribution							
1	2.1	4.7	5.1	5.7	5.2	3.8	4.4
2	3.0	4.1	5.2	6.8	6.5	4.3	4.7
3	1.0	2.3	2.4	3.9	3.1	2.0	1.9
4	0.6	1.7	2.2	3.3	2.6	1.7	1.5
5	0.3	0.5	0.7	1.0	0.7	0.4	0.4

Source: JICA Study Team

3.3.4 Trip Attraction Model

The trip attraction models employs a linear regression analysis to calibrate the coefficients. The format of the equation for HBW attractions is as follows:

$$A_j = b_1x_1 + b_2x_2 + b_3x_3 \quad \text{............ Equation 3.2}$$

where A_j = Trip Attractions in zone j

x_1, x_2, x_3 = Socioeconomic variables namely Primary, Secondary and Tertiary Employment.

b_1, b_2, b_3 = Constants and co-efficients determined by calibration, reported in Table 3.3.7.

The format of the equation for other then HBW attractions is as follows:

$$A_j = a + b_1x_1 + b_2x_2 + b_3x_3 \quad \ldots\ldots\ldots\ldots\ldots \text{ Equation 3.3}$$

where	A_j	=	Trip Attractions in zone j
	x_1, x_2, x_3	=	Socioeconomic variables namely Students, University Students, Households and Tertiary Employment.
	A, b_1, b_2, b_3	=	Constants and co-efficients determined by calibration, reported in Table 3.3.8.

The coefficients of the attraction model are shown in Table 3.3.7 and 3.3.8. The coefficients for HBW purpose are shown separately from the other three trip purposes, because the HBW purpose uses different coefficients for each economic activity class. The correlation coefficient is also presented in these tables.

In application the control total for each trip purpose is taken from the "production model. It should be noted that the trip ends from the NHB attraction model are used to replace those from the trip production model as by definition, they do not occur at home.

Table 3.3.7 Attraction Model Coefficients for HBW

Economic Activity Class	Employment Category			R^2
	Primary	Secondary	Tertiary	
1	1.205	0.215	0.465	0.97
2	-	0.690	0.627	0.97
3	-	0.187	0.564	0.92
4	-	0.008	0.733	0.84
5	-	-	0.281	0.69

Source: JICA Study Team

Table 3.3.8 Attraction Model Coefficients for Non-HBW

Variable	HBE	HBO	NHB
Constant	-	292.8	-
Students	2.129	-	-
University Students	2.236-	-	-
Households	-	-	0.00918
Tertiary Employment	-	0.406	0.175
R^2	0.99	0.67	0.54

Source: JICA Study Team

3.4 PERSON TRIP DISTRIBUTION

3.4.1 Overview

In the next stage of the model development, trips generated by various traffic zones must be linked to trips attracted to zones. This is the Trip Distribution phase of the model. In this and subsequent stages of the model development, there is a need to estimate travel cost. These costs can be generalized cost either be in units of pound or generalized time in units of equivalent minutes, and many studies use the latter to allow for the reduced impact in future years of any monetary costs arising from increases in the value of time. This model has used Piaster as its unit in preparation of costs for distribution, and this is therefore adjusted in the design year application.

3.4.2 Estimation of Perceived Value of Time and Operating Cost

The behavioral values of time used to derive the value of time in the distribution and mode split models are shown in Table 3.4.1 by Economic Class for work and non work trips. These values are also used later in the model to estimate the value of time for input into the public transport assignment. The base year values are derived from the Home Interview Data and are a combination of workers value of time for each household in the case of work trips whereas for other purposes it is the number of persons in the household as shown in the following equation:

Value of Time = Average Household Income/(Number of Workers or Persons)

…….Equation 3.4

Future year values of time are estimated by the application of the economic growth factors .

The behavioral operating cost for a car was estimated at 12.5 Pt per km[10] which is related directly to the cost of fuel. Separate terminal costs for private and public transport were estimated from the Home Interview Survey. These costs are included in the model development primarily for testing future policies related to restraint of car usage. In addition the cost of access to a toll road are also included in estimating the cost of a private vehicle trip.

For road links other than busways, the speed assumed for buses on a link is 85% of the road link speed. This thus includes an allowance for buses stopping to pick up or set down passengers. This is a simplification of the formula that was established in earlier projects in South East Asia. The formula[11] was modified for conditions in Cairo.

[10] This perceived cost is estimated from the local cost of fuel together with an overall average fuel consumption. This value is then part of the calibration procedure.
[11] The original formula for modified speed was $0.9842*Speed – 0.0087*Speed^2$.

Table 3.4.1 Behavourial Value of Time(LE per hour) by Economic Class and Trip Purpose

Economic Activity Class	Home Based Work Trips	Other Trips	All Trips-Weighted Average
1	1.13	0.28	***0.57***
2	1.99	0.56	***1.09***
3	3.33	1.06	***1.99***
4	6.31	2.11	***3.98***
5	16.23	6.09	***10.85***

Source: JICA Study Team

Skims of the in-vehicle travel time, walk time and wait time and public transport fares are obtained from building public transport paths in the model. Wait time and walk time for public transport are weighted by a factor of two.

The overall generalized cost used as an input into the trip distribution or gravity model is a combination of private and public transport. The two costs are combined in proportion to the existing mode for each income class to yield a composite cost of travel.

3.4.3 The Gravity Model

The Trip Distribution model or Gravity Model links the trip production and attractions to form the trip matrices. This is carried out separately for 4 trip purposes and five economic activity classes, thus there are 20 trip distribution models for a particular model year.

The gravity model function takes the following forming this study:

$$T_{ij} \alpha P_i A_j F(c_{ij}) \text{ ….. Equation 3.5}$$

Where T_{ij} is the trips between zone i and zone j;

P_i is the number of trips produced in zone i;

A_j is the number of trips attracted to zone j;

$F(c_{ij})$ is the function presenting impedance to travel between zone i and zone j, often known as the F-Factor curve.

c_{ij} = Composite cost of travel between zone i and zone j

The objective of the model calibration is to develop a F-Factor curve that best fits the observed data. Calibration was performed based on the home interview survey. During the calibration process, three checks on the estimated and observed data were used namely:

- Mean Trip Length (units of generalized cost, the Piaster);
- Percentage of Intrazonal Trips; and
- Shape of the trip length(generalized cost) distribution curves.

In the CREATS model, the F Factor curve takes the form of the Gamma function and is given by the following formula:

$$F(c_{ij}) = c_{ij}^{X1} \exp(X2\ c_{ij}) \text{ ...... Equation 3.6}$$

where X1 and X2 are calibration constants.

The calibration parameter values are presented in Table 3.4.2 together with the comparison between the observed and estimated mean cost of travel. This comparison shows a small percentage difference between the observed and estimated. The F-Factor curves are also shown in Figures 3.4.1 to 3.4.5 for each Economic Activity Class. A comparison between the number of observed and estimated intrazonal trips is presented in Table 3.4.3 for each economic class.

Whilst the comparison is not as good as for the trip means, the comparison show the percentage of intrazonal trips across all economic classes of around 10%.

Table 3.4.2 Gravity Model Parameters and Calibration

Economic Activity Class	Trip Purpose	X1	X2	Mean Trip Length (Pt)	
				Observed	Estimated
1	HBW	0.85	-0.02	168.9	168.88
1	HBE	0.65	-0.02	144.2	144.21
1	HBO	-0.36	-0.02	147.6	147.64
1	NHB	-0.99	-0.02	119.4	119.41
2	HBW	-0.06	-0.01	158.0	157.98
2	HBE	0.47	-0.02	139.1	139.04
2	HBO	-0.29	-0.02	139.9	139.92
2	NHB	-0.88	-0.02	113.5	113.43
3	HBW	0.15	-0.02	153.8	153.55
3	HBE	0.56	-0.02	136.1	136.07
3	HBO	-0.24	-0.02	132.3	132.24
3	NHB	1.15	-0.03	129.6	129.62
4	HBW	0.06	-0.02	149.4	149.39
4	HBE	1.06	-0.03	135.7	135.71
4	HBO	-0.30	-0.02	134.5	134.40
4	NHB	0.64	-0.02	138.5	138.51
5	HBW	-0.15	-0.01	150.1	150.12
5	HBE	1.56	-0.03	133.2	133.12
5	HBO	0.34	-0.02	134.4	134.38
5	NHB	-1.07	-0.01	119.1	119.10

Source: JICA Study Team

Table 3.4.3 Comparison of Percentage of Intrazonal Trips

Economic Activity Class	Observed	Estimated
1	9.2	10.4
2	9.5	11.9
3	8.2	10.3
4	7.5	10.3
5	8.4	11.1

Source: JICA Study Team

3.4.4 Consideration of Special Generators

A special generator is a location where trip characteristics are not truly reflected by demographic characteristics alone. Typically special generators are localities such as long distance large public transport terminals where there is an interaction between local and inter city travel which is external to the region.

For the CREATS model these are basically the intercity rail and bus terminals. An estimate of external trips generated at these locations is presented in Table 3.4.4. The traffic flows in the table are additional to those generated in that area by the traditional transport model.

These additional trips, however still need to be distributed to locations within the study area. The most appropriate disbursement of these special trips was a distributions based on population, (reflecting the city-wide nature of the residential catchment area for these facilities) and characteristics of distribution for the mid range economic activity level. In addition those trips associated with the airport were distributed with a higher percentage to the central area reflecting the greater proportion of hotels in the central area of the city.

Table 3.4.4 Special Generator Trips

Traffic Zone Number	Locality	Public Transport Person Trips	PCU Trips
475	Intercity Bus Terminal (Al Moneeb)	1,365	910
476	Intercity Bus Terminal (Al Torgoman)	1,520	1,013
477	Intercity Bus Terminal (Almaza)	2,220	1,480
478	Intercity Bus Terminal (New Al Marg)	470	313
479	Intercity Bus Terminal (Aboud)	5,660	3,773
480	Ramsis Square (Rail Station)	94,500	7,000
481	Cairo Airport	3,906	5,208
482	Giza Sub-urban Station	6,739	499
484	Ain Shames ENR Station	9,172	679

Source: JICA Study Team and Aim Shams University

In the future horizon years these trip number were increased to reflect the changing socio-economic conditions within the study area.

Figure 3.4.1 F-Factor Curves for Economic Activity Class 1

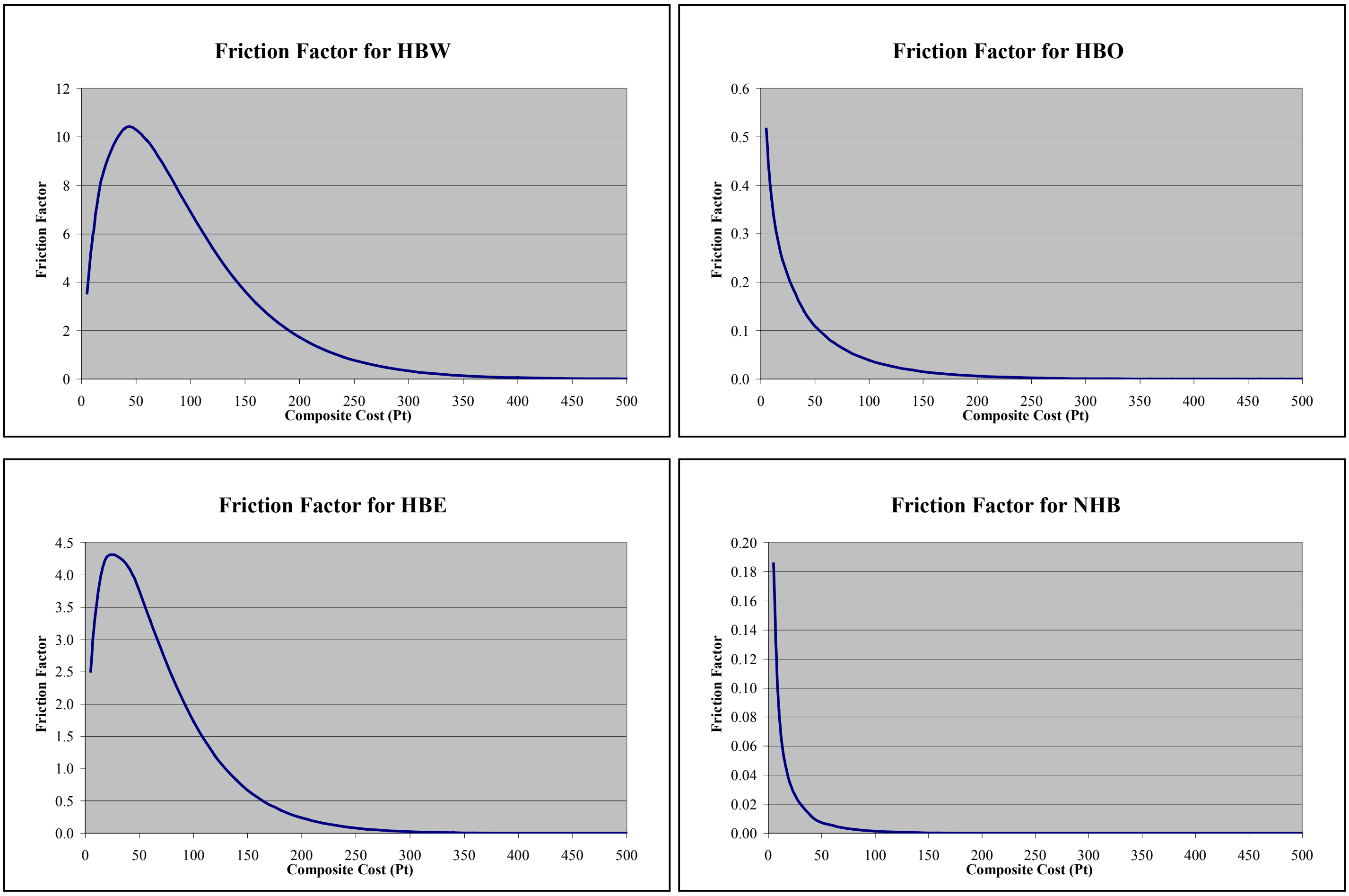


Figure 3.4.2 F-Factor Curves for Economic Activity Class 2

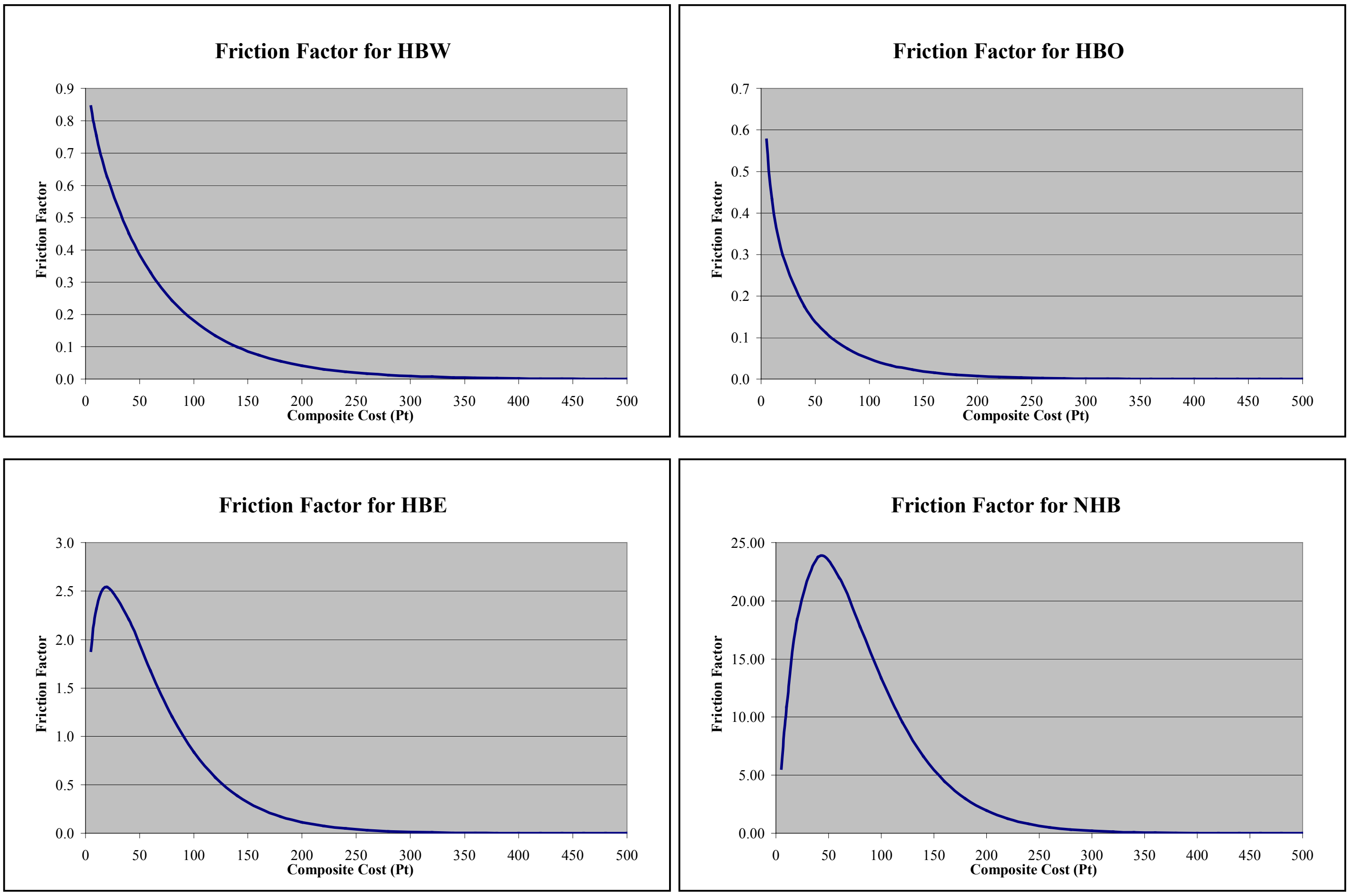


Figure 3.4.3 F-Factor Curves for Economic Activity Class 3

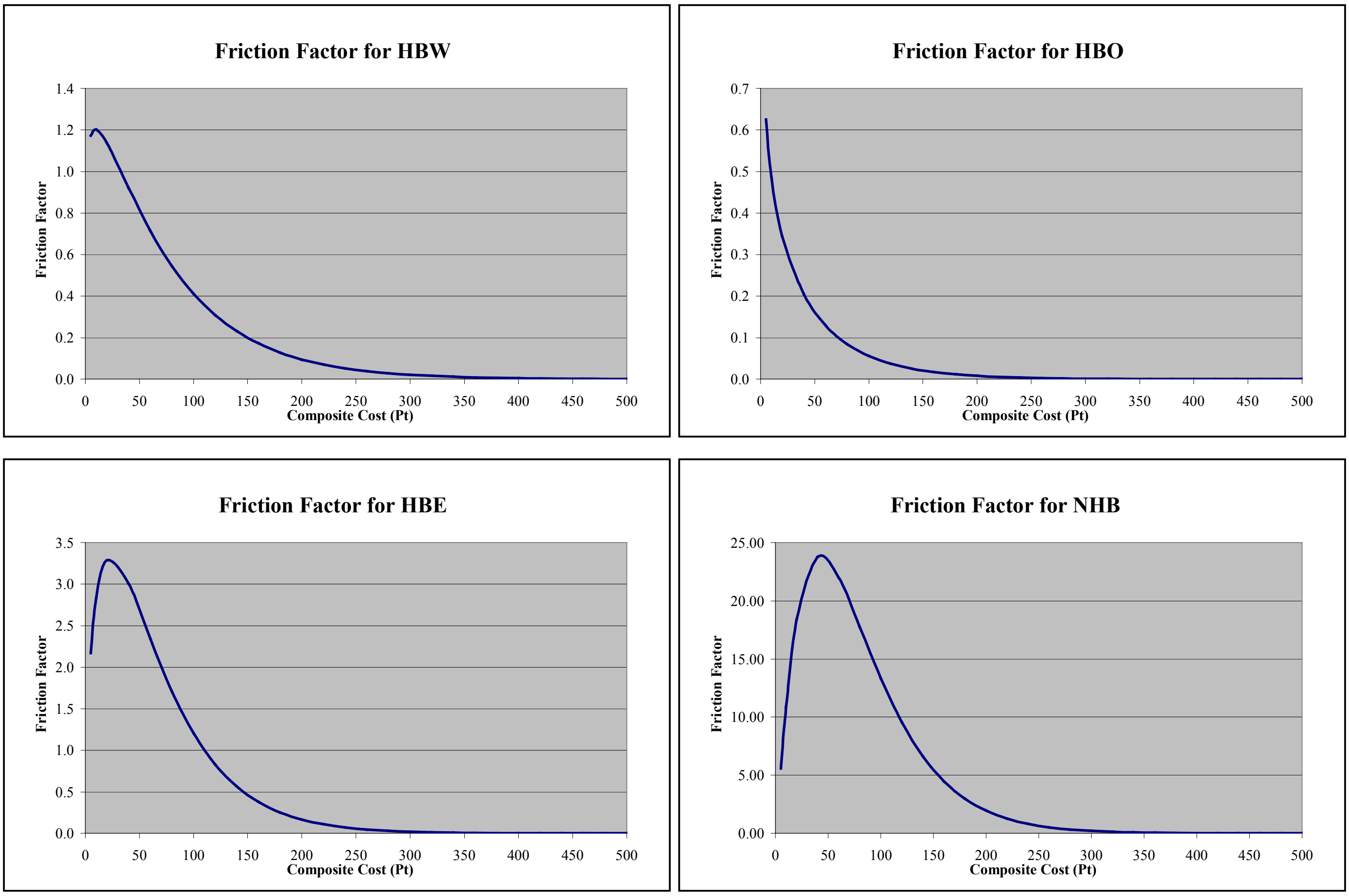


Figure 3.4.4 F-Factor Curves for Economic Activity Class 4

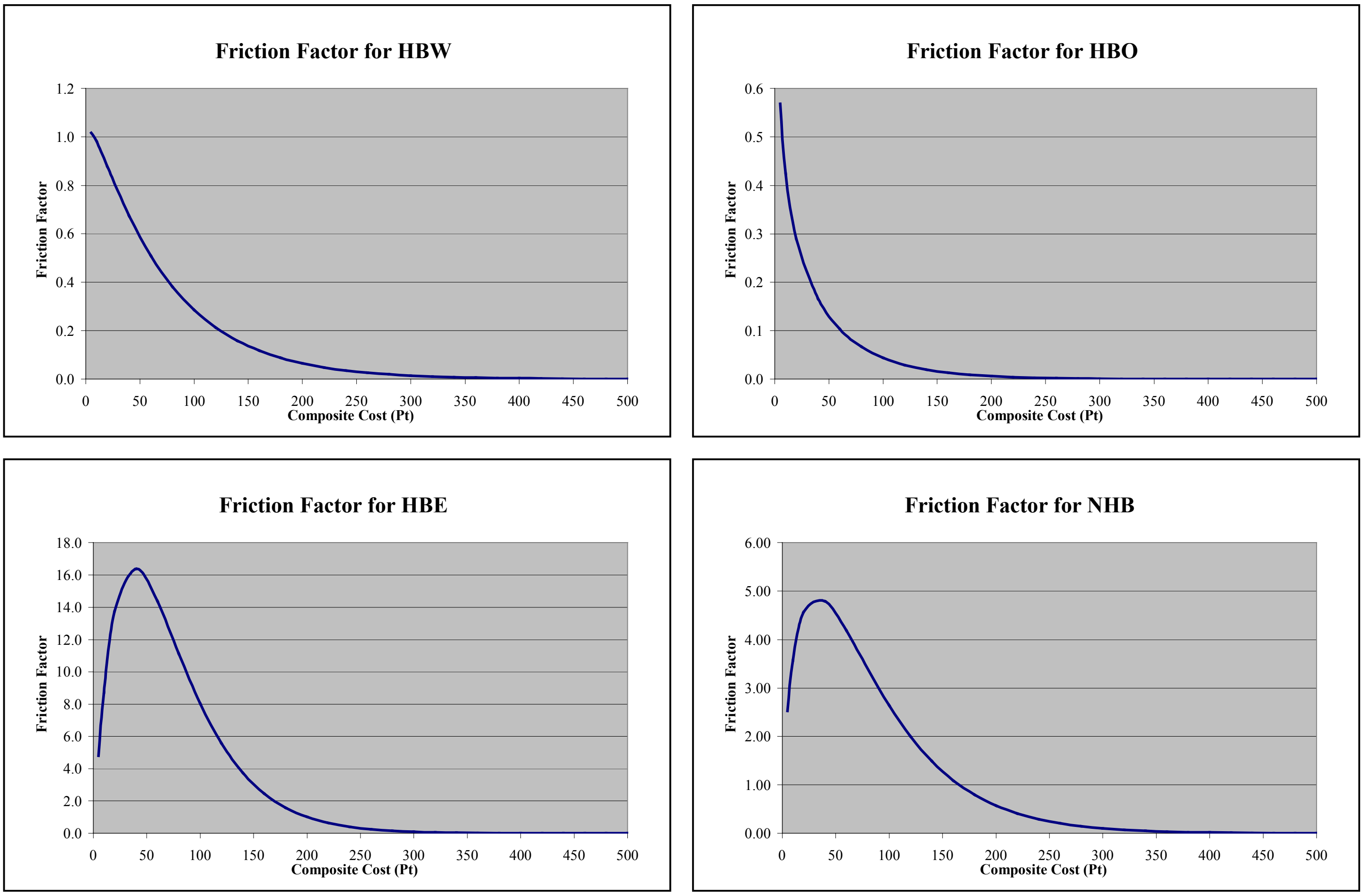
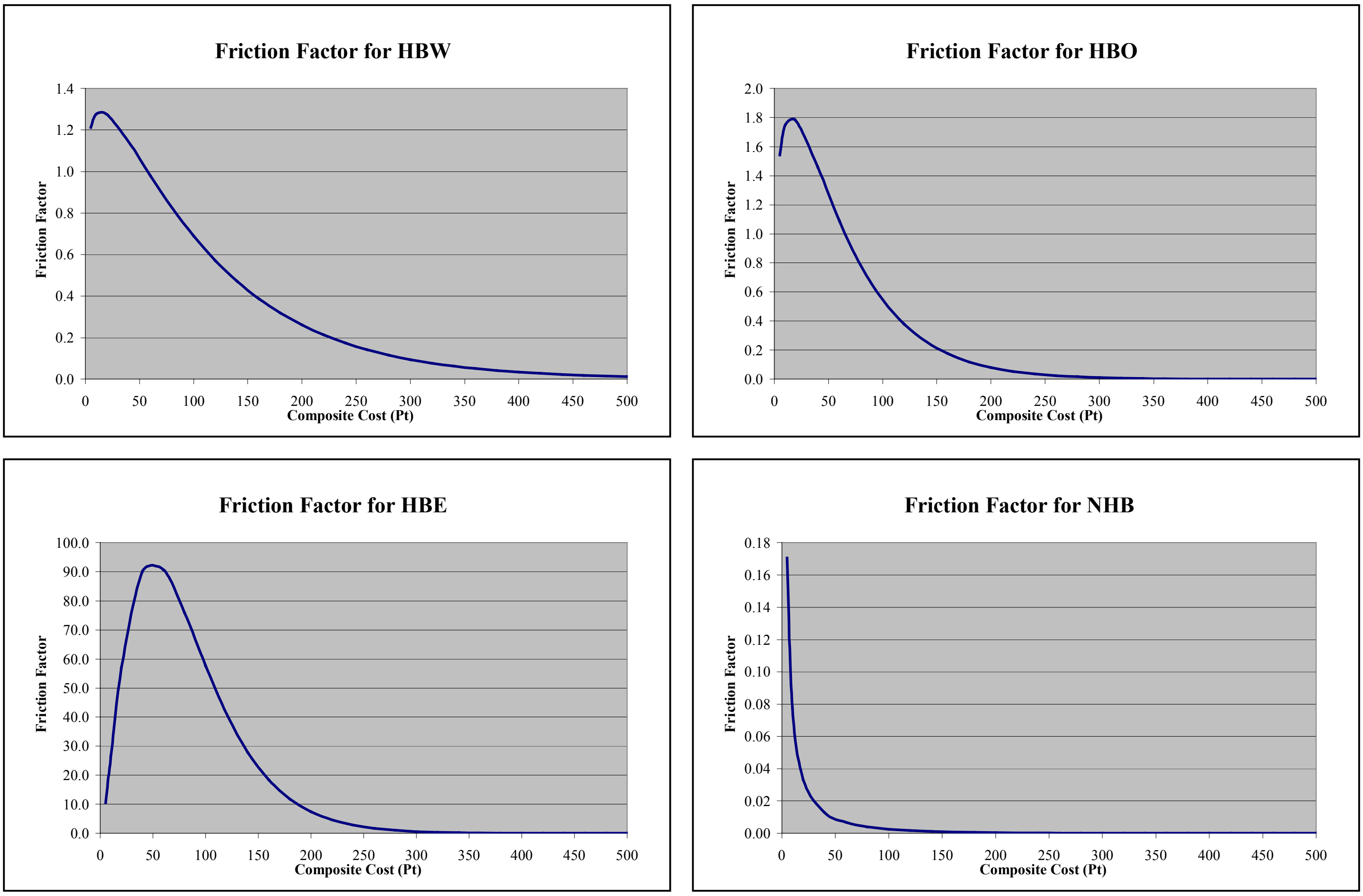


Figure 3.4.5 F-Factor Curves for Economic Activity Class 5



3.5 THE MODE CHOICE MODEL

3.5.1 Overview

Mode Choice is represented in the transport model by a series of models which reflect the choice available to the residents of the study area. These models are applied separately to different segments of the travel market as each segment has its own characteristics and ranges of choices. In the model there are in fact 20 models with one for each trip purpose and each economic activity class for motorized trips[12].

There are a number of techniques which may have be used in the modal split modeling. However the CREATS model is a binary logit mode split model between private and public trips. This takes the form:

$$\% PT = \frac{1}{1+\exp(\lambda\,(C_{PT}-C_{PR}+\zeta)} \quad \ldots\ldots \text{ Equation 3.7}$$

Where :
C_{PT} -- Generalised Cost of Public Transport in Equivalent Minutes
C_{PR} -- Generalised Cost of Private Transport in Equivalent Minutes
λ -- Cost Co-efficient
ζ -- Bias Term

In addition at this stage of the mode choice the taxi trips are split from the private trip matrix and the special bus trips (school and employee bus) are split from the main public trip table. The split between the different modes of public transport is done during the public transport assignment. The binary mode split equation develops the split between total public and total private motorized trips.

3.5.2 Generalized Travel Costs

The mode choice models were developed using generalized travel costs to represent the total costs each person faces when choosing between modes. For each mode the cost expression is as follows:

Generalized travel cost = travel time + (out-of-pocket costs)/(value of time)………………………….. Equation 3.8

12 Only motorized trips are included in the mode split process. The earlier trip generation and trip distribution phases refer to motorized trips only. Walk trips are discussed further in section 3.6.6.

Travel time for public transport usage includes in-vehicle time, walk time at each end of the journey and when transferring between services, and wait time; the wait and walk are weighted by factors discussed earlier in this chapter. There is also a boarding penalty depending on the particular mode of public transport.

For private modes, the travel time includes the in vehicle time and additional terminal time which represents the final access/egress to the travel origin or destination.

The out of pocket costs represent fares for the public transport user; for private modes it includes tolls, parking costs, which are assumed to be shared among the occupants of the vehicle. For taxi mode, the total taxi fare is calculated using the following formula:

Total Fare (Pt) = 122 + 41*Distance …..Equation 3.9

This formula was derived from a review of the taxi trips reported in the Home Interview Survey.

The value of time to be applied to convert time and cost components to a generalized time was discussed in the earlier section on Trip Distribution.

3.5.3 Model Calibration

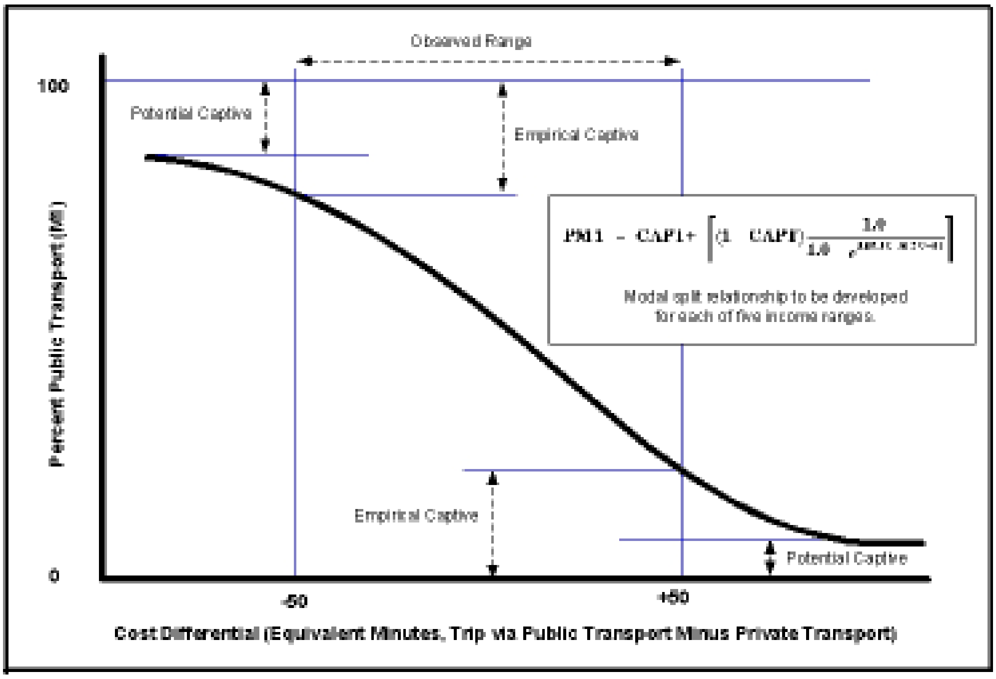
As discussed in the overview, two parameters are required in the estimation of the binary mode split curve. The general format of this curve is shown in Figure 3.5.1. In practice another variable in this curve is the proportion of captives to public transport. There is always a proportion of people that will use public transport. In the calibration of the curve there is also implicit a proportion of captives to the private mode.

The calibration process is carried out for each of the five economic classes and for each of the trip purposes giving a total of 20 separate models. For the households of the lowest economic activity class, the private mode is represented by taxi rather than the private car.

The calibration procedure is a three step procedure:

- Preparation of Observed Person Trip Tables for Private and Public Transport (excluding captives to Public Transport)[13]
- Generalized Cost of Travel[14]

[13] This data is prepared directly from the CREATS Home Interview Survey. In general a captive trip to public transport is defined as one that has no alternative to public transport.
[14] The Generalized Cost of travel is derived directly from the model network.



Source: JICA Study Team

Figure 3.5.1 The Mode Split Curve

- Estimation of Best Fit Curve between proportion of Public Transport and difference in Generalized Cost between Public and Private Transport
- The parameters of the best fit curve are then using as a starting point in an iterative development of all three parameters in the mode split curve namely λ, δ, and the percentage of captives to public transport.

A similar procedure was used in the development of models in South East Asia such as the Bangkok transport model.[15]

In the cases of the higher economic classes, there is a less tendency to use public transport. This is reflected in the modal split parameters as shown in Table 3.5.1. The overall model results across all purposes and all economic classes are presented in Table 3.5.2.

The detailed comparison between the observed and estimated public transport split is presented in Table 3.5.3 for each economic activity class and each trip purpose. In Figure 5.3.2 the modal split is presented for each traffic zone in the transport model. This clearly shows a decreasing proportion of public transport trips for increasing household income.

[15] Urban Transport Database and Model Development Project commissioned by the Asian Development Bank for the Office of the Commission for the Management of Land Transport, Thailand and undertaken by a consulting consortium led by MVA Asia Limited.

Table 3.5.1 Mode Split Calibration Parameters

EconomEconic Activity Class	Purpose	Propption Public Transport Captive	λ	δ
1	HBW	0.60	0.0063	-98.00
1	HBE	0.90	0.0023	100.00
1	HBO	0.40	0.0123	30.00
1	NHB	0.41	0.0123	50.00
2	HBW	0.55	0.0086	-70.00
2	HBE	0.80	0.0135	-42.00
2	HBO	0.37	0.0123	4.00
2	NHB	0.41	0.0123	4.00
3	HBW	0.44	0.0128	19.00
3	HBE	0.68	0.0127	-11.00
3	HBO	0.13	0.0056	76.00
3	NHB	0.24	0.0056	76.00
4	HBW	0.08	0.1320	27.00
4	HBE	0.48	0.0039	41.00
4	HBO	0.00	0.0056	160.00
4	NHB	0.00	0.0090	200.00
5	HBW	0.0	0.0180	30.00
5	HBE	0.15	0.0039	41.00
5	HBO	0.00	0.0080	200.00
5	NHB	0.00	0.0090	200.00

Source: JICA Study Team

Table 3.5.2 Overall Percentage Mode Split Comparison

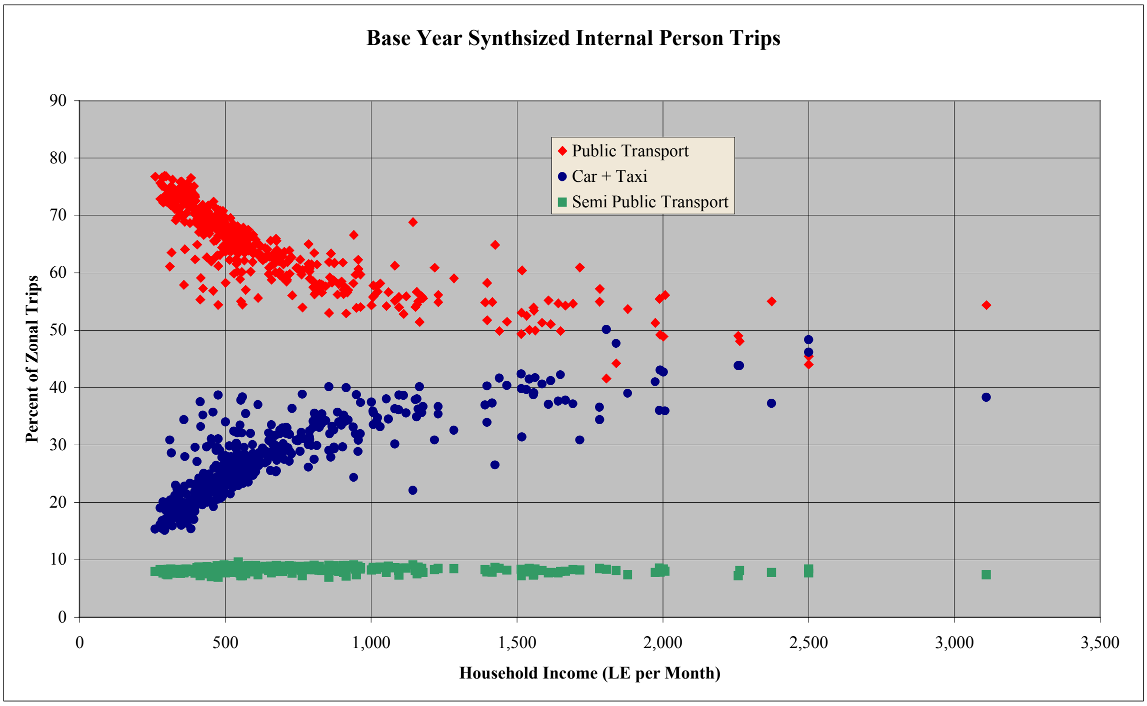
Mode of Travel	Model Results	Observed Results
School / Employee Bus	8.4	8.4
Public Transport	62.9	63.2
Car	20.6	20.4
Taxi	8.1	8.0

Source: JICA Study Team

Table 3.5.3 Comparison between Observed and Modeled Results Percentage of Public Transport Trips

EconomEconic Activity Class	Purpose	Model	Observed
1	HBW	89.8	90.2
1	HBE	95.0	94.5
1	HBO	77.9	77.4
1	NHB	68.5	69.9
2	HBW	78.8	79.5
2	HBE	89.0	91.7
2	HBO	57.2	65.0
2	NHB	62.3	67.9
3	HBW	60.1	61.3
3	HBE	80.4	82.6
3	HBO	42.1	44.6
3	NHB	49.6	51.1
4	HBW	34.0	33.0
4	HBE	70.0	70.4
4	HBO	24.5	25.6
4	NHB	10.2	10.8
5	HBW	21.4	21.8
5	HBE	50.7	51.1
5	HBO	12.9	13.6
5	NHB	10.8	12.4

Source: JICA Study Team



Source: JICA Study Team

Figure 3.5.2 The Distribution of Mode Split by Household Income

3.6 DEVELOPMENT OF OTHER TRIP TABLES - COMMERCIAL, EXTERNAL VEHICLE AND WALK

3.6.1 An Overview of Commercial Vehicle Travel

The discussion of commercial vehicle simulation is structured into a series of linked topics. An overview of the role of trucks within the traffic stream is reviewed in the first instance. This is followed by a discussion of matrix estimation techniques used to developed base year (year 2001) truck trip matrixes, as well as the content of resulting matrixes. Finally, an approach to forecasting zonal truck activity in future years is presented. It is noted this section of the report deals with commercial vehicle simulation procedures and methodologies; further detail regarding cargo movements is found in Chapter 6.

An initial insight regarding the relative roles of the various road-based modes can be gleaned from findings of the CREATS traffic counting program. A review of some 100 traffic counts confirms that passengers cars (including taxis) are the dominant vehicle of transport accounting for, on average, some two-thirds of all counted vehicles. Trucks (including pick-ups), buses (all configurations) and other vehicles (including motorcycles) accounted for a further 16, 14 and three percent of counted vehicles, respectively. The representation of both buses and truck increases when viewed on a pcu basis. While passenger cars still dominate (56 percent of surveyed pcu's), trucks and buses account for near 21 percent of pcu's each. These findings are consistent across all survey types with exception of the cordon survey. As expected, traffic composition patterns differ at the periphery of the study area. Principally, trucks represent the single most prevalent vehicle category at the study area cordon (Figure 3.6.1).

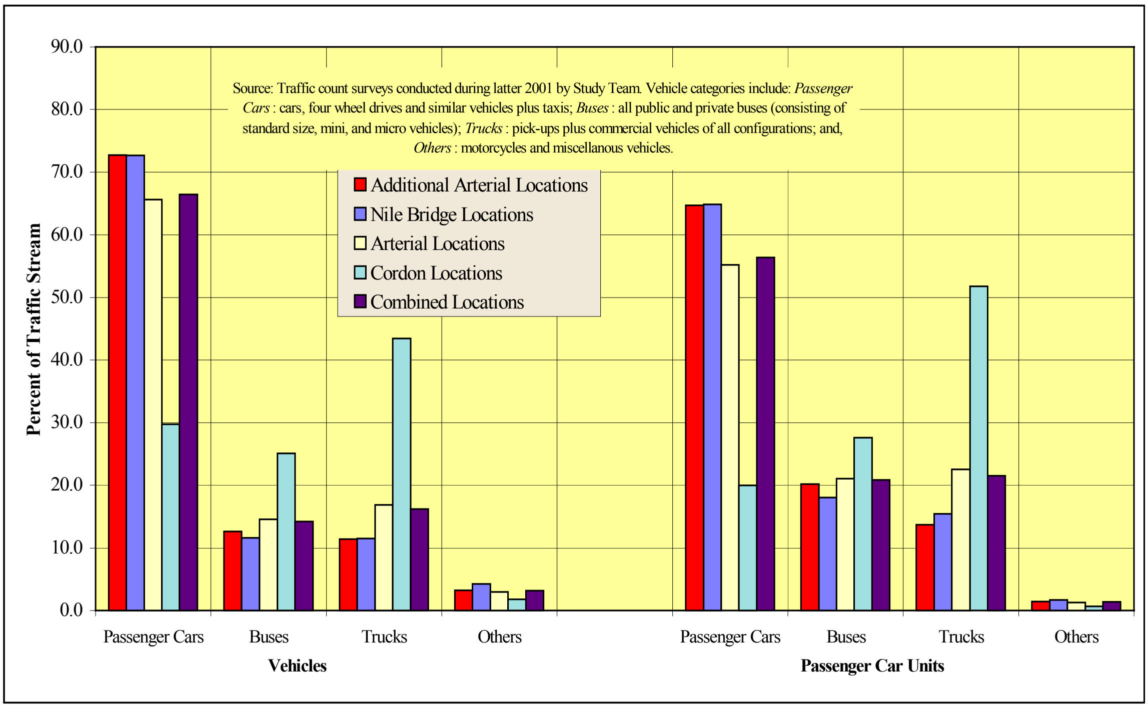


Figure 3.6.1 Composite Vehicle Mix in the Traffic Stream Representative Year 2001 Weekday

Pick-ups and 2-axle configurations are the dominant truck type noted in the traffic stream accounting for, on average, some 80 percent of counted trucks. This representation decreases slightly when calculated on a pcu basis. Traffic counts collected along the study area periphery again exhibit some deviation from information obtained at locations throughout the interior study area. Larger trucks with more than 3 axles tend to form a higher proportion of the traffic stream at these sites. This is not surprising as cordon stations are located on inter-city roads which provide direct linkages to other parts of Egypt, including major cargo generation points such as ports and industrial centers (Figure 3.6.2).

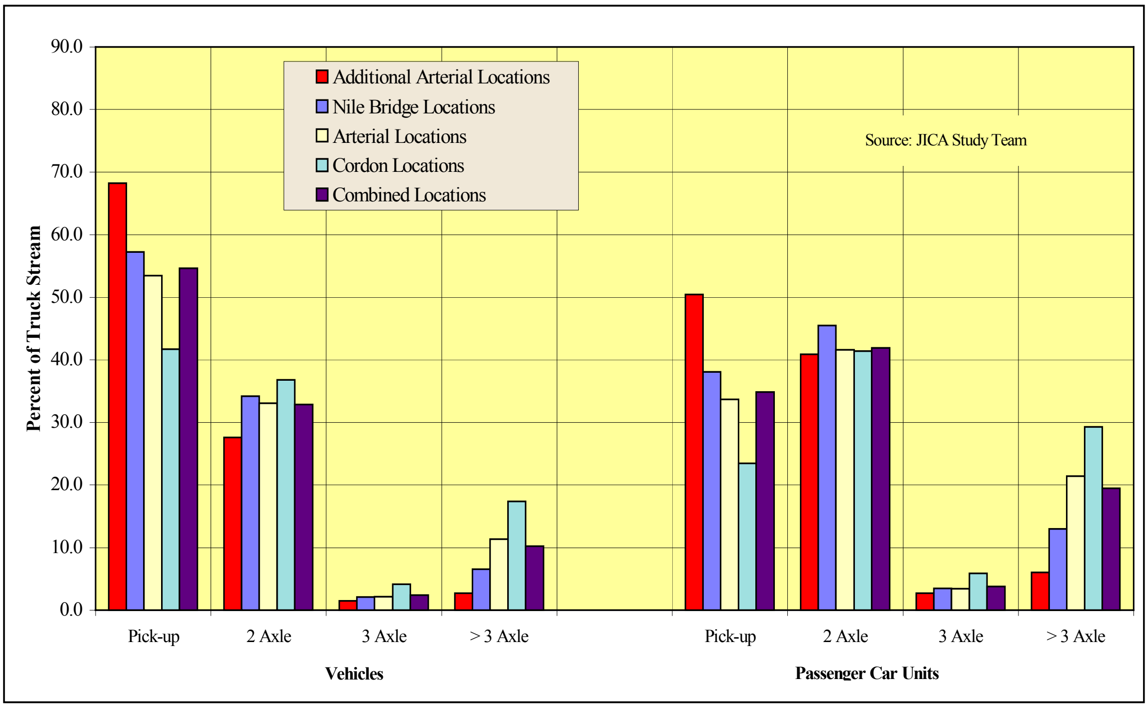


Figure 3.6.2 Composite Truck Mix in the Traffic Stream
Representative Year 2001 Weekday

The highest prevalence of truck activity was noted at Station C35, the Alexandria Agricultural Road north of the Cairo Ring Road (followed by Station C25, Ring Road between Alexandria Agricultural Road and Ismailia Desert Road). A total of some 35,000 trucks crossed Station C35 during the course of a weekday, consisting of about 13,700 pick-ups, 14,700 2-axle trucks, 600 3-axle trucks and 6,300 trucks having more than three axles. A total of 83,700 vehicles of all types were concurrently counted; thus, trucks represent near 42 percent of total daily traffic volume. On a pcu basis, trucks aggregated to 63,300 pcu's, or about 51 percent of the total pcu stream. Highest relative share at the higher-volume locations was noted at Station C27, Ring Road between Ismailia Desert Road and Suez Desert Road, at which some 60 percent of counted vehicles (a modest total of 23,300 units) consisted of trucks (14,200 units) (Figure 3.6.3).

An insight into a representative study area hourly truck volume distribution is gained by combining findings all 24 hour count sites. Highest truck volumes were measured during afternoon hours across all vehicle types. The hour beginning 17:00 hours emerged as the single highest truck activity hour while accommodating 6.2 percent of daily truck volume; however, truck activity is very consistent between the hours of 14:00 and 19:00 with each hour carrying some six percent of daily truck activity (Figure 3.6.4).

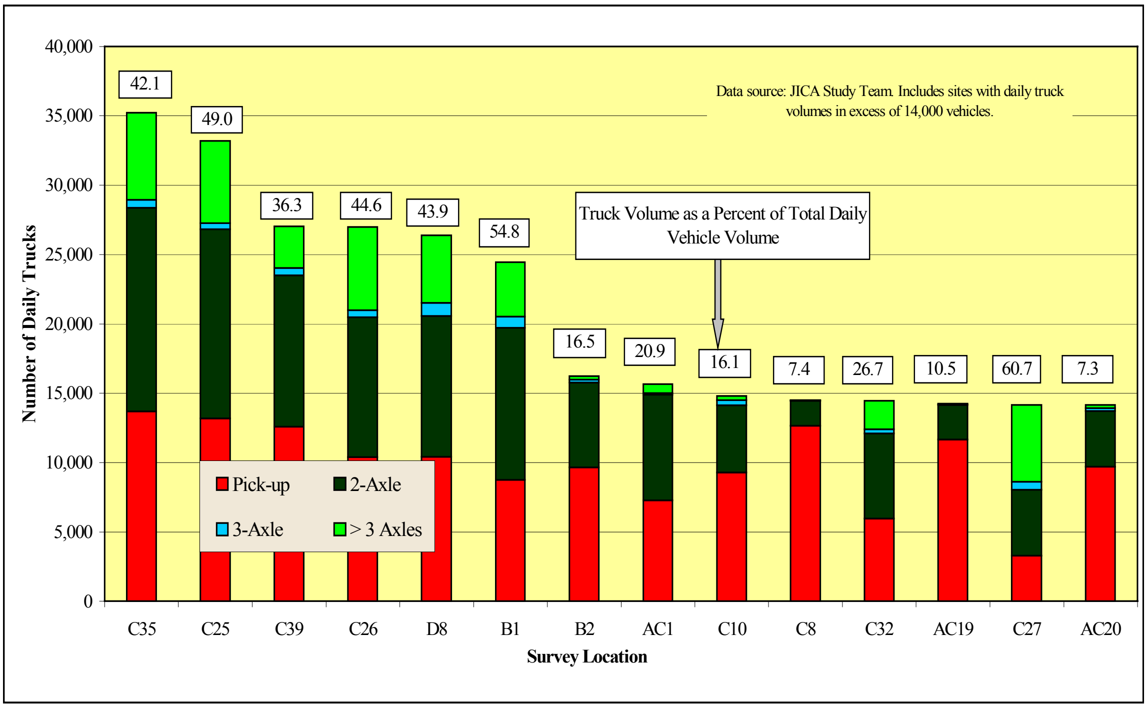


Figure 3.6.3 Survey Locations with Highest Truck Volumes
Representative Year 2001 Weekday

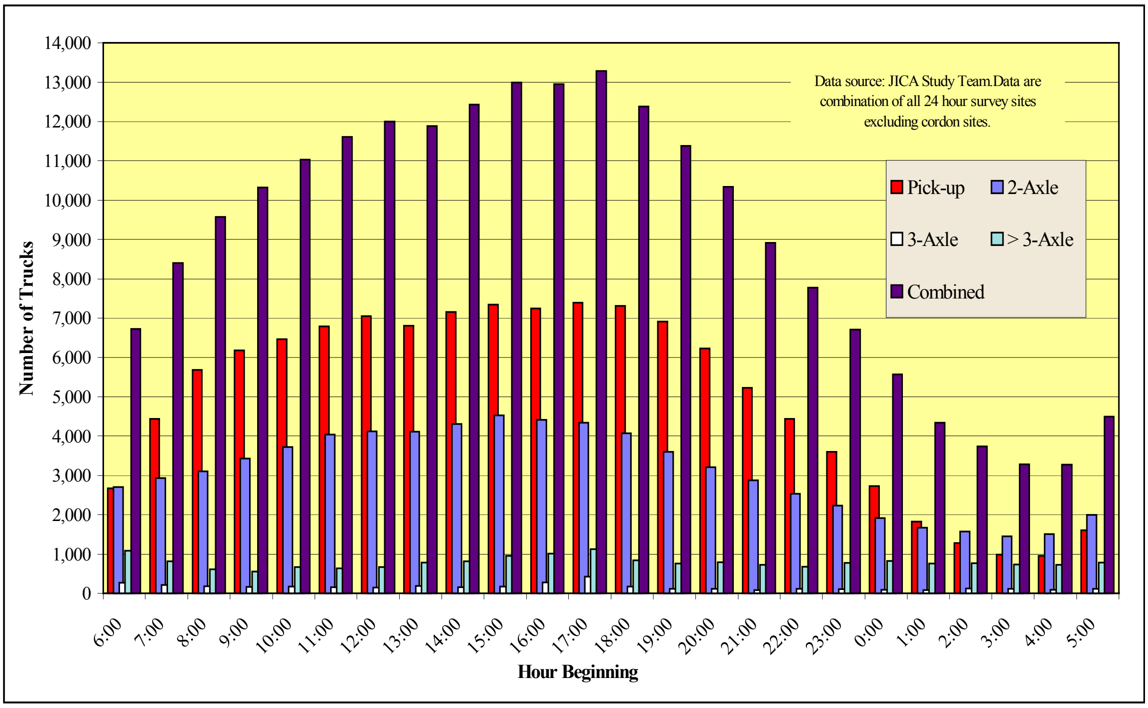


Figure 3.6.4 Composite Absolute Hourly Truck Volume
Representative Year 2001 Weekday

During the afternoon peak truck hours, commercial vehicles constitute, on a composite average, some 15-20 percent of the total traffic stream. However, the roleof the truck increases considerably during night and early morning hours. For the hour beginning 04:00, for example, trucks constitute almost one-third of the representative traffic stream on a vehicle basis, and near 45 percent on a pcu basis (Figure 3.6.5).

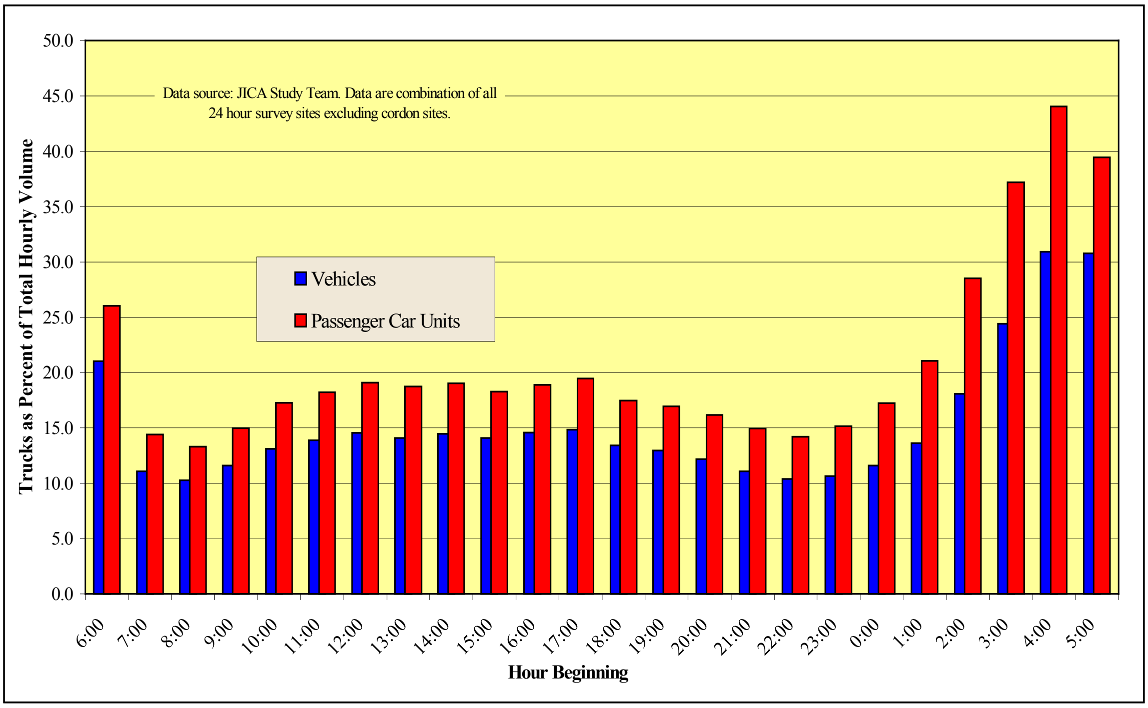


Figure 3.6.5 Composite Relative Hourly Truck Volume
Representative Year 2001 Weekday

3.6.2 Base Year Commercial Vehicle Matrix Calibration

Three surveys provide input to the formulation and calibration of commercial vehicle trip matrixes:

- The Cargo Survey, during which interviews were conducted with some 3,000 drivers of commercial vehicles at eight sites within the study area to ascertain, among other items, type and amount of cargo carried as well as origin and destination of cargo shipments.
- The Traffic Count Survey, during which traffic counts, stratified by hour, direction and vehicle type (including four distinct truck categories) were collected for 16 or 24 hours at some 100 sites throughout the study area.

- The Roadside Origin-Destination Survey, executed at 24 locations along the periphery of the study area and within corridors carrying traffic between 6th October City, 10th Ramadan City and central precincts of the study area. The roadside origin-destination survey, involving some 21,100 interviews, queried major items such as trip origin, trip destination, number of passengers, trip purpose and, in case of trucks, type and amount of commodities carried.

Following sample expansion, un-calibrated matrixes of truck trips (pcu format) were created. These was assigned to the base-year (2001) highway network, and resultant link volumes compared to traffic data obtained via the traffic volume count survey. This was iteratively accomplished for two truck categories:

- Small trucks, consisting of pick-up trucks and commercial vehicles of two axles. Pick-up trucks within the study area tend to be used for both commercial and personal purposes. For example, a farmer may use the pick-up for carrying vegetables to the market for commercial (selling) purposes, and use the pick-up in the evening for transport of the family for recreational purposes. A clear stratification by use is practically impossible; thus, for calibration purposes, it has been assumed that the pick-up traffic counts are equally split between commercial and non-commercial purposes.

- Large trucks, consisting of commercial vehicles with three and more axles. During the calibration procedures for this matrix, road network speeds for links located within the Ring Road were adjusted to reflect the on-going daytime ban on heavy commercial vehicles.

Matrixes content was iteratively adjusted using matrix estimation analogies which develop a mathematical enhancement of an existing (a priori) matrix until assigned inter-zonal trip demand correlates closely with observed traffic volume. Results confirm that excellent correlation was achieved at all locations (Figure 3.6.6). It can therefore be stated with confidence that the calibrated 2001 truck trip matrixes are capable of accurately reproducing observed base-year road demand.

3.6.3 Base-Year Commercial Vehicle Matrix Content

The matrixes, which each consist of 503 by 503 cells, or some quarter million trip interchange possibilities, were, for presentation purposes, collapsed to 18 internal planning sectors plus three external sectors. Roughly three-fourths of total truck pcu's consist of small trucks (290,000 daily pcu) with the remainder (85,000 daily pcu) consisting of large truck trips.

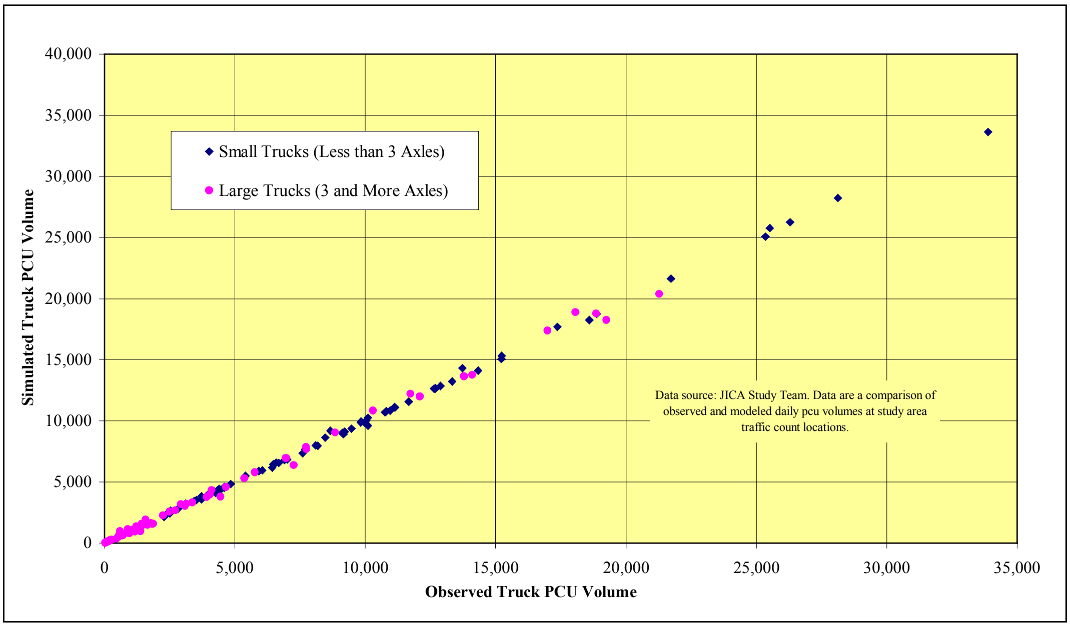


Figure 3.6.6 Comparison of Observed and Simulated Values Truck Matrixes Calibration Procedures

A further collapse of matrixes to the superzone level (for definition see Chapter 2) of detail permits some interesting graphical comparisons among study area precincts. On a percentage basis compared to small trucks, large trucks have a higher proportion of trips in more outlying parts of the study area. More than 40 percent of large truck trips have one or both trip-ends outside of the study area. A higher relative proportion of large truck trips are also linked with 6th October and 10th Ramadan cities than is the case with small truck trips. Activity for small trucks trips tends to be focused on the central as well as abutting southeast and northeast superzones (Figure 3.6.7). In absolute terms, the prevalence of small truck activity over large truck activity becomes evident in all superzones. For example, in the central superzone, a total of some 85,000 trips includes 74,000 trips by small trucks. Only in case of external trips is absolute demand in reasonable balance, thus again confirming the strong external orientation of large truck trips (Figure 3.6.8).

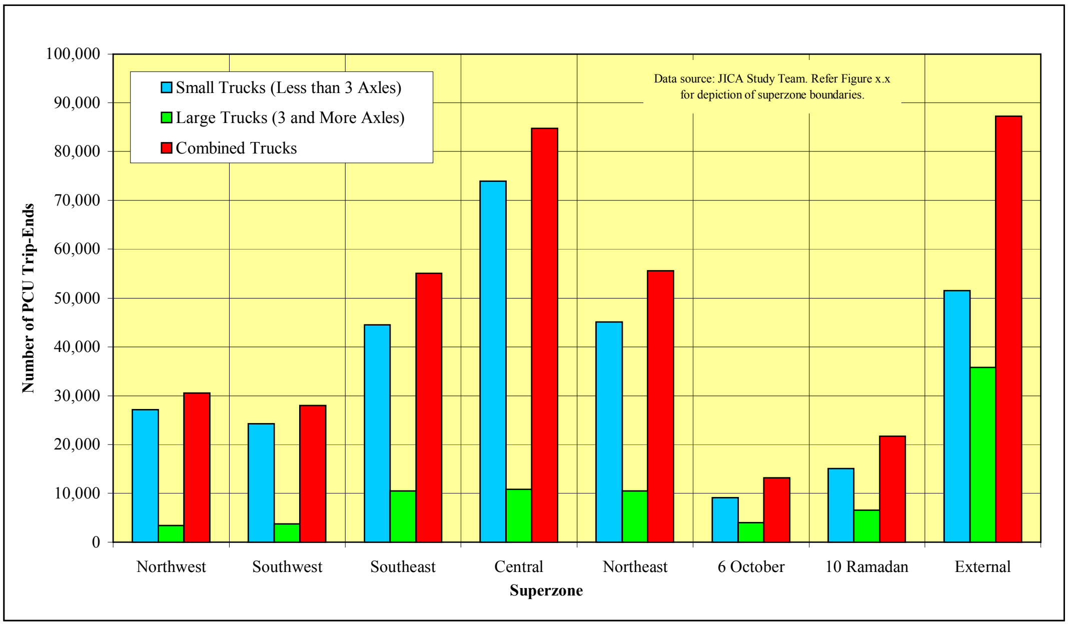


Figure 3.6.7 Relative Distribution of PCU Truck Trips by Superzone

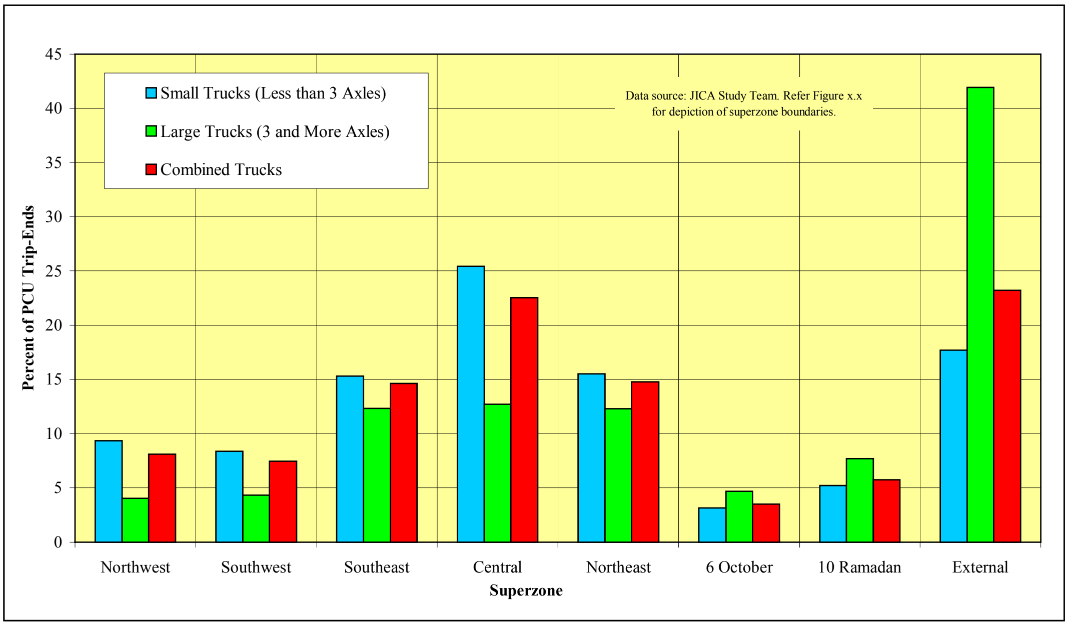


Figure 3.6.8 Absolute Distribution of PCU Truck Trips by Superzone

The distribution of truck trips between superzones confirms that highest relative trips is for trips both beginning and ending in the central superzone. This movement could, in general terms, be designated as largely consisting of small trucks on relatively short trips. Strong linkage also exists between the northeast and external, as well as between external and external superzones. In the latter case, some 20,000 daily truck pcu trips are identified as having both trip ends outside of the study area, that is, in transit through the study area (Figure 3.6.9).

It is noted that full detail of truck matrixes at the complete 503 analysis zone level of detail are, of course, available and that the previous summations and simplifications are for presentation purposes only.

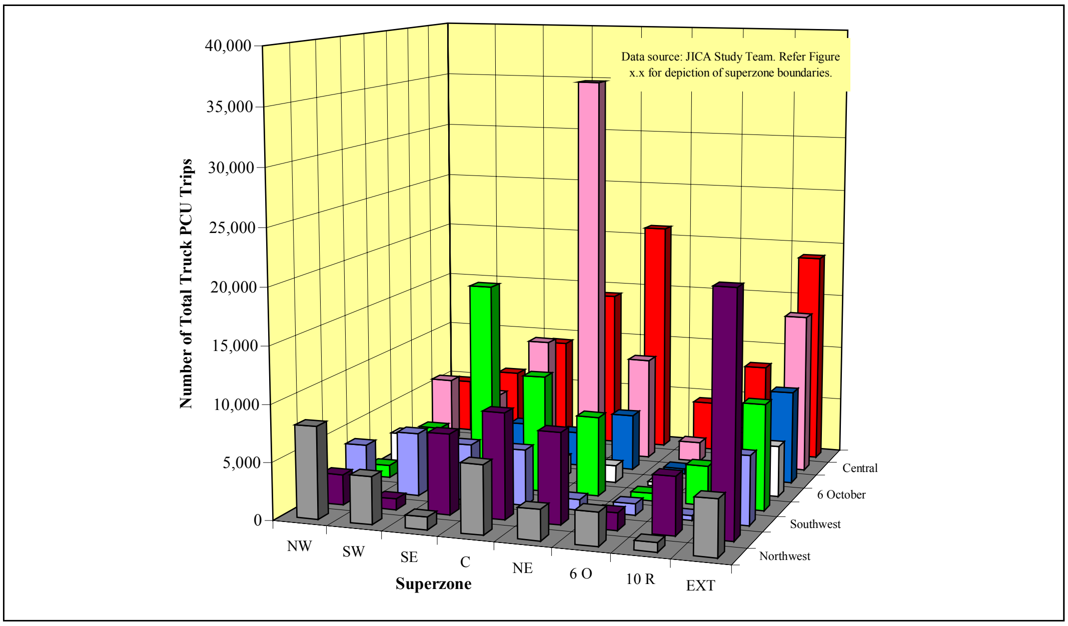


Figure 3.6.9 Interchange of PCU Truck Trips Between Superzones

3.6.4 Commercial Vehicle Demand Simulation

The simulation of truck trips is generally seen as being linked with economic activity. In case of CREATS, a variety of comparisons were undertaken involving small truck trips, large truck trips, population, density as well as four types of employment (primary, secondary, tertiary, total). Findings suggest that internal small truck trips are influenced by total employment, while large truck trips are impacted by secondary employment (Figure 3.6.10). In the latter case, some divergence in the precincts inside the Ring Road can be observed which are likely catalyzed by the truck ban.

A variety of linear and non-linear mathematical relationships were examined with a view to finding best fit. Density was introduced in the form of trips or employment per square kilometer of zone area. In case of small trucks, an area adjustment of data and a power relationship of the form emerged as having best fit of the form:

$Y = a(x^b)$……..Equation ….3.10

where
- Y = internal small truck pcu trips per square kilometer of zone area
- a,b = calibration co-efficients
- x = zonal socioeconomic data per square kilometer of zone area

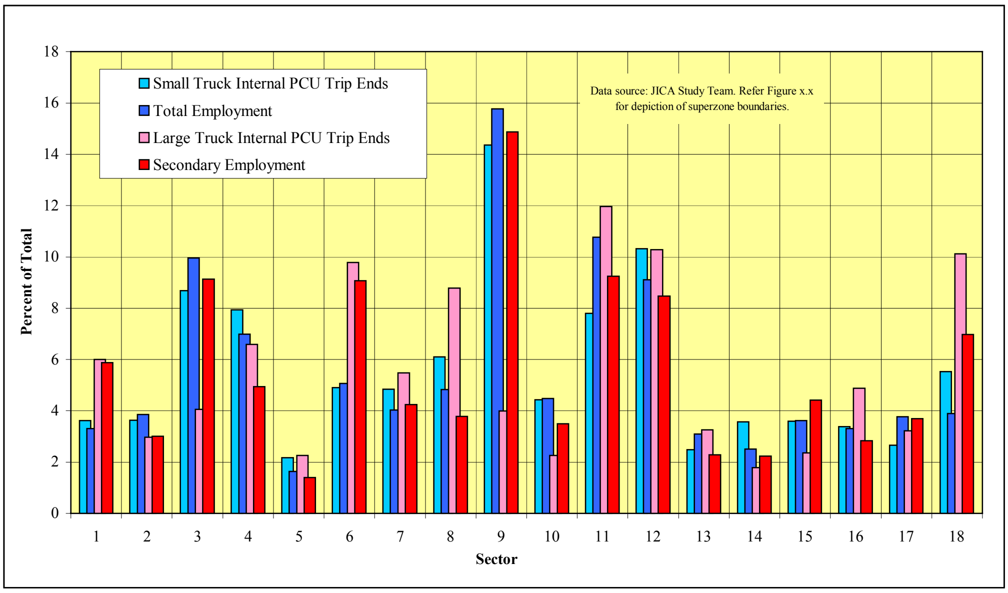


Figure 3.6.10 Comparison of Internal Truck Trips and Employment

Whilst in the case of large truck trips absolute totals and a linear regression of the form :

$$Y = a + bx \ldots\ldots\text{Equation} \ldots.3.11$$

where Y = internal large truck pcu trips per zone
a,b = calibration co-efficients
x = zonal secondary employment

were utilized. These relationships serve as trip generation models using zonal truck trips as dependent variable, and employment as independent variables. The best fit equation coefficients are:

Mode	Constant (a)	Secondary Employment Coefficient (b)	Total Employment per Square Km Exponent (b)	Coefficient of Determination (R^2)
Small Trucks	0.0266		1.015	0.59
Large Trucks	69.5	0.021		0.48

The coefficient of determination are not high. In the development of the commercial vehicle model there is often a large scatter of the data. These were the best curves after trying several other combinations of data. To ensure that the use of these curves did not cause spot fluctuations in truck trips, for each traffic zone the truck trips were estimated by mode for base and future year. The growth between base and the future year was estimated and then applied as a growth factor to estimate the future trips. Thus, the use of base and future zonal socioeconomic variables results in the calculation of a relative rate of growth vis-à-vis observed conditions; that is,

$$T_F = T_B * \frac{T_{RF}}{T_{RB}} \quad \text{...... Equation 3.12}$$

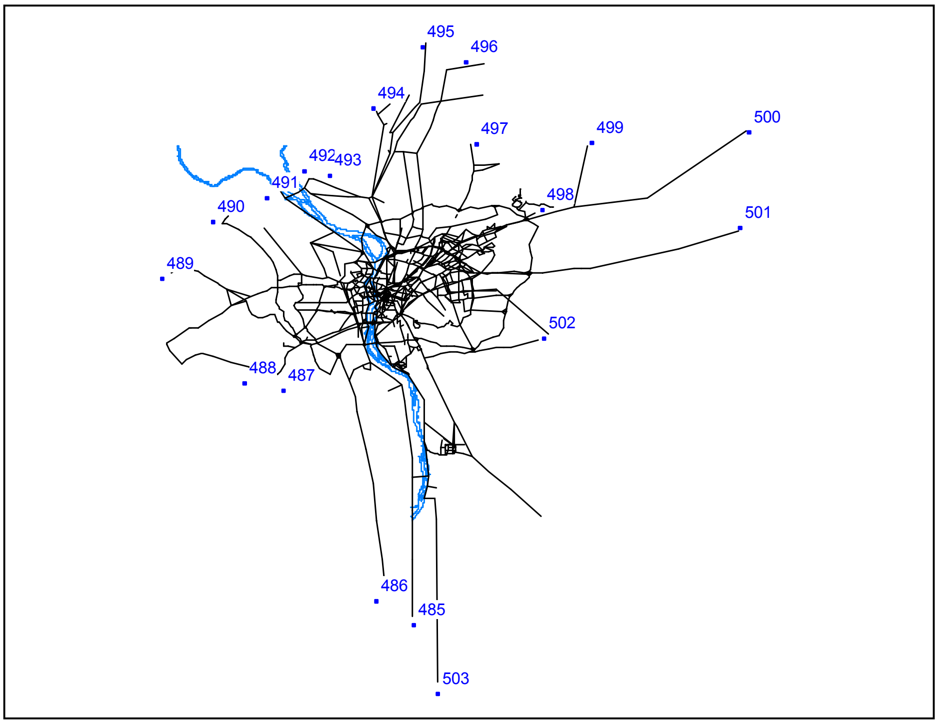
where, for each zone,

T_F	=	Estimated future - year trips
T_B	=	Base - year trips
T_{RF}	=	Trip estimate derived from future socioeconomic variables
T_{RB}	=	Trip estimate derived from base - year socioeconomic variables

3.6.5 Development of External Vehicle Demand Simulation

The home interview survey does not intercept trips by non-residents of the study area. Information on such trips was obtained from the cordon roadside surveys. These surveys were designed to intercept all significant external to internal movements plus those external to external movements passing through the study area. Five external matrices are prepared namely car, bus, taxi, small and big trucks.

The location of the external zones is shown in Figure 3.6.11 whilst a locality description is presented in Table 3.6.1. The future external trip making is obtained by increasing the base year matrices to reflect regional growth.



Source: JICA Study Team

Figure 3.6.11 Location of External Zones

Table 3.6.1 External Zones Locality

Zone No.	Location
485	Upper Egypt Agricultural. Road
486	Giza Asyout Desert Road
487	Cairo Fayoum Road
488	Cairo Wahaat Road
489	Cairo Alexandria Desert Road
490	Qanater El Khairyiah Khataba Road
491	Qanater El Shbeen El Koum Road
492	Shatanouf Ashmoun Road
493	Qanater El Khairyiah
494	Cairo Alexandria Agricultural Road
495	Shbeen El Qanater Tokh Road
496	Shbeen El Qanater Belbies Road
497	Cairo Ismallia Road
498	Haiksteb Belbeis Road
499	10^{th} of Ramadan Belbies Road
500	Cairo Ismallia Desert Road
501	Cairo Suez Desert Road
502	Qattammia Ain El Sokhna Road
503	Giza El Saf Road

Source: JICA Study Team

3.6.6 Development of Walk Trip Table

An important element in the trip making pattern in the study area is the walk trip. These trips in general are not a major input into the consideration of major infrastructure projects. These trips are normally of short duration. However often the trips are between adjacent zones and are difficult to model in the case of the larger outlying traffic zones, it was not possible to establish a mode split relationship between walk and motorized trips. They are not considered in the main transport model and are removed at the trip generation stage.

This said, these trips have not been forgotten but have been developed off line of the main model which deals with motorized trips. The walk trips are estimated in a using a Furness growth factor technique. Estimation of future trip ends is shown as follows:

$$W_F = W_B * \frac{T_F}{T_R} \text{ ……… Equation 3.13}$$

where, for each zone,

W_F = Estimated future year walk trips
W_B = Base Year walk trips estimated from surveys
T_F = Future Trip ends estimated from trip generation program
T_B = Future Trip ends estimated from trip generation program

In essence the trip generation program described earlier in this chapter is run with a set of walk trip generation rates developed by economic activity level and household size as for motorized trips. The difference between the base year and the future year generations yields a growth factor applied as described above.

3.7 BASE YEAR ASSIGNMENT AND CALIBRATION

3.7.1 Overview

The assignments combine the impact of all the previous steps in the model and are therefore the final and major checks on the model output. This section firstly describes the development and combination of the final trip tables.

This section then describes the highway traffic assignment procedure. The output link speeds from the highway assignment are modified to update bus speeds for use in the public transport assignment.

3.7.2 Highway Assignment Procedure

A daily assignment by vehicle is carried using capacity restraint and equilibrium techniques. The overall trip table for public and private transport is calculated as shown in Figure 3.7.1.

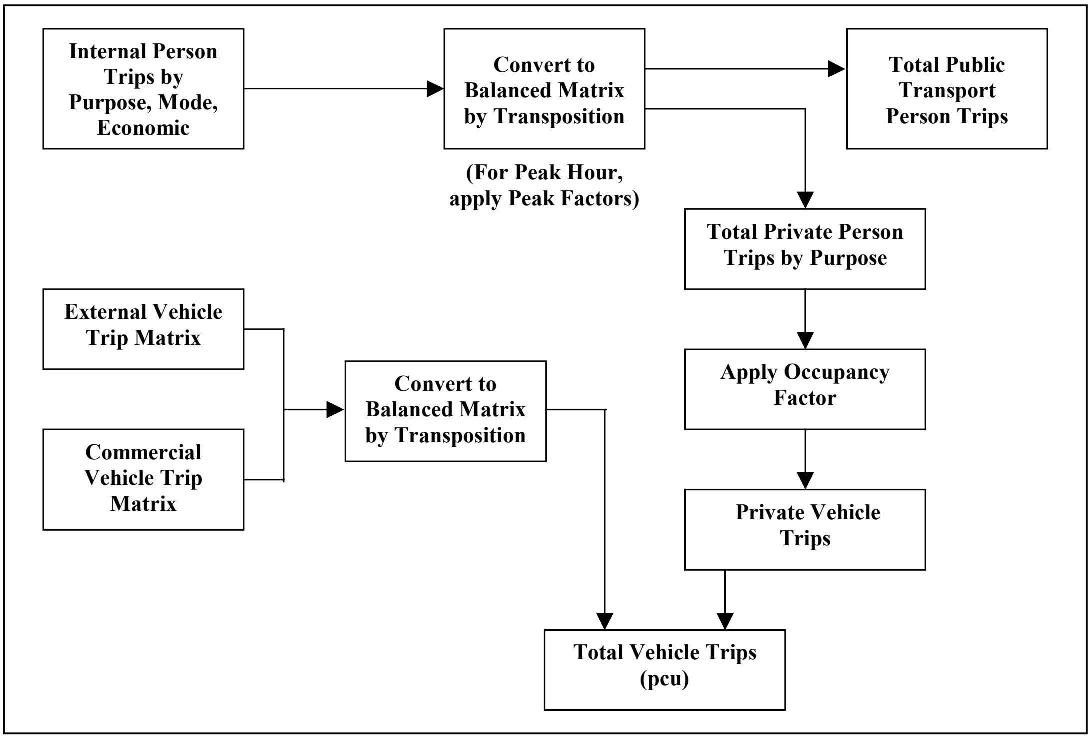


Figure 3.7.1 Estimation of Assignment Trip Tables

The trip table format after the completion of mode split stage of the modeling process is in the Production Attraction format discussed earlier in this chapter. As shown in the flowchart it is first necessary to convert these matrices into an origin and destination matrix by adding the transpose of the matrix to itself.

At the city wide of level of modeling it is appropriate to use multi-routing path building and assignment techniques utilizing capacity restraint. By applying capacity restraint, account is taken of congestion altering journey speeds. The assignment techniques used is an Equilibrium procedure.

This procedure combines flows from previous iterations, the method calculates what is the optimum proportion of each iteration which should be combined to achieve a "user-optimized" solution.

Buses, Shared Taxis are incorporated by pre-loading the network, prior to assignment of all other vehicles. Pre-loading the network is usually applied to modes with "fixed" or "non-dynamic" routing, where there is a small likelihood of changing routing as a consequence of changing levels of congestion. The trucks are pre-loaded in an initial assignment because they are barred from certain links in the network. The Bus and Shared Taxi volumes, (obtained from the Public Transport Network) are pre-loaded because in model they follow fixed routes.

This preloading will result in some reduced capacity of the network prior to the assignment of other vehicles. After the preload, the remaining vehicles will be loaded. The iterative traffic assignment cycle is presentation in Figure 3.7.2.

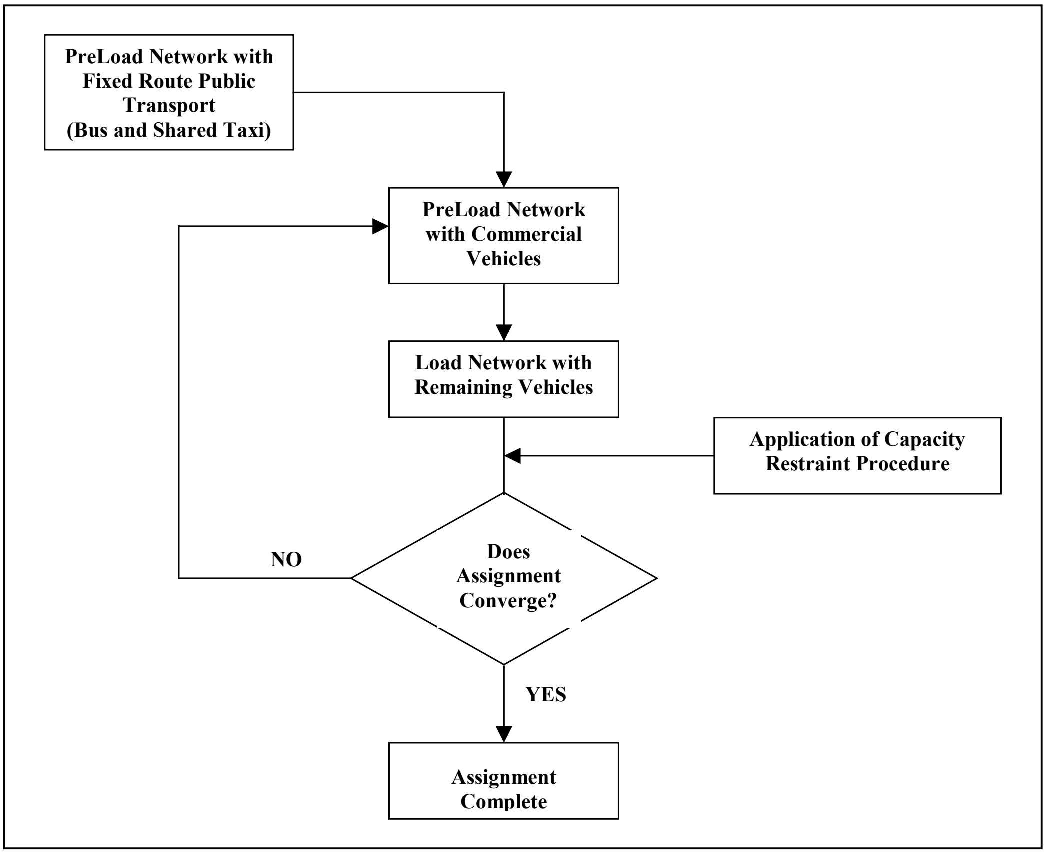


Figure 3.7.2 Traffic Assignment Cycle

The Equilibrium procedure employs the convergence indicator (sigma, σ) for the previous iteration. This measure, which tends to zero as the model reaches equilibrium, has the formula:

$$\sigma = \frac{\sum_{ijr} T_{ijr} \cdot (C_{ijr} - C_{ij}^{*})}{\sum_{ij} t_{ij} \cdot C_{ij}^{*}}$$

……. Equation 3.14

where

T_{ij} = number of trips from zone l to zone j

T_{ijr} = number of trips from zone l to zone j on path r

C_{ij}^{*} = minimum cost of travel from zone l to zone j

C_{ijr} = cost of travel from zone l to zone j on path r

In effect the assignment is repeated until equilibrium is maintained on the following iteration. In the case for example of a toll road, on an early iteration little traffic is assigned to the toll road but as other city roads become more expensive as a result of congestion, traffic is diverted to the relatively cheaper toll road. This procedure is repeated continuously until network equilibrium. The toll diversion is achieved through obtaining a network in equilibrium balance.

In converting the person trip tables to vehicle trip tables, there is an application of a vehicle occupancy factor. These are presented in Table 3.7.1. These are applicable only for private transport. The vehicle assignment for road based public transport is included as a preloaded volume on the road network.

Table 3.7.1 Vehicle Occupancy Factors

Trip Purpose	Car Occupancy	Taxi Occupancy
HBW	1.5	2.0
HBE	2.4	3.0
HBO	2.1	2.5
NHB	1.7	2.0

Source: JICA Study Team

For the peak hour assignment, peak hour factors are estimated as shown in Table 3.7.2. These are estimated for the peak hour which is defined as an average hour between 07:00 and 09:00 on a weekday.

Earlier in this section, the estimation of the whole day trip table was estimated by adding the Production Attraction (PA) format matrix to the transpose of itself. At this stage in the estimation of the peak hour matrix, these factors are applied to the PA matrix to develop the peak hour matrix.

Table 3.7.2 Peak Hour Factors

Mode	Normal Matrix				Transposed Matrix		
	HBW	HBE	HBO	NHB	HBW	HBE	HBO
Car	0.0461	0.0404	0.02	0.05	0.00055	0.0002	0.0002
Taxi	0.037	0.0312	0.0019	0.0025	0.0005	0.00015	0.0002
School Employee Bus	0.0069	0.0082	-	-	0.0002	0.00005	-
Public Transport	0.079	0.0805	0.046	0.0005	0.001	0.0005	0.00005

Source: JICA Study Team

These peak hour factors includes the effects of vehicle occupancy, PCU values and peak to daily ratios. These are applied by purpose, by vehicle type on a “to and from home” basis. The “from home” (or “Normal Matrix”) factors are high in the morning peak representing the journey to work, whilst “to home” (or “Transposed Matrix” factors are relatively low representing the journey from work for workers working other than “normal” hours. The peak to daily ratios were derived from the home interview survey.

3.7.3 Public Transport Assignment

Public transport network assignment is complex due to the number of factors which have to be considered when examining the optimal modal path. These include:

- The in-vehicle time
- Waiting time (a function of headway)
- Decision on waiting for faster infrequent service or traveling via a slower frequent service
- The inconvenience of transferring between public transport services
- The different travel cost of a service, difference between modes
- Mode comfort factor
- Walk time to alternative services
- Which fast service stops closest to final destination

A range of parameters are available to control the path building process, including:

- Mode specific in-vehicle time weighting factors
- Mode specific waiting time weighting factors

- Mode specific boarding penalties

- Mode Specific Value of Time

These parameters are presented in Table 3.7.3 for the major modes in the base year. All parameters were estimated in the calibration of the public transport assignment with the exception of the Value of Time which was derived from the Home Interview Survey. The value of time in the future increases according to economic changes. The fare in particular for the various bus and shared taxi routes was developed on a line basis and obtained from the CREATS survey program.

Table 3.7.3 Mode Specific Parameters

Mode	Wait Time Factor	Run Time Factor	Boarding Penalty (Equivalent Minutes)	Value of Time (Piaster per Hour)
Bus	0.8-2.0	0.7-1.2	5-30	97-158
Tram	2.0	0.6	7-12	86-100
Metro	0.3	0.8	5	125
Shared Taxi	1.0	0.9	15	109

Source: JICA Study Team

In the case of where there are two or more public transport routes available for a trip, the probability of choosing a route is given by the following formula:

$$P_i = \frac{e^{-SF(TD_i - ETD)}}{1 + e^{-SF(TD_i - ETD)}} \quad \text{.......Equation 3.15}$$

where TD_i is the time using Service i , ETD_i is an average time using all available services and SF is a scale factor whose value is set to 0.005.

3.7.4 Calibration Results

The traffic assignment is undertaken as part of the final validation process. Due to the problems of identification of individual vehicle types in the vehicle traffic assignment it is not possible to make a clear comparison of traffic counts and vehicles by individual vehicle types. For this reason a comparison is made across all vehicle types in the form of passenger car units or pcu's across the external and river screenline as shown in Figure 3.7.3.

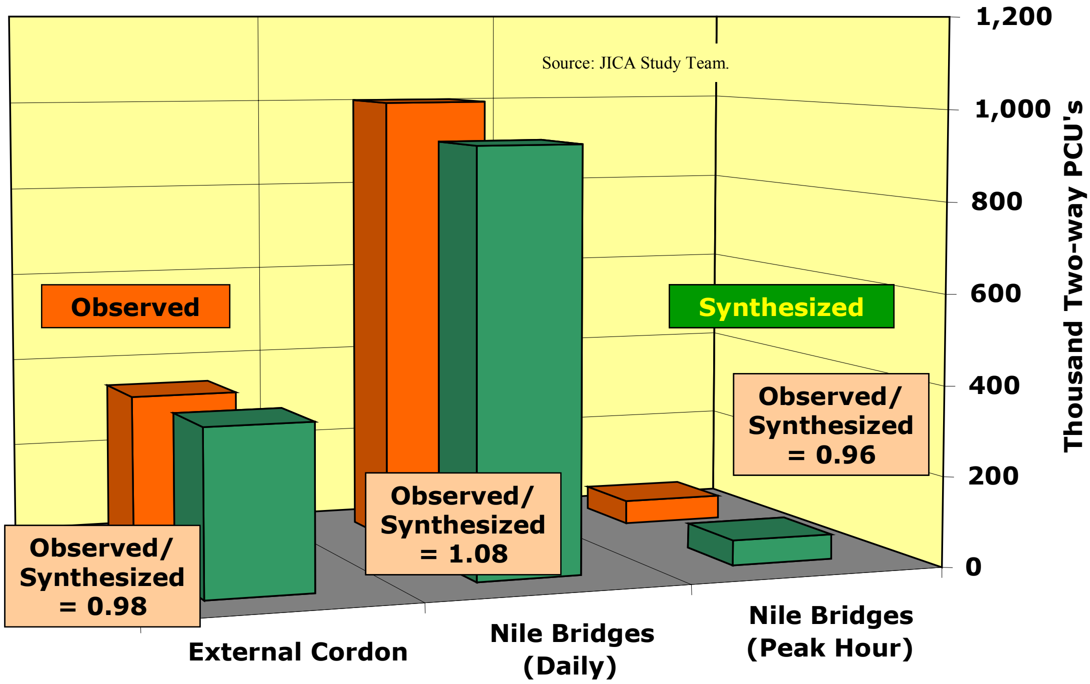


Figure 3.7.3 Cordon Comparison between Observed and Estimated Traffic

In addition a comparison between the observed and individual traffic counts at over 100 observed sites. This comparison between observed traffic count and estimated traffic flows at individual sites is done via the Mean Absolute Difference (MAD) Ratio.[16] For daily traffic counts with a value in excess of 10,000 the value of the MAD ratio is 0.34 which is considered to reflect a good calibration. By all indications the assignment has accurately replicated the base year.

For public transport a comparison is presented in Table 3.7.4 between the synthesized passengers and the "observed" estimated passengers from other sources such as the CREATS Home Interview Survey or ticket sale information available from the operator.

There are approximated 13 million passenger boardings daily in Cairo today as seen in Table 3.7.4. The estimate from the CREATS transport model is 13.3 million, a difference of only 2%. This is a good result from the public transport assignment. A comparison by major modal class shows a difference in estimate of CTA passengers of 8%, of Metro passengers of 2% and of Shared Taxi of 1%. Overall this demonstrates that the model is predicting the correct number of Public Transport passengers and the distribution by the different public transport modes.

The total person trip matrix is provided in the database report, Volume 4.

[16] MAD Ratio is defined by the following formula: MAD Ratio = $\sum \left| \frac{Count - Assignment}{Assignment} \right| / n$ where n is the number of observations.

Table 3.7.4 Comparison of Synthesized Daily Public Transport Passengers

<table>
<tr><th>Public Transport Mode</th><th>Model/Synthesized Result (Million Boardings)</th><th>Observed Result (Million Boardings)</th></tr>
<tr><td>CTA-Bus</td><td>2.963</td><td rowspan="2">2.852</td></tr>
<tr><td>CTA-Air Conditioned Bus</td><td>0.141</td></tr>
<tr><td>GCBC Bus</td><td>0.681</td><td>0.597</td></tr>
<tr><td>CTA Mini Bus</td><td>0.512</td><td>0.516</td></tr>
<tr><td>Ferry</td><td>0.10</td><td>0.012</td></tr>
<tr><td>Tram</td><td>0.056</td><td>0.057</td></tr>
<tr><td>Heliopolis Metro (Tram)</td><td>0.115</td><td>0.118</td></tr>
<tr><td>Metro</td><td>2.034</td><td>2.084</td></tr>
<tr><td>Train[17]</td><td>0.134</td><td>0.200</td></tr>
<tr><td>Shared Taxi</td><td>6.608</td><td>6.508</td></tr>
<tr><td>Co-op Mini Bus</td><td>0.073</td><td>0.126</td></tr>
</table>

Source: JICA Study Team

3.8 DISAGGREGATE MODAL CHOICE MODEL ANALYSIS

3.8.1 Introduction

(1) Disaggregate Modal Choice Model

The intension of the disaggregate model is to develop a transport activity model in terms of individual base, according to the consumer's activity theory of the modern microeconomics. In this sense, the disaggregate model is different from conventional transport demand models such as four-step models, which are developed based on "aggregated" volume of transport demand under a traffic zone system.

The disaggregate model has been developed since 1970's as a new approach to cope with various transport issues, which were not successfully solved by the traditional aggregate models. For example, explanatory variables of a modal split model were basically travel time and travel cost in the aggregate models. However, it had become necessary in view of transport policy decision making to include variables such as service frequency, waiting time, transfer resistance and so on to cope with various transport issues in urban areas. It can be said that the need had led to the disaggregate model development[18].

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[17] Train passengers are persons traveling on suburban services of the ENR.

[18] The interested reader is urged to consult following publications for more in-depth discussions on this topic: *Metropolitan Transportation Planning, Second Edition*, Hemisphere Publishing Corporation, Dickey, J.W., 1983; *Urban Travel Demand–A Behavioral Analysis*, Domencich, T.A. and McFadden, D., North-Holland Press, 1975; *Stochastic Choice of Mode in Urban Travel: A Study in Binary Choice*, Warner, S.L., Northwestern University. Press, 1962; and, *Theory and Application of Disaggregate Model*, Japan Society of Civil Engineers, 1995 (in Japanese).

The disaggregate approach assumes a rational individual activity in selecting alternatives based on his own "desire" or "utility", by maximizing his utility.

The approach assumes that two types of factors would determine individual's utility of alternatives. Those are LOS (level of service) and SE (socio-economic) variables. The LOS variables are level of service given by transport modes such as travel time and travel cost by the modes. The SE variables are such as age, sex and income, which represent the individual's characteristics of the trip maker. The model estimates modal choice by individual by using those variables.

However, people who are same, in terms of SE variables, may not necessarily choose the same transport modes. Therefore, the approach also assumes that these are composed of an objectively measurable part and non-measurable part, as shown below. The approach assumes that the difference comes from the non-measurable part of the variables. The approach derives models by assuming a probabilistic variable for the non-measurable part.

Utility of an individual for alternative i is described as below.

$$U(i) = V(i) + e(i) \quad \text{------------------- Equation 3.16}$$

where, $U(i)$: utility of an individual for alternative i;

$V(i)$: measurable part of alternative i and the individual; and

$e(i)$: non-measurable part of alternative i and the individual and which is assumed as a probabilistic variable.

When $U(i)$ is bigger than utilities of any other alternatives for an individual, the individual chooses the alternative i. Then, the probability to choose i, $P(i)$ is expressed as follows.

$$P(i) = P[U(i) > U(j), \text{ for all } j<>i] \quad \text{------------------------Equation 3.17}$$

The formula (2) can be modified as follows.

$$P(i) = P[V(i) + e(i) > V(j) + e(j), \text{ for all } j<>i] \quad \text{-----------Equation 3.18}$$

A formula of a disaggregate model is given by assuming a distribution of e. If e is assumed to follow the Gumbel distribution, a logit model is obtained. If e is assumed to follow the normal distribution, a probit model is obtained.

Major differences between the aggregate and the disaggregate model, in terms of modal sprit model development, are summarized as below.

- Data

  The aggregate model uses aggregated data such as number of person who used a specific mode by aggregating numbers according to an assumed traffic zone system.

The disaggregate model uses individual modal choice data, such as who used which mode. In addition to this, SE characteristics of the individual are also utilized to estimate the model.

- Analysis

  The aggregate model uses modal shares between origins and destinations with LOS variables.

  The disaggregate model uses results of choices by individual, which is expressed by 1 or 0. The model is estimated by maximum likelihood method based on LOS and SE variables by individual.

- Forecast

  The aggregate model forecasts modal shares in terms of modal shares according to LOS variables by transport mode.

  The disaggregate model forecasts individual modal choices according to SE and LOS variables. Modal shares are calculated as summation of individual choices.

As mentioned earlier, the disaggregate model was developed based on studies of demerits of the traditional four-step models. Therefore, the model has various merits against the aggregate models. However, the disaggregate model still has some problems to be improved. These are summarized as below.

- Merit of the disaggregate model against the aggregate models
  - Sensitivities to explanatory variables are superior.
  - The disaggregate model is free from zoning system, because the model does not depend of the zoning system.
  - Spatial transferability is superior, because the model is derived from individual rational choice activities.
  - Number of samples to estimate the disaggregate model is relatively small compared to the aggregate models.
  - Estimated disaggregate model tends to be statistically significant even if number of variables are many, compared to the aggregate models.
- Demerit of the disaggregate model against the aggregate models
  - For future forecast, the disaggregate model needs future individual data. However, it is usually impossible. Some measures to the issue are proposed such as Naive Method, Classification Method and Sampling Method.
  - The issue of IIA (Independence of Irrelevant Alternative), which appears when one applies a logit model to estimate modal split model for more than three alternative modes. For example, a ratio of choice probability for bus against choice probability of car is independent from the third alternative.

It means that the ratio does not change even if the third mode, i.e. a train, appears. The probability to choose bus should be affected more than the probability to choose car when train appears, because train is similar to bus in terms of transport service. Nested Logit Model is proposed to solve the problem.

- Although LOS variables by mode should be different by individual, the variables are usually calculated based on traffic zone system because of difficulty of actual work.

(2) Disaggregate Analysis in the Study

The Study Team conducted two kinds of surveys for the disaggregate analyses in the Study. One is a Revealed Preference Survey (RPS) and the other is a Stated Preference Survey (SPS) to collect adequate information for the analysis (refer to 3.10.2 and 3.10.3).

In addition to the above surveys, the Study Team collected necessary information from the Home Interview Survey (HIS). The information of HIS includes various information, which is necessary for the disaggregate analysis. The Study Team sampled necessary data from the HIS database.

Adopted disaggregate model by the Study team was a modal split model, which analyzes individual modal choice between private car and public transport. The selected disaggregate model in the Study is therefore a Binomial Logit Model as shown in equation (4), which is the simplest formula as a disaggregate model.

$$Pc = \frac{e^{f(X^C_i)}}{e^{f(X^B_i)} + e^{f(X^C_i)}} \qquad \text{---------------------------- Equation 3.19}$$

where, $f(X^C_i) = a_0 + \sum_{i=1}^{N} b_i X^C_i$

Pc: Probability to choose car mode by an individual

X^C_i : the i^th value of car mode variables by an individual

$a_0,\ b_i$: parameters

The probability to choose a car Pc becomes bigger if utility of car, which is expressed by $f(X^C_i)$, becomes bigger. If one considers that travel cost and travel time are disutility, the probability becomes bigger when these become smaller.

To estimate parameters of equation (4), the Most Likelihood Method is used. Because the probability, which is the dependent variable, is 1 or 0 in the disaggregate model analysis, the method of least squares is not adequate for the estimation usually.

Likelihood L is defined as a formula (5) to estimate unknown parameters in the first place.

$$L = \prod_{k}\prod_{nk} P_k \text{ ---Equation 3.20}$$

where, k : number of modes;

nk : number of individuals who selected mode k; and,

K : mode number.

The formula (5) is expressed as formula (6), by converting both side of the equation with logarithm and by expressing L* = *ln* L as log. Likelihood.

$$L^* = \sum_{n \in Sc} ln\ Pc + \sum_{n \in Sb} ln\ (1 - Pc)$$

$$= - \sum_{n \in Sc} ln\ (1 + e^{f(xi)}) + \sum_{n \in Sb} f(x_i) - \sum_{n \in Sb} ln\ (1 + e^{f(xi)})$$

$$= \sum_{n \in Sb} f(x_i) - \sum_{n} ln\ (1 + e^{f(xi)}) \text{ -------------------------- Equation 3.21}$$

where, a probability to choose a car is expressed as follows.

$$Pc = \frac{1}{1 + e^{f(xi)}} \quad \text{-------------------------------- Equation 3.21'}$$

where, $f(x_i) = a'_0 + \sum b'_i\ (X^B_i - X^C_i)$

Disaggregate model parameters are estimated by maximizing the L*. The maximized L* is given by solving the following simultaneous equations, because the function L* has a peak.

$$\partial L^* / \ \partial a_0 = n \in Sb - \sum_{n} \left(\frac{1}{1 + e^{-f(xi)}} \right) = 0$$

$$\partial L^* / \ \partial b_1 = \sum_{n \in Sb} x_1 - \sum_{n} \left(\frac{1}{1 + e^{-f(xi)}} \right) = 0$$

.

.

$$\partial L^* / \ \partial b_j = \sum_{n \in Sb} x_j - \sum_{n} \left(\frac{1}{1 + e^{-f(xi)}} \right) = 0 \quad \text{--------------- Equation 3.22}$$

The simultaneous equations (7) are non-linear. The Newton-Raphson method is usually applied to solve the equations by using the Taylor expansion.

(3) Modal Choice Variables for Disaggregate Analysis

Variables used in the disaggregate analysis are composed of two types of data as mentioned before. One is level of service (LOS) variables and the other is socio-economic(SE) variables.

The LOS consists of variables which explain transport service characteristics by mode such as travel time, travel cost, waiting time, service frequency and so on. The SE consists of individual information that explains individual characteristics of trip makers such as sex, age, income, car ownership, occupation and so on.

In the disaggregate analysis, those data are used in a form of difference between competitive two modes. For example, travel time difference between the two modes is calculated as input for the analysis. Although it is possible to calculate differences in the case of the LOS, it is not possible for the SE, because the SE is same for one person. Therefore, the SE is given to one mode only to make the analysis possible. The SE is called as "mode specific" variables in this sense. On the contrary, the LOS is called as "common" variables.

As explained earlier, one of the advantages of the disaggregate model is that the model can cope with many variables compared to the traditional aggregate models. The Study Team tried to include many explanatory variables to make the model useful. The variables collected and analyzed are shown in Table 3.8.1.

Table 3.8.1 Explanatory Variables for the Disaggregate Analysis

Variables	Value	Type of Variables	Sign Condition
SE Variables			
Sex	Male:1, Female:0	Mode Specific	
Age	By age category	Mode Specific	
Driving License	Own: 1, not own: 0	Mode Specific	+
Car Ownership	Own: 1, not own: 0	Mode Specific	+
Income	By income category	Mode Specific	+
LOS Variables			
Travel Time	Minutes	Common	-
Travel Cost	Piaster	Common	-
Waiting Time	Minutes	Common	-
Number of Transfers	Number	Common	-
Walk Time	Minutes	Common	-

Source: JICA Study Team

These ten explanatory variables were used for all disaggregate analyses in the Study.

The Study Team used survey results with regard to the SE variables and information on chosen mode of travel, while the Study Team did not use the results regarding the LOS variables from the surveys. The LOS variables were calculated according to the current transport network of the Study on zone-to-zone bases, which was explained earlier in this chapter, for the chosen mode and for alternative mode as well by referring Origin and Destination information collected by the survey.

Various transport policy effects such as travel speed increase/decrease, public transport fare raising, parking charges, petroleum price raising, development of intermodal facilities and etc. would be able to be analyzed by the estimated model, if the disaggregate analyses are successful.

(4) Evaluation of Disaggregate Analysis

The Study Team will show the following indices for all parameter estimation results to evaluate estimated disaggregate models in succeeding sections.

- McFadden's coefficient of determination (ρ^2)

This value varies between 0 and 1. It is different from "coefficient of correlation". If the value is 0.2 ~ 0.4, the estimation is considered as successful. The coefficient is calculated as below.

$\rho^2 = 1 - L(\theta) / L(0)$ ----------------------------------Equation 3.22

where, $L(\theta)$: logarithm likelihood calculated by estimated parameters.

L(0): logarithm likelihood when all parameters are zoro.

- Hit Ratio

The hit ratio is a percentile of numbers of correct estimation against numbers of wrong estimation by the estimated disaggregate model. In case of binary logit model, if an estimated choice probability is bigger than 0.5, the individual is considered to choose mode 1, otherwise the individual chooses mode 2.

- chi-square

The chi-square is a statistics to test a hypothesis whether all the model parameters are zero or not.

The Study Team also considered the estimated time value from the coefficients of travel time and travel cost. If the time value is ridiculous compared to the current Egyptian economy, the estimated disaggregate models would be unreliable.

Other than those criteria, which were mentioned above, the Study Team examined signs of estimated coefficients. If the signs do not appear as expected, the estimated disaggregate models would not be reliable.

3.8.2 RPS Survey Data Analysis

(1) Introduction

The Study Team conducted the Revealed Preference Survey (RPS) to develop disaggregate models for evaluation of urban transport policy changes. The Study team intended to utilize the models to confirm potential policies to be adopted in the Master Plan.

The objectives and methodology of the survey are introduced here.

1) Objectives of the survey

Objectives of the RPS is to collect information on individual modal choice so as to develop disaggregate modal choice models. Therefore, the RPS questionnaire forms include individual attributes, which is similar to the HIS, actual modal choice with information on the travel, which is also similar to the HIS, and information on available alternative travel modes for the trip of the individual, which is not in the HIS.

2) Survey method

The RPS survey intends to collect actual modal choice information of the residents. To collect such information efficiently, the Study Team decided to adopt "choice based sampling method" and conducted the survey at transport terminals for public transport and parking areas for private transport in principle.

A sample of 2500 travelers were planned to be interviewed in the RPS at the terminals classified as follows:

- Formal public transport modes: Bus, Metro, Tram/Heliopolis Metro and Suburban Rail
- Informal public transport: Shared Taxi and Cooperative Mini Bus
- Parking places: On Street and Off Street

However, it appeared difficult to conduct the interview at the terminals in some cases. The one was interviews at large-scale railway stations of ENR, where it was difficult to identify commuting passengers from long distance travel passengers. The other was cooperative mini bus passenger interview, because the buses have no terminals.

The Study Team decided to conduct on board interview surveys to those passengers in place of terminal interviews to cope with the problems.

3) Survey period

After training program for the interviewers during six days between 11 and 16 October 2001, the RPS started on 16 October and ended on 10 November 2001.

4) Mobilized surveyors

A total of 198 interviewer-days were spent in order to complete the survey. The average rate of survey execution is 14.3 forms/day/interviewer. An average of 10.42 interviewers were mobilized everyday.

5) Planned and collected samples

Planned and collected samples by mode are shown in Table 3.8.2.

Table 3.8.2 RPS Planned and Collected Samples

Mode	Planned sample	Achieved sample	Achieved/ Planned
Bus	300	304	1.01
Mini Bus	200	224	1.12
Tram/Heliopolise Metro	200	210	1.05
Metro	300	324	1.08
Suburban Rail	200	264	1.32
Shared Taxi	300	308	1.03
Cooperative Mini Bus	200	221	1.11
Private Car (on street parking)	500	566	1.13
Private Car (off street parking)	500	520	1.08
Total	**2,700**	**2,941**	**1.01**

Source: JICA Study Team

(2) Result of Analysis

The Study Team coded collected information of the survey and the results were incorporated into the CREATS database. In the next step, the Study Team prepared necessary data for the disaggregate analysis as explained before.

Result of the disaggregate analysis on the RPS is shown in Table 3.8.3.

The hit ratios and the ρ^2 showed very satisfactory results. However, signs of estimated coefficients did not satisfy the conditions. In particular, waiting time, number of transfers and walk time were not satisfactory.

With regard to time values, which can be calculated by a coefficient of travel cost divided by a coefficient of travel cost, the results were not satisfactory. The highest value appeared in All Purpose model (8.22 Piaser / Minute), and the value of a business trip (3.03 Piaster / Minute) was lower than that.

Elaborated analyses were done to satisfy mainly the sign conditions for All Purpose, Work, School and Business trips as shown in Appendix of this chapter. However, the results were not satisfactory.

Table 3.8.3 Results of RPS Analysis

SE Variables		All Purpose	To Work	To School	To home	Business	Others
1	Sex	(.61417) 0.11957	-(1.92108) -1.64361	(2.53821) 1.65873	(.0344) 0.01221	-(.22317) -0.19628	-(.92076) -0.34167
2	Age	(.69049) 0.00465	(3.28641) 0.07684	(.60392) 0.03529	-(.06933) -0.00086	(2.66314) 0.05249	-(.47192) -0.00630
3	Dr.License	(17.004) 3.62043	(7.4782) 5.20484	(6.27267) 5.17174	(6.21131) 3.94329	(5.18802) 2.84579	(8.04859) 3.29724
4	Car Ownership	(12.65791) 2.69916	(7.52027) 3.59117	(2.90695) 2.39488	(3.7272) 3.89790	(2.85345) 1.34208	(5.68275) 3.64314
5	Income	(4.82277) 0.00051	(2.40679) 0.00066	(.20985) 0.00445	(3.00009) 0.00076	(2.59675) 0.00086	(2.48017) 0.00049
LOS Variables							
1	- Travel Time	-(.07936) -0.00057	(.26717) 0.00489	-(1.15805) -0.03412	-(.05579) -0.00103	-(.25816) -0.00494	-(.15897) -0.00252
2	- Travel Cost	-(2.74097) -0.00469	-(.22696) -0.00099	-(3.04603) -0.02577	-(1.85064) -0.00719	-(2.71735) -0.01500	-(1.38604) -0.00483
3	- Waiting Time	(2.3103) 0.07096	(.37802) 0.03174	-(.27584) -0.04021	(1.10164) 0.06165	(.45044) 0.03726	(.26946) 0.01727
4	- Transfers	(1.40137) 0.19729	(1.64988) 0.58849	(1.88843) 1.32321	(2.19154) 0.68332	-(.21691) -0.08767	-(.27204) -0.08289
5	- Walk Time	(1.61086) 0.01701	(2.3534) 0.06831	-(3.27725) -0.14077	(1.14287) 0.02654	(.0011) 0.00003	(1.16868) 0.02573
Constant		(8.74859) 4.01982	(3.49359) 4.62793	(2.42524) 9.31399	(3.9479) 5.25442	(3.25363) 4.90001	(4.42402) 4.53035
Number of Samples		2,580	663	330	760	282	545
	Private Mode	1049	313	183	574	156	305
	Public Mode	1531	350	147	186	126	240
Number of Variables		10	10	10	10	10	10
Hit Ratio		90.78%	95.63%	95.45%	90.79%	85.46%	89.54%
chi-square		2287.8996	731.8156	361.7581	745.5057	199.6413	453.6595
ρ^2		0.63827	0.79310	0.78423	0.70369	0.49268	0.59298

Source: JICA Study Team

3.8.3 SPS Survey Data Analysis

(3) Introduction

The Study Team conducted the Stated Preference Survey (SPS) to develop disaggregate models for evaluation of urban transport policy changes as same as the RPS. The Study team intended to utilize the models to confirm potential policies to be adopted in the Master Plan.

The objectives and methodology of the survey are introduced here.

1) Objectives of the survey

The SPS is a survey to clarify people's choice activity change when some conditions change, while the RPS analyzes actual choice activity of individuals. Therefore, the SPS is generally utilized to analyze individual choice activity, which would not be done by the RPS, in case the condition changes drastically.

For example, if a new transport mode is to be introduced, it is generally difficult to analyze how many ridership would be realized to the new mode, when the RPS survey is the only information for the analysis. In this case, an opinion survey is conducted to obtain people's tendency to use the new mode, by showing level of service and fare level of the new mode. Based on this kind of survey (SPS), modeling work can cope with the issue. This method is also utilized to estimate people's choice changes when a drastic change happens to, for example, transport fare, petrol cost, travel speed and so on.

In the Greater Cairo Region, population concentration to the city center has been a big problem. The Government has been constructing "new communities" around the region to move the residents from center to the suburbs. In this context, transportation means between the new communities and the central Cairo has been one of big topics for years. The existing road network would not be able to satisfy the transport demand in future. A new rail-based public transport mode might be necessary by considering environmental aspect.

Based on the above discussion, the Study Team conducted the SPS on residents of the new communities around Cairo. Three objectives of the survey were identified as follows;

- To obtain people's intension to use public transport modes in case the service is improved drastically between the new communities and the central Cairo;
- To obtain people's intension to shift to the public transport from private cars in response to various public transport oriented measures; and,
- To obtain people's opinion on living environment of the new communities.

2) Survey method

The SPS was conducted to residents in nine new communities in the suburbs of Cairo: 6th of October, Shekh Zayed, 10th of Ramadan, Badr, Shibin el Qanatir, Shorouk, Obour, 15th of May and New Cairo.

The sampling of the interviewed households within each city was done following the random sampling procedure used in HIS.

3) Survey period

After a training of surveyors starting 23 to 27 October 2001, actual execution of SPS started on 27 and ended on 31 October 2001.

4) Mobilized surveyors

A total of 195 interviewer-days were spent in order to complete the survey. The average rate of survey execution is 7.35 forms/day/interviewer. To achieve the above number of interviewer-day, an average of 39 interviewers were mobilized everyday.

5) Planned and collected samples

Table 3.8.4 shows planned and collected samples of the SPS.

Table 3.8.4 SPS planned and achieved interviews.

City	Planned Sample	Achieved Sample	Planned / Achieved
15 May	200	272	1.36
10 Ramadan	200	349	1.74
6 October and Shikh Zayed	250	290	1.16
New Cairo	100	116	1.16
El Shourouk	100	116	1.16
El Obour	50	58	1.16
Badr	50	74	1.48
Shebien El Qanater	50	100	2.00
Total	**1,000**	**1,375**	**1.38**

Source: JICA Study Team

(4) Result of Analysis

In the SPS analyses, the Study Team conducted two kinds of analyses. The one is an ordinary disaggregate analyses, while the other is an analyses on private mode users according to interviewee's intension to use public transport.

The results of SPS on both public and private mode analyses are shown in Table 3.8.5.

The hit ratios were high enough by reaching more than 95%. The ρ^2 were also very high. The signs are satisfactory in two analysis cases as shown in the Table. However, t-values of coefficients of travel cost parameters were not sufficient.

Time values, which were calculated by using the estimated coefficients of travel time and travel cost, appeared to very small as around 0.1 Piaster per minute. Coefficients of the Car Ownership were remarkably high as similar to the RPS analyses results.

The results of analyses, therefore, would not be accepted by the Study Team.

Table 3.8.5 Results of SPS Analysis Public and Private Mode Users

SE Variables		1	2	3
1	Sex	(1.32777) 1.22285	(1.57807) 1.415642	(1.56791) 1.384627
2	Age	(1.72225) 0.03678	(1.69802) 0.03648	(1.62636) 0.03502
3	Dr.License	(2.48768) 1.45850	(2.486) 1.43675	(2.40769) 1.36884
4	Car Ownership	(6.84353) 5.26144	(6.76545) 5.28754	(6.91843) 5.18767
5	Income	(2.80413) 0.00146	(2.64353) 0.00136	(2.7831) 0.00140
LOS Variables				
1	- Travel Time	-(1.44452) -0.01791	-(1.2825) -0.01565	-(1.50295) -0.01822
2	- Travel Cost	-(.57836) -0.00196	-(.64745) -0.00218	-(.0897) -0.00023
3	- Waiting Time	-(.14379) -1.41887	-(.0833) -1.07983	(.) 0.00000
4	- Transfers	(.95289) 0.36642	(.) 0.00000	(.) 0.00000
5	- Walk Time	-(1.08006) -0.03669	-(.83299) -0.02669	(.) 0.00000
Constant		(5.09934) 11.27001	(5.13304) 11.37526	(5.95115) 10.00309
Number of Samples		611	611	611
	Private Mode	67	67	67
	Public Mode	544	544	544
Number of Variables		10	9	7
Hit Ratio		95.74%	95.58%	95.25%
chi-square		709.530	708.603	707.089
ρ^2		0.83497	0.83413	0.83287

Source: JICA Study Team

Table 3.8.6. shows the results of car user analyses. The Study Team intended to analyze potential conversion of private mode users from private transport mode to public mode.

The Study Team asked to interviewees, who use private mode to travel to Cairo CBD, whether they would use CTA bus service if travel time is shortened. The Study Team also asked them acceptable cost increase when buses travel faster as they wish.

The Study Team generated a new data set by using above information. In case a private mode user responds that he would use bus service when travel time is shorted by 25% and fare is increased by 50 %, for example, the Team generated new LOS data based on his response by changing his mode of travel from private to public mode.

The results were very satisfactory in terms of the hit ratios and the ρ^2. However, estimated coefficients of travel cost parameters were positive in all analysis cases.

It means that if the travel cost is higher, people would choose private mode. The Study team could not accept the results.

Table 3.8.6 Results of SPS Analysis Private Mode Users

SE Variables		1	2	3	4
1	Sex	-(1.22095) -1.165295	-(1.12719) -1.06795	-(1.0972) -1.02163	(.) 0.00000
2	Age	(1.43366) 0.04859	(1.41186) 0.04843	(1.42575) 0.04703	(.) 0.00000
3	Dr.License	(.) 0.00000	(.) 0.00000	(.) 0.00000	(.) 0.00000
4	Car Ownership	-(.78666) -3.75667	(.) 0.00000	(.) 0.00000	(.) 0.00000
5	Income	(.) 0.00000	(.) 0.00000	(.) 0.00000	(.) 0.00000
LOS Variables					
1	- Travel Time	-(4.23757) -0.11598	-(4.20115) -0.11447	-(4.24699) -0.10578	-(4.64568) -0.09445
2	- Travel Cost	(4.36268) 0.04666	(4.42389) 0.04797	(4.55668) 0.04520	(4.42095) 0.03144
3	- Waiting Time	(2.50076) 0.34838	(2.5432) 0.34465	(2.79311) 0.32214	(.) 0.00000
4	- Transfers	(.94581) 0.47955	(.87878) 0.43983	(.) 0.00000	(.) 0.00000
5	- Walk Time	(1.15461) 0.07075	(1.0223) 0.06251	(.) 0.00000	(.) 0.00000
Constant		-(.03986) -0.23608	(1.20338) 4.01572	(2.96218) 6.96633	(5.01899) 6.70698
Number of Samples		135	135	135	135
	Private Mode	73	73	73	73
	Public Mode	62	62	62	62
Number of Variables		8	7	5	2
Hit Ratio		94.07%	94.81%	94.07%	88.89%
chi-square		132.227	130.817	128.581	115.591
ρ^2		0.68804	0.68253	0.67501	0.61188

Source: JICA Study Team

3.8.4 HIS Data Analysis

(5) Introduction

The Study Team conducted the Home Interview Survey (HIS) covering the whole study area. As shown in the Progress Report (2), the survey interviewed more than 57,000 households to obtain trip activities by household and by individual.

The HIS database contains various information related with travel activities of sample households and individuals. For example, the database includes information on age, sex, income level, driving license, trips made by the person, origin and destination of the trips, modes used for the trips and so on.

As explained earlier, the disaggregate model analysis uses these individual information as well as trip information such as travel mode, trip purpose and so on. Therefore, the Study Team decided to utilize the HIS database to develop the disaggregate model in this study, other than the RPS database and the SPS database. This analysis results were expected to confirm the reliability of the previous analyses.

(6) Data Sampling from HIS Database

The disaggregate model building needs less number of data compared to traditional aggregate model building as mentioned before. The Study team sampled necessary number of samples for the disaggregate analysis as shown in the Figure3.8.1.

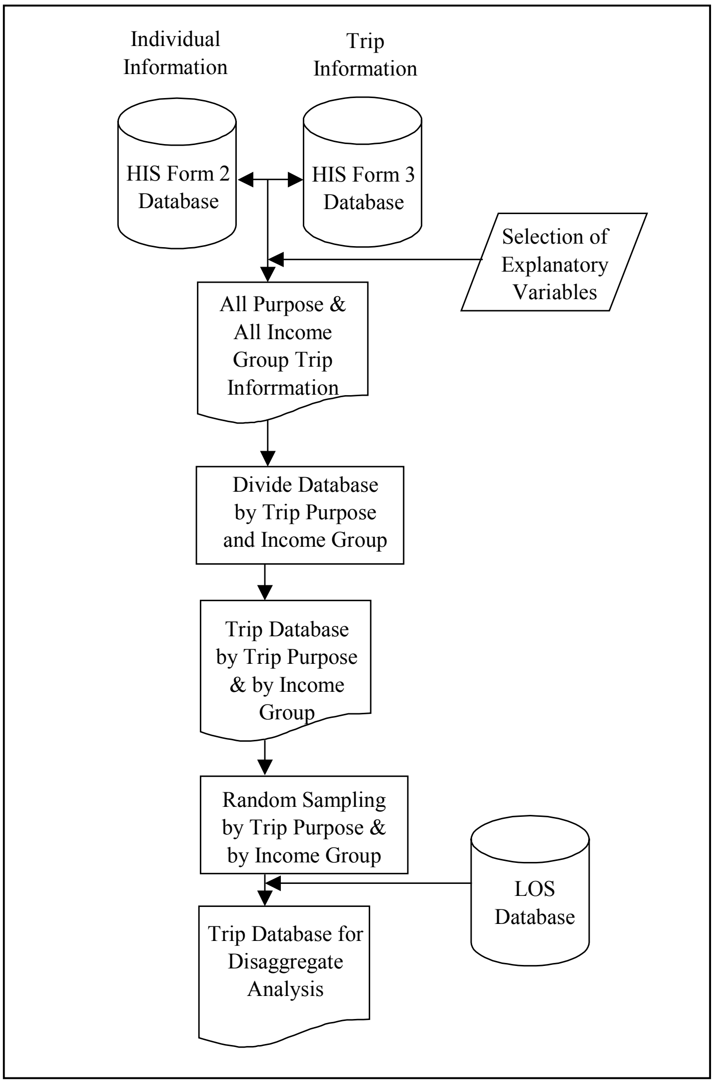
The Study Team used Form 2 and 3 HIS database, the one has individual information, while the other holds trip information. By linking the two database, the Study Team extracted necessary information for the disaggregate analysis. At this stage, all necessary information for the analysis was collected as same as the RPS and SPS analyses.

In the next step, the Study Team divided the collected trip information into 20 categories by Trip Purpose and by Income Group. The category was same as the aggregate model category.

By using the database by category, the Study Team sampled necessary number of information for the analysis. Number of samples of trips by the category for the private and public mode was determined as six hundred each. This number was considered as enough for the disaggregate analysis according to various researches.

The Level of Service (LOS) by trip mode was finally added to the database based on LOS database for the aggregate model analysis. The LOS variables were 1. Travel Time, 2.Travel Cost, 3. Waiting Time, 4. Number of Transfers and 5. Walk Time.

The Study Team initially tried to analyze the HIS data under the 20 purpose-income category. However, the analyses were found not adequate finally. Therefore, the Team reorganized the data from twenty categories to four purpose oriented data. Following descriptions were made only for the four category analyses. It should be noted that the purpose category is same as the aggregate modeling analyses. It is different from the previous SPS and RPS analyses. Number of samples was increased considerably by the reorganization.



Source: JICA Study Team

Figure 3.8.1 Disaggregate Information Database Building for HIS Data

(7) Result of Analysis

Table 3.8.7 – 10 shows the results of disaggregate analyses on the HIS data by trip purpose.

The Home-Based-Work purpose analyses showed unacceptable results. The hit ratios, ρ^2 and conditions of sings were not adequate as a result. Although the Study Team tried to get satisfactory results and made a lot of analyses, the results were not satisfactory.

Table 3.8.7 Result of HIS Analysis Purpose: Home-Based Work

SE Variables		1	2	3	4
1	Sex	(1.88737) 0.140735	(1.84877) 0.137820	(3.51095) 0.256327	(3.52605) 0.257332
2	Age	(3.71104) 0.00934	(3.72047) 0.00936	(3.67461) 0.00913	(3.66846) 0.00911
3	Dr.License	(21.43846) 1.64891	(21.41195) 1.64523	(21.01983) 1.56793	(21.01656) 1.56761
4	Car Ownership	(11.3058) 0.94821	(11.34703) 0.95117	(6.15861) 0.45129	(6.15067) 0.45064
5	Income	-(13.9824) -0.00037	-(13.97547) -0.00037	(.) 0.00000	(.) 0.00000
LOS Variables					
1	- Travel Time	(1.32334) 0.00391	(2.00359) 0.00550	(2.377) 0.00641	(2.32597) 0.00569
2	- Travel Cost	-(7.25979) -0.00443	-(7.5653) -0.00456	-(7.75285) -0.00458	-(7.78516) -0.00451
3	- Waiting Time	-(2.73814) -0.02628	-(2.34056) -0.02046	-(2.76025) -0.02382	-(2.69189) -0.02289
4	- Transfers	(1.46631) 0.07800	(.) 0.00000	(.) 0.00000	(.) 0.00000
5	- Walk Time	-(.24239) -0.00091	-(.61451) -0.00224	-(.63243) -0.00227	(.) 0.00000
Constant		(5.16106) 0.81004	(5.88447) 0.88004	(8.11161) 1.18876	(8.43373) 1.15607
Number of Samples		6,000	6,000	6,000	6,000
	Private Mode	3000	3000	3000	3000
	Public Mode	3000	3000	3000	3000
Number of Variables		10	9	8	7
Hit Ratio		72.53%	72.48%	71.95%	72.00%
chi-square		1584.163	1582.013	1372.931	1372.531
ρ^2		0.18910	0.18898	0.16394	0.16404

Source: JICA Study Team

Table 3.8.8 shows the results of Home-Based-Education purpose trip analyses.

These were worse than those of Home-Based-Work trip analyses. The Study Team made effort to improve the results by changing explanatory variables. However, the Team could not accept the results.

Table 3.8.8 Result of HIS Analysis Purpose: Home-Based Education

SE Variables		1	2	3	4
1	Sex	-(3.25453) -0.180923	-(3.09864) -0.170747	-(3.12361) -0.172068	-(1.37273) -0.073837
2	Age	-(5.31983) -0.02953	-(5.63759) -0.03105	-(5.64495) -0.03107	-(.19076) -0.00094
3	Dr.License	(14.95243) 1.94809	(14.11441) 1.80543	(14.12583) 1.80564	(.) 0.00000
4	Car Ownership	(11.10863) 0.78605	(6.61878) 0.37973	(6.57398) 0.37641	(11.67215) 0.63437
5	Income	-(10.14606) -0.00026	(.) 0.00000	(.) 0.00000	(.) 0.00000
LOS Variables					
1	- Travel Time	(8.66699) 0.03030	(8.81627) 0.03068	(9.47778) 0.02916	(9.26738) 0.02768
2	- Travel Cost	-(8.14321) -0.00577	-(7.84663) -0.00551	-(7.80723) -0.00540	-(7.0787) -0.00472
3	- Waiting Time	-(10.09267) -0.08365	-(10.36414) -0.08532	-(11.18355) -0.08771	-(10.58842) -0.08115
4	- Transfers	-(1.08879) -0.05816	-(.94337) -0.04988	(.) 0.00000	(.) 0.00000
5	- Walk Time	-(7.67072) -0.02988	-(7.61664) -0.02940	-(7.7946) -0.02812	-(7.35165) -0.02598
Constant		-(2.76002) -0.43187	-(2.13231) -0.33031	-(2.54587) -0.37522	(1.09437) 0.15345
Number of Samples		6,000	6,000	6,000	6,000
	Private Mode	3000	3000	3000	3000
	Public Mode	3000	3000	3000	3000
Number of Variables		10	9	8	7
Hit Ratio		63.17%	61.57%	61.55%	59.80%
chi-square		728.601	621.926	621.036	382.123
ρ^2		0.08607	0.07338	0.07343	0.04483

Source: JICA Study Team

Table 3.8.9 summarized the analyses results of Home-Based-Others.

Although signs of coefficients were almost satisfactory, hit ratios and ρ^2 were low. The t-values of travel time coefficients were not sufficient.

The Study Team could not accept the results as same as the previous analyses.

Table 3.8.9 Result of HIS Analysis Purpose: Home-Based Others

SE Variables		1	2	3	4
		-(8.84898)	-(8.85565)	-(8.86747)	(.)
1	Sex	-0.643003	-0.643503	-0.644232	0.000000
		(7.47742)	(7.47193)	(7.45215)	(7.73035)
2	Age	0.01516	0.01515	0.01510	0.01552
		(14.23741)	(14.22813)	(14.23815)	(12.03688)
3	Dr.License	1.28866	1.28739	1.28797	1.00771
		(11.41438)	(11.43767)	(11.45284)	(12.71776)
4	Car Ownership	0.99005	0.99161	0.99267	1.08584
		(2.57559)	(2.56711)	(2.57015)	(2.60867)
5	Income	0.00010	0.00010	0.00010	0.00010
LOS Variables					
		-(.89885)	-(.70948)	-(1.12894)	-(1.01297)
1	- Travel Time	-0.00327	-0.00238	-0.00334	-0.00297
		-(10.04027)	-(10.11784)	-(10.15783)	-(10.9671)
2	- Travel Cost	-0.00806	-0.00810	-0.00802	-0.00861
		-(1.55592)	-(1.42943)	-(1.32863)	-(1.24301)
3	- Waiting Time	-0.01793	-0.01563	-0.01419	-0.01321
		(.63143)	(.)	(.)	(.)
4	- Transfers	0.04002	0.00000	0.00000	0.00000
		-(.43236)	-(.61202)	(.)	(.)
5	- Walk Time	-0.00186	-0.00255	0.00000	0.00000
		(5.71076)	(6.37732)	(6.64533)	(9.45834)
Constant		0.88934	0.92517	0.89146	1.21678
Number of Samples		4,884	4,884	4,884	4,884
	Private Mode	2594	2594	2594	2594
	Public Mode	2290	2290	2290	2290
Number of Variables		10	9	8	7
Hit Ratio		70.97%	71.03%	71.01%	69.23%
chi-square		1254.516	1254.117	1253.743	1173.636
ρ^2		0.18361	0.18372	0.18384	0.17215

Source: JICA Study Team

Table 3.8.10 is the results of Non-Home-Based trip analyses. Hit ratios and ρ^2 were satisfactory. However, sings of time value coefficients did not become negative in any analysis cases.

The Study Team had to abandon the analysis results.

Table 3.8.10 Result of HIS Analysis Purpose: Non-Home-Based

SE Variables		1	2	3
1	Sex	(.87104) 0.330395	(.88485) 0.335336	(.82553) 0.310079
2	Age	-(.4842) -0.00530	-(.51953) -0.00568	(.) 0.00000
3	Dr.License	(3.39387) 1.06868	(3.41773) 1.07466	(3.41037) 1.03254
4	Car Ownership	(6.88003) 2.30054	(6.88446) 2.27897	(6.88048) 2.27385
5	Income	(1.87121) 0.00034	(1.91338) 0.00035	(1.95156) 0.00035
LOS Variables				
1	- Travel Time	(.70972) 0.00887	(.92909) 0.01098	(.92903) 0.01095
2	- Travel Cost	-(2.84026) -0.00923	-(2.9439) -0.00947	-(2.95951) -0.00951
3	- Waiting Time	-(2.27418) -0.11649	-(2.30431) -0.10406	-(2.32004) -0.10495
4	- Transfers	(.51319) 0.12943	(.) 0.00000	(.) 0.00000
5	- Walk Time	-(1.88677) -0.03321	-(2.08684) -0.03550	-(2.10756) -0.03580
Constant		(3.79521) 2.71312	(4.20019) 2.83460	(5.18001) 3.01465
Number of Samples		479	479	479
	Private Mode	198	198	198
	Public Mode	281	281	281
Number of Variables		10	9	8
Hit Ratio		83.72%	83.51%	83.30%
chi-square		257.362	257.097	256.826
ρ^2		0.37451	0.37544	0.37635

Source: JICA Study Team

3.8.5 Discussions

In the course of finalizing this CREATS Master Plan report, some comments were raised from the Steering Committee of the Egyptian side. The comments and responses are summarized as below.

- "Market segment tests and out layers analysis tests" should be done to show accuracy and success of the calibrated logit model.

  As explained in this section, the Study Team was not able to develop successful disaggregate models. The tests, which are mentioned by the Steering Committee, would usually done after disaggregate models were successfully calibrated to make sure accuracy and limitation of the models. In the Study, the Team tried to obtain successful models by using various source of data including the HIS result. The Team also analyzed data by splitting the samples into some market segments, such as trip purpose and income group. However, it was not successful. Therefore, the both test would be meaningless in this context.

- Development of disaggregate modal split model between different public transport modes.

  The Study Team determined a modeling framework before the modeling work started. The modal split models were to be developed between public and private modes. The public transport passengers were considered to use the least generalized cost mode. Therefore, only private-public modal split models were developed. We consider that the disaggregate model is not always applicable to all parts of transport demand analyses at the current situation. In addition to this, there would be a discussion that public modes are a composite mode of public transport modes because a public mode consists of various public modes. We usually use "representative" mode for public transport mode. Railway is first, subway is second followed by bus and so on, even though railway is used only 10% of a whole travel distance of a person. So, what is a public transport mode? We treated the public transport mode as public and that we decided to develop a modal split model between public and private mode.

- Development of trip end modal split model.

  We understand that there is an idea of "trip-end model". However, the model doesn't respond to LOS changes. In the CREATS, modal shift from private mode to public transport was critical. If the Team adopted the trip end model as a modal split model of the Study, the team would not have been able to develop the Master Plan, because LOS improvement of public transport was the major means of the modal shift. Therefore, trip-interchange model was adopted as the modal split model of the Study.

3.8.6 Conclusion

The Study Team tried a series of disaggregate analyses by using the specially planned survey data as well as by sampling from the HIS database.

However, no satisfactory result was obtained from the analyses. The Study Team examined reasons why the analyses were not successful. The followings are a summary of the examination.

- In any results, private mode related parameters, such as driving license and car ownership indicators were incomparably big.

- Sign Conditions on travel time and travel cost was not adequate.

- Changing explanatory variables were not effective to improve the situation.

Based on the above discussion, the Study Team has to conclude that there is no real competition between private and public mode in the area. If a person has a car, he uses the car. This appeared in the magnitudes of the estimated private mode availability related parameters. He does not care for public transport mode as an alternative. It is shown by that the sign conditions on travel time and travel cost did not show any sense in the analyses.

Finally, it should be stressed that public transport services should be improved and enhanced to become competitive with private transport mode.

3.9 INDICATIVE FUTURE YEAR RESULTS

3.9.1 Overview

For the application of the transport model in the future, two basic inputs are needed namely:

- Future Planning Data: and
- Future Year Network.

As discussed in the previous chapter planning data has been prepared for three future years namely 2007, 2012 and 2022. In the year 2022, there is also a different land use data which has an alternative distribution of tertiary employment.

Detailed results of the application of the transport model are discussed elsewhere in this report. Included in this chapter is a discussion on the application of changing land use data and the model reference cases in all years, later referred to as Scenario D.

In the estimation of economic benefits the model is executed with a committed network, a no change or do minimum network followed by a second execution of the model with an alternative scenario such as network enhancements. The difference between the results of these two model runs allows for the estimation of economic benefits or in some cases negative economic benefits.

3.9.2 Impact of Change in Future Planning Data

Over the next twenty years the population of the study area is expected to grow by 6 million people as shown in Table 3.9.1. During the same time period the number of motorized trips per person will increase by 20%. This is a direct result of the projected economic growth. During the same time it is estimated that the number of trips made by those households at the higher end of the economic scale will increase by nearly 350% rising from a daily number of 3.7 million in 2001 to 12.7 million in 2022, a growth rate of 6.4% per annum.

Table 3.9.1 Impact of Planning Data

Year	Population (Million)	Average Household Income (2001 LE)	Motorized Trips (Million)	Percentage of Trips in Economic Activity Class 4 and 5
2001	14.4	672	14.4	25.7
2007	16.1	754	16.6	30.7
2012	17.7	879	19.2	37.5
2022	20.7	1176	25.1	50.6

Source: JICA Study Team

If the economic growth by 2022 has increased by a further 20%, then the number of motorized trips in 2022 will increase to 26.4 million with the percentage of trips in the high economic activity classes increasing to 58%. Alternatively if the projected economic growth is lower by 20%, the number of trips will decrease to 23.5 million with only 40% in the higher economic activity classes.

The trip tables that tabulate the total person trips between each traffic zone are summarized by the 18 sectors, (described earlier in the report), in Tables 3.9.2, 3.9.3, 3.9.4, 3.9.5 for the years 2001, 2007, 2012 and 2022 respectively. These tables are also available at a Qism level. Two copies of the detailed tables is held in the ENIT library.

3.9.3 Horizon Year Model Reference Case in 2022

The results from the application of the model for many different scenarios are discussed later in this report. In this section a comparison is presented between the base case and the 2022 the Reference Case or Scenario D in 2022. For this scenario in 2022, there are substantive changes in both the public and road network from that of the network in 2001 including:

- An Urban Expressway;
- Regional Roads;
- Urban Street Improvements;
- Metro Line 3;
- Pyramid Metro Line;
- Super Trams;
- High Quality Service to Satellite Cities;
- Busways; and
- Structural Changes to the Operation of Bus and Shared Taxi.

Table 3.9.2 Person Trips in Year 2001

Sector	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	TOTAL
1	161,275	11,983	12,554	39,934	3,803	1,418	3,984	5,269	3,887	3,356	2,190	1,478	1,667	1,245	2,070	1,102	1,224	52	258,490
2	11,983	355,655	157,284	109,337	6,817	6,978	17,179	30,984	66,797	32,949	33,112	20,289	11,648	7,192	22,564	33,868	8,471	1,714	934,821
3	12,554	157,284	383,789	184,281	18,575	17,442	43,731	71,078	112,247	71,337	64,823	38,370	29,571	16,682	47,716	29,438	18,882	2,070	1,319,870
4	39,934	109,337	184,281	484,163	64,499	22,194	62,675	93,559	95,411	44,071	46,640	30,601	19,526	11,486	22,794	11,073	10,955	1,198	1,354,397
5	3,803	6,817	18,575	64,499	133,539	25,546	7,941	11,487	13,303	4,930	6,079	4,385	1,993	1,173	2,200	1,128	1,013	191	328,802
6	1,418	6,978	17,442	22,194	25,546	464,378	67,247	22,445	25,589	10,170	13,979	12,100	6,245	4,212	5,507	2,900	3,556	550	712,456
7	3,984	17,179	43,731	62,675	7,941	67,247	239,695	76,584	67,821	25,262	43,471	43,556	13,922	8,729	13,321	7,021	7,671	1,639	751,448
8	5,269	30,984	71,078	93,559	11,487	22,445	76,584	113,937	80,856	40,875	70,994	55,579	23,778	14,811	18,793	8,851	10,950	1,651	752,480
9	3,887	66,797	112,247	95,411	13,303	25,589	67,821	80,856	112,790	105,856	96,327	63,155	53,234	32,964	54,605	26,169	29,798	1,317	1,042,125
10	3,356	32,949	71,337	44,071	4,930	10,170	25,262	40,875	105,856	179,642	116,700	59,269	51,505	24,035	66,882	29,524	26,164	3,202	895,728
11	2,190	33,112	64,823	46,640	6,079	13,979	43,471	70,994	96,327	116,700	278,808	163,167	154,447	88,245	65,039	26,241	53,101	6,659	1,330,023
12	1,478	20,289	38,370	30,601	4,385	12,100	43,556	55,579	63,155	59,269	163,167	291,891	97,503	73,868	38,771	17,205	35,005	18,834	1,065,226
13	1,667	11,648	29,571	19,526	1,993	6,245	13,922	23,778	53,234	51,505	154,447	97,503	152,510	67,792	43,491	17,080	37,849	8,224	791,986
14	1,245	7,192	16,682	11,486	1,173	4,212	8,729	14,811	32,964	24,035	88,245	73,868	67,792	160,444	27,848	22,286	56,368	16,160	635,538
15	2,070	22,564	47,716	22,794	2,200	5,507	13,321	18,793	54,605	66,882	65,039	38,771	43,491	27,848	212,452	52,977	35,779	6,054	738,861
16	1,102	33,868	29,438	11,073	1,128	2,900	7,021	8,851	26,169	29,524	26,241	17,205	17,080	22,286	52,977	228,358	36,242	4,458	555,921
17	1,224	8,471	18,882	10,955	1,013	3,556	7,671	10,950	29,798	26,164	53,101	35,005	37,849	56,368	35,779	36,242	301,171	8,540	682,739
18	52	1,714	2,070	1,198	191	550	1,639	1,651	1,317	3,202	6,659	18,834	8,224	16,160	6,054	4,458	8,540	164,506	247,019
TOTAL	258,490	934,821	1,319,870	1,354,396	328,802	712,456	751,449	752,480	1,042,125	895,728	1,330,023	1,065,226	791,986	635,538	738,861	555,921	682,739	247,019	14,397,930

Source: JICA Study Team

Table 3.9.3 Person Trips in Year 2007

Sector	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	TOTAL
1	294,534	23,045	16,772	28,355	3,223	1,474	3,202	4,064	6,282	8,682	3,527	1,835	3,932	2,943	5,551	3,623	2,897	133	414,075
2	23,045	388,950	155,849	124,827	8,681	11,684	20,845	36,634	73,064	37,360	44,783	27,034	17,687	10,647	26,733	32,640	12,460	2,093	1,055,017
3	16,772	155,849	407,068	181,929	18,743	29,499	53,698	73,888	134,439	74,611	89,592	51,891	44,163	27,850	55,605	34,036	30,424	3,295	1,483,351
4	28,355	124,826	181,929	495,181	64,161	34,380	79,041	92,293	107,205	61,231	73,428	41,191	37,715	22,295	42,520	25,103	24,743	3,350	1,538,948
5	3,223	8,681	18,743	64,161	187,320	20,969	12,381	9,483	13,166	5,137	7,190	5,414	3,072	1,953	3,801	2,143	1,910	518	369,266
6	1,474	11,684	29,499	34,380	20,969	476,563	64,482	27,598	35,926	16,285	26,172	20,205	11,024	6,966	12,268	6,918	7,100	1,656	811,170
7	3,202	20,845	53,698	79,041	12,381	64,482	252,553	67,843	69,575	28,683	51,726	33,879	18,600	13,599	20,502	11,820	12,931	3,591	818,951
8	4,064	36,634	73,888	92,293	9,483	27,598	67,843	132,679	86,182	46,607	87,326	57,028	28,916	18,327	29,731	16,123	18,047	2,958	835,727
9	6,282	73,065	134,439	107,205	13,166	35,926	69,575	86,182	135,787	109,199	104,520	62,845	59,893	40,311	72,207	39,782	41,511	2,106	1,194,002
10	8,682	37,360	74,611	61,231	5,137	16,285	28,683	46,607	109,199	221,883	121,423	56,204	45,130	21,941	67,877	33,888	27,113	3,721	986,974
11	3,527	44,783	89,592	73,428	7,190	26,172	51,726	87,325	104,520	121,423	342,501	177,224	127,788	71,536	86,081	42,211	61,289	7,139	1,525,455
12	1,835	27,034	51,891	41,191	5,414	20,205	33,879	57,028	62,845	56,204	177,224	452,764	82,327	72,397	43,929	23,128	36,036	26,959	1,272,289
13	3,932	17,687	44,163	37,715	3,072	11,024	18,600	28,916	59,893	45,130	127,788	82,327	186,894	74,456	40,241	18,833	47,776	12,604	861,050
14	2,943	10,647	27,850	22,295	1,953	6,966	13,599	18,327	40,311	21,941	71,536	72,397	74,456	222,580	19,565	14,176	60,725	18,399	720,666
15	5,551	26,733	55,605	42,520	3,801	12,268	20,502	29,731	72,207	67,877	86,081	43,929	40,241	19,565	288,143	57,696	27,942	3,242	903,635
16	3,623	32,640	34,036	25,103	2,143	6,918	11,820	16,123	39,782	33,888	42,211	23,128	18,833	14,176	57,696	269,149	38,075	1,848	671,192
17	2,897	12,460	30,424	24,743	1,910	7,100	12,931	18,047	41,511	27,113	61,289	36,036	47,776	60,725	27,942	38,075	395,610	6,946	853,536
18	133	2,093	3,295	3,350	518	1,656	3,591	2,958	2,106	3,721	7,139	26,959	12,604	18,399	3,242	1,848	6,946	221,141	321,701
TOTAL	414,075	1,055,017	1,483,351	1,538,948	369,266	811,170	818,951	835,727	1,194,002	986,974	1,525,455	1,272,289	861,050	720,666	903,635	671,192	853,536	321,701	16,637,004

Source: JICA Study Team

Table 3.9.4 Person Trips in Year 2012

Sector	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	TOTAL
1	408,640	43,698	27,124	22,089	2,538	1,328	2,604	3,724	9,230	3,720	4,188	2,481	2,403	1,887	3,851	2,780	2,412	82	544,781
2	43,698	332,711	165,870	120,232	4,068	9,344	18,580	32,194	77,487	31,934	45,865	25,984	14,082	8,321	24,899	37,907	10,121	941	1,204,237
3	27,124	165,870	485,989	225,842	19,166	30,260	58,747	84,099	153,201	80,552	96,977	51,250	40,797	26,390	60,426	37,182	28,111	2,057	1,674,039
4	22,089	120,232	225,842	687,172	60,303	31,557	87,772	101,151	114,369	53,508	63,977	34,263	28,159	18,868	44,450	25,755	19,275	1,978	1,740,719
5	2,538	4,068	19,166	60,303	288,217	28,305	9,229	5,540	9,635	2,635	4,202	4,616	1,319	841	1,925	1,064	758	606	444,967
6	1,328	9,344	38,260	31,557	28,305	573,041	72,376	30,155	42,909	15,452	22,926	20,682	9,077	5,881	11,737	6,809	5,877	2,099	919,816
7	2,604	18,580	58,747	87,772	9,229	72,376	313,895	76,054	76,370	28,376	48,492	30,124	16,555	12,668	20,967	12,294	11,141	2,345	900,587
8	3,724	32,194	84,099	101,151	5,540	30,155	76,053	175,949	103,126	48,303	99,874	62,724	28,696	19,889	34,587	19,258	17,892	2,019	945,233
9	9,230	77,487	153,201	114,369	9,635	42,909	76,370	103,126	170,293	119,567	127,797	72,315	61,482	45,390	89,017	49,393	45,344	1,996	1,368,923
10	3,720	31,934	80,552	53,508	2,635	15,452	28,376	48,303	119,567	286,502	141,427	62,069	48,917	24,221	77,923	36,364	27,877	2,113	1,091,460
11	4,188	45,865	96,977	63,977	4,202	22,926	48,492	99,874	127,797	141,427	430,369	212,039	146,432	79,194	94,895	41,509	64,800	5,574	1,730,539
12	2,481	25,984	51,250	34,263	4,616	20,682	30,124	62,724	72,315	62,069	212,039	659,194	99,573	89,240	45,698	21,221	38,690	52,095	1,584,259
13	2,403	14,082	40,797	28,159	1,319	9,077	16,555	28,696	61,482	48,917	146,432	99,573	239,856	83,679	48,157	19,905	48,169	7,960	945,218
14	1,887	8,321	26,390	18,868	841	5,881	12,668	19,889	45,390	24,221	79,194	89,240	83,679	276,032	22,329	15,881	62,717	14,979	808,406
15	3,851	24,899	60,426	44,450	1,925	11,737	20,967	34,587	89,017	77,923	94,895	45,698	48,157	22,329	359,237	61,572	31,437	1,690	1,034,797
16	2,780	37,907	37,182	25,755	1,064	6,809	12,294	19,258	49,393	36,364	41,509	21,221	19,905	15,881	61,572	338,529	42,469	885	770,778
17	2,412	10,121	28,111	19,275	758	5,877	11,141	17,892	45,344	27,877	64,800	38,690	48,169	62,717	31,437	42,469	573,423	6,538	1,037,054
18	82	941	2,057	1,978	606	2,099	2,345	2,019	1,996	2,113	5,574	52,095	7,960	14,979	1,690	885	6,538	309,032	414,989
TOTAL	544,781	1,204,237	1,674,039	1,740,719	444,967	919,816	900,588	945,233	1,368,923	1,091,460	1,730,539	1,584,259	945,218	808,406	1,034,797	770,778	1,037,054	414,989	19,160,804

Source: JICA Study Team

Table 3.9.5 Person Trips in Year 2022

Sector	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	TOTAL
1	811,994	74,334	70,968	152,204	10,814	7,912	16,477	35,982	76,102	23,976	38,512	19,286	12,074	6,812	14,155	9,751	8,612	852	1,390,817
2	74,334	370,382	199,475	160,063	4,916	14,138	24,127	41,473	92,702	41,971	55,161	35,743	20,988	12,544	29,546	44,983	13,052	2,278	1,437,875
3	70,968	199,476	565,079	253,478	19,284	46,029	71,919	93,281	179,611	98,302	121,463	85,114	59,044	40,567	73,747	45,851	40,766	9,679	2,073,660
4	152,204	160,063	253,478	658,049	66,112	47,400	102,379	123,360	154,363	77,024	102,603	63,637	47,128	30,420	58,802	34,347	32,483	7,314	2,171,166
5	10,814	4,916	19,284	66,112	357,781	31,799	9,714	7,094	13,512	3,972	6,622	7,047	2,307	1,443	2,749	1,575	1,274	375	548,390
6	7,912	14,138	46,029	47,400	31,799	710,295	85,455	41,529	66,202	23,363	35,593	40,416	14,803	9,219	16,737	9,843	9,285	2,479	1,212,497
7	16,477	24,127	71,919	102,379	9,714	85,455	349,425	84,420	87,376	34,762	59,738	44,487	22,742	17,714	25,829	15,166	15,673	3,714	1,071,117
8	35,982	41,473	93,281	123,360	7,094	41,529	84,420	195,810	116,516	56,469	120,247	82,710	38,213	27,004	39,453	22,297	24,913	6,777	1,157,548
9	76,102	92,702	179,611	154,364	13,512	66,202	87,376	116,516	198,642	138,159	150,563	123,270	82,128	63,892	99,364	56,944	61,414	17,281	1,778,043
10	23,976	41,971	98,302	77,024	3,972	23,363	34,762	56,469	138,158	320,413	153,683	77,926	56,933	30,246	88,284	43,197	35,173	6,663	1,310,514
11	38,512	55,161	121,463	102,603	6,622	35,593	59,738	120,247	150,563	153,683	484,756	305,401	164,969	99,332	101,638	50,209	81,326	23,792	2,155,610
12	19,286	35,743	85,114	63,637	7,047	40,416	44,487	82,710	123,270	77,926	305,401	1,126,942	123,372	104,214	53,606	29,171	62,019	98,351	2,482,713
13	12,074	20,988	59,044	47,128	2,307	14,803	22,742	38,213	82,128	56,933	164,969	123,372	248,088	87,529	50,786	23,152	53,848	18,829	1,126,934
14	6,812	12,544	40,567	30,420	1,443	9,219	17,714	27,004	63,892	30,246	99,332	104,214	87,529	301,373	24,935	18,677	74,643	18,850	969,415
15	14,155	29,546	73,747	58,802	2,749	16,737	25,829	39,453	99,363	88,284	101,638	53,606	50,786	24,935	412,865	69,883	34,749	3,612	1,200,738
16	9,751	44,983	45,851	34,347	1,575	9,843	15,166	22,297	56,944	43,197	50,209	29,171	23,152	18,677	69,883	418,453	50,735	2,091	946,326
17	8,612	13,052	40,766	32,483	1,274	9,285	15,673	24,913	61,414	35,173	81,326	62,019	53,848	74,643	34,749	50,735	751,973	11,530	1,363,467
18	852	2,278	9,679	7,314	375	2,479	3,714	6,777	17,281	6,663	23,792	98,351	18,829	18,850	3,612	2,091	11,530	504,655	739,121
TOTAL	1,390,817	1,437,876	2,073,660	2,171,166	548,390	1,212,497	1,071,117	1,157,548	1,778,043	1,310,514	2,155,611	2,482,713	1,126,934	969,415	1,200,738	946,326	1,363,467	739,121	25,135,953

Source: JICA Study Team

In this case the Urban Expressway operates as a toll road with an entrance charge of five pounds in current price value. Under the reference case scenario, the Shared Taxis perform the main function of a feeder to other services. The detailed description of the public and private networks is not discussed here. The network changes, schedule of implementation and fare structure are discussed in further detail later in the report (see Chapters 4and 5). The fare structure of the public transport modes has been rationalized and is given broadly in Table 3.9.6 for the year 2022

Table 3.9.6 Public Transport Fare Structure of Major Modes ('01 LE)

Mode	Boarding Fare (Pt)	Fare per km (Pt per Km)
Bus	5	5
Shared Taxi	50	10
Metro	40	1
Tram	50	-

Source: JICA Study Team

The public transport network by 2022 is structured as a rail orientated network to attract trip makers from the otherwise use of their cars. The future rail network amongst other network improvements includes Metro Line 3, Pyramids Metro Line and Super Trams (described in Chapter 4).

The number of overall trips increases from 14.4 million in 2001 to 25.1 million in 2022. There is a nett decrease in public transport share over this time from 72% today to 58% in 2022. In absolute terms the number of public transport trips increase from 10.3 million trips daily to 14.5 million trips (see Table 3.9.7)

Table 3.9.7 Overall Daily Mode Distribution of Trips (Million)

Year	Mode	
	Private	Public
2001	4.1	10.3
2022-Scenario D	10.6	14.5

Source: JICA Study Team

This is a direct result of the number of household shifting into levels of higher economic activity. The trip makers in the higher economic activity levels are more likely to use the private vehicle (see Table 3.9.8). The daily number of private mode trips increases between 2001 and 2022from 2.2 million to 7.5 million, a three fold increase.

Table 3.9.8 Overall Daily Mode Distribution of Trips (Million) for Economic Activity Class 4 and 5

Year	Mode	
	Private	Public
2001	2.2	1.5
2022-Scenario D	7.5	5.2

Source: JICA Study Team

In the case of the number of public transport trip segments, the number increases from 13 million in 2001 to 20 million daily in 2022 The market share market share for major modes is shown in Table 3.9.9 for 2001 and 2022.

Table 3.9.9 % Public Transport Market Share

Mode	2001 Share	2022 Share
Bus	32	19
Shared Taxi	50	23
Metro	15	45
Other	3	13

Source: JICA Study Team

The share of metro increases significantly, tripling in fact whilst the other mode category also increases significantly. In the later case this is as the result of the inclusion of Super Trams. The market share of metro increases at the expense of both bus and shared taxi.

Under this scenario the average speed of all person trips, both public and private is 18 kph in comparison to 19 kph today. Although there is a higher use of the road network resulting in road network congestion, these delays are compensated for by faster travel on the extensive rail based public transport.

In the case of the road network, there are half a million pcu's entering the Urban Expressway daily. The volume of traffic crossing the river increases by over 200% but the indicator of performance, the volume to capacity ratio only increases by 24%. This is as a result of new infrastructure and being able to achieve a public transport share of nearly 60% even with the anticipated growth in car ownership.

Between 2007 and 2022 the overall use of the road network increases from 73 million pcu-km to 140 million pcu-km, an increase of a 190 %. This significant increase in road usage over time is discussed further in subsequent chapters.

3.10 RECOMMENDATIONS

3.10.1 Overview

Now for the first time the study area of the Greater Cairo Region has a detailed transport model developed to a level of 503 zones and available to government for further analysis.

This transport model has been developed from an extensive survey program in 2001. This is in essence the transport planning database described in Volume 4. This needs continual updating and development of even further databases such as for example a detailed internal roadside interview survey inside the city.

3.10.2 Future Model Development

The model as developed to date is a classical four-step transport model. The model should be maintained by the appropriate agency with adequate professional staffing as discussed in Chapter 10. It should be continuously updated and reviewed as new data and new data becomes available.

As the model is used by interested parties, the agency responsible for the maintenance of the model should consider the comments of these parties and initiate changes in the model as appropriate. When additional surveys are undertaken this information should be incorporated into the model structure. In some cases it will be necessary to modify the equations within the model.

APPENDIX A

Disaggregate Analysis Result for RPS
By Trip Purpose

Table A3-1 Disaggregate Analysis Result for RPS
Purpose: All

SE Variables		1	2	3
1	Sex	(.66645) 0.129191	(.) 0	(.) 0
2	Age	(.81733) 0.00542	(.86496) 0.00572	(.) 0.00000
3	Dr.License	(17.10385) 3.61939	(17.25474) 3.63416	(17.90557) 3.67699
4	Car Ownership	(12.82712) 2.71389	(12.85596) 2.69591	(12.84407) 2.68089
5	Income	(4.86556) 0.00052	(4.89364) 0.00052	(5.26005) 0.00055
LOS Variables				
1	- Travel Time	(2.56725) 0.01473	(2.59876) 0.01490	(2.67634) 0.01528
2	- Travel Cost	-(2.9521) -0.00493	-(2.90968) -0.00484	-(2.869) -0.00475
3	- Waiting Time	(.) 0.00000	(.) 0.00000	(.) 0.00000
4	- Transfers	(.) 0.00000	(.) 0.00000	(.) 0.00000
5	- Walk Time	(.) 0.00000	(.) 0.00000	(.) 0.00000
Constant		(11.51402) 4.53064	(12.2142) 4.43003	(13.8861) 4.26584
Number of Samples		2,580	2,580	2,580
	Private Mode	1049	1049	1049
	Public Mode	1531	1531	1531
Number of Variables		7	6	5
Hit Ratio		90.74%	90.74%	90.74%
chi-square		2274.905	2274.465	2273.712
ρ^2		0.63505	0.63507	0.63500

Source: JICA Study Team

Table A3-2 Disaggregate Analysis Result for RPS
Purpose: Work

SE Variables		1	2	3
1	Sex	-(2.11404) -1.815325	(.) 0	(.) 0
2	Age	(3.58418) 0.08273	(3.35995) 0.07382	(3.41108) 0.07342
3	Dr.License	(7.56124) 5.17783	(8.26438) 4.65367	(8.56265) 4.73197
4	Car Ownership	(7.95699) 3.62159	(8.30768) 3.71966	(9.21069) 4.00072
5	Income	(2.4523) 0.00066	(2.3381) 0.00062	(.) 0.00000
LOS Variables				
1	- Travel Time	(2.09123) 0.03111	(1.97186) 0.02833	(1.70443) 0.02420
2	- Travel Cost	-(.48439) -0.00204	-(.67209) -0.00269	-(.86792) -0.00340
3	- Waiting Time	(.) 0.00000	(.) 0.00000	(.) 0.00000
4	- Transfers	(.) 0.00000	(.) 0.00000	(.) 0.00000
5	- Walk Time	(.) 0.00000	(.) 0.00000	(.) 0.00000
Constant		(5.29256) 6.35989	(6.53243) 7.36800	(6.50238) 7.18492
Number of Samples		663	663	663
	Private Mode	350	350	350
	Public Mode	313	313	313
Number of Variables		7	6	5
Hit Ratio		95.02%	94.87%	94.57%
chi-square		723.557	718.157	711.526
ρ^2		0.78496	0.77936	0.77243

Source: JICA Study Team

Table A3-3 Disaggregate Analysis Result for RPS Purpose: School

SE Variables		1	2	3
1	Sex	(2.57973) 1.687008	(2.52466) 1.639679	(2.54353) 1.657959
2	Age	(.82849) 0.04765	(.90629) 0.05199	(.93526) 0.05366
3	Dr.License	(6.74093) 4.58487	(6.76775) 4.54803	(6.78073) 4.55673
4	Car Ownership	(3.42325) 2.70007	(3.3903) 2.67477	(3.42339) 2.69630
5	Income	(.25815) 0.00501	(.35143) 0.00561	(.) 0.00000
LOS Variables				
1	- Travel Time	-(.75162) -0.02322	-(.15687) -0.00427	-(.215) -0.00583
2	- Travel Cost	-(2.97096) -0.02485	-(2.85578) -0.02384	-(2.83745) -0.02344
3	- Waiting Time	(.1365) 1.22052	(.) 0.00000	(.) 0.00000
4	- Transfers	(.) 0.00000	(.) 0.00000	(.) 0.00000
5	- Walk Time	-(3.14116) -0.13337	-(3.57889) -0.14827	-(3.55194) -0.14700
Constant		(2.90045) 10.46049	(3.42083) 10.82945	(4.98425) 10.08330
Number of Samples		330	330	330
	Private Mode	147	147	147
	Public Mode	183	183	183
Number of Variables		9	8	7
Hit Ratio		95.15%	94.85%	94.85%
chi-square		357.890	356.367	355.956
ρ^2		0.77620	0.77349	0.77327

Source: JICA Study Team

Table A3-4 Disaggregate Analysis Result for RPS
Purpose: Business

SE Variables		1	2	3
1	Sex	-(.2209) -0.193411	(.) 0	(.) 0
2	Age	(2.64326) 0.05209	(2.6349) 0.05152	(2.65312) 0.05144
3	Dr.License	(5.25202) 2.86317	(5.25352) 2.86298	(5.27044) 2.86431
4	Car Ownership	(2.85901) 1.33541	(2.8987) 1.34607	(2.89884) 1.34617
5	Income	(2.60817) 0.00087	(2.61725) 0.00087	(2.62379) 0.00087
LOS Variables				
1	- Travel Time	-(.20636) -0.00360	-(.25163) -0.00430	-(.27126) -0.00403
2	- Travel Cost	-(2.82629) -0.01512	-(2.8617) -0.01524	-(2.94217) -0.01520
3	- Waiting Time	(.) 0.00000	(.) 0.00000	(.) 0.00000
4	- Transfers	-(.00509) -0.00179	(.03216) 0.01115	(.) 0.00000
5	- Walk Time	(.) 0.00000	(.) 0.00000	(.) 0.00000
Constant		(3.52273) 4.86890	(4.4393) 5.04283	(4.5507) 5.05063
Number of Samples		282	282	282
	Private Mode	126	126	126
	Public Mode	156	156	156
Number of Variables		8	7	6
Hit Ratio		84.75%	84.75%	84.75%
chi-square		199.433	199.383	199.382
ρ^2		0.49584	0.49754	0.49936

Source: JICA Study Team

CHAPTER 4: PUBLIC TRANSPORT SYSTEM

This chapter sets forth recommendations regarding formal and informal public transport services. The adopted approach synthesizes policy (software, humanware) with fleet and infrastructure (hardware) aspects of public transport services. These are developed initially on a sectorial basis, then integrated with the overall Transport Master Plan. The adopted approach consists of a series of linked and cascading work tasks (Figure 4.0.1).

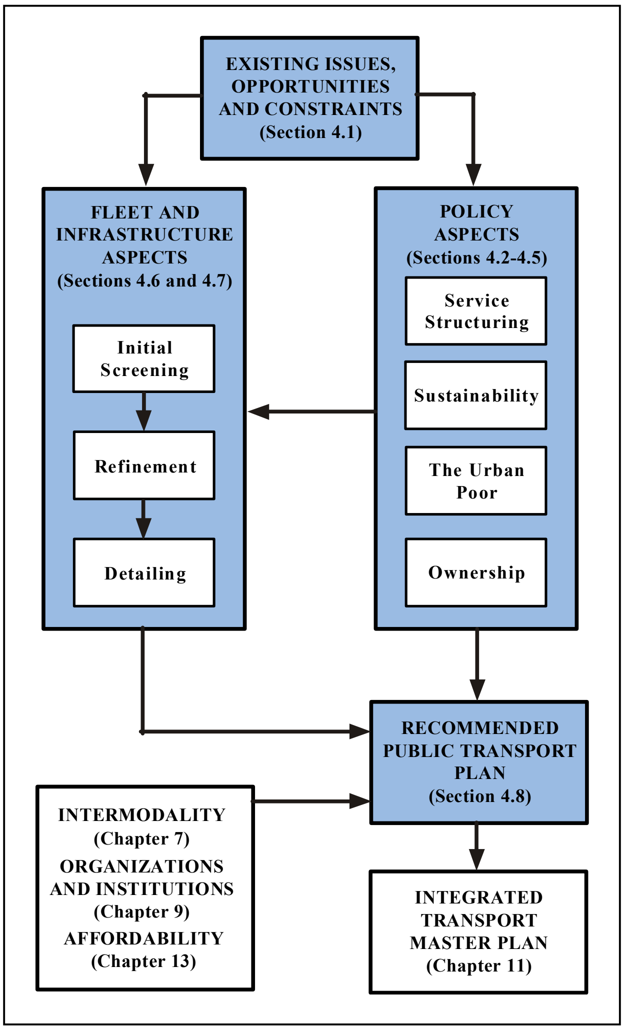


Figure 4.0.1
Public Transport Analytical Framework

A modal perspective is first summarized in Section 4.1. This provides insight into issues, opportunities and constraints representative of recent operating conditions of the major public transport modes. It is noted that a much more comprehensive and in-depth review of Cairo urban public transport is presented in Chapter 7 (*Public Transport System*) and Chapter 12 (*Transport and the Urban Poor*) of this studies *Progress Report (2): Current Urban Transport Status*[1].

The next four sections present policy recommendations which set a path for the potential restructuring of public transport. The intention is to build upon existing strengths by introducing

[1] *Progress Report (2), Volume I: Current Urban Transport Status; Transportation Master Plan and Feasibility Study of Urban Transport Projects in Greater Cairo Region in the Arab Republic of Egypt*, op. cit.

new measures and policies designed to further enhance this vital sector. Section 4.2 proposes a more unified approach to providing services, based on a hierarchy of modes with services allocation based on maximizing modal capabilities in terms of speed and capacity. Section 4.3 reviews sustainability, that is, approaches to finding a more equitable balance between fare structure, costs and services. Section 4.4 reviews the needs of urban poor, while Section 4.5 examines ownership options, that is, how the private and public sectors can more efficiently combine to serve the transit needs of Cairenes. Even though these four generic topics are presented separately, their implementation can only truly be achieved in a linked and cascading manner.

It is noted that the policy-oriented discussions presented in Sections 4.2 through 4.5 generally (but not exclusively) focus (a) on those elements of the formal public transport system where such change is likely to be most effective, and (b) the major operators in terms of passenger volumes. In other words, the CTA, CMO and shared taxis. The case of ENR is somewhat unique. Suburban services play, at present, a minor role in the overall public transport picture carrying some one percent of daily unlinked person trips. However, this role is likely to expand in future in line with growing maturity of the satellite city program. Suburban services are grouped within the overall national ENR passenger and freight services, and thus subject to national policies. The recent ENR master plan[2] and follow-up investigations[3] address a number of issues in this regard, with particular recommendations being (a) improved data collection techniques, (b) facility cleanliness, (c) market-oriented administrative structure, (d) enhanced ticket checking and (e) faster travel times. Thus, under current administrative structures, it is obligatory than any impetus for change originates at the national level.

Sections 4.6 and 4.7 address hardware issues, that is, fleet and infrastructure requirements. Initially, a screening approach is applied reliant upon modeling which focuses on main inter-sector demand corridors, as well as capabilities of the CREATS GIS data base. These are used to examine likely public transport needs with a particular view to isolating a hierarchy of potential service structures. Subsequently, a series of refined scenarios are iteratively tested using the capabilities of the CREATS transport model. The recommended plan is presented in Section 4.8 for target year 2022 as well as intermediate years 2007 and 2012. Included in this section are cost estimates.

- It is noted that three other chapters in this volume are of critical relevance to public transport, but are presented separately due to their uniquely important content which transcends sectorial boundaries. These are Chapter 7, *Intermodality*; Chapter 9, *Organizational and Institutional Issues*; and, Chapter 13 *Economic and Financial Evaluations*. In the latter case, this includes a discussion of affordability; in other words, what realistic options exist for financing the

[2] *The Master Plan for Egyptian National Railways*, prepared for the Japan International Cooperation Agency and the Transport Planning Authority of the Ministry of Transport and Communication, by the Japan Railway Technical Service, et. al., December, 1996.

[3] *The Findings of the Present Status on the Egyptian National Railways*, for the Japan International Cooperation Agency, by a Team of JICA Experts, January 2002.

various elements of a composite Master Plan, including not only public transport but also other sectorial elements.

The recommendations contained in this chapter prescribe a series of logical and needed enhancements to public transport. However, as a master plan document, it cannot (and should not) address detailed matters pertaining to, for example, route by route analyses. These must be a topic of further, follow-on work once the policy and political ramifications of the proposed Transport Master Plan have been put in place. Recommended priority projects, whose implementation is seen as being of the highest priority and for whom more detailed feasibility studies will follow immediately after completion of the CREATS Master Plan phase, take full account of this consideration. Priority projects are, along with other elements of the integrated Master Plan, presented in Chapter 11 of this volume.

It must further be stated that several of the recommendations promulgated in this chapter are dependent on political will. Those technical adjustments in transport practices which require changes in current policies or regulations can only be realized if political will for such change exists at appropriate levels of Government.

- **Thus, in the final analysis, the impetus for implementation of the Master Plan, and many of its projects and programs, rests with the Egyptian people and those persons elected to lead them.**

The Study Team is confident that appropriate action will be taken.

4.1 EXISTING ISSUES, OPPORTUNITIES AND CONSTRAINTS

Public transport services in Cairo may, at present, be categorized as consisting of two generic groupings; namely, formal services and informal services.

- Formal urban public transport services are provided by the public sector. The CTA (Cairo Transport Authority), and its subsidiary GCBC (Greater Cairo Bus Company), provide bus services throughout Greater Cairo using standard-sized buses and mini buses. The CTA also operates light rail services (tram and Heliopolis metro) as well as the water-borne Nile ferries. Even though CTA provides region-wide bus services, some additional formal bus services are provided by, and within, Qalyobeya Governorate, although the scale of these services is, in comparison to CTA, minor. Other major elements of the formal urban public transport sector include the Cairo Metro Organization (CMO), which provides rail mass rapid transit services (the Metro) and the Egyptian National Railways (ENR), sponsor of suburban commuter rail services.

- The informal sector consists of route-specific shared taxis operated by the private sector using microbuses with typical capacities of eleven or fourteen seats. This mandate has been expanded and some services are also being provided via private-sector Transport Cooperatives using minibuses of up to 30 seats, although the scale of these services remains very modest vis-à-vis the shared taxi industry.

Public transport development in Cairo has, in recent decades, been characterized and shaped by a series of milestone events. These include:

- Construction of a rail mass rapid transit system (metro) extending over 60 kilometers within four major transit corridors of the city. The two metro lines are considered state-of-the-art systems, and, within the Cairo context, are seen as modern, efficient services. Ridership has steadily increased and, at present, exceeds two million persons per day. In fact, during peak periods, some sections of Metro Line 1 are considered to be operating under congested levels of service.

- Formal sector bus services have suffered an erosion of market share. CTA/GCBC daily single trip ticket sales have, for example, declined from 3.40 million in 1991 to 2.75 million in year 2000. The informal sector (predominately shared taxis), on the other hand, appears to have achieved a very strong role in terms of road-based public transport services absorbing near 6.5 million journeys per day at present.

- Erosion of CTA/GCBC bus operations, and liberalization of regulations pertaining to private sector participation in public transport operations have, and continue to, create market opportunities for the informal bus sector. The shared taxi services, which predominately use microbuses, have some advantages over formal operations. They change their schedules and deviate from routes in response to consumer demand and congestion (although they may be legally prohibited from doing so). They can negotiate traffic more easily than large buses, and consequently can run more frequently than formal services. Microbuses are more likely to provide guaranteed seats to their patrons, and are more accessible within a short walking distance than some formal services. Finally, they can provide services in areas where CTA does not or cannot operate. Nevertheless, microbuses create a number of transport problems. They often parallel or headrun CTA buses, thus taking away riders from the public operator. They often disrupt traffic by stopping short or lingering at curbs to collect passengers. Microbus operations tend to be fiercely competitive, as there are few barriers to entry and single-bus ownership is prevalent. As a result of this competitive pressure, drivers often pay little regard to traffic conditions, safety or other vehicles in the competition for passengers. Moreover, it is understood that a number of shared taxis operate outside of the established regulatory framework and without proper vehicle or driver licensing.

- All trolley bus lines have been abandoned over the years, as have components of the light rail system (tram, Heliopolis metro) including segments located within segregated rights-of-way. The light rail network has, despite its high potential as an efficient mode of urban transport, declined from near 400 route kilometers in 1971 to 226 route kilometers at present; 58 route kilometers have been lost over the last few years alone. Remaining light rail facilities and rolling stock are in dire need of replacement, rehabilitation or modernization.

- The suburban railway network has largely stagnated without major enhancements of service despite radical intensification of urban development within the rail catchment. One new line was recently opened along existing trackage, linking Giza City with 6th October City. Service is, however, via a circuitous 26 kilometer journey and using an end-station located several kilometers from the 6th October central area.

- Fare levels are not merely controlled, they are virtually frozen, ostensibly for the benefit of poorer Cairenes. While some segments of the population have undoubtedly benefited from this, paralleling problems have arisen. In particular, transit operations are yielding insufficient cash flow to allow upgrading of services and fleet renewal.

- Formal transport operators, as government entities, are totally reliant upon federal Ministries for capital funding and, along with other Ministries, departments and organizations, must compete each year for scarce domestic resources in the political arena. As a result, near and long-term tactical as well as strategic planning for the provision of urban public transport services is severely constrained (if not pre-empted) by uncertainties in funding. Instead, operators must focus all efforts on the day-to-day operation of the system, and procuring sufficient revenues for this task.

- Uncertainties in funding have catalyzed a shortage of maintenance investment on rail public transport systems, particularly the light rail network and, to a lesser degree, suburban rail services. If strategic changes are not implemented, such potential problems will also spread to the metro system. In fact, the 14-year old Line 1 of metro is showing increasing signs of deterioration and growing delays catalyzed by maintenance shortfalls (the year 2002 agreement to upgrade Line 1 rolling stock has the potential to considerably improve this situation). In terms of formal bus services, a typical vehicle is now in service 18-20 hours per day, with greatly reduced opportunity for maintenance. Hence, more breakdowns and down times are inevitable. The CTA only receives sufficient funds each year for approximately 100 new buses. These must be allocated to fleet replacement, intensified services on existing routes, and service on new routes. A more realistic (but unattainable under present conditions) replacement need is on the order of 350 buses per year.

- Formal bus services are constrained in the route structure they offer and, as indicated, fares they may charge. Concurrently, the aging fleet (the average age is now in excess of 12 years) must serve an ever-expanding catchment, to now include linkages with outlying communities. Service frequencies are, as a result, declining throughout the system. While the CTA/GCBC bus and minibus networks have increased from some 6,100 kilometers to 10,100 kilometers over the decade beginning year 1991, fleet size has increased only from about 3,700 to 4,400 buses (73 percent thereof being considered operational in year 2000). Thus, the fleet size has not kept pace with network expansion. Crowding on CTA buses has reached intolerable levels; comparisons to other international operators suggest that the number of persons transported daily per CTA bus is among the highest worldwide.

- The metro is the only urban public transport service offering reliable, high-speed service with peak period commercial speeds near 35 km/hr and frequency at three to 3.5 minutes headway. Commercial operating speeds of the light rail network average some 15 km/hr with main problems being outdated equipment and considerable delays at at-grade intersections with road traffic. While ENR services reach some 40 km/hr, service is infrequent, typically 30 or 60 minutes during peak periods. There are no bus priority treatments in effect (other than at some central area boarding concentrations); all formal bus services operate in mixed traffic at an average scheduled commercial speed of 15-20 km/hr, considerably less in central areas.

The realization of a balanced and multi-modal environment presents a continuing challenge for Cairo. Coordination among the different public transport modes and between public transport and private cars is minimal. Independent scheduling, uncoordinated route structure, and independent fare structures do not facilitate interchange among the various urban public transport modes. Two significant barriers seem to prevent such coordination. First, there seems to be little institutional cooperation among the different agencies planning and operating public transport services, in particular, among CMO, CTA and shared taxi services. Secondly, current fare policies of the individual modes do not facilitate cooperation among the various operators. Fares and subsidy structures of the different modes are set in isolation of each other.

4.2 SERVICE STRUCTURING

The form and extent of public transport services is influenced by a variety of factors, among them urban form, multimodal considerations and historic practices. Underlying issues and current practices have previously been detailed in *Progress Report (2)*. This section contains a synopsis of the main issues, potential approaches thereto and the recommended course of action.

4.2.1 Issues

(1) Urban Form

The provision of public transport services is intrinsically linked with the form and extent of the urban fabric; there exists a dynamic interaction between transport and the nature of the city economy. Recent spatial and demographic evolution has seen Cairo grow from a metropolitan population of 5.5 million persons in 1968 to 6.7 million, 8.6 million and 11.3 million persons in 1977, 1982 and 2000, respectively. Population within the CREATS study area, whose boundaries extend some 30-40 kilometers from central Cairo, breached 14 million persons during year 2001. The relative annual population growth rate hovered near 2.5 percent over the last 30 year period, a total slightly in excess of the national average. While this rate has decreased somewhat over the last decade to near two percent, forecasts for the study area still suggest a population of over 20 million persons by year 2022.

The historic form of Cairo is slowly changing. The urban area grew from some 16,000 hectares in year 1968 to almost 30,000 hectares by year 2000. However, the axis of intensification has been predominately north-south following, in general, the Nile River. The anchor of this pattern has been the central core areas of Cairo and Giza, which together house near 1.6 million persons and provide in excess of one million employment opportunities. But recent policies have made successful inroads into modifying the historic north-south development pattern. The initiation of the New Communities Program, which at present consists of five large urban agglomerations housing eight new towns, will dramatically broaden the axes of urban activity to now include a northeast-southwest corridor. The new towns at present house some half million persons, but are planned for an eventual population of roughly four million persons, anchored by the 10th of Ramadan and 6th of October Cities. Thus, by year 2022, the east-west axis will have diffused, but not eliminated, the north south developmental axis (Figure 4.2.1). Transport pressures associated with the high-population central precincts will remain. For example, during year 2001, some 60 percent of study area population and 70 percent of employment opportunities were located within the Ring Road. This is clearly reflected in the distribution of daily person trips made within the study area (Figure 4.2.2). This central concentration of population and employment is forecast, in line with changes in the developmental axes, to diffuse somewhat in future. Year 2022 population and employment are expected to reduce their relative intra-Ring Road share of study area totals to near 50 and 60 percent, respectively. While this is a clear amelioration from present levels, core principles underlying transport demand, that is, economic activity, population concentrations and employment opportunities, will still be substantial. Thus, in terms of public transport services, an important issue becomes evident.

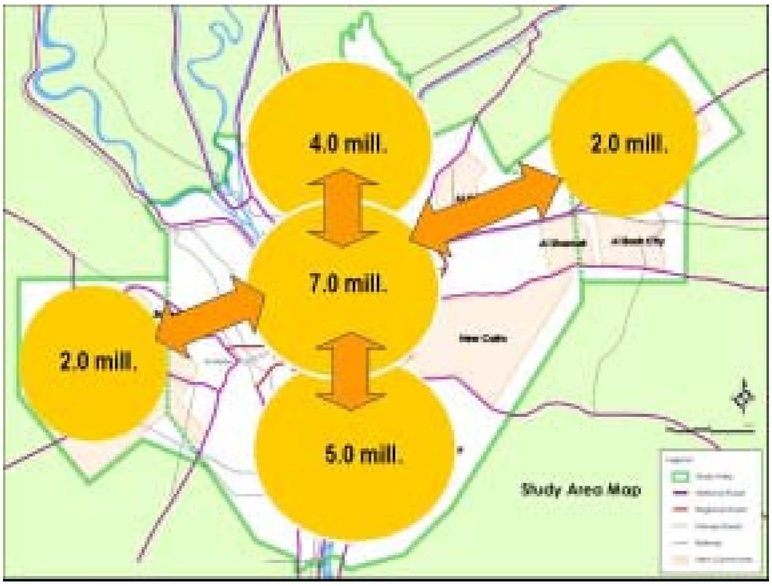


Figure 4.2.1
Indicative Year 2022 Population Distribution

- **Issue: The type, modal composition and extent of the public transport system must be structured so as to satisfy a variety of transport needs ranging from longer-distance suburban trips to shorter, but high-density, movements within the urban core.**

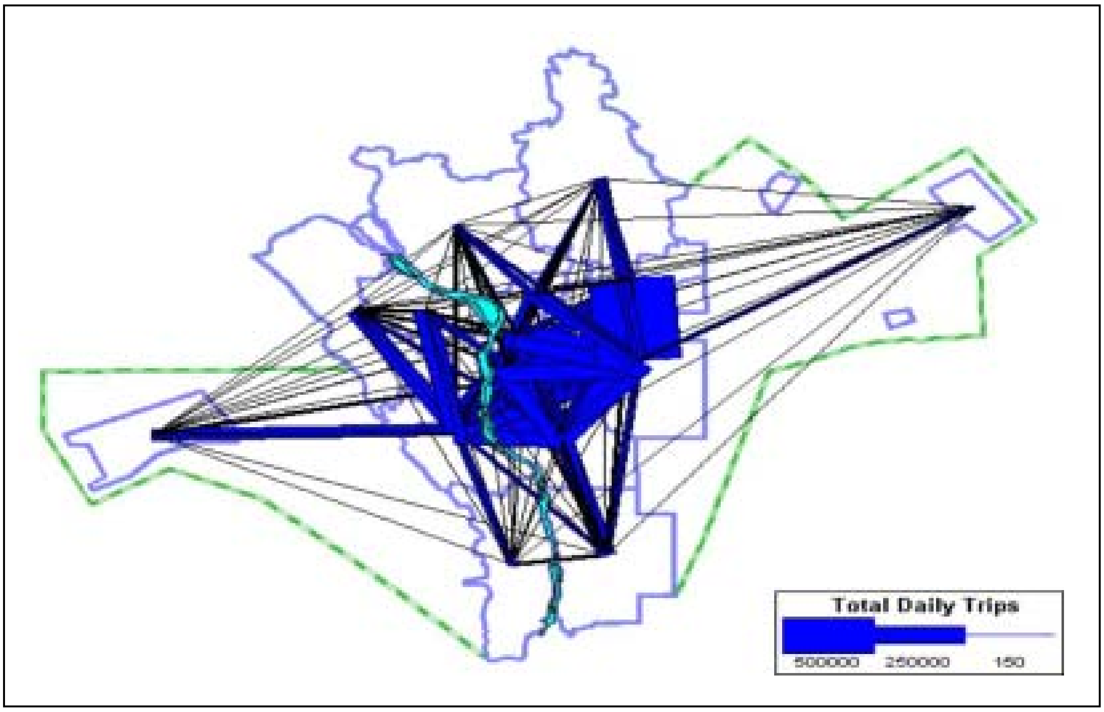


Figure 4.2.2
Indicative Year 2001 Daily Person Trip Desire Lines

(2) New Communities Axes

Distances between the new communities and central Cairo are substantial, on the order of 30 kilometers. Land use within these corridors is dynamic, thus likely catalyzing varying impacts upon the technology selected to meet forecast demand.

At present, person trip demand is largely focused between new communities and the metropolitan area. However, linear development patterns, consisting of residential and industrial activities, are already clearly evident (particularly along the 10th of Ramadan axis). Thus, in the longer term future, and in the absence of rigid land use controls, this pattern is likely to continue with a high probability of nodal sub-centers forming within the new community corridors. Differing types of person trip demand are likely to result (Figure 4.2.3).

- Longer-distance trips, between the new communities and the metropolitan area, as well as between nodal sub-centers. The public transport technology selected to service this demand cannot be an urban mode (i.e. a metro-type technology), but instead must be capable of achieving higher operating speeds between more widely spaced stations. This implies, depending on demand, priority bus services or some form of suburban rail technology. As stated, land use is dynamic; in the absence of rigid land use controls, transport technology in itself is capable of contributing to urban growth within the transport corridor. Thus, locations for (widely spaced) stations must be chosen with care and consistency vis-à-vis land use planning, and should coincide with the (planned) formation of nodal sub-centers.

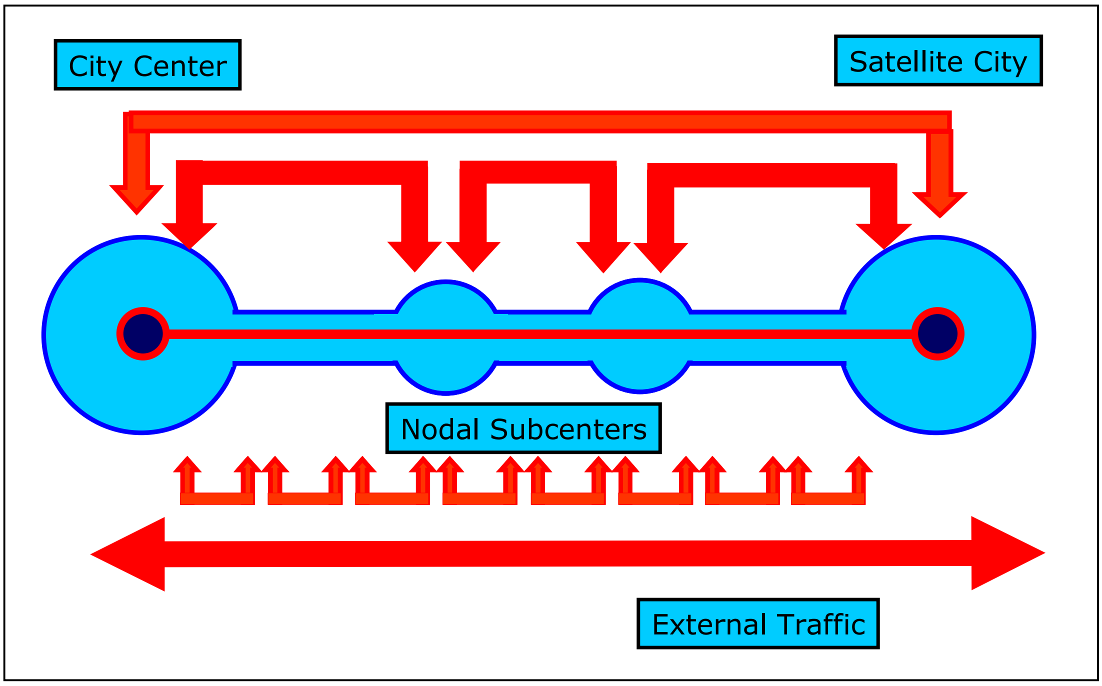


Figure 4.2.3
Indicative Future Satellite Cities Trip Patterns

- Shorter-distance trips, that is, between sub-elements of the linear corridor and/or the nodal sub-centers. It is likely these trips can best be met by traditional bus services operating in mixed traffic.

- External trips, that is, trips for which one or both trip ends is located outside of the study area. At present, a high proportion of these trips consists of inter-urban buses and long-distance trucks. This pattern is expected to continue in future. The potential diversion from this traffic stream to corridor public transport modes is considered minimal.

- **Issue: The current structure, and future evolution, of the urban fabric within the new community axes is dynamic, and is expected to catalyze a need for various public transport technologies whose allocation will vary over time.**

(3) Passenger Preferences

Public transport services carried a total of 12.436 million daily trips[4] during a typical 2001 weekday. This represents 68 percent of all motorized trips generated within the

[4] This total refers to unlinked trips, which include all journey elements (generally by different modes) made as part of a single trip linking origin with destination. In terms of public transport usage, unlinked trips

CREATS study area. Shared taxis (microbuses) carry some 6.5 million daily passengers, or roughly one-half of daily motorized public transport trips. Public buses (CTA/GCBC bus/minibus) account for a further 3.5 million daily trips, and the metro slightly over two million trips per day. The contribution of other modes is, relative to the "big three", modest aggregating to about 0.4 million trips per day (Figure 4.2.4).

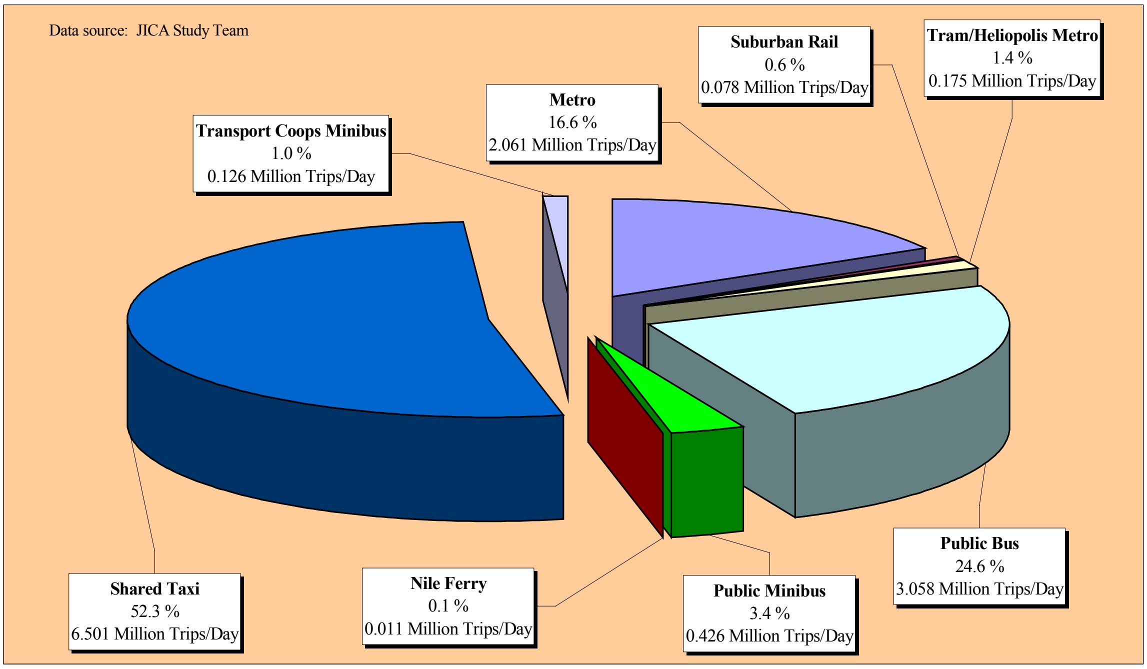


Figure 4.2.4 Year 2001 Modal Preferences
Daily Motorized Unlinked Public Transport Trips-CREATS Study Area

Fluctuation in modal use exists depending on public transport trip orientation; however, the shared taxi mode retains a majority position. For total study area trips (12.44 million), as shown in Figure 4.2.4, some 52 percent of unlinked, internal public transport trips are accomplished using the shared taxi mode. For trips both of whose trip ends lie within the Ring Road (6.34 million), shared taxi use decreases to some 42 percent, while public bus trips increase to 34 percent (vis-à-vis a 25 percent study area wide average). For trips whose trip ends lie either within, or cross, the Ring Road (10.33 million), the shared taxi component totals 48 percent, and in case of trips both of whose trip ends lie outside of the Ring Road (2.11 million), the shared taxi utilization increases to some three-quarters of public transport trips (Figure 4.2.5). Thus, one may surmise that, in the latter case, the use of shared taxis is basically a mode captive situation (except, for example, trips within the Metro Line 1 corridor) as services by other modes are considerably reduced from levels found within the Ring Road. Conversely, depending of course on trip origin-destination patterns and service structures, it can be argued that shared taxi

may be equated with fare payments. Thus, a single linked trip from home to work could, for example, include four unlinked trips and two public transport fare payments (walk, bus, metro, walk).

utilization for trips within the Ring Road, or that cross the Ring Road, include an element of modal preference in that shared taxis may well offer more convenient and frequent service than other modes of public transport.

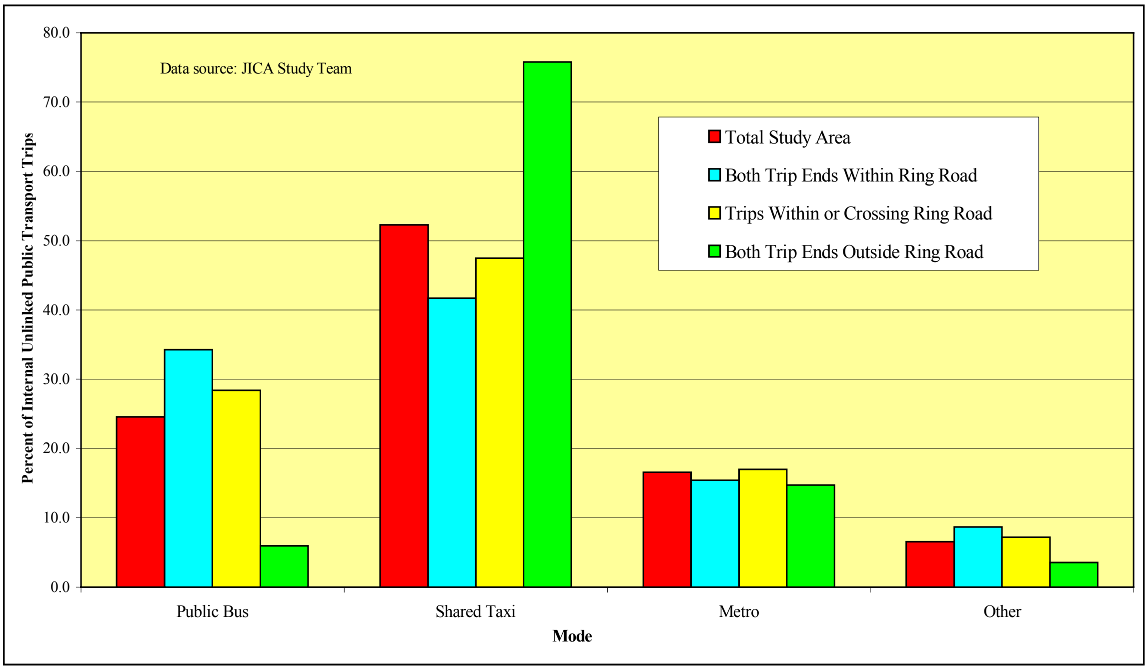


Figure 4.2.5 Areal Variation in Year 2001 Modal Preferences Daily Motorized Unlinked Public Transport Trips

CREATS investigations confirm that in Cairo, as in much of the world, a clear tendency toward increasing private vehicle ownership (and the use thereof) exists. The relative evolution of transport in Greater Cairo over the past three decades suggests that the use of passenger cars (including taxis) has increased to now absorb almost one-fourth of the motorized trip market. Some forms of public transport, in particular public bus services and light rail, have suffered a corresponding decline in relative patronage. Shared taxis, on the other hand, dominate market share in 1998 and 2001. Nevertheless, public transport usage retains a critical importance, and, in fact, serves as the backbone of urban mobility in Cairo.

Future public transport demand will, of course, vary depending on land use scenario as well as type of infrastructure proposed. This pattern will be quantified in later sections of this chapter. However, in general, year 2022 public transport demand within the study area will remain strong, accounting for more than half of all motorized trips, and aggregating to some 17-20 million daily person trips.

The implications in terms of transport planning are clear:

- **Issue: There exists a compelling need to focus on the movement of persons rather than on the movements of vehicles.**

(4) Sector Performance

The evolution of public transport supply and demand in Greater Cairo over recent decades suggests that formal sector public transport services have, with notable exception of the metro, suffered a decline in market share. The experiences of Cairo are, however, not dissimilar from those of other large cities in emerging countries. A primary "pressure" is, of course, continuing growth in the rate of motorization and shift to private modes of transport at the expense of public modes. Further, major road improvements have been, and continue to be, implemented (bridges over the Nile River, urban expressway, viaducts, tunnels and underpasses, Cairo Ring Road). While these undoubtedly facilitate (and encourage) travel by personal modes such as car and taxi, formal public transport access to some important road facilities, such as Al Azhar Tunnel and the 6th of October Expressway, is denied. However, a further contributor may be the state of the formal public transport system itself. As government-owned entities, operators find themselves constrained by controlled fares (in response to political/social goals) which, in turn, catalyzes a shortfall in revenue thus contributing to lack of maintenance and, ultimately, the inability to replace aging vehicles. A deficient fleet implies cutbacks in levels of service and eventually reductions in service. Shortfalls in public bus operations, and liberalization of regulations pertaining to private sector participation in public transport operations have, and continue to, create market opportunities for the informal bus sector (primarily shared taxis).

The realization of a balanced and multi-modal environment presents a continuing challenge for Cairo. Coordination among the different public transport modes and between public transport and private cars is minimal. Independent scheduling, uncoordinated route structure, and independent fare structures do not facilitate interchange among the various urban public transport modes. Thus, services tend to be duplicative leading to inefficient application of increasingly stressed resources. Two significant barriers seem to prevent such coordination. First, there is little institutional cooperation among the different agencies planning and operating public transport services, in particular, among CMO, CTA and shared taxi services. Secondly, current fare policies of the individual modes do not facilitate cooperation among the various operators. Fares and subsidy structures of the different modes are set in isolation of each other. A number of previous studies have addressed this issue, with a particularly excellent product being the recently completed *Fare Policy Study*[5]. A number of relevant recommendations were developed jointly between that Study Team and providers of public transport services. These include, among other recommendations, a staged approach to achieving a degree of modal integration, fare optimization and joint ticketing strategies. Unfortunately, none of the recommendations have, to the CREATS Study Teams knowledge, been implemented to-date. It is further noted that of the three major transport planning efforts carried out to-date in Cairo (based on data from years 1971, 1987 and 1998)[6],

[5] *Final Report: Greater Cairo Public Transport Fare Policy Study*; prepared for the Ministry of Transport, Transport Planning Authority, by Development Research and Technological Planning Centre (DRTPC), Cairo University in association with SYSTRA (Paris, France), December, 1995.

[6] *Greater Cairo Transportation Planning Study*, by SOFRETU, 1973; *Greater Cairo Region Transportation Masterplan Study in the Arab Republic of Egypt*, for the Government of the Arab Republic of Egypt, by Japan International Cooperation Agency, 1989; *Greater Cairo Public Transport Study*, for Ministry of

recommendations regarding public transport systems have not, by and large, been implemented with notable exception of the metro, a mode traditionally seen as being very capital-intensive (albeit warranted from a demand perspective).

The historical evolution of the Cairo public transport system clearly gives rise to the following:

- **Issue: A rationalization of public transport systems is desperately needed, with each system allocated in such a manner that utilizes its relative strengths, be they speed, capacity or type of service, to the fullest. Intermodal connectivity under such a scenario is absolutely essential.**

4.2.2 Approach

The fact that high-capacity and needs-responsive public transport is essential to the future well-being of high-activity precincts in Cairo cannot be understated. Indeed, the strong patronage of Metro Lines 1 and 2, and the emergence of the private sector paratransit services, confirms this trend. As land uses continue to intensify, transport demand, posed by tourists, residents and workers, will likewise grow. However, a road-oriented infrastructure system has finite capacity limits, either in the form of road space or, more likely, parking space. Thus, as road/parking systems reach capacity, transport demand will inevitable be constrained by extensive road congestion and a lack of storage (parking spaces) for vehicles. Public transport, on the other hand, offers a much higher capacity threshold without storage requirements; thus, transport demand can, by and large, continue to evolve in an unconstrained fashion. The economic implications are clear. While a road focused urban scenario is conducive to good economic growth until a capacity "ceiling" is reached (road/parking systems approaching saturation), economic diversion (for example, high-rise office buildings being increasingly constructed in outlying areas), followed by economic stagnation in high-activity areas can ultimately be expected. Only a viable and responsive public transport system fosters continued economic growth (Figure 4.2.6).

The keys which permit public transport to function in this manner are, simply put, speed and capacity. Bus lanes/busways can carry 12,000 to near 20,000 persons per hour per direction, in the latter case with bypass opportunities at critical junctures such as loading/unloading areas. Light rail transit can accommodate some 10,000-30,000 persons per hour per direction in segregated alignments. Mass rapid transit on the other hand, can accommodate 30,000-90,000 persons per hour per direction at much higher speeds; indeed, the maximum capacity of Cairo Metro Line 1 (which retains some aspects of a regional rail system) is estimated at some 70,000 persons per hour. The capacity of freeway lane is, at 2,000-3,000 persons per hour, comparatively low (Figure 4.2.7).

Transport, National Authority for Tunnels, by Systra, August 2000

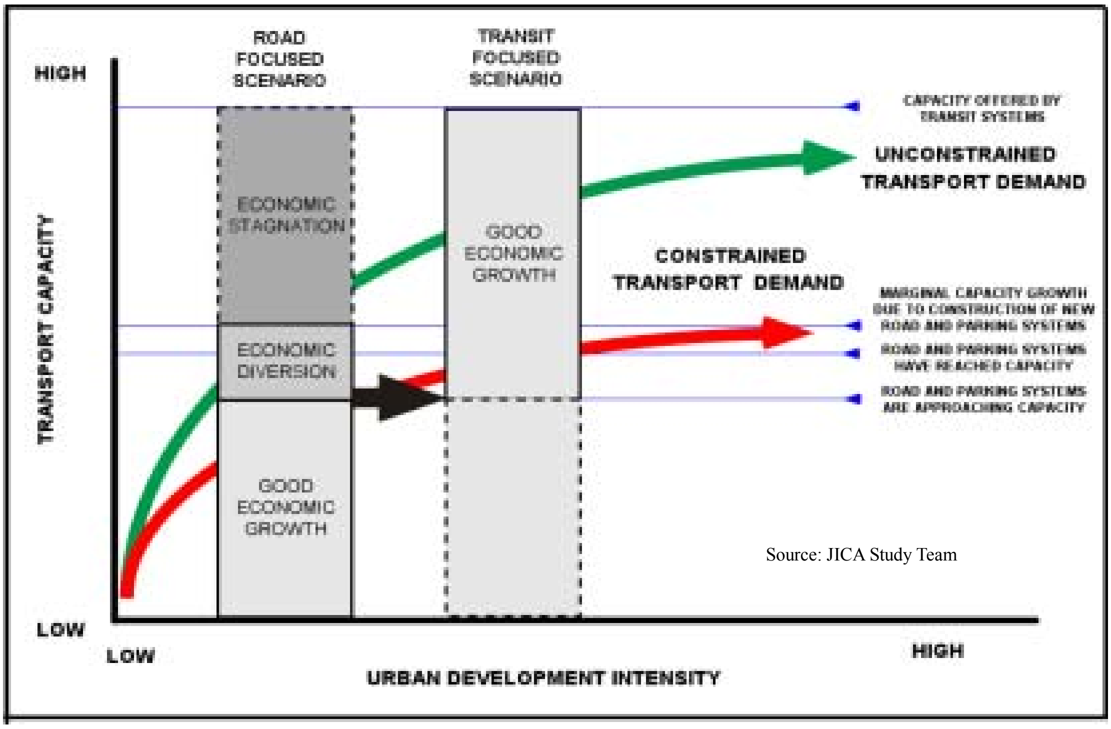


Figure 4.2.6 Conceptual Relationship Urban Transport Activity and Development

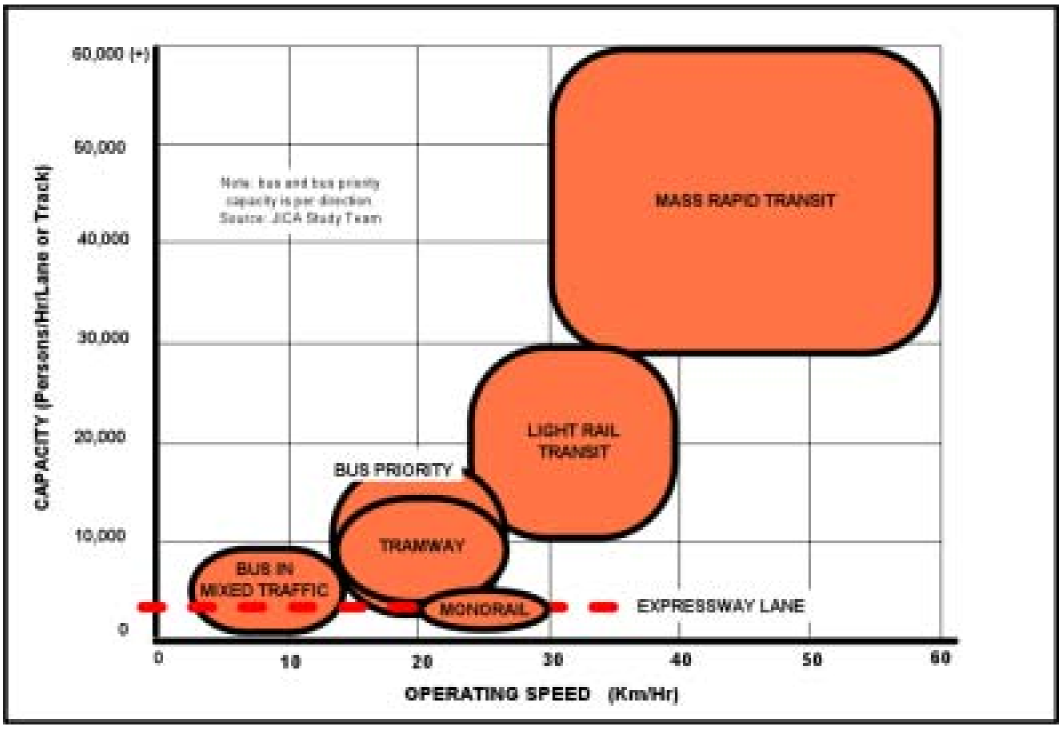


Figure 4.2.7 A Hierarchy of Urban Public Transport Systems

4.2.3 Action

Developing an intermodal public transport system reliant upon a public and private sector partnership requires the efficient integration and interconnection of the different public transport elements. Real intermodal public transport can only be approached with a rational vision whose foundation lies upon an assessment of the capabilities of the different public transport modes and their interconnectivity with each other. This interconnectivity relates on the one hand to the (important) role of terminals and on the other hand to the hierarchy of public transport systems as discussed in the previous section.

Under such an approach, one may argue that fixed-route and high capacity systems should, on one hand, be given priority in the scheme, while other more flexible public transport systems should be superimposed to create an integrated network.

Conversely, low capacity but highly demand-responsive and flexible systems such as shared taxis could be considered end-line service providers and should not necessarily be constrained by a fixed route network. But the radius of operations should be geographically limited to a well defined sector, therewith avoiding long-haul travel or predatory practices by this mode. An important element is the allocation of public transport resources into an integrated, intermodal system within which service duplication is largely avoided. This means that whenever possible, the service of an area by more than one main public transport system is only acceptable when this is based upon a capacity need. The principle is demonstrated in Figure 4.2.8.

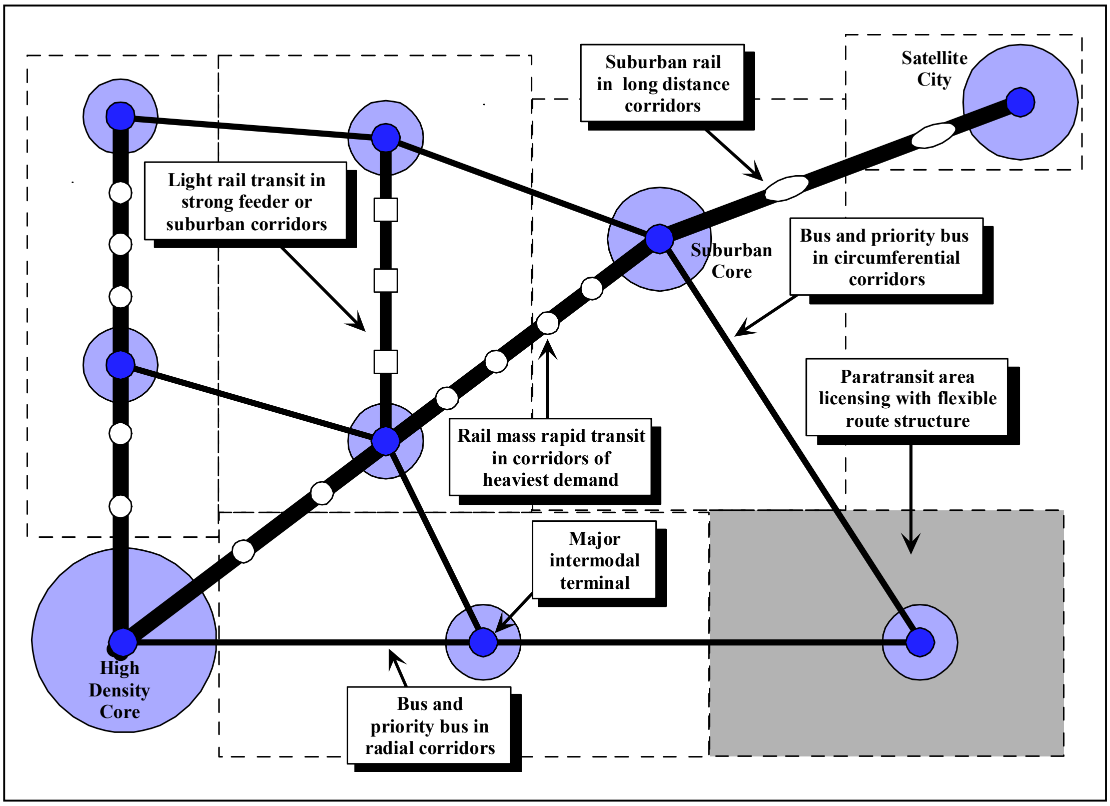


Figure 4.2.8 Potential Integrated Service Model

- Rail mass rapid transit is allocated to those corridors of highest demand, as appropriate to the capabilities of this important mode. Typically, allocation would be within radial corridors linking a high density core (such as the CBD) with more outlying business districts or suburban centers. Some bus services would also be provided in the rail corridors, however, not in an unbridled, competitive manner. For example, some paralleling bus services are desirable for local convenience as rail stations tend to be spaced further apart than bus stops. Also, should the rail system approach capacity, then there exists a valid argument for providing more intense bus services.

- Light rail or tram would be provided in strong feeder (to rail mass rapid transit) corridors, or between suburban sub-centers. These corridors would, in the first instance, be determined based on the present alignments of the CTA Tram as well as Heliopolis Metro and, in the longer term, the potential expansion of this system. As with rail mass rapid transit corridors, some form of bus service would also exist but, again, in a complementary rather than competitive sense.

- The formal bus service structure would be redeployed to predominately operate in major corridors, either radial or circumferential, in which higher-order rail systems do not exist. Bus priority treatments, such as bus lanes or busways, could likely be implemented in some corridors or along some critical corridor segments, most likely those where future upgrading to higher-capacity rail modes is likely[7]. Thus, the structure, fleet and intent of formal bus services would be refocused to providing a premium, high-quality service involving both local and express runs within the major corridors.

- The allocation and utilization of shared taxis is a considerable challenge in operational, administrative and political terms. However, modal optimization is not meant to imply a curtailing or elimination of this service (which, in Cairo, carries more than one-half of unlinked public transport trips). Quite to the contrary, the goal is to more effectively harness the considerable potential of this important mode and minimize its most obvious disbenefits. In the first instance, current practices under which shared taxis are licensed to operate on a route basis (which is often ignored) should be adjusted. A series of areas would be designated in which this mode enjoys considerable freedom (based on some form of licensing) to provide demand-responsive area service. Vehicles would not be permitted to operate outside of their areas, with enforcement possibly enhanced via color-coded license plates. Thus, shared taxis would largely service precincts away from main corridors but within designated areas. However, shared taxis would not be permitted to actually operate within the main corridors serviced by higher-order modes, including bus/priority bus (and, in turn, formal bus services would focus to the main corridors thus releasing enhanced service catchments to the informal sector). There are, in some instances, considerable differences in trip

[7] Further detail regarding bus priority concepts is contained in *Technical Report (3): Urban Public Transport Perspectives; Transportation Master Plan and Feasibility Study of Urban Transport Projects in Greater Cairo Region in the Arab Republic of Egypt*, prepared for the Japan International Cooperation Agency and the Higher Committee for Greater Cairo Transportation Planning, by Pacific Consultants International, et. al., May, 2002.

patterns between users of the various modes. To accommodate this as much as possible, and to ensure that shared taxis can adequately and competitively service intra-area demand (which would include, but certainly not be limited to, feeder services to higher-order modes operating within the main corridors), it may well be desirable to license the area based on a given number of vehicles, rather than a restrictive route structure. In this manner the service structure is encouraged to evolve based on market (customer) requirements rather than bureaucratic dictates.

- Transport Cooperatives, which provide informal sector bus services using minibuses, at present carry modest numbers of passengers compared to the dominant shared taxi mode. Services are based only in Giza Governorate, with one focus being 6th of October City. In principle and intent, the service provided is similar to that of the shared taxis, with exception of vehicle size and type of management (cooperative versus the dominant single-ownership of the shared taxis). Thus, the allocation of this mode could either follow an area license basis, or, as discussed in later sections of this chapter, a route license basis. In fact, the management set-up of the cooperatives can offer valuable guidance regarding the suggested formation of operator associations within the license areas (refer Section 4.5).

- Service to more outlying activity concentrations (such as satellite cities in the CREATS study area) implies a need for higher speed (due to considerable distances involved) and stops at few intermediate locations. Urban rail systems are not suited for this task, thus, suburban rail systems should ultimately be employed assuming proper demand thresholds are met. As with urban rail corridors, some form of bus service would also exist but, again, in a complementary rather than competitive sense.

Intermodal terminals play an important, if not critical role, in the efficiency of the system and determine for a large part the level of direct and indirect impact on the total traffic system. The quality of intermodal public transport is therefore determined by the efficiency of the terminals that link the different systems. This efficiency is the results of, on the one hand, available connections and, on the other hand, the quality of the terminals.

4.3 FINANCIAL SUSTAINABILITY

Sustainability refers to the ability of providing public transport services within a reasonable financial framework whose foundation rests on realistic sources of revenue and fare levels. This section contains a synopsis of the main issues, potential approaches thereto and the recommended course of action.

4.3.1 Issues

(1) Fare Policies

The initial point relates to the formal public transport fare structure. These fares are subject to absolute regulation, apparently as a matter of social policy; fares are not simply regulated, they are frozen. In case of road-based operators, and in order to increase revenue, new services must be established under a separate (higher) fee for what are termed superior services. As a result, in the case of CTA, the actual service offered is a complex overlay of parallel routes, differentiated by small changes in service characteristics in order to justify different (higher) fares.

In case of CTA bus services, single-trip base fares range from 25 to 250 Piasters, with 25 Piasters being the dominant fare (on 85.0 percent of lines which are serviced by 80.3 percent of operational buses and carrying 84.4 percent of ticketed passengers) and the latter fare being for aircon services. GCBC bus services single-trip base fares range from 10 Piasters to 250 Piasters and, as is the case with CTA buses, the 25 Piaster fare is dominant (on some three fourths of routes). However, a major difference is that on more than half of those routes an extended fare of 50 or 75 Piasters may be levied. Likewise, on 20 percent of the 50 Piaster routes, an extended fare of 75 or 100 Piasters may be levied. CTA minibus single-trip fares range from 25 to 100 Piasters, with 50 Piasters being the dominant fare (on 50.6 percent of lines which are serviced by 62.0 percent of operational buses and carry 65.5 percent of ticketed passengers). Extended fares of 30 to 50 Piasters are found on 16 percent of the 25 Piaster routes. While public bus fares are levied on a line-distance (and service type) basis, metro fares are distance proportional. Single-trip fares (in May 2001) ranged from 50 Piasters (nine stations) to 80 Piasters (34 stations). The fare schedule for shared taxi services is more difficult to quantify as a number of variables are involved, among them driver preferences, service location and route length. Further, it is understood that some operators “turn back” along their route prior to reaching the designated destination, thus forcing passengers to utilize another shared taxi (and pay another fare) to complete the journey. Nevertheless, near 1,700 fare payments were monitored to obtain an overview of fare structure (all fares on shared taxi services are on a single-payment cash basis). Findings suggest that a similar range to that of formal services exists, with monitored values ranging from 10 to 250 Piasters.

The Public Transport Passenger Survey, during which more than 6,100 persons were interviewed at 105 public transport terminals to obtain a clearer understanding of modal choices and preferences, found that shared taxi and metro modes are among the most expensive choices (ignoring the premium aircon bus services). This holds true for both single journeys and multiple journeys, as, for example, two consecutive modes. For single journeys, average metro and shared taxi fares hover between 55 and 60 Piasters (Table 4.3.1). These findings are very consistent with reviews of

Table 4.3.1 Average Fares for Single Journey Public Transport Tickets

Mode	Average Fare (Piasters)
Shared Taxi	58
Metro	55
Public Bus	34
ENR Suburban Train	41
Air-conditioned Bus	228
Public Minibus	48

Source: JICA Study Team

formal operator records as well as results of the Transport Network Survey, during which average single-trip shared taxi fares were monitored via some 2,000 on-board journeys. Findings suggest that the mathematical average for shared taxi is 56 Piasters, while formal bus sector statistics yield averages of 31, 40 and 46 Piasters for CTA bus, GCBC bus and CTA minibus services, respectively.

- **Issue: Public transport fares are imbalanced and politically constrained. As will be shown in Section 4.4, the exact grouping they are supposed to help, that is, the urban poor, are possibly not receiving the intended benefit.**

(2) Fare Evolution

Fares on Cairo formal public transport systems have increased only slowly. During the late 1980's, the base single trip fare for CTA bus and CTA tram was 10 Piasters; during year 2001 it was 25 Piasters. For CTA minibus services, a late 1980's price ranged from 15 to 40 Piasters, while at present the range has increased up to one LE. Metro year 1987 single trip prices ranged from 25 to 70 Piasters depending on number of stations; during year 2001 this range had increased to 50 and 80 Piasters. Quarterly private sector metro passes ranged from 25.5 LE to 45.5 LE in 1987; during 2001, the same range had increased to 41LE and 71 LE.

When viewed on a ratio basis, the CTA base fare increased by a factor of 2.5 (from 10 to 25 Piasters) between 1987 and 2001. Similarly, averaged Metro increases are 1.4, 1.5 and 2.2 for single trip tickets, discounted single trip tickets and passes, respectively. Over the same time period, the inflation index increased by a factor of 3.13. Thus, compared to inflation, a ticket pricing ratio shortfall exists for CTA (1.25) as well as Metro single trip tickets, discounted single trip tickets and passes (2.1, 2.1, and 1.5) (Figure 4.3.1). This is highly problematic for public transport operators when, on one hand, ticket revenue is stagnating (indeed declining in real economic terms) while, on the other hand, costs for maintenance, spare parts (including those purchased overseas in hard currency) and other labor-intensive activities continue to increase in absolute terms. For example, for the CTA organization, over the last five fiscal years, ticket sales revenue per (single ticket purchasing) passenger has hovered in a range of 25 to 32 Piasters; likewise, interest

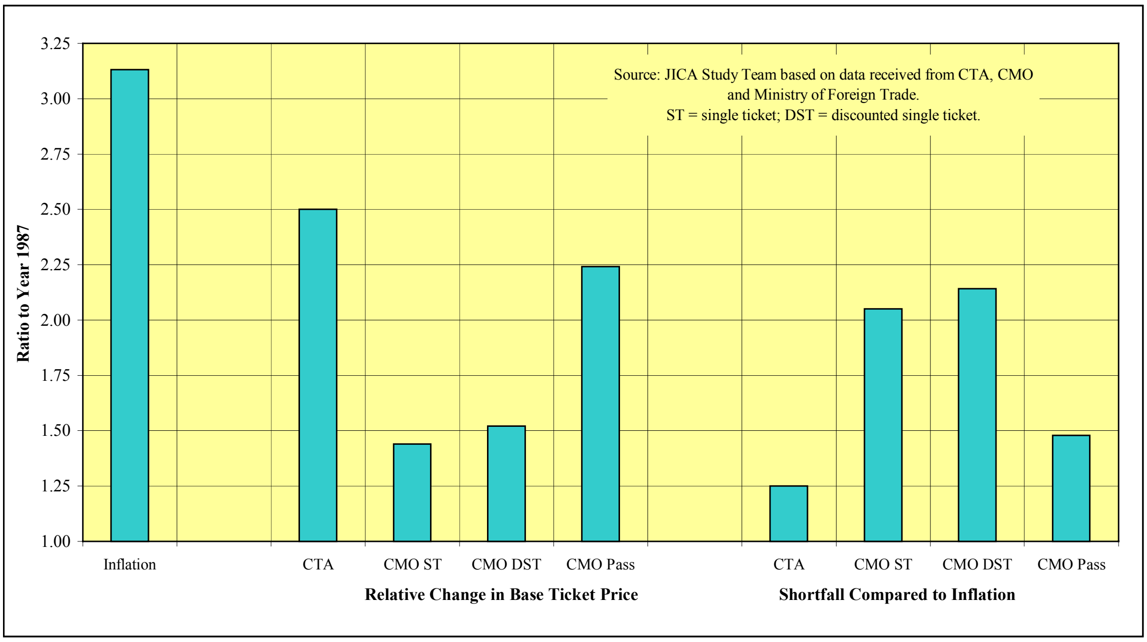


Figure 4.3.1 Comparison of CPI and Public Transport Fare Evolution

plus depreciation costs per passenger were reasonably steady at some 26 to 29 Piasters. However, operating costs increased from 47 to 69 Piasters per passenger. Widening shortfalls in cash flow are inevitable under such circumstances; the operating deficit per passenger and total (operating, interest, depreciation) deficit per passenger consequently grew from 22 to 37 Piasters and from 50 to 64 Piasters, respectively (Figure 4.3.2).

- **Issue: formal sector ticket prices have increased but at a lesser rate than inflation. The revenue base for public transport operators therefore continues to erode in real terms concurrent with increasing absolute operating costs.**

(3) Privileged Passengers

Concerns exist regarding payments for passengers entitled to privileged tickets. A significant proportion of passengers are often entitled to free or reduced price tickets. Such passenger groups include disabled persons, war veterans, students, police and armed forces. In this situation it is the state which legislates for this privileged travel. In Cairo, the public operator is simply instructed to carry certain categories of passengers for free or at reduced price. Any compensation is then integrated with the overall task of balancing an annual budget and negotiating the overall amount of annual subsidy. In case of CTA bus services, there exist, for example, 24 categories of users which may ride buses either free or on a reduced fare basis. These concessional fares are available to veterans, handicapped, police, armed forces, various governmental entities, employees and employee family members, among

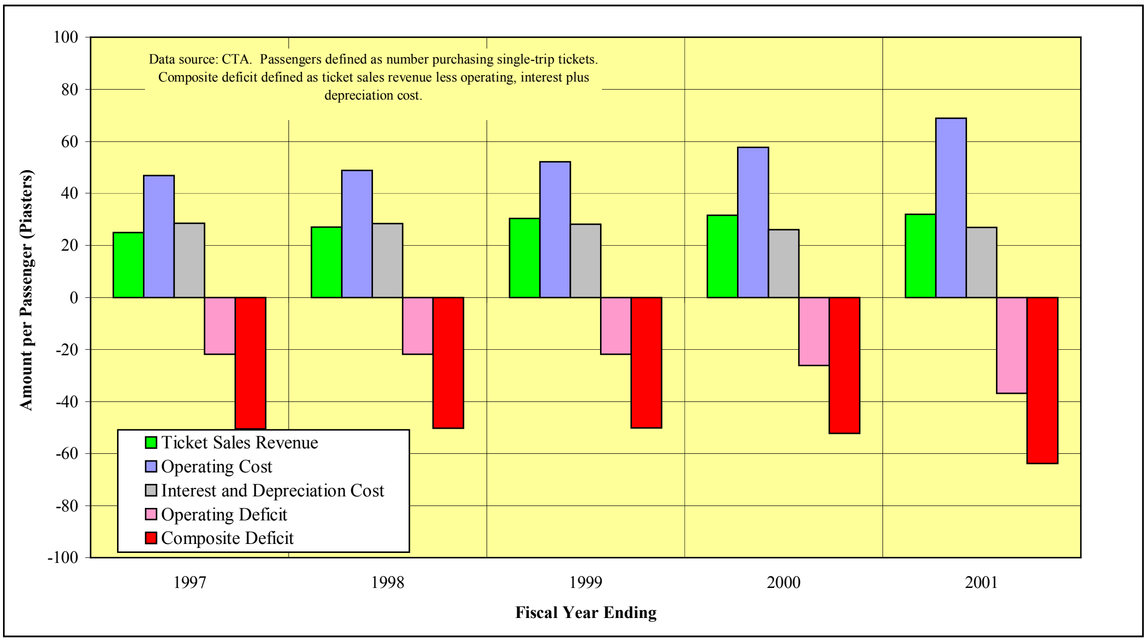


Figure 4.3.2 Overview of Recent CTA Cash Flow

others. The CTA receives no direct reimbursement for these concessional services and can only indirectly request increased subsidies for the operation as a whole. In case of CMO, reduced fares (roughly 50 percent of standard single-trip ticket prices) are available for members of the police, armed forces, journalists, children and blind persons. Metro passes are also available on a weekly or quarterly basis, with varying and considerable discounts given for the private sector, governmental sector, students/handicapped and staff.

In the absence of sophisticated fare collection mechanisms, it is typically very difficult to ascertain the exact numbers of privileged passengers using the system without focused passenger surveys. A more rigorous analysis was possible using results of the HIS, aspects of which queried in detail usage characteristics of unlinked person trips using public transport. For formal operators, student passes represent the most dominant form of concessionary travel, accounted for some 42 percent of pass use (Figure 4.3.3).

On an operator-specific basis, usage of passes is highest for suburban rail services and the metro, accounting for roughly one-half of total daily users. Some 17 percent of light rail services (tram, Heliopolis metro) patrons, and about 12 percent of Nile ferry patrons, use passes. The use of passes on public bus services hovers in vicinity of 10 percent of patrons (Figure 4.3.4).

- **Issue: Travel by privileged persons, which is designated by political edicts, seriously erodes revenue and undercuts average passenger yield.**

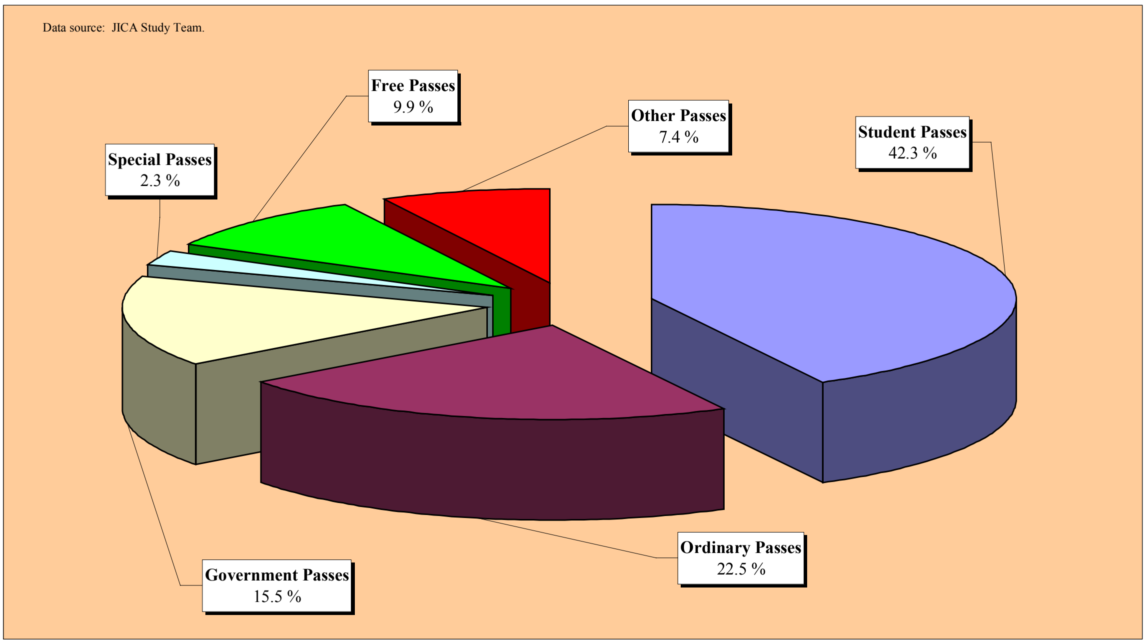


Figure 4.3.3 Types of Passes in Daily Use
Formal Public Transport Services –Year 2001

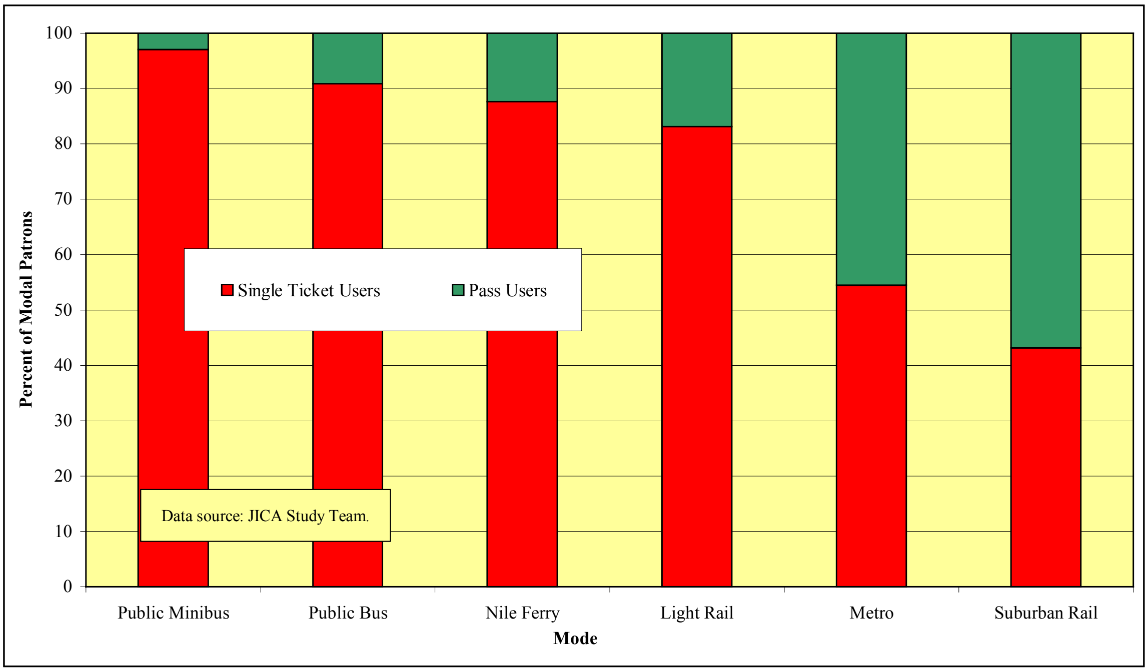


Figure 4.3.4 Proportion of Single Ticket and Pass Patrons
Formal Public Transport Services

(4) Operational Requirements

The operational requirements placed upon formal services have been particularly severe in case of CTA. A review of service trends over a ten year period to year 2000 yields several relevant observations (Figure 4.3.5):

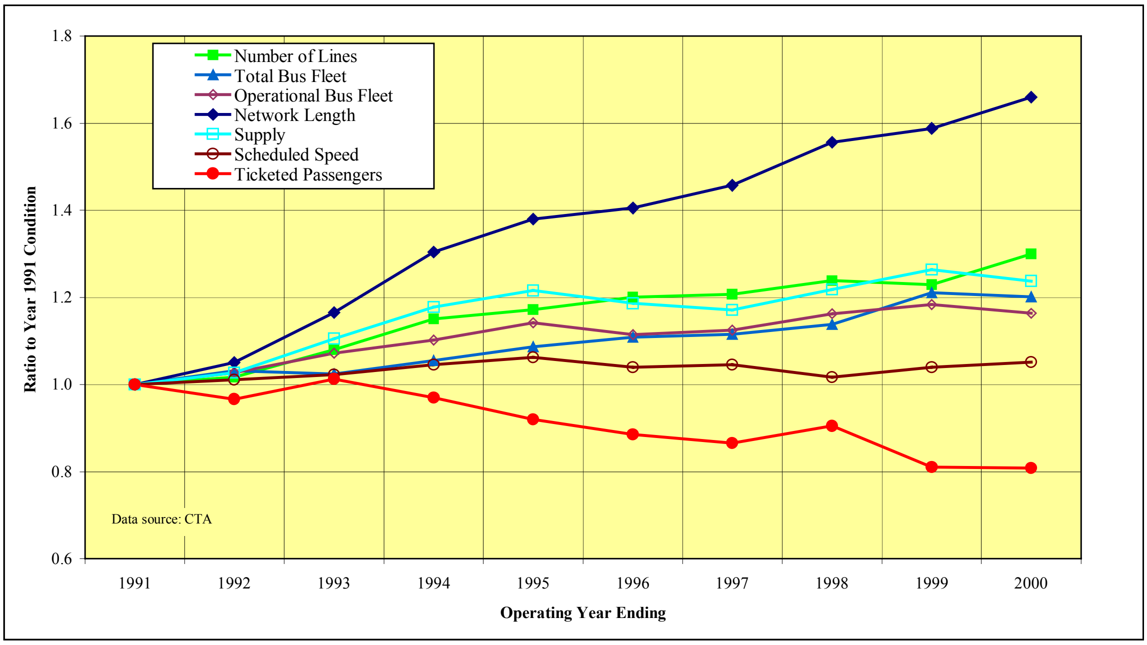


Figure 4.3.5 Performance Indexes for CTA/GCBC Bus and CTA Minibus Services Ten Year Period Ending Year 2000

- Network length exhibits highest relative growth increasing from a year 1991 factor of 1.00 to a year 2000 factor of 1.66 by year 2000. This trends highlights one of the operational difficulties faced by the CTA. The original mandate of the organization, which was to provide bus services in Cairo, has gradually been expanded by government to provide services within the metropolitan area of the three Governorates, and most recently to service outlying destinations such as satellite cities.

- The size of the fleet has only grown some 20 percent over the last decade from some 3,700 to 4,400 buses (73 percent of which were considered operational during year 2000). Thus, fleet size has not kept pace with network expansion. The CTA only receives sufficient funds each year for approximately 100 new buses. These must be allocated to fleet replacement, intensified service on existing routes, and service on new routes.

- A vehicle is typically in operation 18-20 hours per day, with greatly reduced opportunity for maintenance. Hence, more breakdowns and down times are inevitable.

- Ticketed passengers have declined by about 20 percent over year 1991 levels to some 2.75 million per typical day. This decline is attributed to both operational strains placed upon the existing operation, and the emergence of competitive services.

Fleet replacement is a particular problem. At begin of 2002, the CTA fleet consisted of 2,647 units with an average age of 12.7 years. The present policy of adding 100 new buses is, in a basic sense, killing the fleet. A continuation of present policies will see the fleet at best hold steady at some 2,671 and 2,536 buses in five and ten years time, respectively. However, the average fleet age will have increased from the present 12.7 years to 13.5 and 13.6 years, respectively. Only an increase of 200 buses per year begins to slowly decrease the average age, and an influx of some 400 buses per year is required if average age is to decline to more reasonable levels (Figure 4.3.6). Large influxes of new vehicles appear, of course, to grow the fleet. However, this is based on existing vehicle retirement policies and such totals should be viewed with caution. More than 1,800 vehicles of the current fleet are more than 10 years old, and some 350 vehicles 20 or more years old. Any radical change in policy regarding the influx of new vehicles should, ideally, be taken in concert with new policies regarding the retirement of buses after a reasonable service life.

- **Issue: public transport operators are increasingly being pressured (often in response to political goals) to provide ever-expanding services to meet the travel needs of the public. Concurrently, the operators are not being provided with infrastructure and fleet support to adequately address these responsibilities.**

(5) Financial Performance

Formal public transport operators, as government-owned entities, are considerably constrained by existing policies regarding cash flow. These, in effect, dramatically limit the opportunity for operations-specific management decisions; rather, operations decisions can only be made in accordance with externally (and politically) approved cash flows. The Ministries of Finance and Planning (Governorates are apparently not directly involved in the provision of funds, although they play a considerable political role) approve each year a subsidy which covers annual operational shortfall plus a given amount for fleet/facilities enhancement. However, it is understood that the amount of subsidy paid to the operators is typically less than requested; the decision regarding amount of subsidy approved rests with the concerned Ministries, not the operator.

The operators are thus totally reliant upon Government for funding and, along with other Ministries, departments and organizations, must compete each year for scarce domestic resources in the political arena. As a result, near and long-term tactical as

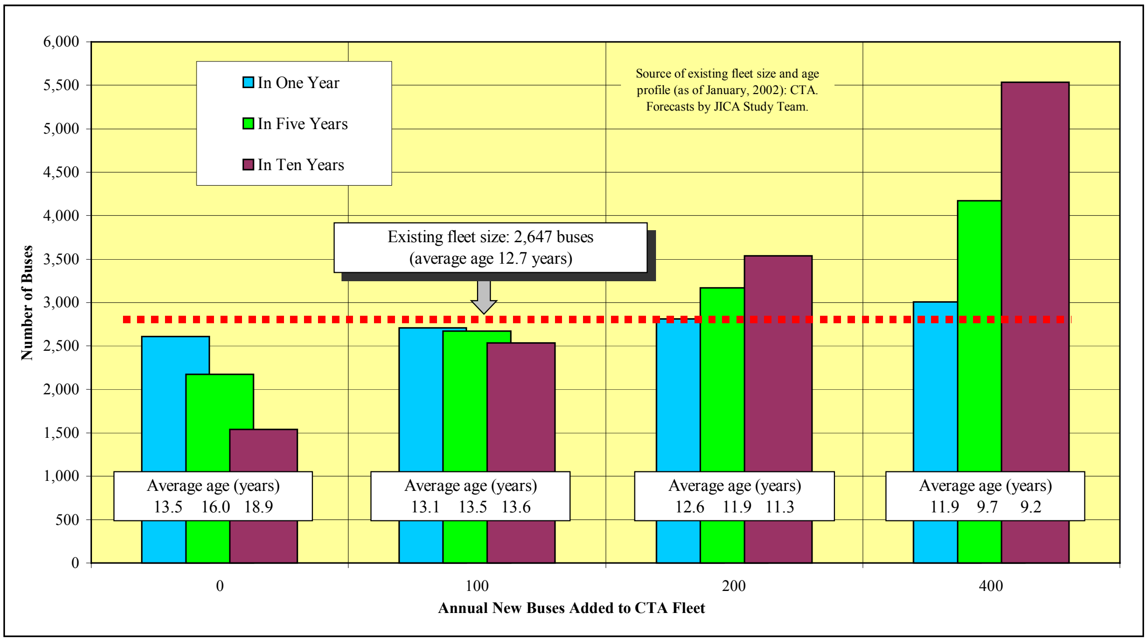


Figure 4.3.6 Simulated Evolution of the CTA Bus Fleet

well as strategic planning for the provision of urban public services is severely constrained (if not pre-empted in some instances) by uncertainties in funding.

Data for the most recent fiscal year confirm that coverage is considerable less than unity; that, is, costs (depending on definition) exceed revenue derived via the fare box and other ancillary income (but excluding subsidy). In case of CTA buses, for example, coverage approaches 70 percent if depreciation and interest are excluded from accounting, and hovers between 40 and 50 percent if the latter two are included. Only in case of minibus and air conditioned bus services is breakeven operation achieved, and not so if all externalities (interest, depreciation) are included. Metro services, if only operating costs are considered, achieves a coverage rate of above 1.5. However, inclusion of depreciation and interest depressed the coverage to considerably less than unity. ENR Cairo suburban services achieves a coverage in vicinity of 0.25 (Figure 4.3.7).

A comparison of total costs and incomes suggests that, for the fiscal year ended June, 2001, the composite subsidy requirement (including operations, interest and depreciation) for formal urban public transport services aggregated to some 720 million LE, including 380 million LE for the CTA, 309 million LE for the CMO and 32 million LE for ENR suburban services (Figure 4.3.8).

A comparison of financial performances among international urban operators should be treated with caution due to definitional differences employed in accounting practices. Nevertheless, a review of operational cost (including depreciation and interest) as well as revenue (excluding subsidy) data from 247 worldwide operators provides an interesting comparison.

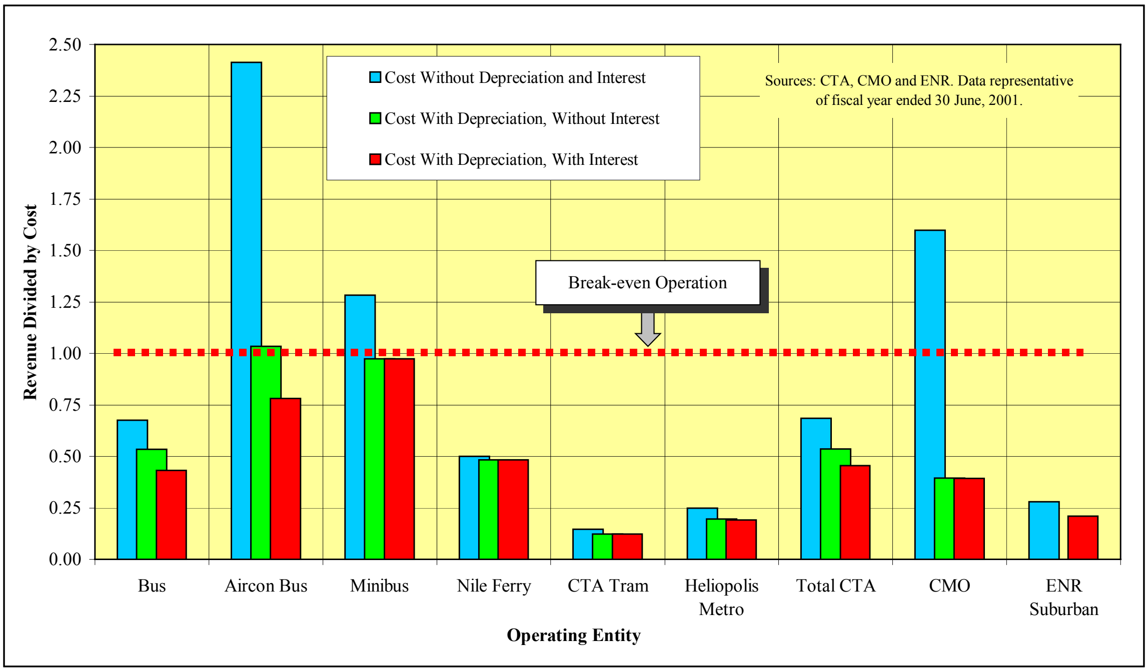


Figure 4.3.7 Recent Annual Financial Performance Formal Public Transport Services

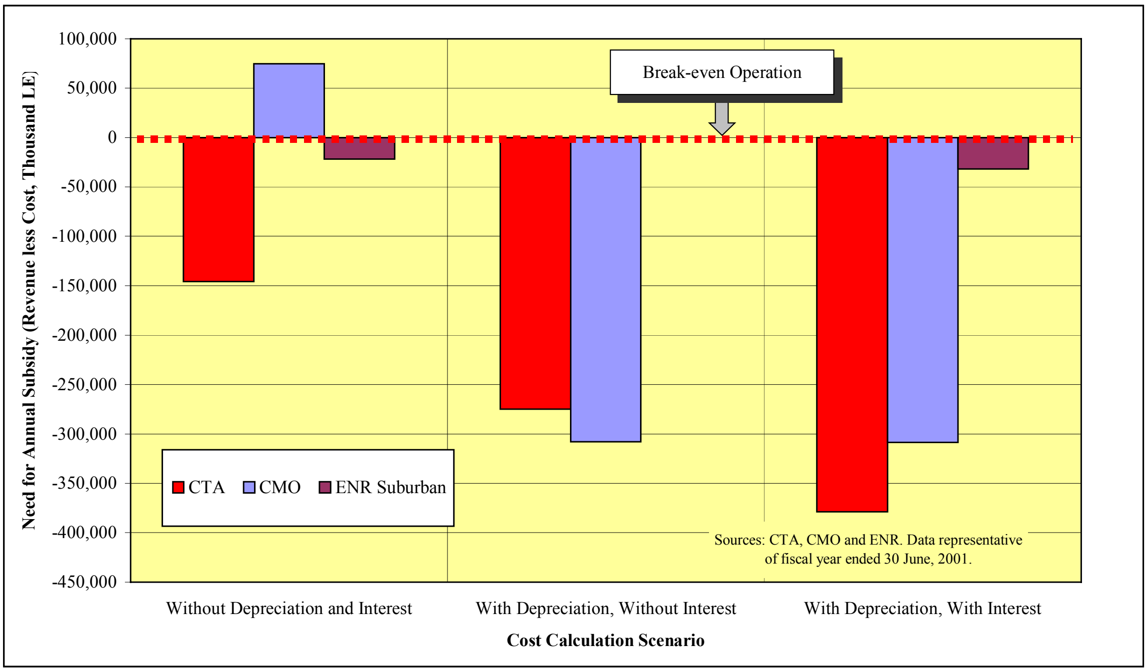


Figure 4.3.8 Recent Annual Subsidy Need Formal Public Transport Services

- The mathematical coverage ratio average for operators providing only bus services is 0.93; in other words, 93 percent of costs are covered by revenue. In case of operators offering only rail services, the coverage ratio average is 0.78. This is expected as urban rail, being a capital-intensive mode, typically generates a much higher depreciation burden than, say, a bus system.

- The coverage ratios for CTA and CMO were 0.46 and 0.39, respectively, for fiscal year ended June, 2001. These ratios mirror international experience in that rail system coverage lies below bus system coverage. However, the CTA and CMO coverage ratios both appear low when compared to even average international expectations for their particular modes (Figure 4.3.9).

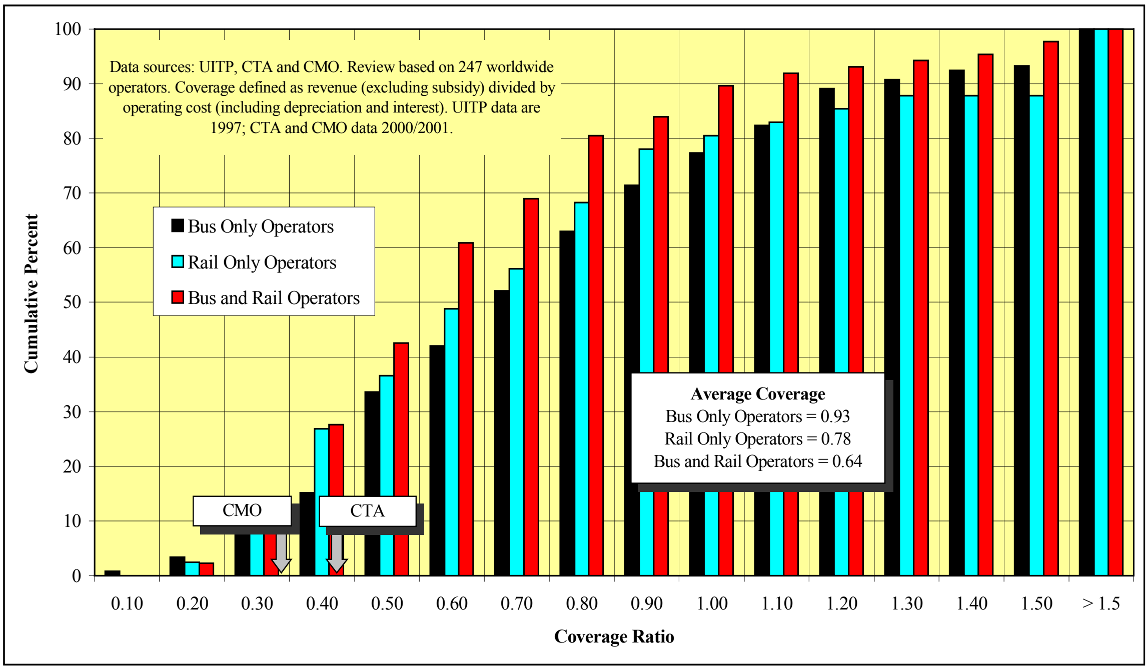


Figure 4.3.9 International Overview
Public Transport Operator Financial Performance

Financial information for the privately operated sector (shared taxis) is not available. Such records would rest with individual owners, which are numerous given the proclivity of the one owner – one vehicle system. CREATS survey data suggests that the typical shared taxi departing at route origin has collected between seven and eight LE in fares. The recent explosion of the shared taxi market would support the supposition that revenue is sufficient to generate profit under existing operating practices. Simply put, the fleet would not have expanded as rapidly, and currently absorb more than half of public transport trips, if a profit motive were not satisfied. In case of the shared taxi sector, broader questions persist. While income may well exceed costs, are costs adequately represented? For example, driver training and vehicle maintenance.

- **Issue: Costs of the Cairo formal public transport sector, with few exceptions, exceed fare box (plus ancillary) revenues. Conversely, the private sector is anecdotally seen as having largely achieved positive cash flow. The decline in ridership for some public operators, in combination with growing costs, is catalyzing a need for ever-increasing subsidies from public coffers.**

4.3.2 Approach

Funding of urban public transport services remains a critical issue, although it should be stated that it is possible to run urban bus services without government support. Some cities in Latin America and Asia currently function without the requirement to be partly financed through subsidy. However, in many cities, revenues from the sale of tickets often fall short of funds necessary to cover operating costs. Indeed, it may readily be argued that if public transport is to fully address social obligations it cannot be expected to fully cover its costs. Competing demands from other sectors (health, welfare, defense, among others) and an insufficient tax revenue results in constraints on the volume of funds (apart from ticket revenues) available to the urban public transport sector. This insufficiency of funds has implications for the following:

- Available subsidies for lower income users and the issue of controlled fares;
- Levels of payment for the compensation for carrying privileged passengers i.e. those traveling on free or reduced price tickets; and,
- Funds available for fleet and infrastructure renewal.

These issues are discussed in general terms below; refer Sections 4.3.3, 4.4.3 and 4.5.3 for specific recommendations derived within the Cairo context.

(1) Subsidies and Controlled Fares

As part of the wider social objectives of a government, fares are often kept lower than would be expected in a competitive market. This implied subsidy has the effect of improving mobility and accessibility, particularly for lower income groups. Also, by keeping fares low, this has a positive contribution towards biasing modal choice in favor of public transport and thus assisting in reducing city congestion. Because this implied subsidy is broadly targeted, it has the effect of subsidizing more wealthier sections of the community, such as the middle classes, who also use public transport. The most effective form of subsidy to alleviate poverty would be to make direct transfer payments to poorer families. This would then transfer the burden away from public transport companies, who would be free to set ticket prices at more realistic levels. It is clear, though, that such direct transfer payments are difficult to administer and involve probable means testing.

Given that there are difficulties in the administration of subsidies, the second best case would still involve indirect subsidies through controlled fares. There are, however, concerns regarding the levels of reimbursement that should be made to an operator as compensation for carrying passengers at these lower fare levels. Where the state and the operator are closely interlinked, it is often the case that compensation payments are delayed or reduced. This is because economic pressure forces the government to rationalize fund across all sectors. In the Cairo context, for example, fares are politically constrained, yet the resulting financial shortfall (subsidy) is not fully reimbursed by Government to the operator, but apparently reduced from indicated book values. Thus the operator must absorb double deficit: reduced income for the carriage of the passenger, and reduced reimbursement of incurred shortfall. However, the net result is that the public transport company is unfairly disadvantaged and does not have sufficient resources to undertake its major roles. This conflict of interest can be much reduced should the funding arrangements be made more transparent. There is a clear case that the existence of a contract setting out both the roles and obligations of both the buyer and seller of services would improve this situation. It is also clear that the greater the distance in relationship between the parties, the more likelihood that this transparency will observable. In the case where a contract is made between the state and a private operator, the legal obligations involved in such a contract ensure that there is a greater possibility of it being honored.

(2) Privileged Passengers

A significant proportion of passengers are often entitled to free or reduced price tickets. Such passenger groups include, as in Cairo, disabled persons, war veterans, students police and armed forces. In this situation it is the state which legislates for this privileged travel. Although pledges are made to refund companies, experience elsewhere in the world has shown that these agreements are not always fully honored, resulting in only partial payments made.

A further issue is whether or not this pledge is even made. For example, as in Cairo, the public operator may simply be instructed to carry certain categories of passengers for free or at reduced price. Any compensation is then integrated with the overall task of balancing an annual budget and negotiating the overall amount of annual subsidy. In the absence of sophisticated fare collection mechanisms, it is typically very difficult to ascertain the exact numbers of privileged passengers using the system without focused passenger surveys. In many countries, particularly East European transitional economies, there is a pervasive tradition of providing free, or reduced fare, transport for a wide range of public servants. This raises two major problems. First, the categories in receipt of free fares are often not the most needy, so that the redistribution effects of supporting the concessions by internal cross subsidies are, in fact, detrimental to the poor and/or the operator. Second, where there is a large proportion of non-fare paying passengers it often becomes difficult, and relatively more costly, to enforce payment by those who are supposed to pay.

(3) Fleet Renewal

One area where this is particularly important regards the investment in new buses to replenish bus fleets. A scarcity of funds means that priorities must be given to staff wages, vehicle maintenance and running costs, leaving insufficient funds to buy new vehicles. This leads to higher maintenance costs for existing vehicles. The continued use of older vehicles decreases attraction for users and reinforces the poor image of public buses when compared to the private car. Allowing private companies to operate increase the opportunity to access capital markets to raise investment funding. Similarly, establishing a clear and unambiguous legal framework, with the opportunity to make a normal rate of profit, would create an incentive to private operators to undertake new investment. Fleet renewal in Cairo is also complicated by the fact that revenue can only be obtained from the National Investment Bank of the Ministry of Finance which levies interest of some 12 percent. This interest is, in turn, incorporated into annual operator financial statements. In effect, the government is charging itself (and thus increasing costs) for providing public transport services. Operators may not turn to alternative sources of financing for fleet renewal.

4.3.3 Action

The investment needs of the public transport sector are substantial. As currently structured, however, the sector would likely not be in a position to efficiently and effectively absorb the investment needed, should it even be available. In a simplistic sense, operators at present can barely maintain their properties as is, let alone expand to fulfill the role they must fill if it they are to be, in a sustainable and on-going manner, useful tools in combating traffic congestion and providing mobility for Cairenes. A program of reform of surface public transport should therefore be developed with two principal and inter-related goals.

- **First, it should strive to create an efficient and effective sector capable of meeting the social and public policy needs of Greater Cairo with as little public subsidy as possible. Such a goal is not meant to imply that subsidization of service is not desirable, only that for a given policy goal, the amount of subsidy needed should be as small as possible. Second, the program should aspire to make the sector as commercial as possible, and responsive to potential private sector participation and capital, thereby freeing scarce public resources for other purposes.**

The approach, in this instance, focuses on techniques which might be utilized to improve operations of government-owned operators. Further information regarding types of ownership, and how public and private sectors might better cooperate, are presented in Sections 4.2 and 4.5 of this chapter.

(1) Commercialization of the CTA

Various options exist for re-structuring the organization of the public transport (in particular bus) sector. These include, as discussed in Section 4.5, commercialization of the existing transport operator, management competition / delegated management, line-by-line tendering, area or network tendering, and gradual deregulation of the network. Opinions have been voiced to the Study Team that the CTA should be totally privatized, hence eliminated from the public rolls. However, when viewed through the prism of existing realities, a complete immediate privatization of the CTA, and its 40,000 employees, seems highly unlikely. Furthermore, given the status of current assets, one would intuitively wonder who would be willing to make such a purchase. However, a step-wise approach toward partial privatization might be achievable and, politically speaking, more palatable.

That the path to commercialization/privatization is desirable is clear. Available literature[8] confirms that public transport services operated by the public sector will typically be less efficient than those operated under a competitive environment. The main reasons for this appear to be politically imposed constraints, institutionalized protection of labor, as well as entrenched long-term disincentives to productivity improvement.

Commercialization entails, in the first instance, the transition of the existing state company as an independent entity, with the important objective of setting CTA at 'arms length' to the state and giving it more commercial freedom. The state would, however, retain ownership. A performance agreement is established between the state and the company. This more clearly defines the roles of the two parties with the state as the 'buyer' of the bus services and the 'company' as the seller. The company is encouraged to be structured in a similar manner to private companies i.e. with separate business units, whereby it becomes more clear which part of operations is more cost-effective.

This commercialization can be used as part of a transition process whereby the state company is prepared to operate in a competitive market. Ideally, the performance agreement structure would be a transitional phase to the introduction of more competitive principles in public transport delivery. Unavoidably this implies a reduction in cost[9]. Several considerations should be noted in this regard.

- The CTA employs in excess of 40,500 persons (Table 4.3.2). This averages to between nine and ten employees per bus, and roughly one employee per 29,000 passengers. In fairness it must be noted that the CTA also operates light rail and water borne modes; however, one must concurrently question worker totals under some job descriptions. These usage indicators can be compared to other transit systems[10]: for example, Adelaide (1.5 staff per bus and 31,000 passengers per staff), Bangkok (5.4/*), Copenhagen (3.1/69,000), Curitiba (6.9/39,000), Hong Kong (3.0/88,000), London (3.0/54,000), Nairobi (7.3/44,000), Pusan (2.8/130,000) and Sao Paulo (5.1/28,000). While any such comparison must be done with caution, a cursory examination would suggest that CTA performance statistics fall into the upper ranges of international experience, even if discounting employment in non-bus modes of transport. Not surprisingly, this suggests that the CTA, as a public company, may well be experiencing excessive absolute staffing levels, and/or perhaps high staffing levels in wrong fields (for example, there apparently exists a shortage of qualified drivers).

[8] One typical example quoted in *Cities on the Move: A World Bank Urban Transport Strategy Review*, op. cit., is for Delhi, India, where private bus operations achieve a 93 percent peak period fleet utilization vs. 83 percent for the public sector, while 4.6 staff per bus service the private operation and 9.6 staff per bus the public operation.

[9] A number of practical recommendations in this regard have been tendered during the course of the *Greater Cairo Public Transport Fare Policy Study*, op. cit.

[10] *Review of Urban Public Transport Competition*, op. cit.

Table 4.3.2 Summary of CTA Employment

Job Description	Workers	
	Number	Percent
Monitoring	982	2.4
Public Services	4,100	10.1
Drivers	9,652	23.8
Conductors	6,803	16.8
Technicians	13,527	33.4
Administration	4,760	11.7
Trainees	0	0.0
Hospital	723	1.8
Total	40,547	100.0

Data source: CTA, August 2001.

- Certain benefits will clearly accrue in the use of more commercial accounting procedures, and the ability to explore alternative financing opportunities. For example, at present, fleet depreciation is based on an allocation of 100 percent of asset value over the first four years, plus 25 percent of annual asset value (per first four years) indefinitely thereafter. Fixed assets are based on a weighted formula, and applied indefinitely. Also at present vehicles may only be acquired via funding from the National Investment Bank at an interest rate of approximately 12 percent per annum. The CTA may not, at present, finance capital purchases via other sources.

- As part of commercialization, it is anticipated that more aggressive use of competitive procedures will be employed (and permitted). These could include a range of support services, asset acquisition, engineering and so on. In a further phase, some operations or maintenance services could be concessioned, for example, in an arrangement involving some privatization. Competition in performance can also take place between units performing similar functions within the organization, or by benchmarking on bus operators in other cities or countries.

Three crucial elements are seen as being part of a performance agreement:

- A minimum service level, likely defined in terms of vehicle kilometers and/or passenger kilometers, as determined by criteria such as population density. The financial impost to government will be LE per passenger and/or vehicle kilometer, based on costs that are benchmarked as being efficient.

- A patronage incentive to deliver passengers above those who will use the service at the minimum service level. The incentive takes the form of LE per passenger.

- Possibly a specified contract to carry some classes of privileged passengers with reimbursement, if not included in the patronage incentive costs, based on unit costs of carriage benchmarked as being efficient.

Advantages of this system accrue to both operator and the state. From the operators perspectives, it provides a measure of stability which permits the intelligent planning of public transport services from an operations perspective within clearly defined frameworks. From the state's point of view, cash flow can consistently be budgeted while clearly reflecting the political and social goals of government. From the financial point of view, it breaks the current cycle in that the operator cannot expect to receive an automatic (or increasing) subsidy each year without expecting to support a continuous effort toward more efficient service.

If there is consensus among both the CTA and the government that the path of commercialized operation is to be followed, the initial step, and vital input to a performance agreement, would be the framing of a Transport Action Program (TAP). This is further seen as the first of a series of floating five-year plans which define the organizations operational and fiscal frameworks, how it is performing vis-à-vis criteria defined by the performance agreement, and what changes might be instituted for the next performance agreement (for discussion purposes, a five year agreement period has been assumed although this must not necessarily be so; alternative time periods could be utilized depending upon consensus among government and the CTA).

There should be six core elements within the TAP:

- Service strategies, to include changes in service philosophies proposed by CREATS. The service strategies would include analyses to the route level of detail and encompass criteria such as route structure optimization, headways, scheduling, vehicle types, capacities, intermodal coordination and service catchments (refer Chapter 9, *Organizational and Institutional Matters*, for the potential role of a metropolitan transport bureau in this regard).

- Operational measures which further clarify broader CREATS concepts in terms of operating regulations/procedures; route pricing; ticketing management; accounting; cash processing; revenue management; and, customer relations.

- Fleet and infrastructure as needed to achieve the service and operational strategies plus administrative and maintenance functions. These elements should reflect realistic needs being cognizant of fiscal, organizational and political constraints, yet concurrently striving to maximize elements of the performance agreement.

- Organizational re-structuring designed to maximize the benefits of a transition to commercialized operation.

- Capital and operational cost calculations as well as revenue for major sources such as fare box, subsidies, innovative financing and others recognizing the operations-based intent of the performance agreement.

- Human resources enhancement measures; modification of regulations and procedures cannot be introduced without training staff (at the working, supervisory and management levels) in order to understand and accept the necessity of the changes, to apply correctly the new procedures.

(2) ENR Suburban Services

Ridership on the existing ENR suburban services is modest vis-à-vis the other principal modes of urban transport. However, in future, this role is expected to strengthen with growing density of the urban area, and continuing maturity of the satellite cities. As 6^{th} of October and 10^{th} of Ramadan develop further, there will be an increasing need for a quick rail link to Cairo which can satisfy commuting needs; such services have been proposed within the public transport element of the Master Plan as has a general upgrading, in terms of rolling stock and stations, of existing suburban commuter lines. At present, ENR is structured purely for a national type of service; operations, costs and revenues of the suburban lines are indistinguishable within national accounts. Thus, there appears to exist little sensitivity toward the unique transport needs and financial implications of urban commutation as distinct from the servicing of national long-distance passenger flows. There is a need for reorganizing the company internally in order to obtain a specific suburban operations division whose primary objective is to address the needs for commuting within Cairo as well as between Cairo and the satellite cities. The suburban division should be a separate entity of ENR with its own administration, accounts and responsibilities. In this way, the division can better evolve and develop the specialized image, service and commercial activity which is required for satisfying and exploiting fully this distinct client base. If properly structured, there also exists a very strong potential for private-public sectors joint projects via such an entity.

If ENR were to create a new suburban division, which institutional implications would this have? The approach adopted by the French Railways and the administration of suburban services in the Paris Region offers interesting insights into this question.

A specific entity, the Paris Region Division (PRD), was created in 1989. This division represents the Parisian Region Transport Company (PRTC) and the regional authorities - the nominees and civil servants of the Paris Region. PRD proposes to the Executive Committee and to the Administrative Counsel of the French Railways, in direct association with PRTC and the Region, the policies for commercial activities in the Paris Region. PRD has global market view and develops study assignments on the rail network and new infrastructure. PRD defines and coordinates the policies, and forecasts the operational budget of the activity and administers the investment budget in collaboration with the Regions of the French Railways (Figure 4.3.10).

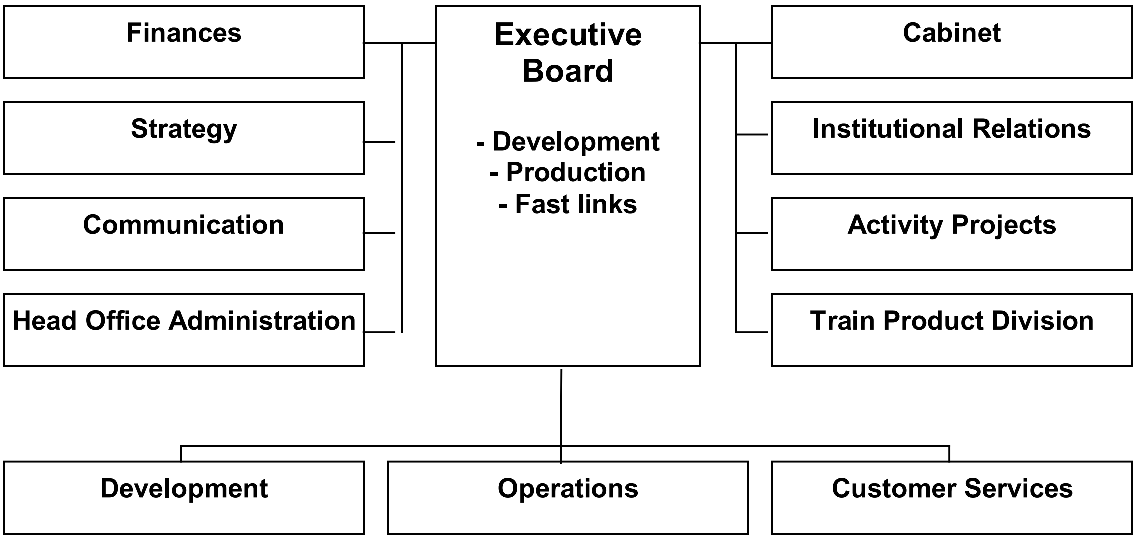


Figure 4.3.10 Organizational Structure of the PRD

The administration of suburban rail services in the Paris Region also interacts with a series of other participants in the transport process. These include:

- **The State** Tutelage authority of the public transport enterprises, the State controls the operations and management. It approves the contracts and co-finances the operations. The State also disposes of the regulatory power; authorizes the realization of national and regional projects; and, controls the organization of public transport. The Region Prefect has authority over the regional services of the State, notably the Regional Assembly Division which coordinated the elaboration of Urban Transport Plans. The Region Prefect presides the Parisian Region Transport Company (PRTC).

- **Parisian Region Transport Company (PRTC)** The PRTC is a public establishment created in 1959, which disposes of financial sovereignty. It associates the State, the eight departments of the Paris region and the Regional Counsel since the adoption of a law "Solidarity – Urban Renewal". Its administrative counsel is composed of 17 State representatives and of 17 communal representatives. Presided by the Region Prefect, the PRTC organizes public transport in the Paris Region in terms of choice of operators, destinations, headways; ensures the coherency between public transport modes by coordinating all of the operators (French Railways, Parisian Metro Authority, and the Assembly of Private Bus Operators); determines fare levels; supervises service quality; and, finances the operational transport balance thanks to notably the collect of a transport tax from enterprises in the Paris Region.

- **The Regional Counsel of Paris Region (RCPR)** The RCPR is an assembly composed of 209 nominees elected for 6 years by popular vote. RCPR votes the budget and approves the contracts between the State and the Region. It initiates and elaborates the Paris Region Master Plan. RCPR is qualified in terms of transport but also in terms of environment, safety, land use, building of schools, education, and economic development. Each competence sector is subject to a commission composed of 5 to 27 regional counselors. The Regional Executive is composed of the President and of 15 vice-presidents, each in charge of one of the qualified sectors of the Regional Counsel. The Economic and Social Counsel of Paris Region (ESCPR) is a consulting assembly composed of 110 members and represents issues related to economy, and social matters. It issues opinions regarding competence subjects of the Region and all questions related to the development of the Paris Region.

- **French Railway Network (FRN)** Since a law from 1997 reforming the organization of railway services, FRN is the owner of the railway infrastructures (rails, platforms, etc.). FRN delegates the management of the infrastructure (operation and maintenance) to the French Railways (Infrastructure Activity Division) but ensures the design studies of rail network development projects.

- **Operators** Parisian Metro Authority, Assembly of Private Bus Operators, Association for the Development and Improvement of Transport in the Paris Region, and Association of Professionals in the Road Transport Sector in Paris Region.

(3) Separation of Planning and Operations

It is believed that there is a general consensus that, for any liberalization measures or restructuring of the sector to be effective, there must be a clear separation between planning, including the regulatory framework, and operations. This means, in effect, that the state retains control of such aspects as urban transport policy, route and vehicle licensing, route planning and timetabling, supervising integrated ticketed systems and, in most instances, the control of, or some influence on, fares.

The route planning and timetabling aspect is necessary to ensure that the city has a comprehensive supply of public transport services and that there is co-ordination within the network, including working with tram and metro stations, in terms of areas served and the need to introduce new services where required. A good example of the co-ordination needed can be seen in this CREATS study area. One crucial factor in the success of the development of the new communities in the Greater Cairo Region is the provision of good links between these communities and the city of Cairo. New communities such as the 15th of May and New Cairo, which are both close to Cairo and have a number of bus links to the center of the city, have been much more successful in attracting new residents than Al-Oboor and Shorouq City which are further away but also have a much lower level of bus service provision. Clearly other factors such as health and education facilities also play a role. However, the state in its role as a planning authority has the ability to provide such services in advance. If such service provision were left to the private sector, it is most probable that bus services would follow anticipated population increases rather than precede it.

Supporting the discussion above, the global trend in the urban transport sector is for the state to retain control of planning. In some cases, the private sector can contribute by providing specialist personnel to assist in or carry out route planning exercises. However, at a higher level, the formulation of objectives remains with the state authorities.

A further observation relates to the reluctance, perhaps, of some countries to introduce liberalization measures. This issue often relates to the perceived loss of control and also can concern the transparency of arrangements for funding of the existing state public transport operator. Another critical issue concerns the future status of the state company. Due to restrictions on the hiring and firing of staff, such companies are often excessively over-manned. Exposing such companies to market conditions entails reducing costs and, by implication, the shedding of staff. This has political implications for the state government. For the state company, there is often a nervousness due to the lack of sufficient commercial skills to compete with private companies.

A positive approach suggests that liberalization does contain some opportunities for the incumbent operator. These include more freedom in the employment of staff, increased wage levels and the possibilities for introducing performance bonuses. As an example of how attitudes can change over time, an example is given of the city of Krakow, in Poland. During a transitional phase, the municipal bus (and tram) company had moved from being directly run as a municipal department to being a separate entity, although still being under the ownership of the municipality. As a separate entity, it had a performance agreement with the municipality. Due to efficiency measures taken by the company, its cost-recovery ratio (revenues/operating costs) had improved considerably and was higher than most bus companies operating in Western Europe. The role of the Consultant, in this case, was to facilitate discussions between the two parties as to the most suitable future liberalization measures to be taken in the city. From observations made at the relevant workshops, it was clear that the municipal company was very positive in opening up the sector to competition. It was their belief that the company was now strong enough to fight off any private sector bids, enabling it to make greater profit although exposed to more risk, which could be passed on in the form of higher wages for company employees.

In the above example, when developing the regulatory framework, a main concern would be that the removal of a public monopoly should not result in its replacement by a private monopoly.

- This particular course of action is closely linked with proposed changes in institutional and organizational structures, which are addressed in detail in Chapter 9 of this volume.

(4) Revenue Enhancement

Revenues generated by the public transport system itself are considered the most desirable source of finance for operations and proposed improvements. Because these revenues are derived primarily from users or others who derive direct benefit from the system, they support the "beneficiary pays" principle. Project revenues can be generated in several ways, including fares collected directly from users, sale of advertising space at the stations and on the vehicles, rent from retail concessions at stations, parallel uses of the right of way, peripheral real estate development, and parking fees at park-and-ride facilities.

Several options exist for enhancing revenue within the framework of current services.

- Fare adjustments. Increasing the basic fare, or modifying policies for privileged passengers, will increase revenue the extent being dependent upon degree, if any, of passenger loss. Overseas experience suggests that each 10 percent increase in fare will result in a three percent loss in ridership; however, these statistics may be of questionable validity in Cairo given the high degree of transit captive patronage. It is also of relevance to note that in case of buses, the private sector (shared taxi) average single-journey fare is about twice the CTA bus base fare (58 Piasters versus 25 Piasters, respectively).

- Increase ridership. Revenue can be increased if ridership (hence income) can grow to a greater degree than cost outlay for expanded services to accommodate additional riders. Such increases can traditionally be achieved by targeting Cairenes with a choice of travel options. While increasing road congestion and shortage of parking serve as catalysts to increased ridership, impetus remains in the hands of operators via provision of reliable and on-time service, dissemination of transit information (printed maps, brochures), public relations/advertising efforts and marketing techniques such as transit incentive programs (example: subsidized monthly passes sponsored by major employers). The recent success of the shared taxi industry offers examples of benefits achieved via user-targeted services.

- Premium Service, such as air conditioned buses, limited stop or non-stop express routes can be targeted to select population catchments at premium fare. Operations monitoring is necessary to ensure positive cash flow. A potential lucrative sub-market in Cairo are tourists; little obvious effort is seen on the part of operators to target this market. For example, a properly marketed (fliers in hotels, tourist agencies, internet) limited stop aircon bus service between the Giza/Cairo hotel district and Pyramids (to come Egyptian Museum) seems a logical strategy.

Other revenue potentials include income derived from beneficiaries of the project other than users. Possible non-user-related revenue sources include advertising at stations and on vehicles, retail concessions at stations, park-and-ride fees and parallel uses of the right of way. To some degree, local operators are already using this technique, although approaches appear limited in extent.

- Advertising: Major public transport terminals and stations provide both ample surface area for the display of advertisements and a captive audience of "eyeballs" for advertisers. Fare cards and passes incorporating "credit card" design also provide an opportunity to sell advertising space. The introduction of translucent vinyl vehicle wraps has added a new dimension to transit advertising by allowing buses and rail vehicles to be transformed into high-impact rolling billboards for various goods and services.

- Retail Concessions: Stations and terminals can also be designed to accommodate leasable space for small businesses catering to users, including convenience stores, branch banks and automatic teller machines (ATMs), coffee shops and snack restaurants, newspaper and magazine vendors, etc. In Bangkok, Thailand, the BTSC has been particularly aggressive with this concept by including space for up to five ATMs and six or more concession spaces at each mass transit (The Skytrain) station. As a result, it has been able to derive more than seven percent of its operating revenue from advertising and retail concessions, substantially exceeding an industry average of one to five percent.

- Park-and-Ride: Commuter parking facilities are also a potential source of revenue for mass transit operations, particularly under the CREATS scheme which visualizes more peripheral metro park-and-ride within the Ring Road corridor. In addition to generating revenue from parking fees, parking lots reserved for transit customers expand the service area of a given rail line beyond walking distance to the station and feeder bus routes. Because of their role in attracting additional ridership, provisions for park-and-ride should be included in the final design of major transit, in particular rail-based, projects. For the same reason, careful consideration should be given to the setting of parking fee levels. The inter-related effect of parking fees and total system revenues needs to be considered in setting pricing policies.

- Parallel Uses of Right-of-Way: The owner of a continuous right-of-way through an urban area as dense as Cairo possesses an asset of considerable potential value to other developers of network utilities, such as telecommunications companies. With some advance planning, ducts for fiber-optic or copper cable can be integrated into the design of the civil works and revenue may be derived by leasing the space. An alternative is to build an oversized fiber-optic network as part of the project and to lease bandwidth not needed by the transit system for internal signaling and communications.

There also exist, on a broader scale, innovative opportunities for revenue generation in conjunction with the private sector. Overseas transit operators are increasingly becoming involved in joint development projects with the private sector. This could, for example, including leasing of air-rights owned by the operator on a perpetual basis to permit construction of a building over transit facilities. In Japan and Europe, the joint air-rights development approach is exceedingly popular and often incorporates major retail/commercial outlets with transport modal interchange centers.

Implementation of major joint development projects at key transport modes or terminals will enhance the value of abutting properties, particularly property suited for commercial services. Value capture refers to the transfer of a percentage of the additional value derived by owners abutting a revitalized, joint-development project to the operator to off-set cost of in-place capital facilities or operating expense.

In Japan and Hong Kong especially, railroad operators are engaged in significant amounts of real estate development along their rights of way. The Mass Transit Railway Corporation in Hong Kong derives eight percent of its annual revenues from development projects along its lines. In Japan, private railways have been involved in the development of new towns on the periphery of major cities and in high-rise developments over their central city stations. In Bangkok,, Thailand, a primary driver of some of the early private proposals for mass transit systems was potential real estate development.

This should not preclude direct Government support and other development incentives for master planned, mixed-use developments at important public transport nodes. As the public transport network develops and the real estate market improves, these centers have the potential to enhance ridership and promote environmentally-friendly public transport-oriented development. It is important that the government take a strong leadership role in promoting these developments at the appropriate times in the future. Even without direct investment in adjacent real estate, value capture by the government may be possible using special assessment districts or tax increment financing. However, while there may be potential for gaining revenues for the public transport operation from these approaches, given the potential uncertainty about the development of the property market over the short term, and their political feasibility, these have not been explicitly included in the quantitative financial appraisal. With a stabilization of the property market over time it may be appropriate to consider this approach in funding later components of the CREATS program.

(5) Fare Policy

Suggestions regarding fare policies will inevitably catalyze controversy due to the political and social implications which underlie current practices. CREATS has addressed key issues which set a framework for a revised approach to this issue. While this framework is, in keeping with the tenets of a master plan, broad, it is noted that a number of previous studies have addressed fare issues and opportunities in considerable detail, with a particularly excellent product being the recently completed *Fare Policy Study*[11]. A number of relevant recommendations were developed jointly between that Study Team and providers of public transport services. These include, among other recommendations, a staged approach to achieving a degree of modal integration, fare optimization and joint ticketing strategies. Unfortunately, none of the recommendations have, to the CREATS Study Teams knowledge, been implemented to-date.

[11] *Final Report: Greater Cairo Public Transport Fare Policy Study*; op. cit.

The freezing of fares for existing public transport operations results in inefficient operations, and unfairly disadvantages the poor (refer Section 4.4 for further discussion). Such a policy is inefficient in the short term, since it greatly limits the resources available to the operator to upgrade and maintain services, particularly in the case of CTA. In the medium and longer terms, it is not only economically unsustainable, but also highly questionable as an effective means of delivering the social effects intended, since it fosters and incentive for the CTA, for example, to concentrate any newly available resources on services intended for wealthier patrons. As a result, services for poorer patrons are increasingly (of necessity) neglected, with the result being the present convoluted fare and route structures, as new operations continue to be layered onto older, frozen operations. Frozen fares are also a considerable barrier to effective inter-modal integration, since operators are understandably loath to part with any of their limited revenues.

- **Fare policy must be re-assessed region-wide across all modes from an operational, as opposed to political, perspective. The discussion on intermodality (the ease and cost of public transport interchange) contained in Chapter 7 of this volume, is particularly relevant in this regard.**

This task is not an easy one as it involves a series of interlocked and cascading considerations, limitations in currently available operator resources and, perhaps most importantly, political considerations. It has been voiced a number of times to the Study Team that approval for any form of fare adjustment can only come from the highest of political sources. Such an approach carries a number of disbenefits for operators as previously pointed out and discussed. The Team presents its recommendations via a series of proposals which should be viewed in a composite, not individual, sense and as being derived on technical grounds.

1)Structure

Operators at present use two generic approaches to calculating fare levels. The CTA employs a quasi-flat fare approach centered on a base fare which, in case of CTA buses, is 25 Piasters. Various adjustments in price are employed based on line length or type of (premium) service; GCBC fare structuring has more opportunity for higher-cost lines than do, in order, CTA minibuses and CTA buses. Rail-based modes employ a distance-proportional system. In case of the CMO, for example, fares are structured within four zones, with each zone permitting travel within a given number of stations band. The CMO system is well suited to a fixed mode such as MRT as more complex and automated fare collection devices are installed in each station and the fare transaction is completed prior to boarding of a vehicle. Road-based modes fare collection is almost exclusively manual and accomplished on-vehicle after boarding.

The Study Team does not see a pressing need at present for modification of the two core fare levying schemes. However, the types of fares offered are needlessly complex. As mentioned previously, there exist 24 categories of users which may ride CTA buses either free or on a reduced fare basis. These concessional fares are available to veterans, handicapped, police, armed forces, various governmental entities, employees and employee family members, among others. In case of CMO, reduced fares are available for members of the police, armed forces, journalists, children and blind persons, among others. Metro passes are also available on a weekly or quarterly basis, with varying and considerable discounts given for the private sector, governmental sector, students/handicapped and staff, among others. The financial ramifications of privileged persons travel rests fully with the operators.

- There is a pressing need to simplify the fare structure in line with operator commercialization goals, and to achieve reasonable balance among the operators in the type of fares offered.

From the point of view of a commercialized operator, and given that the performance agreement expects the achievement of adopted financial goals, two types of commercial tickets are seen as being realistic:

- A single-journey ticket and a multi-journey ticket.

The single trip ticket would, as the name implies, permit a single boarding of services. Two types of multi-journey tickets could include weekly (or say 20 boardings) and monthly (or say 80 boardings). Multi-journey tickets would be sold at a reasonable discount from single-journey prices, possibly 10-20 percent for weekly tickets, and 20-30 percent for monthly tickets on a per-ride basis. It must be emphasized that if such a consolidation of fare options proceeds, it must proceed in its entirety. For example, during the latter 1990's, the CTA launched a pilot effort with the issuances of an 80-trip multi-journey card. The goal of this was to replace the unlimited journey pass. These cards were unfortunately withdrawn from the market within several months due to lack of use as the political decision to eliminate unlimited journey passes was not made.

A second consideration relates to concession tickets, that is, privileged passengers whose price structure reflects their status, employment, age or physical condition. Privileged passengers are an issue for all operators, particularly those with a high percentage of users (metro, ENR). The goals are understandable; the Government of Egypt strives to give certain benefits to some segments of society, or to its (possibly underpaid) employees. However, the Study Team would disagree that passing this responsibility unilaterally to public transport operators is an equitable or efficient approach. No one would disagree that special favors for sub-groups such as the handicapped or infirm is a responsibility for all sectors of society. However, alternative strategies should be adopted in other cases, for example, police and military. No one is questioning that they have fulfilled valuable services to their country, and richly deserve rewards. However, the Team would propose that the operator could continue to carry these persons at reduced rates; however, subject to transparent and reliable accounting, would be directly reimbursed for doing so.

- Discounted fares for privileged passengers would still be available, but the differential between discounted and commercial fare must be reimbursed to the operator by a sponsoring entity.

The Study Team would propose that the privileged passenger differential, that is, the difference between the amount paid to board the vehicle and an equivalent commercial fare, be reimbursed to the operator by sponsoring ministries. The main subgroups would include handicapped, infirm and socially deprived (Ministry of Social Affairs); police and fire fighters (Ministry of Interior); as well as armed forces and veterans (Ministry of Defense). Similar approaches have also been proposed within the framework of the *Greater Cairo Fare Policy Study*, albeit with little success to-date. More concerted efforts are needed in this regard.

There remain two additional groups: students and employees. In case of students, severely discounted ticket prices are likely to continue, and it is questionable that a single sponsoring entity can be defined to reimburse all categories of students, other than the state in general. Two options exist for addressing this issue within the framework of the performance agreement. Appropriate allowance for internal cross-subsidy could be made to account for this market sub-group. However, the likely impact is some marginal increase in fares for all other users. Alternatively, a specified contract to carry students with reimbursement, if not included in the patronage incentive costs, based on unit costs of carriage benchmarked as efficient, can be included. This implies that reimbursement for the carriage of students is seen as a direct social obligation of the state.

The treatment of employees (whether public, private or operator) is a matter of commercial policy. Any organization, whether private or public sector, is free to negotiate a contract of carriage for its employees with the operator. However, a fairly direct way of addressing this is for the employer to purchase a given quantity of commercial tickets from the operator, then distribute to employees either free or for some discounted amount; that is a matter of internal company policy. Likewise, whether or not the operator carries its employees for free is a matter of internal commercial consideration. For example, free transport could be used as an employment perk. It is understood such programs exist in part on metro, particular Line 1, and on the CTA tram serving the industrial district of Helwan.

The treatment of privileged passengers, once political hurdles are overcome, implies more sophisticated monitoring of passenger journeys than at present. Implications again vary by operator; in case of CMO, for example, this would be less problematic as automated fare equipment is already in place at all stations. In case of CTA road-based transport, however, this would suggest that some form of automated ticketing system be introduced or alternative ticket types used (this was also proposed in the recent *Fare Policy Study*). Alternatively, periodic on-board surveys designed to establish utilization benchmarks could be conducted. In either case, such practices would be seen as part and parcel of the commercialization of formal operators.

The use of automated ticketing equipment is seen as being particularly necessary for those bus lines slated for integration with higher-order modes such as metro so as to facilitate fare integration and passenger counts for revenue sharing.

2) Indexing

While public transport fares have increased over the past decade, the rate of increase has considerably lagged that of the consumer price index.

- Beginning immediately, public transport fares should be linked with the consumer price index, or annual inflation rate, to ensure that the operator revenue base does not erode temporally in real monetary terms.

Adjustments in fares might be accomplished every, say, three years. This has the advantage over an annual approach in that a sense of continuity is maintained and, in a more practical sense, single trip fares can be more readily fine-tuned to the most commonly used supplies of coins and notes. For example, a 47 Piaster fare is needlessly complex (and in fact change would tend not to be given anyway); a 50 Piaster fare is more practical.

- There is a pressing need to recover the shortfall in current fare levels catalyzed by not having linked public transport price with recent historic inflation.

Closely associated with this proposal are two goals, which operators should strive to reach.

- The cost of operations plus debt servicing (interest) should be covered via the fare box (plus ancillary revenues), thus lessening a need for public subsidies.

- Total operator coverage, which would include depreciation (hopefully applied in a more precise form than at present) as a part of costs, should be in vicinity of international norms, that is, 0.6 to 0.7.

3) Fare Levels

The proposed "catch-up indexing", and commercial treatment of fare structure, carries vastly different implications for local operators. In case of CTA, some 90 percent of usage is via single trip tickets, with about one-third of non-single ticket journeys (pass usage) being free travel. Thus the key issue is operational coverage more so than carriage of privileged passengers (although this will also benefit from concepts discussed in following paragraphs).

- An immediate adjustment of the CTA base single journey ticket price from 25 Piasters to 40-50 Piasters is urged, with proportional increases for extended fares.

Under such an approach, organizational base cost (operations, interest) coverage would be at unity, while total costs (including depreciation) coverage would hover near 0.8. It is unlikely that such an increase could be implemented immediately or all at once; thus some form of temporally (but timely) staged approach might be more palatable.

It is fully understood by the Team that any increases in fares is an emotional issue. However, findings of CREATS surveys suggest that public bus users are receptive to paying higher base fares if service improvements are implemented. Some 60 percent of respondents indicated they would be willing to pay more for better services, with the highest proportion of responses being 25 Piasters[12] (Figure 4.3.11). A 30 Piaster change would, for example, increase the base fare to 55 Piasters, or a total similar to the average shared taxi single trip tariff.

Metro has different concerns. Firstly, base cost (operations, interest) coverage already exceeds unity, but total cost (including depreciation) coverage lies at 0.39. But the situation is more complex. Some one-half of users (as is the case with ENR suburban services) use a pass of some form, and of pass users, about one-quarter are students. CMO passes are issued under various categories, with differentiation between public and private sector. It is the understanding of the Study Team that this structure was largely inherited from former ENR policies. The problem is the average CMO yield per total passenger during the fiscal year ended mid-2001lies at 55 Piasters per single trip passenger, 29.6 Piasters per total passenger, and 9.4 Piasters per pass passenger. This is a huge differential between pass and non-pass passengers; typical experience suggests this differential should be on the order of 1.2 to 1.5, but for the metro it is much higher.

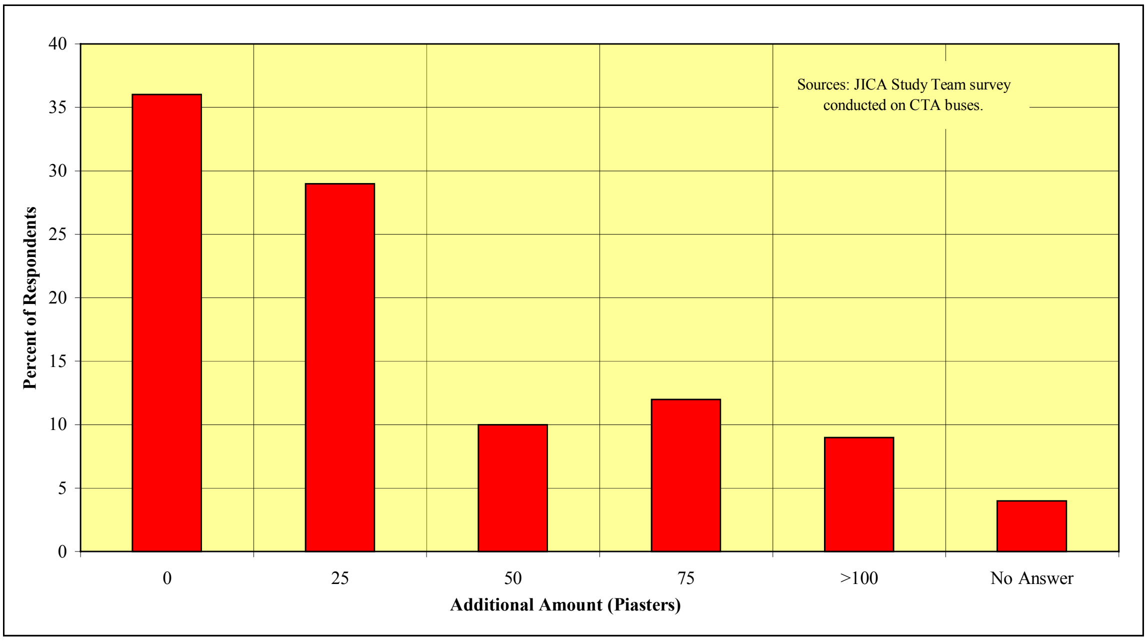


Figure 4.3.11 Willingness to Pay Higher Incremental Fare for Better Services CTA Bus Passengers

[12] Although one must concurrently note that some overseas experience suggests that surveys related to fare sensitivity can solicit positive responses to change options, yet support for the action may diminish during actual implementation.

- In the near term, a possible policy may be to hold single journey ticket prices relatively stable, and increase discounted/pass fares periodically above the rate of inflation (that is, pass costs increase more rapidly than single trip ticket costs) until more reasonable balance between single ticket and pass yields are achieved.

In the longer term the commercialization of the operator, and the associated rationalization of fare types as discussed previously, is the way forward.

In case of ENR, it is very necessary that suburban services accounting, and possible operations, be divorced from national operations as previously proposed. These are different systems with different goals and objectives. Only after suburban costs and revenues are clearly segregated from national accounts can appropriate financial strategies be outlined.

The current status of shared taxis should also be addressed. In short, it is unacceptable. Financial records, not to mention accurate financial records, are unavailable on a routine basis. It is not meant to suggest that government should intrude into the private sector, or stifle initiative. After all, shared taxis fulfill a valuable role within the overall Cairo public transport framework. Nor should the divulging of information be seen as part of a broader government conspiracy to impose unfair taxes or levy additional charges (formal or informal). Instead, if public and private sectors are to function in an integrated manner, government is expected to play a supervising and coordinating role, plus ensuring that adequate safety and environmental standards are met (which in turn implies various types of expenditures). Thus, a broad accounting framework should be established where, as part and parcel of operating agreements with the private sector, some form of annual financial accounting practices be followed. The shared taxi industry is a business, and as such it should conform to standard, accepted and transparent business practices.

(6) Information Dissemination

A central source of information for public transport services in a large urban area such as Cairo plays an important role in the retention and expansion of patronage. Public transport, faced with increasing competition from private modes of transport, is not an easy product to "sell"; certainly it cannot be marketed efficiently unless the potential user can easily determine what service is offered, where it can be obtained and how much it costs.

Key steps in the creation of a cohesive policy is to both increase the capability of individual operators, and to move information dissemination toward a multi-modal context. At present, information dissemination (in whatever forms it may exist) is, much as services, structured totally along modal lines. Yet, the overall public transport system is extensive. If no information exists for some elements of the public transport system, it is not possible to even begin to plan for multi-modal trips.

At present, and with the exception of the metro, there exists practically no information regarding formal public transport services. There is a pressing need to prepare such information for formal services, in particular the CTA/GCBC system. It is suggested that initially the CTA focus on "the basics", that is, build a solid, functional information system upon which, at a later date, more sophisticated approaches may be built.

- Printed information. The initial priority should be the development of an area-wide route map for CTA/GCBC bus and mini bus services[13]. The map should be of sufficient detail to permit the user to trace each route by number designation. A CBD inset on the same map is desirable as is general information about using the transit system. The CBD inset should clarify which routes use which terminal.

- The second priority should be development of pocket-size route pamphlets, one route per pamphlet. Information presented should include routing superimposed on major travel streets and cross-streets, schedule (if appropriate) at intermediate and termini check points, as well as major items of interest along the route.

- Signage. It is, as indicated earlier, highly desirable to implement a signage program at bus stops and, in cooperation with other operators, at terminals. This plan should be viewed as an expansion of the CTA program which currently provides upgraded bus stops. The key information which should be conveyed is which route stops here, where is it going and a time element (schedule and/or begin/end of service). Signage at terminals should be more comprehensive in terms of descriptive layout, multi-lingual content, operator designations and display of information.

- Public involvement. The role of public transport is to provide mobility for Cairenes. The scale and complexity of CTA/GCBC requires well-trained professionals to ensure appropriate execution of route planning and operation. The potential role of citizen inputs to these decision making processes should not be overlooked. The value of citizen input is already reflected in the development and evolution of shared taxi routes - which represent essentially a pact between vehicle owners and vehicle users. The CTA may well be able to harness such input to plan and/or assess route structures and operations via community/neighborhood meetings and on-board origin-destination surveys (refer previous section, Transport Action Plan).

The next step is to evolve toward more wide-reaching techniques, that is, the establishment of a Public Transport Information Service (PTIS). Most of the requisite steps do not require quantum changes in existing policies, only a recognition of, and support for, the importance of proper information systems. Within each of the participating operators, an Officer should be designated with overall responsibility for the coordination and planning of information services. Upon implementation of the PTIS, the Officer will be responsible for successful day-to-day operation, liaison with senior management and ensuring that all transport information is up-to-date. The PTIS can include various components:

13 It is understood that several years ago such a map existed, but was discontinued.

- A limited number of staffed, walk-in centers sited at strategic activity points such as, for example, Tahrir Square or Ramses Station. This requires a prominent ground level location either within an existing office or store building, or as a special facility. The main function would be personal, face-to-face interaction with the public and dispensing public transport information both to existing users and potential users. Center staff should furnish and dispense (a) timetables for routes and lines of all modes of public transport in Cairo, (b) information on transport routes, (c) information on fare structure, (d) transport maps for distribution and inspection, (e) promotional literature, (f) available services with particular attraction for tourists, (g) information which cannot be readily obtained from standard information handouts; and, (h) directions for further enquiries. An indicative layout for a walk-in center is shown in Figure 4.3.12.

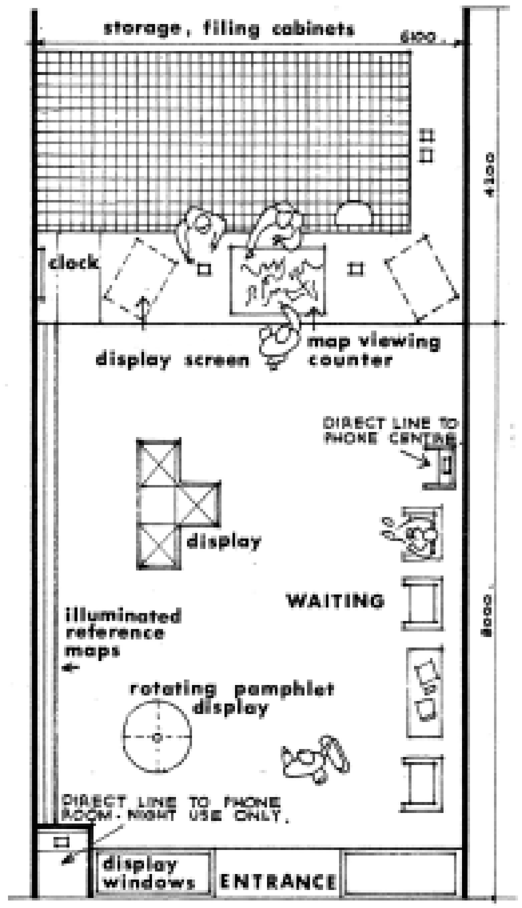


Figure 4.3.12 Indicative Layout Walk-in Information Center

- The use of computers and the internet is rapidly growing in Egypt. Properly designed web sites can be invaluable in providing information to users and potential users. Tokyo, as an example, has particularly advanced this art in the form of web pages and downloadable information files for personal computers. By entering trip origin and destination, the system finds the most efficient routing and modal options among the myriad of public transport services available in Tokyo. Key parameters such as travel time, expected waiting time and trip cost are provided. While it is unlikely that Cairo would require such a sophisticated system in the near future, web page content can nevertheless be readily be tailored to address the most pressing questions posed by system users. Such preferences need to be established via on-board surveys of passengers.

- A telephone information center whose only function is to answer telephone enquiries regarding public transport. The telephone center can therefore be located at any site where adequate space and telephone facilities are available. Trained telephonists manning the center should be in a position to provide (a) information on routes and lines for all modes of public transport in Cairo, (b) information on fare structure, and (c) directions for further enquiries including those not specifically related to public transport services. Modern equipment will be required to ensure efficient operation of the telephone center including an automatic call distribution system and a call queueing system.

- The key components of the PTIS would be walk-in centers, telephone centers and web sites. These can be supplemented by further secondary information centers. Such unmanned facilities, designed to furnish user-oriented information in the form of displays and printed pamphlets, can be located in key shopping centers, tourist information bureaus, post offices, major transport terminals/stations and other prominent locations.

As part of the overall marketing program, the provision of an "information bus" should be investigated. The bus would:

- Feature information racks, necessary storage areas, displays and manned information counter in a modified interior;
- Dispense information, timetables and route maps for all public transport services;
- Be staffed by persons knowledgeable of all public transport services;
- Make scheduled appearances at employment centers, major hotels, shopping centers, exhibitions/festivals, and sports events.
- Make guest appearances at institutions of learning and provide lectures/exhibits about public transport, and,
- Be decorated with a color scheme or mural setting it apart from other units in the fleet.

Effective public transport information dissemination in Cairo can be achieved.

(7) Automated Data Processing

Operators now use, to varying degrees, computers in the maintenance of data records and for strategic summations for managerial purposes. However, by and large, records are still maintained manually. The expanded application of computer software should be explored to increase planning flexibility and enhance decision-making processes for management.

Three major opportunities exist at the moment:

- The CREATS transport model. This model, although complex, has the capability of forecasting public transport demand for a variety of transit operating scenarios, route structures or modal hierarchies. It is intrinsically linked with the road mode, urban form and land use patterns, and thus has the ability to quickly evaluate both strategic and tactical impacts of operational changes.

- PC application utilizing local programming talent or public transport-specific software. The software packages developed abroad for the transit industry can serve as a repository of information or be engaged in demand estimation, revenue projection and route efficiency calculations. In addition, generic spreadsheet programs can readily be sensitized by operator staff to unique local requirements.

- Metro Line 2 fare collection equipment already records linked passenger boarding and alighting movements, by station. Line 1 fare collection equipment only records boarding totals; however, this technology is in the process of being upgraded to the same standard as Line 2. Once completed, origin-destination matrixes of metro passengers, sensitive to a variety of parameters, among them ticket type and time, can be produced for all stations. This is seen as a valuable data base to assist in operational fine-tuning, optimizing fare structure and other exercise. In conjunction with a limited number of passenger interviews, valuable information can be gleaned regarding modal interchange patterns or potentials, and the creation of feeder services based on actual passenger movements.

4.4 TRANSPORT AND THE URBAN POOR

The mandate of CREATS is quite clear and was established in a mutually consultative manner involving representatives of the Governments of Egypt and Japan. Thus, the focus of technical efforts relates to transport and its principal components; that is, hardware (infrastructure), software (policies, programs) and humanware (human resources). The JICA Study Team wishes, within the spirit of this agreement, to explore the unique transport considerations of the urban poor. It is again noted that the dominant focus of CREATS is transport planning, not poverty alleviation. Nevertheless, it is hoped the following discussion will indirectly contribute toward this noble goal.

4.4.1 Issues

(1) Representation in the Study Area

The CREATS Home Interview Survey was administered to some 57,000 households and 232,000 persons. A variety of data were obtained regarding socio-economic patterns, trip making and travel preferences, including modal choices. This represents the core database from which information regarding the poor is extracted. Poverty is usually thought of as a lack of income, but income poverty is only part of the picture. “Just as human development encompasses much broader aspects of life than mere income, so poverty should be seen as having many dimensions. Poverty cannot be objectively defined through the use of minimum level of income or consumption, but also involves people’s access to income and resources, and self-perceptions of their economic situation and position in society”[14]. Transport is seen as a key element of this broader perception.

[14] *Poverty, Employment and Policy-Making in Egypt: A Country Profile*, by Naglaa El-Ehwany and Heba El-Laithy, International Labour Office; North Africa Multi-Disciplinary Advisory Team, Cairo, Egypt,

Five income categories were tabulated within the HIS in terms of monthly household income in Egyptian Pounds (LE). These ranges are less than 300 LE, 300-500 LE, 501-1,000 LE, 1,001-2,000 LE and more than 2,000 LE[15]. CREATS analyses confirm that the year 2001 study area population aggregates to 14.295 million persons, of which 12.831 million are older than six years (the latter category is used in the calculation of trip production rates). The lowest income category (< 300 LE) contains almost one-third of the study area population, while the 300-500 LE range contains a further 4.5 million persons (age six and older). Thus, the lowest two income categories account for roughly two-thirds of the study area population. The highest income grouping (more than 2,000 LE per household per month), in comparison, accounts for only four percent of study area population (Table 4.4.1).

- **Issue: The urban poor represent, depending on definition, a large element of the study area population.**

Table 4.4.1 Year 2001 Study Area Household Income Profile

Household Income Grouping	Income Range (LE per Household per Month)	Number of Households (Million)	Number of Persons Older than Six Years (Million)	Percent Households	Percent Persons
1	< 300	1.086	3.948	31.2	30.8
2	301-500	1.211	4.510	34.7	35.1
3	501-1,000	0.583	2.148	16.7	16.7
4	1,001-2,000	0.472	1.766	13.5	13.8
5	> 2,000	0.134	0.459	3.8	3.6
Total and Average		3.486	12.831	100.0	100.0

Source: JICA Study Team.

(2) Prime Modal Choice

Household income bears a strong impact upon which modes are used to undertake a trip. The walk mode is most heavily used by the lowest income grouping (< 300 LE/month), accounting for some 36 percent of unlinked trips[16]. In comparison, walk trips account for only about 10 percent of unlinked trips made by households in the highest income grouping. Public transport trips are pronounced for households with incomes up to 1,000 LE per month, accounting for roughly 50-55 percent of unlinked trips. While the use of public transport decreases as household income increases, it is noted that in the Cairo context even the highest-income households use public transport for roughly one-fourth of unlinked trips. The use of a car and taxi is minimal at lower income groupings, but grows quickly accounting for almost 60

October 2001.

15 A separate category of 2,000-4,000 LE was included in the HIS form, however, was merged with the preceding category due to the very few number of samples obtained.

16 Unlinked trips include all journey elements (generally by different modes) made as part of a single trip linking origin with destination. In terms of public transport usage, unlinked trips may be equated with fare payments. Thus, a single linked trip from home to work could, for example, include four unlinked trips and two public transport fare payments (walk, bus, metro, walk).

percent of unlinked trips undertaken by the highest-income household grouping (Figure 4.4.1).

- **Issue: Public transport emerges as a viable option for public mobility, more so for lower income groupings.**

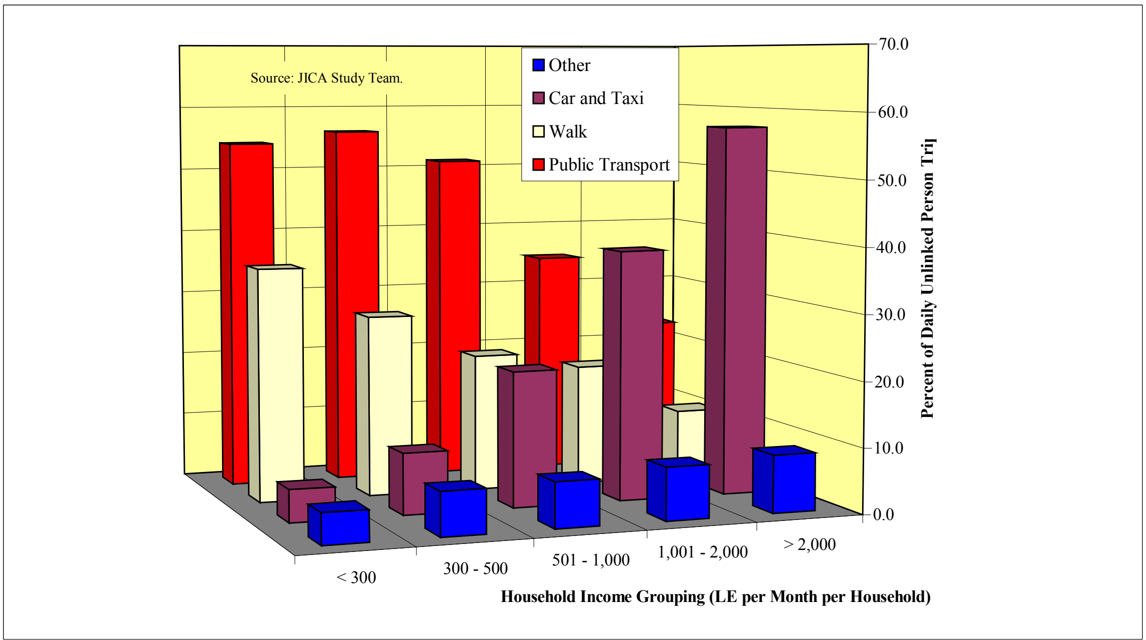


Figure 4.4.1 Study Area Modal Use by Income Grouping

(3) Trip Rate

Not only do modal choices differ among households in varying income groups (lower incomes rely more on public transport), but the intensity of trips differs. Trip generation for the entire study area averages 1.64 daily linked trips per person older than six years of age, of which 0.65 trips (39.4 percent) are classified as home-based work trips (that is, either trip end located at the home, the other at the indicated place of work). Trip making increases with income; for the lowest income category (less than 300 LE per month), average generation is 1.38 linked trips per person per day. This increases steadily, culminating in 2.34 linked trips per person per day for the highest income grouping (above 2,000 LE per month). Furthermore, the ratio of home-based work trips increases with income. For the lowest income grouping, work trips represent 35.1 percent (0.48 linked HBW trips per person per day) of total trips, while for the highest income grouping, work trips represent 47.0 percent (1.10 linked HBW trips per person per day) of total trips (Figure 4.4.2).

- **Issue: Trip generation appears linked with income, with the urban poor making less trips than other segments of society, with the majority of those trips being via public transport (and walk) modes.**

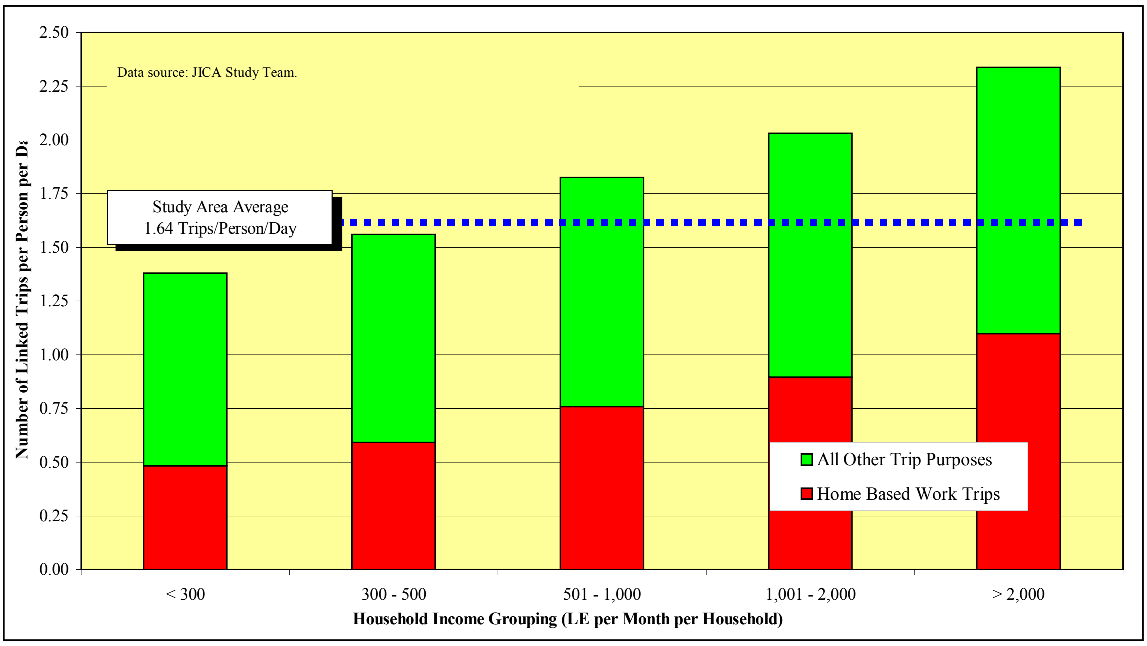


Figure 4.4.2 Study Area Trip Generation by Income Grouping

(4) Public Transport Preferences

Thus, for Cairo, public transport emerges as a viable option for public mobility, more so for lower income groupings. The types of modes used also apparently varies across income groupings. However, it must be remembered that the term modal choice is rather arbitrary; poorer areas, which tend to be clustered in the northern extremes of the study area, may not have access to, for example, CTA and metro services; this would imply considerable reliance upon shared taxis (de-facto modal captive). Usage patterns apparently support this supposition. The use of the shared taxi mode is dominant among the lowest income groupings, accounting for more than 50 percent of unlinked public transport trips by households with monthly incomes of up to 500 LE. Conversely, use of the metro grows with increasing incomes, while public bus/minibus utilization is relatively constant across all income groupings (Figure 4.4.3).

- **Issue: The shared taxi mode emerges as the most-used means of public transport for the lower income groupings. This, in turn, is likely influenced by the type and extent of public transport services available to serve the lower income areas of Cairo.**

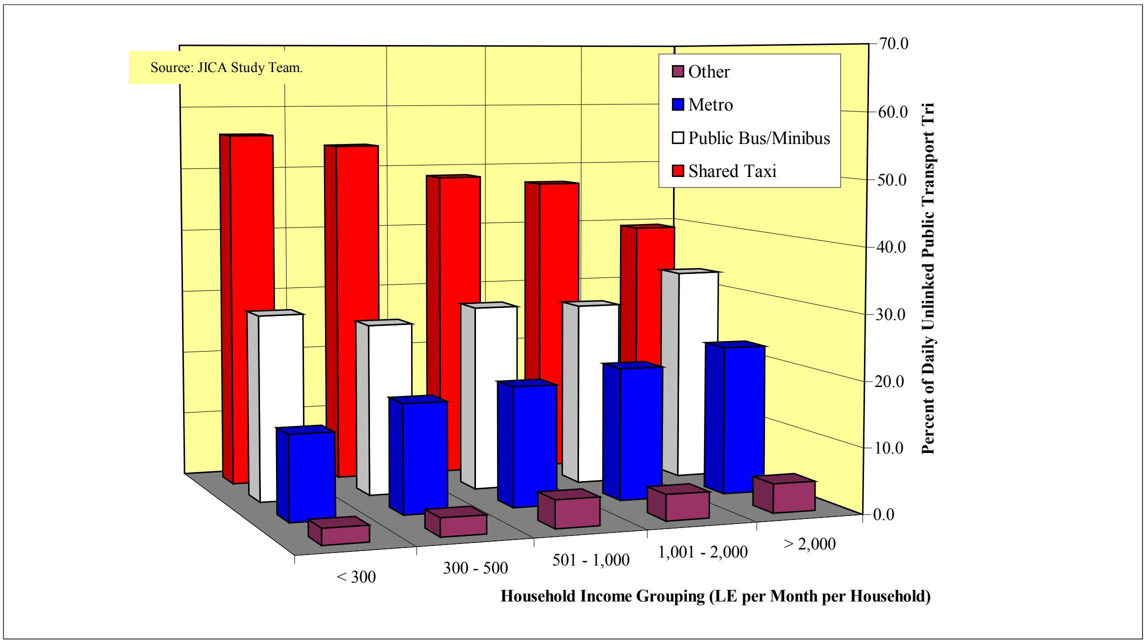


Figure 4.4.3 Study Area Public Transport Usage by Income Grouping

(5) Public Transport Cost

Several trends apparently are emerging. First, lower income households make less trips, predominately via public transport with a strong inclination toward shared taxi services. This would appear to catalyze costing impacts. The Public Transport Passenger Survey, during which more than 6,100 persons were interviewed at 105 public transport terminals to obtain a clearer understanding of modal choices and preferences, has found that shared taxi and metro modes are among the most expensive choices (ignoring the premium air conditioned bus services). This holds true for both single journeys and multiple journeys, as, for example, two consecutive modes (however, metro fares are very discounted when pass usage is considered although higher "up front" pass purchase costs likely restrict their affordability for the urban poor). For single trip tickets, average metro and shared taxi fares hover between 55 and 60 Piasters. These findings are very consistent with reviews of formal operator records as well as results of the Transport Network Survey, during which average single-trip shared taxi fares were monitored via some 2,000 on-board journeys. Findings suggest that the mathematical average for shared taxi is 56 Piasters, while formal bus sector statistics yield averages of 31, 40 and 46 Piasters for CTA bus, GCBC bus and CTA minibus services, respectively.

It may therefore be surmised that lower-income households make less trips, but more by public transport, and with a higher reliance on the more expensive shared taxi mode (vis-à-vis public bus or minibus). Conversely, higher-income households make more overall trips, less so by public transport, but with increasing reliance on the more expensive (in single trip ticket terms) metro. The HIS queried households on public transport expenditure patterns for public transport services using single tickets and multi-trip (reduced fare or free) passes. Compilation of results suggests that, for all income classes, average monthly expenditure on public transport varies from between 31 and 42 LE. The uniformity of these totals reflects the previously-implied interplay of number of trips, trip length and choice of public transport modes. However, what is most interesting is that households with lowest incomes (less than 300 LE per month) spend an average of 31 LE per month on public transport; assuming an average income of 200 LE implies that some 15.3 percent of household income is consumed by public transport spending. The average income for the lowest income grouping cannot be calculated more precisely as only income groupings were queried by the HIS; however, even if the average income were 250 LE, public transport outlay would still represent 12.4 percent of income, a total considerably above that noted for other income groupings (Table 4.4.2).

Table 4.4.2 Study Area Average Expenditure on Public Transport

Household Income Grouping	Income Range (LE per Household per Month)	Estimated Mean Household Income (LE)	Public Transport Outlay (LE per Month)	Outlay as Percent of Household Income
1	< 300	200	31	15.3
2	301-500	400	38	9.5
3	501-1,000	750	41	5.5
4	1,001-2,000	1,500	34	2.3
5	> 2,000	4,000	31	0.8
Average			35	5.2

Source: JICA Study Team

- **Issue: Shared taxi services are considerably more costly than public bus services, yet they are the most-used form of public transport by the urban poor (whether of necessity or desire). Thus, a larger proportion of poorer residents monthly income is consumed by fare payments for public transport services.**

(6) Social Safety Net

Poverty and unemployment combating has become a crucial goal of national action. To achieve this goal, many partners share the responsibility and participate in generating employment opportunities, directly or indirectly. These partners include governmental ministries and funds, the private sector and non-governmental organizations.

Various form of assistance are available to the under employed, handicapped or socially disadvantaged. These are sponsored by several ministries, with the Ministry of Social Affairs and Insurance playing a central role. The disadvantaged tend to be classified by condition, that is, blind, handicapped, mentally retarded, elderly and pensioner. Such individuals are registered with the Ministry, which in turn allows them to take advantage of special fares offered by public transport operators. However, the Ministry does not financially support or reimburse the operators, instead, availability of discounted fare is a matter of law with financial implications thereof being the responsibility of the public transport provider. Some assistance is also available to the poor, which are designated as families earning less that 50 LE per month. In such instances, and once registered, the families are paid a cash subsidy for the differential between 50 LE and actual earnings. However, practically speaking, this definition should more accurately be termed as minimum subsistence rather than poor. While exact statistics are not available, the Study Team was informed that possibly some 600,000 families are registered for this benefit, with most located in rural areas throughout Egypt.

Some forms of assistance, training and job placement are also available from the governorates, or other ministries among them the Ministry of Health, the Ministry of Manpower and Migration, the Ministry of Youth and the Ministry of Education. It is also understood that some 9,000 social organizations, charities and non-governmental organizations are registered with the Ministry of Social Affairs. These provide a variety of (voluntary) services to persons meeting the individual organizations criteria.

- **Issue: While various types of social services are provided, it is understood that none specifically address transport needs of the poor or socially disadvantaged. Instead, any discounted public transport fares for which these subgroups qualify is legislated by law and the financial responsibility for the carriage of such persons is borne of the operator.**

4.4.2 Approach

These findings raise important questions. For example, fare levels in the formal public transport sector are not merely controlled, they are virtually frozen, ostensibly for the benefit of poorer Cairenes. While some segments of the population have undoubtedly benefited from this, paralleling problems have arisen. In particular bus operations, and formal urban transit in general, are yielding insufficient cash flow to allow upgrading of services and fleet renewal. Concurrently, public operators (particularly the formal bus system) are coming under increasing pressure to provide enhanced/expanded public transport services, but with largely stagnant revenue sources. The effects of such policies are clearly manifested in the deteriorating quality of public bus services provided in Cairo.

One might argue that frozen fares have indeed hurt, not benefited, certain segments of the poor, particularly those residing in more outlying portions of the study area. Reduced (or infrequent) public bus services (catalyzed by constrained income of the operator) implies increasing reliance on more expensive shared taxi services. So, in effect, frozen fares on formal public bus services result in higher out-of-pocket payments by some segments of the urban poor due to the necessity of using informal public transport services.

Alternatively, the urban poor, or some elements thereof, may be using the more expensive shared taxi services as a matter of choice, not of necessity. Shared taxi services, which predominately use microbuses, have some advantages over formal operations. They change their schedules and deviate from routes in response to consumer demand and congestion (although they may be legally prohibited from doing so). They can negotiate traffic more easily than large buses, and consequently can run more frequently than formal services. Microbuses are more likely to provide guaranteed seats to their patrons, and are more accessible within a short walking distance than some formal services. Finally, they can provide services in areas where CTA does not or cannot operate. CREATS surveys on public buses also concluded that users are willing to pay more for better services; if the most-indicated additional amount (25 Piasters) is added to the existing average CTA single-ticket bus yield (31 Piasters), the result is very comparable to the typical shared taxi ticket fare (56-58 Piasters).

Nevertheless, the argument that the urban poor are socially disadvantaged is undoubtedly valid, and that some form of transport-focused government assistance or support is likely warranted. One point relates to the type of support; for example, the adoption of more practical ways to providing subsidies to the urban poor rather than freezing public transport fares at unrealistically low levels (from the operators perspective). The second point relates to ownership. Given that formal public transport operators are government-owned, there exists the implied right to set fares at whatever level the owner desires. However, the ramifications of such political decisions should not be allowed to undermine operational concepts which the operator must implement if a reasonable level of public transport service is to be provided to the public. The government may set any fare it wishes as the owner of the formal system; however, it must concurrently be committed to compensating the operator for revenue shortfalls catalyzed by such political decisions. Any other approach will have the main effect of reducing the quality, and eventually the quantity, of formal public transport services.

4.4.3 Action

The remaining question is therefore if the Government of Egypt wishes to subsidize public transport travel for a targeted group of society (and that the commitment has been made that it can indeed afford to do so), how may this be achieved most efficiently? There are no easy answers and available evidence suggests that approaches must be tailored to local norms and perceptions.

(1) Targeted Subsidy

The need for the commercialization of formal public transport services has been noted in other sections of this chapter. This carries the implication that operators and the government could enter into more targeted arrangements regarding transport of the truly poor. This can be achieved through the structuring of the performance agreement or more direct means such as direct subsidies to qualified sub-groups. The tendering of lines or services to the private sector may also evolve once the commercialization has begun to be implemented.

- One of the most effective means of providing a subsidy to low-income citizens, while maintaining the incentive for operator efficiency, is to provide the subsidy directly to the person - not the enterprise. A similar approach should be found for Cairo.

In that way, fares can be set at a commercially viable level (as proposed in other sections of this chapter), and operators would continue to pursue efficiency measures as built into the performance agreement. This was achieved in Peru, for example, whereby tickets were sold at kiosks and other outlets around the city and neighborhoods at a reduced price which was considered affordable to the population. The bus companies would redeem these with the regulatory agency and receive the commercial value of the ticket which had been agreed to in the performance agreement. The amount of income received by the operator was directly linked with ridership and profit was related to operating efficiency. This subsidy is financed by a special municipal tax on gasoline, thus reducing the amount of payments from public coffers. While a subsidy reduction was achieved following enactment of the special tax, the main disadvantage of this approach is that it does not truly focus on the urban poor, but rather can be used by any purchaser.

In Brazil, it is felt that no one should spend more than six percent of their salary on public transportation. The figure of six percent was derived at arbitrarily through negotiations with labor leaders and business. This is seen as a conservative amount, as most studies conducted world-wide indicate that a figure of 10 to 12 percent of income is a more realistic figure for low-income households to spend on transportation before it becomes an unrealistic burden. In Cairo, as a comparison, the estimated public transport cost share is 10-15 percent for the lowest two income strata. Consequently, legislation was passed so that all major employers would provide a subsidy directly to workers equal to the difference in their transportation costs and six percent of their salary. The employer could then deduct this expense from income taxes. This had the advantage, similar to that in Peru, of being a subsidy directly to the user, while public transport operators had the incentive for efficient operation in order to reduce costs and maximize ridership. The main disadvantage of the Brazil system is that it only reaches workers employed in the formal sector, and not necessarily the poorest.

In France, a tax is levied on businesses and collected by the local governments. This revenue is used to subsidize transport operators that operate under franchise agreements with the local transport authorities. The franchise agreement stipulates the fare that can be charged (less than what would be necessary to fully recover costs) and the remaining costs are paid by the transport authority to the public transport operator in a manner agreed to in the contract (performance agreement).

The importance of a central transport authority, with revenue-raising or revenue distribution responsibilities, is a noted in these examples. This issue is also discussed in Chapter 9 of this volume, *Institutional and Organizational Matters*.

Unarguably the best way to directly target the urban poor in Cairo is to incorporate transport into welfare programs offered by, say, the Ministry of Social Affairs. Three hurdles must be overcome (a) the required organizational adjustments, (b) the need to develop a realistic criteria for what is urban poor, and (c) a willingness on the part of the Ministry to accept this adjustment. While these can be difficult steps, they are not impossible particularly once political consensus is reached that a commercialization of public transport operators is required to ameliorate growing direct subsidies, and that some form of targeted assistance to the urban poor is needed.

The following courses of action seems achievable.

- A realistic definition of urban poor must be established (the Study Team would suggest that, in the first instance, perhaps 300 LE per household per month seems reasonable, that is, those Cairenes spending some 15 percent of household income on public transport).

- These individuals would, as other socially disadvantaged persons at present, be registered with, and receive an identify card from, the Ministry of Social Affairs.

- Reduced prices for the poor (and socially disadvantaged) can be achieved by the Ministry issuing free of charge, or at reduced cost, a, say, monthly pass on a given mode. This pass would have been purchased by the Ministry from the operator at commercial prices. Thus, it is at the discretion of the Ministry as to how much discount is given to qualifying persons.

- Alternatively, persons with proper identification can directly pay a reduced rate to the operator, with differential reimbursement for each fare guaranteed to the operator from the government as part of the performance agreement. The main disadvantage of this second approach is that the operator incurs additional expenses associated with ticket collection and processing.

(2) Service Patterns

The evolution of public transport structures in Cairo have not impacted the poor uniformly. The inner city poor living close to dense public transport services will suffer little from lower frequencies from any given operator, since multiple opportunities exist. These users will, however, benefit from lower fares via targeted subsidies. On the other hand, those poor who live on the urban periphery where public transport services are less dense, or insufficient for their needs, are likely to be worse off as normal services deteriorate significantly or are withdrawn – even if fares were to be lowered. The inner urban poor, which are often located near employment opportunities, are also less likely to make more complex trips with multiple interchanges. The urban periphery poor, on the other hand, are more likely to require modal interchanges which can be expensive if fares are not coordinated, thus reducing considerably the affordability (hence access to jobs) of public transport services.

- The discussion on intermodality (the ease and cost of public transport interchange) contained in Chapter 7 of this volume, is particularly relevant in case of the urban poor, particularly for those Cairenes residing in more outlying areas of the study area.

A restructuring of public transport services under which, in essence, formal public transport services focus on major corridors of demand, while the private sector, under an area franchising system, provides more local area (not necessarily route-specific) services, has been proposed. This carries important implications for the urban poor. Firstly, the issue of intermodality again becomes important, particularly for those Cairenes living in more outlying areas, where interchange between local services and higher-order corridor modes is more likely to be required. Secondly, the private sector, whose operation is profit oriented, is likely to set competitive fare levels which strike a balance between needs (and capabilities for payment) of the public and intensity of service. Thus, fares may well be less than that of formal (premium) operations. Thirdly, the private sector should not be limited to specific vehicle types or necessarily fixed routes. As an example, the variety of public transport types available in Bangkok have previously been noted (demand-responsive motorcycle taxis, three-wheeled tuk-tuks, converted small trucks, microbuses) which tend to ply more readily (and affordably) poorer areas and along much smaller roads (paths) than possible for formal services. Fares are almost always a matter of negotiation. Such services, and related activities, often also provide employment opportunities within the catchment they serve.

- Under such an arrangement, the role of government would revert to a supervisory nature, that is, ensure that services are carried out adequately, meet safety and environmental norms, and that predatory practices do not develop.

Should the government feel that the level of provided services is, for whatever reasons, inadequate, then alternative arrangements can readily be made in the form of contracted arrangements, framed in terms of a performance agreement.

4.5 OWNERSHIP

Dramatic transformations have occurred in recent years in the relative balance between public and private modes of transport. This section reviews options as to how these two types of ownership can be reconciled into a cohesive transport system.

4.5.1 Issues

(1) Market Evolution

In many evolving countries, public transport services have their origins in the form of a total governmental monopoly. Although the details of history vary by country, commonalities tend to emerge. In many cases, government-owned public transport companies are used as an instrument of social policy by guaranteeing working conditions for (government) employees, dictating service structures and constraining fare levels. Examples abound of the consequences. As deficits mount, and in the absence of a secure base of subsidies, first maintenance, then service reliability and finally operating capacity are negatively impacted.

Within recent years a paralleling global tendency has been toward liberalization and reform of the economy, in some cases dramatic changes (such as in the former Soviet

Union) and in some cases gradual opening of markets. Market liberalization catalyzes impacts upon public transport operations in that often the private sector is permitted to provide public transport services. Typically this entails operations using modes of low entry costs, that is, small vehicles such as minibuses or microbuses. A very similar pattern has emerged in Cairo.

Shortfalls in public operations, and liberalization of regulations pertaining to private sector participation in public transport operations, combine to create market opportunities for the private sector. The private sector owner is typically very profit oriented and the fact that smaller vehicles are (at least initially) used presents further advantages over formal public operations. As in Cairo, they change their schedules and deviate from routes in response to consumer demand and congestion. They can negotiate traffic more easily than large buses, and consequently can run more frequently than formal services. Finally, smaller vehicles can provide services in areas where public services, using large buses, do not or cannot operate. The ability of the private sector to function in a more responsive manner in a competitive market place catalyzes, in turn, increasing strains upon the public sector operator. Frequently radical calls for change in the manner in which public and private sector transit services result. Thus, a linked and cascading series of events has crystallized (Figure 4.5.1).

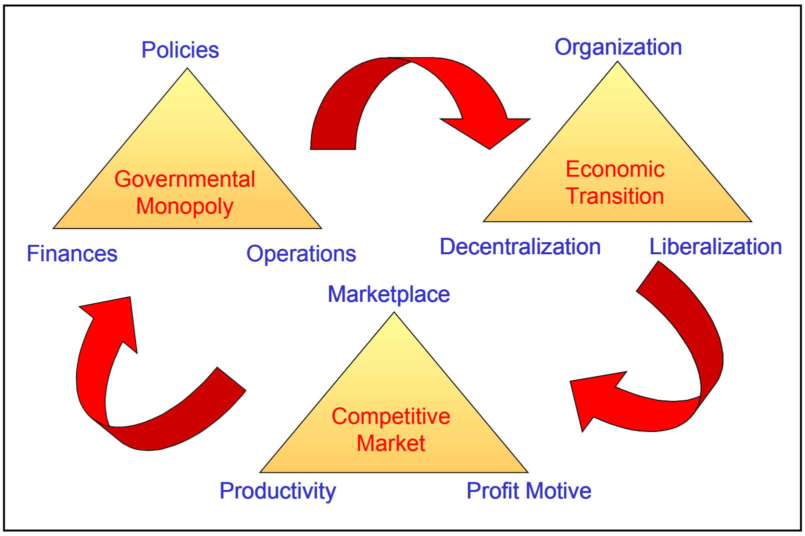


Figure 4.5.1 Evolving Public Transport Market Scenario

- **Issue: In Cairo, as in many evolving cities, economic adjustments and market liberalization have impacted many sectors, including the provision of public transport services.**

(2) Modal Connectivity

Walk forms the dominant access mode across all trip purposes. There is little formal coordination among motorized public transport modes; while routes/lines will intersect at major stations or terminals, there is no formal planning in terms of service coordination or passenger transfer needs. The private sector shared taxis, being responsive to patron needs, have somewhat (if informally) evolved as a feeder mode for higher-order systems. They are the dominant secondary access mode (after walking) being used for some 20 – 30 percent of primary mode journeys (Figure 4.5.2).

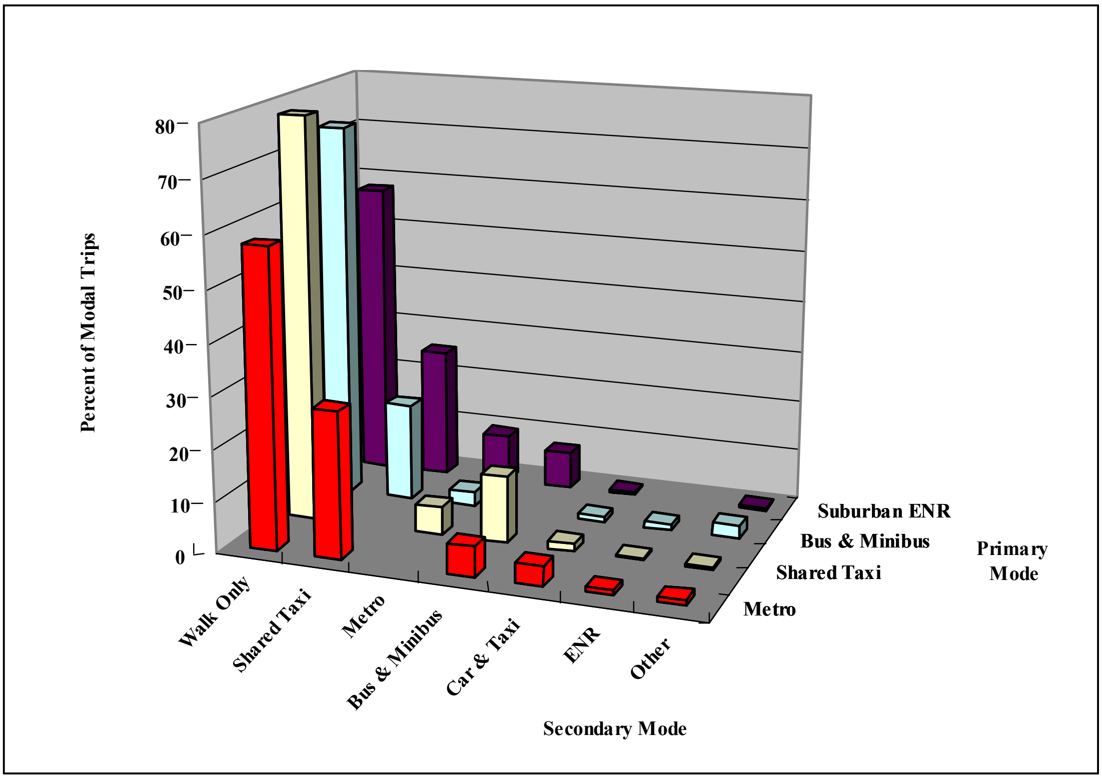


Figure 4.5.2 Year 2001 Modal Interchange Pattern

A review of shared taxi service patterns, obtained via CREATS surveys, confirms that the actual (as opposed to licensed) shared taxi route traverse (length) is a modest 24 minutes, that some 78 percent of passengers board at the route terminus point (a further 22 percent of passengers board along the route) and that average passenger trip length on the shared taxi is 6.1 kilometers, shortest of the major road-based transport operators. In fact, some 50 percent of shared taxi passenger trip length is four kilometers or less (Figure 4.5.3).

- **Issue: The private sector shared taxi services are adaptable to market demand, and appear to already fulfill a de-facto feeder role for higher-order forms of transport via short and medium length routes.**

(3) Licensing Procedures

Shared taxi services are licenses by Cairo Governorate (under the jurisdictional umbrella of the CTA), Giza Governorate and Qalyobeya Governorate Based on information received from these entities, near 20,000 shared taxis are licensed, including some 237 routes as well as over 8,000 microbuses in Cairo Governorate (Table 4.5.1). In case of Qalyobeya Governorate, routes outside of the CREATS Study Area are included; examination of the full Governorate system, and discussions with Governorate representatives, confirms that the majority of the

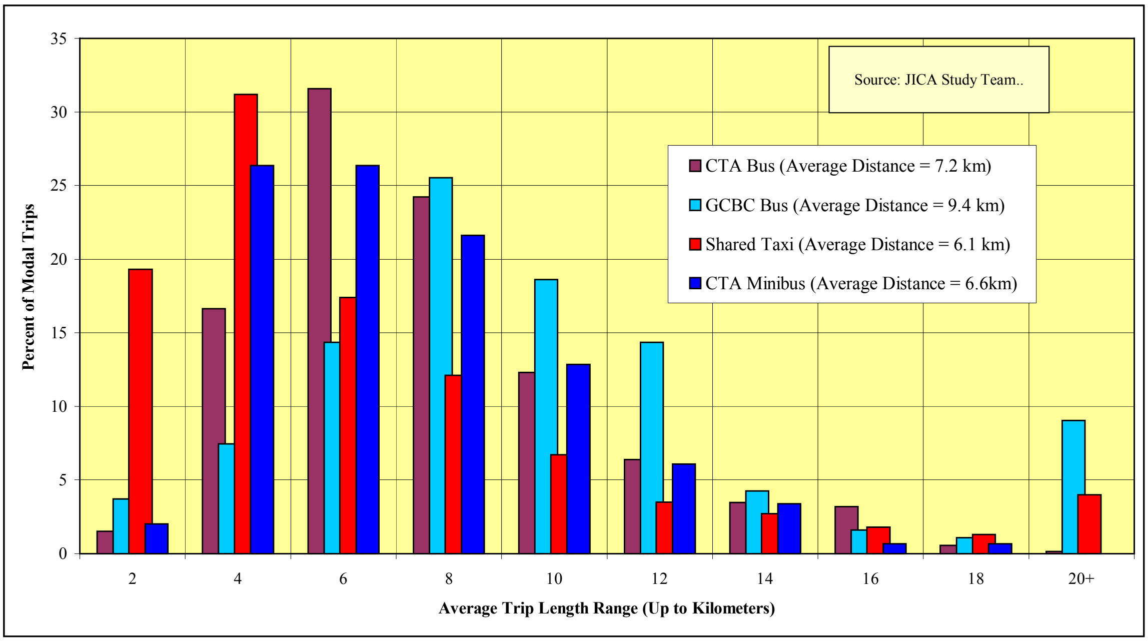


Figure 4.5.3 Year 2001 Average Passenger Trip Length by Road Public Transport

Table 4.5.1 Year 2001 Registered Fleet Size
Shared Taxi Services

Governorate	Vehicles(1)	Routes
Cairo(2)	8,078	237
Giza(3)	5,000	75
Qalyobeya(4)	6,325	158
Total	19,403	470

(1) Vehicles are predominately 11or 14 seat microbuses, although in case of Qalyobeya Governorate, about 30 percent of the fleet is indicated as consisting of seven-seat Peugeot sedans.
(2) During May, 2001
(3) Understood to be based in Giza City.
(4) Total Governorate, including those part outside of the CREATS study area.
Data sources: CTA, Giza Governorate and Qalyobeya Governorate.

Governorate shared taxi route structure indeed serves areas outside of the CREATS Study Area. Thus, realistically speaking, some 350 shared taxi routes may be considered as being licensed and located within the study area.

The licensing information identifies 173 terminals (route termini); in fact, field investigations reveal that some 24 terminals operate as intermediate stops along some routes. Thus, within the study area, a total of 149 shared taxi terminals are identified:

84, 55 and eleven in Cairo, Giza and Qalyobeya Governorates, respectively. Further field reviews established that, at the Cairo and Giza Governorates terminals, 536 routes operate instead of the licensed 312. However, some routes do not operate full time; thus, the apparent full time structure consists of 503 routes. Field investigations confirm that a marked tendency to deviate from licensed routes exists.

- **Issue: Historic attempts to restrict shared taxis to specific licensed routes have not met with unbridled success. Instead, and understandably so, the private sector operators, being responsive to patron desires and apparently somewhat dismissive of bureaucratic controls, tailor routes and operations to patron desires and revenue maximization.**

4.5.2 Approach

The process of reform is not only limited to two extremes, public monopoly and totally free market. Instead, a variety of regimes are possible which draw on the strengths and capabilities of respective sectors in order to provide a responsive and adequate level of public transport service to the populace. Shown in Figure 4.5.4 are the major regimes, along with various transition catalysts. In essence, the main "axes" of the process are determined by a desire to exert less control (regulation), expend less public funding, or a combination thereof. The main regimes are[17]:

- Public Monopoly: In this regime transport operations are exclusively provided by an operator enjoying a permit from a public agency without having to compete for the permit or having to face service competition from other operators.

- Gross Cost Service Contracting involves the procurement of specified services by a public authority from an operator at a price determined through competitive tendering. Contracts are usually for three to five years. The operator passes all on-bus revenues to the procuring authority and does not take any revenue risk. It requires a secure means of ensuring that the procuring authority actually gets any fares that are paid on the vehicle, and careful monitoring to ensure that suppliers actually do provide the service for which they have been contracted.

- Net Cost Service Contracting is similar to gross cost contracting except that the operator keeps the revenue and hence incurs both the revenue and supply cost risks. This increases the incentive to the supplier to provide the service contracted for and obviates the need for complex fare collection and security arrangements. However, it makes modal co-ordination more difficult, and often involves higher net cost for the authorities as the supplier is incurring an extra risk, the revenue risk, against which he is averse, and for which he will require remuneration.

[17] This discussion draws from *Cities on the Move: A World Bank Urban Transport Strategy Review,* by the World Bank, Washington DC, 2001 (draft); and *Review of Urban Public Transport Competition*, for Department for International Development, by Halcrow Fox Limited, 2000.

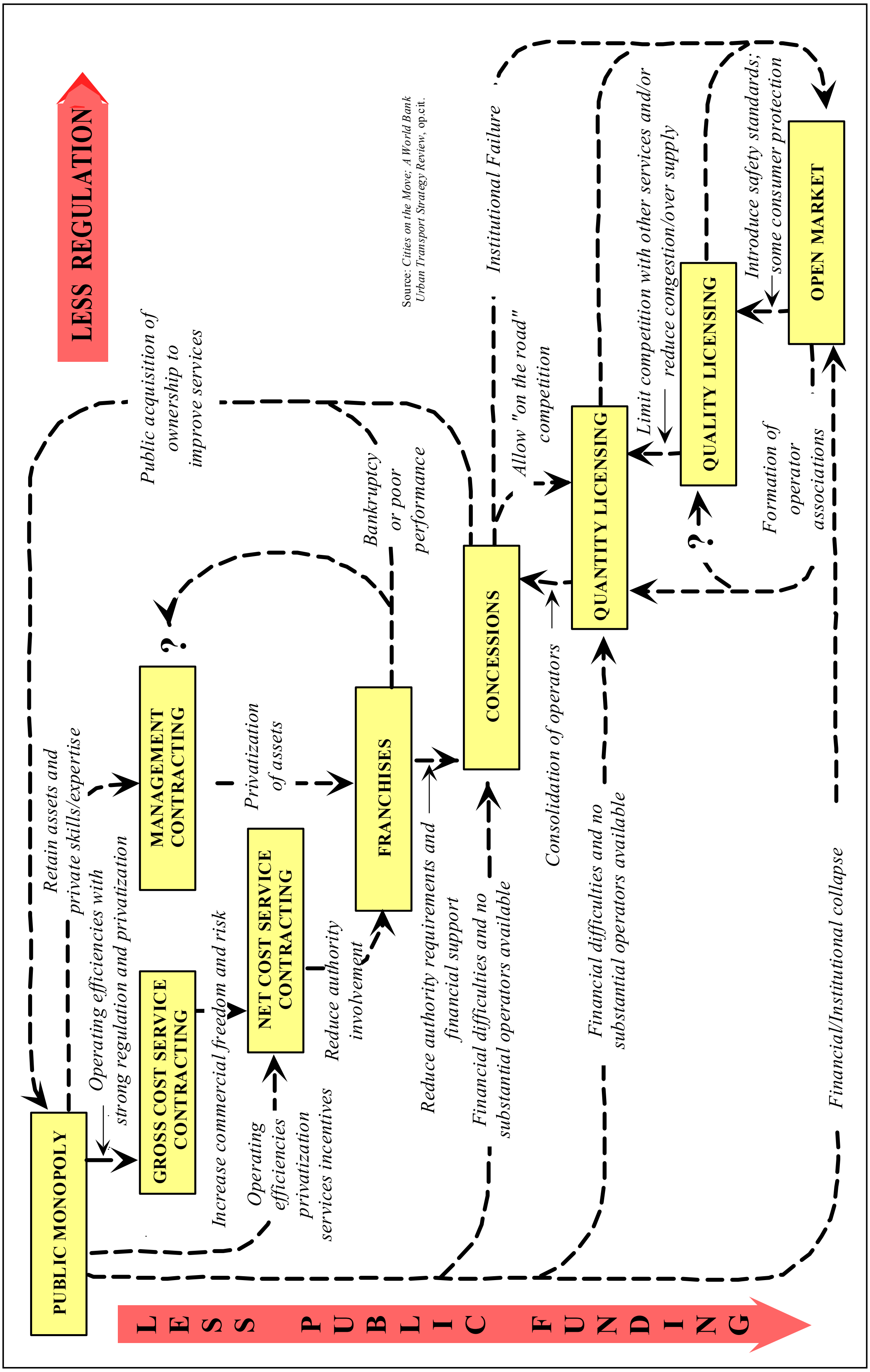


Figure 4.5.4 Urban Public Transport Competition: Regimes and Transitions

- Management Contracting involves operator responsibility for the management of operation of a system, possibly including service specification, within agreed parameters. Operational assets are usually owned by the authority, though the operator may be responsible for their procurement and maintenance, as well as negotiating labor wages and conditions. Inter-modal coordination is relatively easy to achieve with this device, and so long as the payment arrangements are well structured there is a high incentive to provide high quality of service to attract customers. The weakness is that the competitive pressure may be fairly weak, trade union power relatively strong and costs relatively high.

- Franchising involves the grant of an exclusive right to provide a service meeting a number of general quantity, quality, and price standards laid down by the authority, usually as a result of a competition. The franchise may be for a self-contained area such as a suburban area or geographic sector, but it is also possible to have route franchises - especially with fixed track systems. They differ from service contracts in allowing the contractor a greater degree of freedom to develop the system. The franchisee may have to be paid by the authority to provide service and fare combinations that are not commercially viable.

- Concession involve the granting of an exclusive right to provide a service but without payment by the authority although the authority may attach conditions such as maximum fares or minimum service requirements. In all other respects the concessionaire is acting on his own behalf and not as an agent of the authority. Contracts are usually for rather longer periods often ten years or more, to allow the contractor to benefit from his development of the market.

- Quantity Licensing specifies the number of vehicles allowed to operate a defined type of service, or in a defined area. There may be several operators providing services. This means that the licenses will have a value as a “business asset”: a value that may be charged for by the licensing authority, or when the licensee sells it. Where quantity licensing is practiced it will usually be in addition to some form of quality licensing.

- Quality Licensing implies the operation of a public transport service by anyone receiving a license and complying with any conditions attached thereto. These conditions may include vehicle specifications, environmental performance, maintenance standards, type of service to be operated, fares and other practices.

- Open Market implies no restrictions on transport operators except those imposed by general law on business practices, vehicle construction, use of highways and traffic matters.

In general terms, all of the above regimes may be applicable to bus services. In case of rail services, public monopoly, gross and net cost service contracting, management contracting, franchises and concessions may be appropriate. Quantity licensing, quality licensing and open market are typically associated with more informal paratransit operations (such as the Cairo shared taxi system).

4.5.3 Action

Recent Cairo history confirms that the performance of the private and public bus sectors has diverged. Public services have, by and large, seen an erosion of their patronage base for reasons discussed elsewhere. Private operators, in particular shared taxis, have, on the other hand, experienced an unprecedented boom in patronage. Subsidy needs of the formal sector continue to increase. It has been voiced to the Study Team in a number of instances that public operations should be immediately privatized, hence removed from public coffers. However, it is unlikely that such a radical formula will meet with success due to any number of practical and political constraints. However, a more preferred approach is to design a system that combines the relative strengths of public transport service by both the public and private sectors. There is no reason why public and private sector companies should not co-exist and compete on equal terms in a liberalized market. Indeed, the proposed approach presents a step-wise strategy for a transition approach along the path to privatization (Figure 4.5.5).

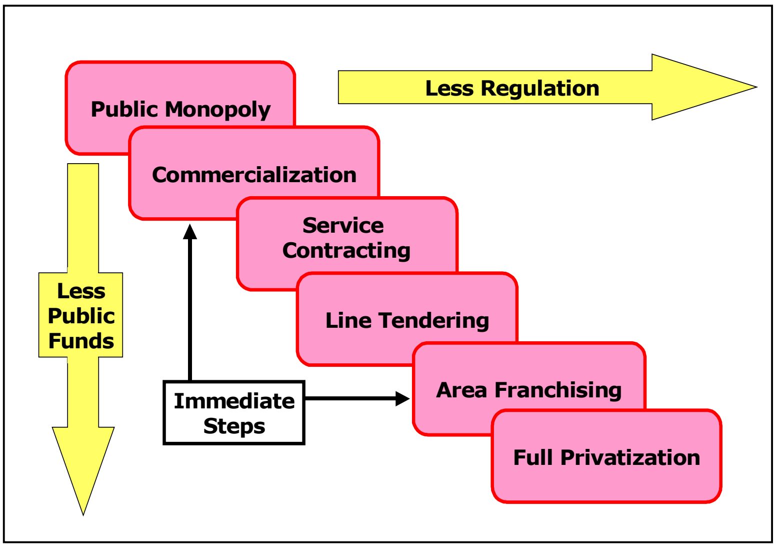


Figure 4.5.5 The Path to Bus Sector Privatization

- **The ultimate goal is to provide the best service at the least cost to government developed around a model where the government's eventual role is that of strategic planner, coordinator and regulator, and that the private sector is responsible for the actual operation of services under minimal regulation and in a competitive environment. As this goal is not seen as being implementable in the immediate future, a series of steps should be followed which re-shape the current industry into a more effective structure and encourage gradual transition toward the ultimate goal and privatization.**

(1) Commercialization

The vital initial step is the depoliticization of operations; that is, separation of regulatory and operational responsibilities to reduce adverse effects of well-meaning (but possibly misguided) governmental intervention in public transport operations. This entails, in the first instance, the reconfiguration of the CTA as an independent entity, with the important objective of setting the company at 'arms length' to the state and giving it more commercial freedom (refer Section 4.3). The state would, however, retain full ownership. The company would be allowed to borrow money from other sources. A performance agreement is established between the state and the company. This more clearly defines the roles of the two parties with the state as the 'buyer' of the bus services and the 'company' as the seller. The company is encouraged to be structured in a similar manner to private companies i.e. with separate business units, whereby it becomes more clear which part of operations is more cost-effective. A performance agreement and contract should contain several main elements: (a) a description of the service asked for, (b) the way the performance is monitored, (c) the payment associated with the provision of those services and the terms and conditions for investment in new vehicle fleet, (d) penalties and fines for under-performance, and (e) procedures for arbitration. Often a performance agreement specifies the number of vehicle kilometers to be supplied. An improvement on this would be to specify the contract in terms of the number of passenger kilometers. This gives an incentive to the operator to increase the attractiveness of its service in order to increase the number of passengers. It also reinforces the concept of transport being about people being moved rather than just about vehicles.

(2) Service Contracting

Once optimization proceeds, there will be impetus for change in two directions. The first is upward, that is, between CTA and the state. This relationship will be governed by the performance agreement. The second is downward, or between/within CTA itself as the operator begins to analyze its own operation, how to make it more efficient, how to minimize costs and maximize revenues, how to increase accountability and, mainly, how to meet (or exceed) the conditions of the service agreement. This may, depending on local preferences and consultations, involve the further separation of the company into individual operating units (with criteria either being service provided, geographic location, or type of mode), each managed and operated independently. The organization (headquarters) would maintain administration and coordination of the system, continue to establish objectives and standards, and audit the accounts of each unit, but responsibility for day-to-day operation, including purchasing and maintenance arrangements, will be the responsibility of the operating units. As conditions so permit, some units could be tendered to the private sector for operation either on a gross cost or net cost service basis.

CTA is at present reasonably well structured to accomplish such an arrangement given that its subsidiary GCBC already reasonably follows this model (although, in practice, separation of GCBC into operating units may well be desirable). Further, CTA is vertically integrated into operating units based on modal service (bus, minibus, tram, Heliopolis metro, Nile ferry). Service contracting has, in effect, already begun, or, more precisely, it is understood that permission from government is being sought to service contract all minibus operations (such a decision would, under a commercialized operation, rest with the CTA). The team was informed that, if successful, the goal is to service contract the minibus operation to the private sector on a competitively tendered basis, in what is effectively a net cost service contract. That is, the selected contractor would keep revenue (except for contractual fees), but in turn be responsible for fleet, maintenance and operations. Presumably some form of negotiated route structure and minimum service levels would be adopted (in effect, a broad performance agreement).

Opportunities are also being explored in regards to the Nile ferries. Ridership for this mode is modest, and is expected to remain so in future, vis-à-vis other land-based modes which offer considerably higher operating speeds and lower headways. Concurrently, comfortable walk access to ferry docks is limited to 500 meters or less. However, a cooperative arrangement could be considered with the private sector to provide, for example, cross-river services (perhaps using CTA docking systems). To enhance attractiveness, ferry operations could be linked at both termini with, say, shared taxi services, perhaps using a single, unified ticket.

These are very encouraging developments, and confirm that CTA management has considerable innovation and foresight, but that considerable political constraints exist.

(3) Line by Line Tendering

It has also been recommended (refer Section 4.2) that the formal bus service structure would be redeployed to predominately operate in major corridors, either radial or circumferential, in which higher-order rail systems do not exist. Bus priority treatments, such as bus lanes or busways, could likely be implemented in some corridors or along some critical corridor segments, most likely those where future upgrading to higher-capacity rail modes is likely. Thus, the structure, fleet and intent of formal bus services would be refocused to providing a premium, high-quality service involving both local and express runs within the major corridors.

The CTA may, for various commercial reasons, wish to spin-off some of the lines, or bundles of lines within these corridors, on a competitively tendered basis. Based on a rather precise description of the services asked for, a line or a number of lines, are tendered. The selected tenderer is hired as an operator of the vehicles required for the line(s). Details of the tender can also define details such as who supplies the rolling stock, and who incurs revenue risk due to patronage uncertainties. The main advantages of this model are that good integration is maintained and, based on past experience, costs are reduced (as, for example, in the UK). All decisions regarding passenger information, marketing and ticketing remain with the CTA. Because a lesser number of lines are offered for tendering, this creates opportunities for smaller companies to participate and reduces the risk of a private monopoly evolving.

The main disadvantages is that, in some instances, overseas operators have tended to focus on lines that are profitable, whilst it is more difficult to encourage operators to tender for unprofitable ones i.e. lines which serve areas with lower population densities. The authority must also maintain a high degree of involvement in the planning and monitoring of services. Because of the number of separate contracts involved, there will be higher tendering costs.

(4) Intermodality

The service restructuring proposed in Section 4.2, as well as integrated involvement of the private sector, increases the importance of intermodal concepts. Integrated public transport operation (refer Chapter 9, *Organizational and Institutional Issues* regarding the proposed new metropolitan transport bureau) can ensure strong service coordination including integrated route structure, through ticketing, coordinated scheduling of services, multi-modal coordination and centralized information dissemination. Intermodal coordination is of critical importance to public transport and other sectors of the Master Plan; it is therefore discussed in considerable detail in Chapter 7, *Intermodality.*

(5) Area Franchising

Given the importance of the shared taxi industry, both as an income generator for the poor and often as a service provider to the poor, simply eliminating it by administrative action should not be the automated response to the perceived problem (as sometimes voiced to the Study Team). Alternatively, CREATS has identified a regulatory and administrative framework within which the potential of the sector can be mobilized and deployed.

The allocation and utilization of shared taxis and cooperative minibuses is a considerable challenge in operational, administrative and political terms. However, modal optimization is not meant to imply a curtailing or elimination of this service (which, in Cairo, carries more than one-half of unlinked public transport trips). Quite to the contrary, the goal is to more effectively harness the considerable potential of this important mode and minimize its most obvious disbenefits. In the first instance, current practices under which shared taxis are licensed to operate governorate-wide on a route basis (which is often ignored), frequently in direct competition with other modes, should be adjusted. A series of areas would be designated in which this mode enjoys considerable freedom to provide demand-responsive area service. One impediment may be the desire of government to guarantee regular scheduled services on routes using a given number of vehicles. This can be overcome by combining area franchising (competitively tendered) with freedom of establishment for (and indeed some encouragement for) area-based operators associations. Considerable freedom would also be given to operators regarding type of vehicle used as long as the fleet complies with established safety, environmental and vehicle inspection guidelines. Smaller vehicles (microbus or smaller) may well be of considerable benefit in serving poorer areas of Cairo where adequate roads are not always available.

Under the proposed scheme, shared taxis and cooperative minibuses would not be permitted to operate outside of their areas (unless, in case of minibuses, some instances of route licensing were adopted), with enforcement possibly enhanced via color-coded license plates. Thus, shared taxis would largely service precincts away from main corridors but within designated areas, and provide feeder services to higher-order modes operating within the main corridors. However, shared taxis would not be permitted to actually operate within the main corridors serviced by higher-order modes, including bus/priority bus (and, in turn, formal bus services would focus to the main corridors). The size and number of designated areas is a matter of negotiation, but using a typical area whose average radius is somewhat larger than the current average trip distance (6.1 km) suggests areas on the order of some 100 to 150 square kilometers, or eight to ten franchise areas within the study area.

The formation of operators associations should be encouraged within each of the areas. It is likely that operators, many of whom will continue to be one person owning perhaps one or two vehicles, will invariably group together and pool knowledge as well as resources via operator organizations, possibly using similar procedures as currently employed by cooperative minibus associations. These could evolve along areal lines within the umbrella of an existing regional jurisdiction (such as the General Syndicate for Land Transport Drivers). In any case, such organizations should be free of governmental interference and control with main objectives being to serve as the collective voice of the industry, ensure the welfare as well interests of its members, and to provide the public with reliable, cost effective as well as safe transport of passengers. Some areas of mutual benefit would include cooperation in terms of:

- Market information exchange;
- Route and line structures;
- Procurement of vehicles, fuels and spare parts through mutual financing;
- Education and training;
- Managerial rationalization; and,
- Development of terminals and stops.

While the associations should perform essentially free of intrusive governmental control, close working relationships are nevertheless required in several areas:

- The distribution of relevant operator permits in a fair and transparent manner;
- Operational requirements (vehicle safety, vehicle inspection procedures, emission standards, driver licensing, vehicle licensing); and,
- Enforcement matters.

Further, the government, as the coordinator and supervisor, must ensure that consumers welfare is not compromised. In particular:

- No association should ever be given a complete monopoly status;
- Associations must be open to new members;

- Where an association is the channel through which tenders are won, any penalty for non-performance should be imposed on the association, which should then discipline its non-performing members; and,

- Illegal or criminal activities must not be tolerated.

Many of the defects attributed to the shared taxi industry at present can possibly be traced to its insecurity. Predatory behavior on the road is necessary to make a living. Inadequate capitalization, and the consequent small size and poor quality of the vehicles, may be at least partially attributed to the absence of a sufficiently secure expectation of future revenue (or indeed political non-interference in the industry) to justify commitment of capital to large, non-versatile assets (assuming such capital is actually available). A more preferred path would consequently be to minimize risk, that is, commit little, and preferably even then only in vehicles which have obvious apparent uses and hence good second hand markets. Some additional encouragement may be needed in this area. Firstly, an area franchise, within the security of an operators association, eliminates employment insecurities. However, restricted access to credit will continue to limit the ability of may operators to buy their own vehicles, thus forcing them into a dependence on an absentee owner. Even with the introduction of area franchising, there will be a period until the system is well established during which it may remain difficult to secure funding for vehicles. Assistance with vehicle finance may be a necessary component of the reform project. The ultimate objective, then, should not be to maintain a highly fragmented shared taxi industry for its own sake, but rather to encourage the development of an entrepreneurial culture on which competition can be based.

The Study Team acknowledges that much hesitation will exist to any course of action which implies fairly radical change (perceived or otherwise). It may, therefore, be preferable to undertake the transition to area franchising via a pilot project. Such a pilot project would include setting aside one geographical area and franchising operations within this area under the operating scenario presented. This has several advantages. Firstly, it allows the metropolitan planning bureau (as recommended in Chapter 9) or, at present, the governorate, to build up experience of competitive tendering before this practice is used throughout the metropolitan area. Secondly, it gives a clearer indication of the capabilities of the private sector in terms of providing own vehicle fleet, forming an association and, through the tendering process, an insight into performing cash flow analyses.