ANALYSES OF THE EVOLUTION OF TRAVEL, TRANSPORT SYSTEM AND URBAN ACTIVITY FOR SUSTAINABLE SHORT/LONG TERM TRANSPORT POLICIES; WITH REFERENCE TO GREATER CAIRO

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Abstract

The paper demonstrates the necessity to investigate past evolution of variables reflecting transport demand, supply and activities. This has practice and research oriented importance. For the "*practicing transport engineers and planners*", it helps in designing realistic and sustainable short/long term policies and proposals and supports feasibility studies of related projects. For the "*researchers*", it provides insight on city growth, travel needs and transport system provision requirements, and also on how their evolution is interrelated and had affected previous state of travel and supply. This leads to better understanding of how to arrive at sustainable transport systems in the short and long terms. The paper starts by explaining the above philosophy, and suggests related enhancement in the analytical transport planning frame. It also points out the need to investigate the evolution of intangibles such as institutional and financing mechanisms, policies and regulations, etc. It then turns to application on Greater Cairo. Evolution of main socio-economic indicators, travel demand and transport supply are investigated utilizing results of 1971, 1978, 1987, 1998 and 2001 O/D surveys. Conclusions are made on the importance of the given concepts and on the need to observe data compatibility in successive O/D surveys for application of the discussed concepts.

Keywords: Transport demand/supply evolution; Sustainable short/long term transport policies; Analytical transport planning frame; Evolution of Greater Cairo transport
Topic Area: G08 SIG7 Urban transport in developing countries

1. Introduction

Three main types of input data have been always required for urban transport planning with its two main timeframes, the *short term*, usually known as *transport management* and the *long term*, namely *strategic transport planning*. These are data on the characteristics of urban travel: reflecting the "*demand*", the transport system data: resembling the offered "*supply*", and data on the "*activities*" of residents: necessitating the need to travel by time, mode and destination. Of course, the level of detail, the size of data collection effort and the needed field surveys differ according to the time frame; each dictating its own methods and tools.

First, the characteristics of urban travel comprise variables such as trip type and mobility rates, modal shares city wide, trips by mode, trips by purposes, fluctuation of trips by time, etc. Studying these variables reveals the volume and pattern of movement, which are always changing as travel needs change and urban activities grow by type, density and location. The second input includes the characteristics of the supply, e.g., no. of cars, public transport modes and fleet size, street and public transport networks, etc. Studying these variables reveals the characteristics of the transport system and the level of service it

provides to the urban traveler. The third input is socio-economic activities of travelers and land use features. This includes population, labor force and employment, family income, etc. Studying these variables reveals the type, density and spatial distribution of different activities and the features of urban residents which generate and shape travel demand.

Variables of these three groups are major inputs for the design of short term transport management solutions and long term strategic transport plans. Demand forecasting models call for calibration of mathematical relationships between demand and the affecting variables (activities and supply), using present data, with the level of sophistication differing between the cases of short and long terms. Future relevant information regarding human activities and the proposed supply can then be used in order to arrive at future demand using the mathematical models calibrated for the present situation.

In addition, many of the above variables are used for setting out transport policies needed to overcome current and future consequences of urban transport problems, which stem from the nature of how the variables of the three groups relate to each other. If the relationship is unbalanced, not reserving city image and environmental quality and not leading to satisfaction of travelers, activity providers and seekers, the consequences of urban transport problems are aggravated. For instance, when activities create low or moderate demand that can be smoothly absorbed by the available supply, the situation would be acceptable, even though some transport problems would still be occasionally faced. If activities are dense and create demand that is higher than the capacities of the transport system, supply inefficiency would prevail and the adverse consequences propagate. Nevertheless, it is not always the matter of low/moderate demand leading to satisfactory supply. Propagation of adverse consequences of transport problems is practiced also under low demand when the available transport system is short of offering the appropriate capacity needed to satisfy that demand. Accordingly, transport engineers when searching for policies to overcome, or more realistically to reduce, the consequences of urban transport problems in the short and long terms are faced with the need to understand the nature of the relationship between "*demand*", "*activities*" and "*supply*" and its possible progress in the future, so as to plan for provision of the appropriate capacity and use of the transport system that is not only reliable but also sustainable and affordable to all.

The paper aim is to demonstrate that when data permits, it is necessary to investigate the evolution of the variables of the above three groups of input over the past years. This has practice oriented and research oriented importance. For the "*practicing transport engineers and planners*", it helps in designing realistic sustainable short and long term policies and proposals. It also supports undertaking feasibility studies of related projects. For the "*researchers*", it provides insight on city growth and travel needs and on transport system provision requirements and how their evolution is interrelated. Thus, it leads to better understanding of the procedures and mathematical models of travel demand forecasting and of how to shape sustainable future transport systems.

2. Philosophy of the paper

It is necessary to complement the exercises of urban transport planning and policy setting with additional analysis and investigation, which are believed to contribute much to understanding of the dynamics of urban travel and transport systems development. This analysis calls for examination of the "evolution" of the three groups of input data: demand, supply and activities over the past years with an eye on future development, when data availability permits. In doing so, it is important to examine, by "amount" and "rate", the changes in the variables reflecting those groups. The "amount" of change can be big or small, its direction can be positive, fluctuating or negative, and its "rate" of change over

the years can be fast, slow or varying. It is important to examine how the main variables change as time grows; both individually and relative to each other. In other words, we should be able to investigate if the supply had been expanding over the past years with the pace that makes it "catch up" with the growing demand? Or had the supply been expanding with the same rate by which the activities, and hence the demand had also been growing in the city? Or had the demand been growing exactly as the activities had been developing over the same period? And so on and so forth.

Answers to the above questions are to be supplemented with research and analysis of possible reasons behind the change which makes the transport engineer fully aware of the city and its development stages and expansion trends. To explain the concept, four hypothetical examples are discussed below and illustrated in Figure 1 (a to d) showing possible cases of trend of past evolution of demand, activities and supply with different magnitudes and slopes as they relate to each other. Real world application is given in section 5 utilizing relevant evolution trends for Greater Cairo based on the results of previous O/D surveys and census data.

The case of "Figure 1.a":

In this case demand, activities and supply are all increasing with the same slope. Here, the increase (although with different magnitudes) exemplifies that continuous increase of activities and travel had been occurring with complementary expansion of supply trying to match those increases, irrespective of the provided level of service (situation S1 level of Service is better than that of situation S2).

The case of "Figure 1.b".

In this case demand and activities are positively increasing and supply evolution is stable (situation S1) or negative (situation S2). Here, the increase in activities and demand had not been matched by the supply. This exemplifies deterioration of transport facilities and dissatisfaction of travelers.

The case of "Figure 1.c":

This case exemplifies a healthy evolution of supply in a manner allowing full accommodation of the increase in demand with high level of service.

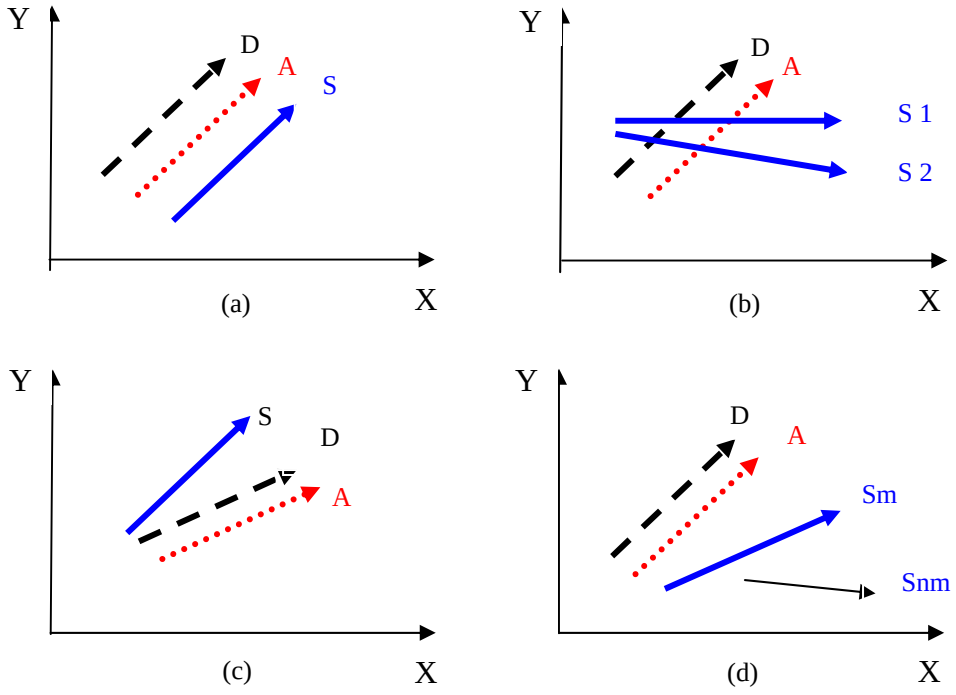
The case of "Figure 1.d":

Here supply expansion by mode type during the past years had not been right. This is a classical case in some cities of the developing countries, with high demand on non-motorized travel, where attention is given to motorized transport facilities (Sm) and at the same time neglecting improvement of non-motorized facilities (Snm). This reveals the need to pay more attention to pedestrian and cycling facilities in future plans and policies, unlike what had been happening in the past.

Learning from past evolution and the underlying reasons, has important advantages. It provides an additional dimension for the formulation of short and long terms solutions and policies. This is demonstrated in the provision of a "realistic" picture of how the transport system and its usage had been developing over the years under the experienced conditions, in comparison with demand and activities evolution. This reflects certain requirements that facilitate policy formulation and designing remedy solutions as described hereinafter.

- It reflects how transport supply had been expanding in view of the faced social and economic conditions, as main driving forces that dictate the degree of response of the city to community needs.
- It reflects the capabilities of the city and how adaptation of new transport technologies had been taking place not only as related to new modes, propulsion and fuels in general but also to ticketing, fare collection, integration of public transport, etc.

- It reflects the previous institutional capabilities of the city with respect to the degree of adoption to management of transport systems and of responding to market needs and new forces of economic reform and privatization, etc.



X = past years
Y = Evolution index = year value / base year value
D = Demand
A = Activities
S = Supply

S1 = Supply Situation 1
S2 = Supply Situation 2
Sm = Supply motorized facilities
Snm = Supply non-motorized facilities

Figure 1: Conceptual hypothetical illustration of different cases of trends of past evolution of demand (D), supply (S) and activities (A) with different magnitudes and slopes as they relate to each other.

- It sheds light on the real practice of decision making procedures and mechanisms in the city and the related impact on the development of transport policies and solutions that prevailed over the years, whether in a positive or a negative manner.
- It also shows to what level of success the previous city transport engineers managed to implement the needed projects and what are the reasons for the achieved success/failure.
- It demonstrates the previous response of city residents to various transport systems, solutions and policies and how these had been received by the travelers.

Furthermore, studying past evolution and the underlying reasons can be utilized to adjust estimates of future travel demand. As mentioned earlier, demand forecasting models reflect demand as a function of human activities and transport system. This is always done in isolation of any reference to previous situations with respect to the variables of the forecasting model. In light of examining the trend of evolution of transport demand, supply and activities, it would be possible to adjust the results of demand forecasts in order to respond to the realities of the past which may still continue into the future. For instance, in a city where economic pressures, institutional deficiencies and slow pace of technological development had been in place over the years, the forecasting model results may need careful adjustments. Simply, demand forecasting models do not take into account the

previous past conditions. Thus, demand forecasts might be overestimated or more accurately the corresponding proposed committed projects can be too ambitious to be realized in view of the prevailing economic, technical and institutional constraints. So, to be realistic, the future transport plan and policies should be adjusted to go in tune with realities of the past that are likely to prevail into the future. Usually, this is not done when planners ignore past evolution and go for some very difficult to implement recommendations, either in the short or the long terms. Accordingly, decision makers are faced with unsustainable and realistically unachievable projects after waiting for engineers to present the results of their transport studies and designs.

3. Enhancement of the analytical transport planning frame

In view of the above discussion, formulation of future transport policies and planning of future transport projects should include the effect of past evolution trends of travel demand, activities and transport supply. Figure 2 shows a conceptual flow chart on which the dashed box and links denote the suggested enhancements of the analytical transport planning frame in order to allow for including the effect of past evolution on setting out policies and projects. Before describing these enhancements, we first give a brief reminder of the general concept of the traditional steps and links of the analytical transport planning frame.

The usual start is to collect data on the present situation covering, socio-economic activities and features of the urban residents, travel demand and the existing supply of transport systems and modes (Box “1” in Figure 2). This information is used for calibration of demand forecasting mathematical models (Box “4”). The planning information on future activities of land use and socio-economic features (Box “2”) are used as an essential background for helping the transport engineer to propose future transport policies and systems (Box “3”). The information of the latter two boxes are direct input into the calibrated models for prediction of future generated demand by location, destination, mode and route (Box “5”). The proposed future policies and systems are to be evaluated (Box “6”) leading to recommended policies and projects for implementation (Box “7”). The general concept of this frame is applied for planning on the short and long terms with varied amount of data and methods and levels of sophistication, as each necessitates.

The above frame fails to consider the effects of forces of past evolution of demand and activities on one hand and transport supply on the other. Such evolution as mentioned earlier should be expected to have practical implications on the recommended future policies and solutions. However, this is a necessity that although can be easily felt and apprehended, yet at the same time is difficult to put into practice. For instance, it is not easy to insert indicators of past evolution of demand and supply into the mathematical models of forecasting urban travel and the usual course of proposing future transport systems and policies. In realizing this difficulty, it is suggested to adopt a pragmatic approach of enhancement of the analytical process of transport planning as indicated in the dashed Box number “8” and the dashed links I and II of Figure 2. In Box 8, the indicators of past evolution are to be determined. Examples of those indicators are given below.

- Examples of activities evolution indicators: population, population density, car ownership, household income, employment, labor force, etc.
- Examples of demand evolution indicators: Mobility rates by gender and by mode, trip split by purpose, modal shares, trip length by mode, trips by mode, etc.
- Examples of supply evolution indicators: Number of cars, public transport lines, network length, operating fleet, etc.

In addition, evolution of intangible elements related to transportation supply provision and operation are to be reported and analyzed. These include for example,

- Policies of public transport ownership and operation
- Policies on car production, car imports, oil prices, etc.
- Policies on encouraging public transport, non-motorized or automobile transport, etc.
- Financing mechanisms in the transport sector (public, private external aid and public/private partnership, etc.).
- Transport institutions (e.g., local authorities, public transport operators, etc.) organization, technical capabilities and development.
- Decision making procedures in the city transport sector, etc.
- etc.

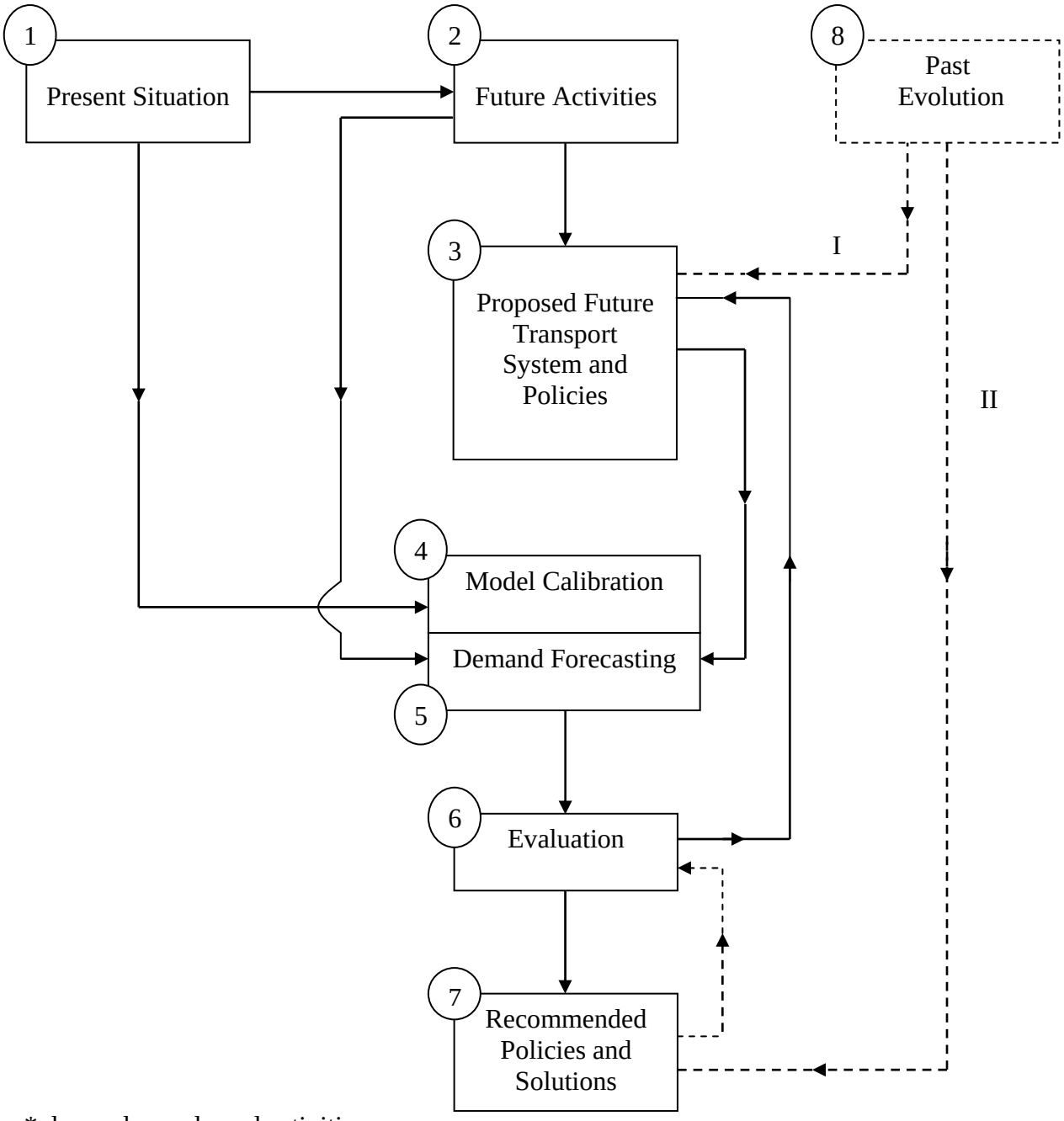
The above tangible indicators of evolution and the results of the analysis of the evolution of the above mentioned intangibles are to be used when proposing future transport policies and systems, (link I in Figure 2 between Box "8" and Box "3"). The basic philosophy is to make sure that the proposals are possible to implement in view of the previous trends and practices over the past years. To explain, we give below illustrative examples of two common cases that can take place in cities of developing countries and two possible cases for a city in an industrialized developed country.

Two typical cases for cities in the developing countries:

If the transport proposals include the introduction of modern LRT to provide the needed capacity to overcome serious transport problems on a heavily congested corridor and the past evolution shows shortage of public fund and lack of untraditional financing with strong indications of continuity of such trends, this proposal most likely will not be implemented. The transport engineer in charge should use the results of past evolution indicators that show continuous increase of bus transport demand on major city corridors and continuous lack of capacity, to demonstrate to decision makers and city politicians the grave situation that would occur if those trends continue to progress in the future without implementation of mass transit. Of equal importance, is to show the past trends of institutional deficiency and heavy dependence on public funding without searching for untraditional financing and how these had been impeding progress in the right direction. This can help to overcome the previous practices that prevented implementation of transport projects and had brought about the many negative results of the lack of public transport capacity.

Another case is proposing a modern busway system to be operated by the private sector while the past evolution of financing and institutional mechanisms in the city do not indicate any shift towards adopting policies for encouraging private sector participation in city transport. Here, it is better not to propose the busway unless the city should either show strong commitment to adopting significant policies and measures to let the private sector enter the market, or be seriously securing necessary public funding from the national government. This is still not enough as also if the above option is to be adopted, important institutional development should be strongly committed to guarantee that the public operator of the modern busway would be competent enough to run such a modern system. Otherwise, the project is unlikely to succeed, and hence should not be proposed in the first place. Another technology is to be suggested such as bus lanes and simple bus priority measures instead of the modern busway. Though the former are less superior to the latter, yet they would be easier to implement and operate under the work environment of the past that is likely to remain unchanged in the future. It is better to suggest less superior solutions that can be implemented and sustained than to recommend more superior ones

that are unlikely to be realized, particularly if the former can still provide a reasonable alternative.



* demand, supply and activities

Suggested Step (Box 8)

Suggested links (I & II)

Figure 2: Suggested enhancement of the urban transport planning frame to include the effects of past evolution of transport demand, supply and activities.

Consequently, it is necessary in these cases (of suggesting alternative projects) to check in the evaluation step, Box "7" of Figure 2, that these projects are really reasonable. If not, then past evolution implications should be considered once more and inserted via link II in Figure 2 between Box "8" and Box "7" so as to propose other projects and/or introduce other warrantees, as those mentioned earlier, concerning untraditional financing, encouraging private sector and/or introducing institutional development, for example, that can let the proposals pass successfully through the evaluation step and still can be realistic enough to be implemented.

Two possible cases for cities in the developed countries:

Although, the ideas given in the current paper mainly reflect on cities of the developing countries, two cases related to developed countries are given below in order to emphasize the contrasting differences between the two types of economies and to stress the importance of the paper for cities of the developing countries.

If future proposals include the introduction of a new metro line in a city which already has a strong metro network and if past development shows strong government commitment and capability of boosting and successfully managing mass rail transit for long time, this proposal should be adopted with no fear of unforeseen obstacles of implementation if past trends are maintained in the future. Another case is when the city is opting for short term introduction of new ticketing technology among its various integrated public transport systems as the contact-less tickets. Here the past evolution of public transport ticketing shows that the city had always been introducing the relevant new ticketing technologies whenever they had emerged with total success. Accordingly the contact-less ticketing technology can be easily introduced without hesitation. Real world examples are Lyon public transport system and Paris metro.

4. General evolution of Greater Cairo land use and transportation

In the current section, the general evolution of Greater Cairo (GC) is given covering main land use facilities, travel demand and supply. In section 5 the application of the proposed philosophy is given in more detail based on GC evolution trends. Before doing so, however, a brief on the previous transport studies of GC used for analyzing past evolution is given.

4.1. General evolution of land use features

The very early capital of Egypt was in Thebes near Luxor, Upper Egypt. Later and for five millenniums the capital had been Memphis on the Giza plateau some 15 kms to the south west of the present location of Cairo. In modern history the capital was called Al Fustat, established 640 around an old Babilion Pazentine Castle located on highlands overlooking the River Nile. In 969 Gohar El Sakally the Fatymmiate army commandor moved the capital to another location few kilometers to the north east of Al Fustat, naming it Al Kahira (Cairo) to be the ruling place of Al Moeiz, the Fatymmiate ruler. It is reported (Fayette, 1964) that some 20 000 flats and similar number of shops existed when Cairo was first established! Cairo has been expanding further and further since those very early days of its very beginning with more than 14 million inhabitants are currently living within its wider boundaries. GC is expected to reach 20 million in 2022.

GC is composed of three main administrative parts, Cairo Governorate, the northern urban part of Giza Governorate and the southern urban part of Qalubia Governorate. Table 1 gives the evolution of urbanized area, population and population density of GC between 1968 and 2000 (JICA/PCI, 2002), where it can be seen that compared to 1968 as a base year, the rate of increase of urbanized area and population are almost equal. Whereas population density is slowly increasing due to the expansion of land area of GC. Table 2

gives a comparison between population, employment and car ownership for 1976, 1986 and 1996 census data as well as relevant estimates for 2001. Taking 1976 as a reference year, it is interesting to observe that the evolution trends of population and employment are nearly equal, with the evolution index ranging between 1.18 and 1.47 through 1986 to 2001, and are almost identical for each of the considered years. The evolution trend of car ownership, however, is much higher than those of population and employment. The car ownership evolution index ranges between 3.5 for 1986 compared to 1.18 and 1.26 for population and employment, respectively and 5.1 for 2001 compared to 1.4 and 1.47 for population and employment, respectively. This indicates the massive increase in car ownership compared to jobs and population growth.

Table 1: Evolution of Greater Cairo urbanized area, population and population density, (Source: JICA/PCI, 2002)

	1968	1977*	1982*	2000*
Urbanized Area	16000	20600 (1.3)	25400 (1.6)	29000 (1.8)
Population	5.5	6.7 (1.2)	8.6 (1.6)	11.3 (2)
Density	344	325 (0.9)	339 (0.99)	390 (1.1)

* Values in brackets are evolution indices taking 1968 as a base year

Table 2: Cairo Governorate Population, Employment & Car Ownership, (Source: National Census and Traffic Police Statistics).

	1976	1986*	1996*	2001*
Population	5.07	6 (1.18)	6.8 (1.34)	7.2 (1.4)
Employment	1.5	1.9 (1.26)	2 (1.3)	2.2 (1.47)
Car Ownership	17	60 (3.5)	74 (4.4)	87 (5.1)
Cars	17	4.2	5.9	7.3

* Values in brackets are evolution indices taking 1976 as a base year

4.2. Past transport studies and adjustment of results for compatibility

The very early transport study for GC was carried out in the late 1960s with a pioneer individual initiative from a Minister of Transport who was interested in transport research and hence a home interview was designed and carried out at that time. Unfortunately, however, no documentation is available about that very first survey of its kind in the country and perhaps also in developing countries at large! Later on, five formal transport studies were carried out between 1971 and 2002. These are as listed in Table 3 indicating the type of OD survey and the study area.

Table 3: Summary of previous transport studies for GC.*

Study Consultant (Pub. date)*	O/D survey year	Study client	Study area	Survey type, year (sample)
SOFRETU, (1973)	1971	Transport Planning Authority	GC	Home interview, 1971, (10000 households)
DRTPC/MIT, (1983)	1978	Cairo University	GC	Roadside interview, 1978, (NA)
JICA, (1989)	1987	Cairo Governorate	GC	Home interview, 1978, (17000 households)
SYSTRA/ DRTPC, et al, (2000)	1998	National Authority for Tunnels	GC	Home interview, 1998, (12500 households)**
JICA, (2002)	2001	Ministry of Transport	GC & region	Home interview, 2001, (54800 households)***

* References details are given in the list of references
** Survey carried out by the Transportation Programme, DRTPC, Cairo University.
*** Survey carried out by the Transportation Programme, DRTPC, Cairo University, in cooperation with Ain Shams University.

In order to be able to investigate the evolution of modal shares and trip split by purpose, certain data manipulation had to be carried out in the current paper on the results of the above mentioned O/D surveys as summarized below. For instance, the 1978 survey results were given for the peak hour. As hourly fluctuation factors were given for each mode for each of the surveyed hours of the day, it was possible to estimate modal shares for the whole day. For 1987 the survey was carried out just before the opening of the first stage of metro line 1 to service, and hence it was not included in the resulting modal shares. Based on operators statistics for 1987, the metro daily trips were obtained and with some assumptions it was introduced to modal shares for that year. The 2001 home interview survey covered a region larger than the GC area including the new towns and developments and rural areas and villages out of the boundaries of GC. Utilizing the home interview survey original files, modal shares and trip purpose split were determined based on the traffic zones of GC excluding the outer zones. Also the 1998 home interview survey original files were manipulated to adjust for some traffic zones changes that had to be made to make the results comparable with the 2001 survey.

4.3. General evolution of transport demand and supply

In 1971, total daily trips were 5.6 million, rising to 10.8 million (+190%) in 1987, 14.1 million (+250%) in 1998 and 21.6 million (+385%) in 2001. The latter year survey covered a much larger area than that of 2001 GC as mentioned above. With this in mind, walk trips reached 26% of total daily trips in 1971, jumping to 36% for both 1987 and 1998 and then reduced to 32% for 2001. The latter drop is logical due to the much larger area of the 2001 survey compared to the earlier ones. Mobility evolution shows a trend of increase, jumping from 0.8 trips per person in 1971 to 1.42 trips per person in 1998 and 1.64 trips per person in 2001.

To match the continuous increase in motorized trips, the Greater Cairo Transport System has witnessed great expansion and changes in type, size and location. For instance, in 1971 public transport consisted only of three modes, Cairo Transit Authority (CTA) bus, light rail and trolley bus. Currently, public transport comprises eight modes, namely CTA bus, CTA minibus, Greater Cairo Bus Company (GCBC) bus, Air-conditioned bus (by CTA and GCBC), River bus, light rail, metro and the informal shared taxi. In 1981 the trolley bus was abolished for technical and maneuverability problems, while in 1985 and

1986 the informal shared taxi and the CTA minibus were introduced, respectively. In 1987 the first metro line was opened followed by the second line in 1996. In 1997 the Air-conditioned bus started operation with the lines and fleet quatripilled and passengers increasing 10 times in 2003! Over the same period 1971 to 2001, three major Nile bridges were built, the number of constructed over passes at major intersections has amazingly increased and 5 car tunnels opened to service (two of them are of 2.5km in length each, under-passing the fringe of the City Center and Old Cairo). In addition, four major elevated expressways were completed in successive stages since 1969, the Ring Road of some 75 km was completed in the mid 1990s and three additional elevated expressways were completed in the late 1990s to link surrounding new developments with the City.

In addition, many major multistorey car parks are constructed and many existing bus terminals are expanded and others constructed on the fringes of the city. Important projects are planned and designed such as metro line 3, which is only awaiting financing decision for implementation. Furthermore, the Greater Cairo Transport Study (JICA/PCI, 2002) has proposed a set of 20 priority projects (including committed ones) for 2022.

The evolution of registered cars in GC is not easy to obtain as cars and other vehicles registration are recorded at the governorates level. As mentioned earlier, GC region is composed of Cairo Governorate and only the main urbanized parts of Giza and Qalubia Governorates. The given values for GC cars in previous studies are, therefore, always estimates and not records. The concentration of cars in the above three governorates is remarkable as it reached some 876000 cars in 2001; about 27% of a total of 3.2 million vehicles in the country in that year. The registered cars for Cairo Governorate alone in 2001 reached about 625 000 cars which is about 19.5% of all vehicle registration in Egypt.

For precision, in the current paper the evolution of the number of cars is given for Cairo Governorate alone (not for GC). Car registration in Cairo Governorate has been always on the increase. Between 1976 and 2001 the number of cars has risen dramatically from about 86000 cars to about 625 000 cars which is a remarkable 727% increase! The evolution index between successive years taking 1976 as a base year is found to be 4.2 for 1986, 5.9 for 1996 and 7.3 for 2001. The number of cars per household in GC based on the 1998 survey (SYSTRA/DRTPC et al, 1999) is concentrated in the highest income groups, reaching 1.2 cars per household compared to 0.03 car per household in the lowest income groups, which is quite logical.

Figure 3 shows the evolution of trip purpose split for four survey years 1971, 1987, 1998 and 2001 as it was not possible to obtain the relevant percentages for the 1978 survey. It is clear that “work”, “home” and “other” purposes trip split trends are stable between 1987 and 2001. However, for education trips the situations is different as the trend of past evolution shows clear increase in this type of trip purpose since 1971, matching the continuous increase in educational institutions and government policies for expanding education, not only in GC but nation wide, over those years. For instance, the number of Universities in GC region alone has increased from 4 in 1971 to 10 in 2001 and in the country from 6 to 20 over the same period. It is also interesting to note that the share of work trips dropped from 26% in 1971 to 21% in 1987 and 20% in each of the years 1998 and 2001. This is mainly due to the reduction of working days of the week to five days that gradually took place in many government and private agencies and businesses since the late 1980s.

Figure 4 shows evolution of modal shares for five survey years for the main motorized modes: car (+ taxi), bus (+ minibus), light rail, metro and shared taxi. In this Figure (car + taxi) are denoted “car” for simplification The following comments can be made (further discussion is given in section 5).

- Car trips (after earlier steady increase) are dropping between 1987 and 1998 and started to increase afterwards.
- Bus trips are always in the decrease.
- Light rail trips are sharply decreasing.
- Metro trips are steadily increasing.
- Shared taxi trips are increasing.

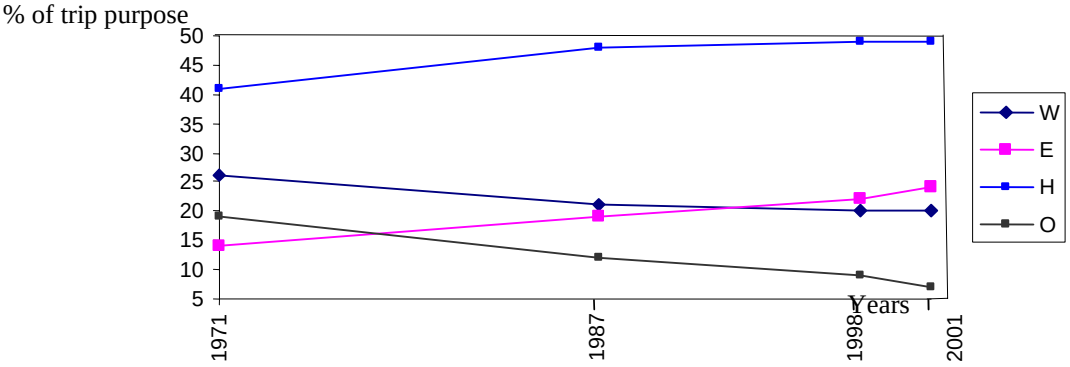


Figure 3: Evolution of trip purpose split (%) in GC from four O/D surveys.

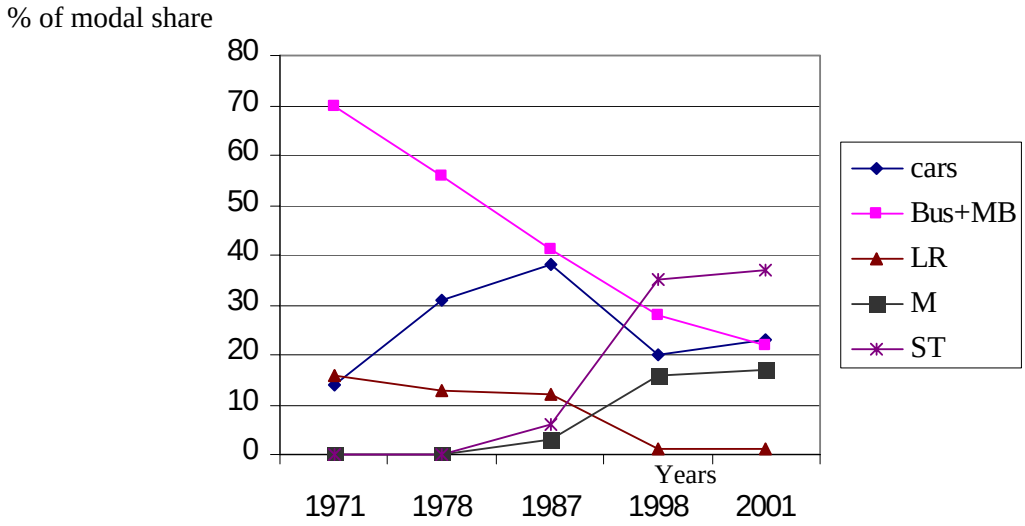


Figure 4: Evolution of modal shares (%) in GC from four O/D Surveys.

5. Application of paper philosophy

As discussed earlier, examination of the evolution trends of activities, demand and supply is very useful for setting out or adjusting transport policies and projects in the short and long terms. This discussion is supported by hypothetical conceptual drawings (Figure 1). Having discussed the evolution of GC features and transportation in section 3, the current section explains the application of the paper philosophy presented earlier in section 2. The wealth of transport information gathered over the five successive transport studies between 1971 and 2001 (see Table 3 and related compatibility discussion in Section 4.2) are used. In doing so, reference is made to two compound Figures as indicated below in addition to Figure 4.

- Figure 5 shows the evolution of transport supply in GC for five main groups of mode as follows
  - Car plus taxi, named car for simplicity, Figure. 5.a.

- Bus plus minibus, named bus for simplicity, Figure 5.b
- Light rail including tram and Hiliopolis metro, Figure. 5.c
- Metro, Figure. 5.d
- Shared taxi, Figure 5.e

According to data availability as well as logicality for explanation: Figure 5.a shows evolution of the number of cars, Figure 5.b shows evolution of bus trips and bus fleet, Figures 5.c and 5.d show the evolution of trips and lines lengths (km) for light rail and metro, respectively, and finally, Figure 5.e shows the evolution of trips and lines lengths of shared taxi.

- Figure 6 is a comparative one showing the different indices of the evolution of activities (Fig. 6.a), demand (Fig 6.b) and supply (Fig 6.c). The range of years for which the evolution is given is governed by data availability. In Fig. 6.a 1968 is the base year for comparison. For Fig. 6.b & 6.c the base year of comparison is 1971.

In the following discussion, six demonstration examples are given to support the philosophy mentioned under section 2, and certainly many others can be thought of.

Example 1: It is clear that bus and minibus share is decreasing and the market loss appears to be for the benefit of the shared taxi which was introduced in 1985 and the metro which entered the market in 1987. From 1990 to 2001 bus demand is decreasing and since 1971 till 2001 bus share of the total public transport market is steadily decreasing, whereas from 1978 onwards the number of operating bus fleet, bus lines and network length are on the increase. This means that the operator is increasing the supply while the demand is decreasing since 1991. Also, it is known that loss of revenue is practiced in addition to increased cost of operation and maintenance of the additional fleet and the additional lines lengths. The reason would be the obligation to open new lines for sake of accessibility, which is confirmed by the increase in urbanized area ever since 1971, with a jump in the evolution trend between the late 1970s and the early 1980s (Fig.6.a). This is mainly related to two elements, (a) the planned expansion of GC on new communities organized on the surrounding desert land starting 1977 and (b) the unplanned random expansion that took place since the late 1970s at the expense of farm land on the fringes. Another mainly important reason is the reliance on periodic provision of new buses without first making full use of existing buses through, the less expensive, better depot management and efficient maintenance of the owned buses in order to optimize the existing resources. The recommended short term policy in such situations would be to divert the effort to the latter sustainable measures before thinking of purchase of additional fleet. Without examining those past trends, the transport engineer in charge of the short term transport planning (management) would have been misled by recommending expensive policies for direct fleet expansion.

Example 2: For the shared taxi it is clear that the supply, the demand and the market share are all increasing with steady high rates since it was introduced in the market back in 1985.

Its flexibility, independence on tough management (as it operates by individuals) and regulations and its successful response to market needs and travelers desirers, have to be realized from its very positive fast evolution trend. This evolution should draw the attention of transport engineers when setting short term policies to three issues. First, is to admit the important role this informal transit is playing in GC transportation and that such mode is there to stay and expand. Second, is to learn from this experience and that of formal bus demand decline to adopt liberal policies of deregulation, commercialization and eventual privatization of the publicly owned and operated bus system that have been

steadily loosing the market. Third, is to realize the need to be aware of the adverse effects of the increased number of shared taxis on the street network which necessitates tough enforcement and control in the present and the future. On the long term, if expansion of shared taxi is inevitable, as it is undoubtedly observed from its past evolution, and the city aims at stabilizing its growth, policies should be devised to control its adverse effects but not to attempt eliminating it. It would also be necessary to provide the long term alternative that can convince travelers to shift and to try to curtail Shared Taxi longer lines and to reorganize its role in feeding main systems rather than competing, as happens on some long distance corridors. The latter would support so much the concept of sustainable integration and certainly needs a change in the policy of urban transport in GC. This is recommended in a pioneer previous study supported with immediate action and short term applicable plans (DRTPC/SOFRETU, 1987) and again conceptually stressed (SYSTRA/DRTPC et al, 1999 and JICA/PCI, 2002) for short and long term policies.

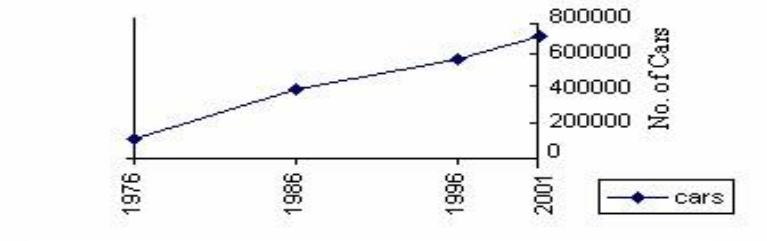


Fig 5.a: Number of cars (for Cairo Governorate)

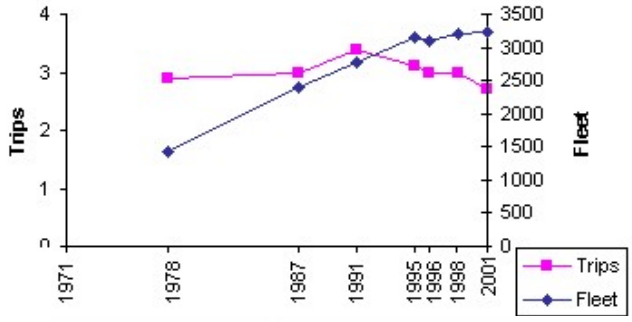


Fig 5.b: Bus (and Minibus) trips and fleet

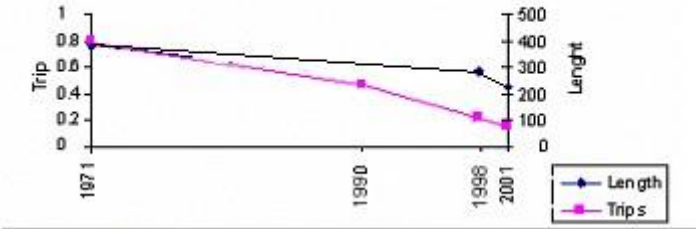
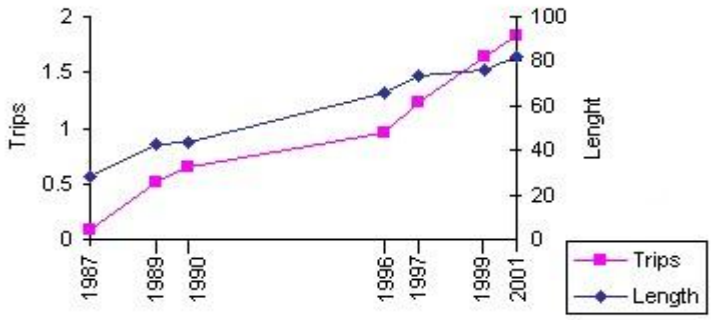


Fig 5.c: Light rail (tram and Heliopolice metro) trips and line lengths

Fig 5.d: Metro trips and line lengths



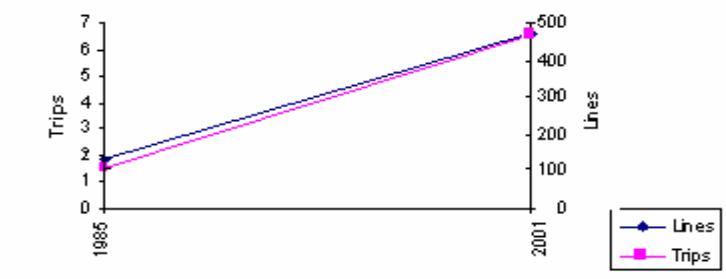


Fig 5.e: Shared Taxi trips and line lengths

Figure 5: Evolution of GC transport supply for five main modes.

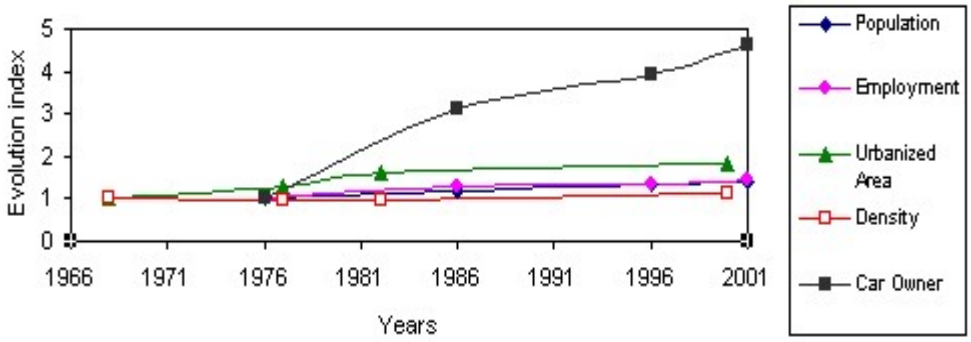


Fig 6.a: Evolution indices for socio-economic activities

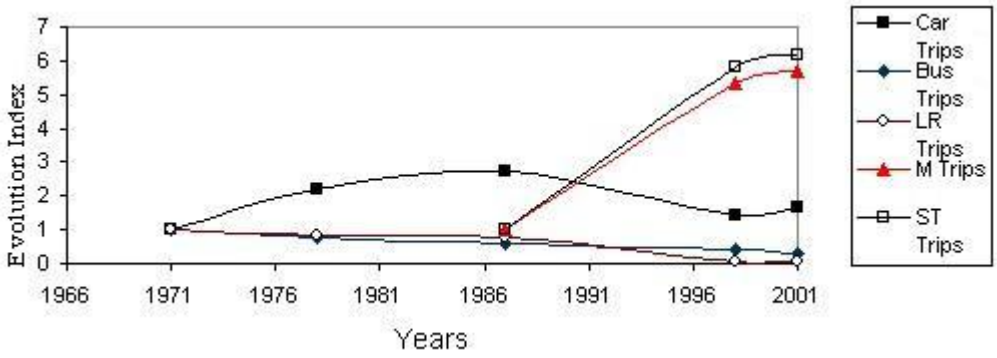


Fig 6.b: Evolution indices for demand on 5 main modes

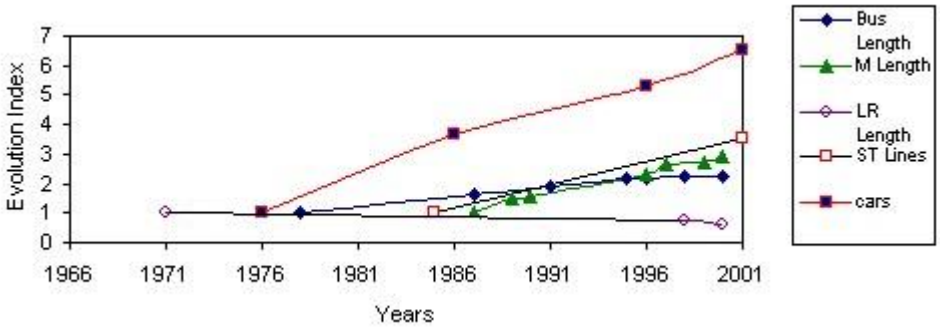


Fig 6.c: Evolution indices for supply of 5 main modes

Figure 6: Evolution indices for GC socio-economic activities, demand and supply on 5 main modes.

Example 3: For metro, it is clear that since its opening (the first line in 1987, and the second in 1996) the increased supply is continuous. This system is remarkably attracting more and more travelers and capturing more and more of the market share. Such success of high capacity high level of service system in a mega metropolis like GC means that the previous policies of financing, constructing and later marketing the metro and its well structured fare policy and management should be encouraged for the long term (DRTPC/SYSTRA, 1995). In addition, of course the city should be able to find out the suitable financing schemes and sources for the heavy investment involved, learning from the history of financing the two metro lines. Expansion of the metro network has been studied and confirmed in two successive studies (SYSTRA/DRTPC et al, 1999 and JICA/PCI, 2002) and feasibility of line 3 has been completed (SYSTRA/DRTPC et al, 1999) and the design and tendering are also finalized through the National Authority for

Tunnels, waiting for the financing decisions, which as mentioned above should be made in view of the successful experience of lines 1 and 2. It is very interesting to examine the evolution of an intangible element concerning financing metro construction in GC. Line 1 was financed by a soft loan from France, whereas line 2 was totally financed from the Egyptian Government. In doing so, the government succeeded to provide financing of line 2 from the national telephone bill. At that time the Ministry of Transport was covering the telecommunications sector (named Ministry of Transport and Communications). Since, 2000 telecommunications sector was separated and assigned to a Ministry of Information and Communications. Accordingly, it is not easy at present to provide financing similar to that of line 2. This demonstrates a lesson from past institutional evolution and should direct efforts for other public and private financing sources local and/or foreign.

Example 4: Comparison of the evolution of registered cars and car ownership in Cairo Governorate and car share in daily travel of motorized modes (Fig 6.b) in GC reveals very important conclusions. As expected, it is clear that the evolution of the former two features are steadily increasing over the years. However, the rate of increase of the number of cars is higher than that of car ownership. This shows that although cars are steadily increasing and congesting streets, yet it is used only by few people compared to the majority using public transport as confirmed by the small share of car travel between all motorized modes. This is in addition to the evolution of car share that is stabilizing over the last 10 years in GC irrespective of the increase in the number of cars. It is important to note that in GC two important projects have also been contributing much to the decline of market share of car trips. The first started in the late 1980s which witnessed the start of metro line 1 in two successive stages in 1987 and 1989, reducing car trips or at least stabilizing its share of total motorized trips. The metro network of some 80 km is absorbing currently more than 2.2 million trips daily and have been steadily increasing ever since it was opened to service. The high level of service and high reliability of metro have been always attracting many car users to shift. Though there is no field observation of that shift, yet it is evident from the observed massive increase in parking demand in and around many metro stations on lines 1 and 2, to the extent that creates severe parking supply deficiency in some locations. The second project is the Air Conditioned bus service which encouraged some car users to shift from the private car. Between 1998 and 2001, the share of Air Conditioned bus trips out of total motorized trips was raised from 0.3% to 1.0%, a remarkable increase of 333% in view of the number of buses in service and the daily trips increased 10 folds between 1997 and 2003. It would have been interesting if statistics on the past evolution of car use and not only cars and car owner ship of word was available. This is indeed a more meaningful feature to study, as discussed in reference (Huzayyin et al, 1998).

Example 5: Still on the evolution of the number of registered cars in Cairo, another interesting application on the importance of analyzing the evolution of policies in parallel to analyzing the evolution of transport supply, clearly appears. For instance, the rate of car increase was the lowest in the 1960s till the mid of the 1970s due to the restricted social policies on car imports. After the 1977 war and the peace era, the government adopted an open door policy that permitted massive car imports to compensate for the previous restricted policies. Consequently, the number of cars increased at a very high rate. Then, nearly in 1980 the open door policy was somewhat rationalized for the more essential imports. So, the rate of car increase was lowered. Between 1998 and 2001 car shares started to increase again as since the mid 1990s, the number of car assembly plants has increased to 18 compared to only 4, before. Also, car imports were more encouraged. This is a lesson to be learned form studying the evolution of trips by mode showing how past car policies have affected evolution of car trips and how these trips can increase in the

future depending on the applied policies. So that is why models of prediction of the number of cars are usually responsive to car production and imports policies learning from the past evolution experience. If the calibrated model is not responsive to those policies, the predicted number of cars should be adjusted to cater for their effects.

Example 6: Form 1978 till 2001 light rail system is diminishing with the kilometers of track decreasing, the demand on service is sharply decreasing and the modal share of the market following suit. This indicates that the operator and the city authorities are not giving attention to light rail, neglecting modernization and eliminating tracks and services. At the same time this decreasing evolution profile of light rail should not be considered as a draw back of the system itself, but rather a problem of unwillingness of the city to put it in the right frame that it deserves. The short and long terms policies here should be directed to introducing a modernization scheme for rehabilitation and total renewal of the light rail network so as to make it more competitive in the market bearing in mind (a) the high capacity the light rail systems provide compared to buses, (b) the fact that this electric driven mode is environmentally friendly and (c) the lower construction cost compared to heavy rail. In modelling and forecasting long term travel demand and proposing future supply based on the existing situation and neglecting the effects and reasons behind the past evolution of light rail, the transport engineer may be misled; predicting continued lower demand and market share on light rail and consequently over passing it in the recommendations.

All the above examples demonstrate the need for Box 8 and links I and II of Figure 2, which call for the enhancement of the urban transport planning frame to include past evolution lessons and analysis.

6. Concluding remarks and recommendations

A number of concluding remarks on the need for careful analysis of past evolution of demand, activities, and transport supply are given below, based on the above discussions and illustrations. First of all, examination of past trends is important for arriving at “applicable” transport polices and “practical” proposals of short and long terms transport projects. Second, evolution of the transport demand and supply should not only be limited to measurable variables such as modal shares, number of bus lines, bus network length, number of the bus operating bus fleet, etc., as some related intangible elements should also be studied. These include, for example, evolution of past institutional development, previously applied policies on financing transport projects and car imports, past experience on privatization in urban transport, etc. Examining those elements and the related past experience help so much in pointing out the constraints or the advantages that can impede or boost the proposed transport projects, respectively. Furthermore, studying evolution of past trends should not only stop at the level of presentation with figures and tables constituting few pages more in the reports of transport studies. It should be supported with analysis leading to inferring the implications of past evolution on applicability of the transport solutions proposed for the future. In that respect, it is necessary to enhance the analytical transport planning frame in order to allow for the introduction of the above mentioned impacts of past evolution of demand, supply and activities on the proposed future transport policies and projects in the past.

It should be noted that studying the evolution of urban transport demand and supply necessitates existence of successive transport studies carried out in different years in the past including O/D surveys and transport system inventory, etc. Otherwise, evolution trends cannot be plotted and examined. However, the surveys of the previous studies should be compatible in many aspects. For instance, the zoning systems on which the O/D home interview surveys should have been analyzed using compatible traffic zones with the

same boundaries, the definitions of trips should be the same, the modes for modal shares determination should be the same, etc. This compatibly allows for comparisons and plotting of the evolution trends and indices for the years for which the surveys were carried out. Consequently, it is essentially recommended that when carrying out a transport study, the city authority should be fully aware and hence strongly insisting when preparing the terms of reference, on ensuring the compatibility of successive studies along the lines mentioned above.

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