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IMPACTS OF THE CAIRO METRO

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Note

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1. The Metro system

The Metro system in Cairo comprises two lines, as shown on map 1. :

1. Al Marg - Mubarak - Sadat - Helwan (also known as the 'regional line'). A route opened in April 1989, formed by connecting two existing surface suburban lines by a cut-and-cover underground section through the central area. Total route length is 43.5 km, of which about 3 km comprises the central area section, the rest of existing surface suburban lines modernised. It is electrified at 1500 v d.c. overhead. Magnetic card tickets are issued, with automatic barriers at most stations. About 1.2m passengers per working day are now carried (the annual total in 1997 being 418m). Some 33 stations are served.

2. Shubra El-Kheima - Mubarak - Sadat (sometimes referred to as 'urban line 1', being the first purely urban route). The first phase (Shubra - Mubarak, 8.5km) opened in October 1996, and the second phase, an extension through the central area to Sadat, in October 1997. Current operational length is 10.9 km. Tunnelling work under the Nile has been completed, and the section into Giza, serving the University (5 km), is expected to open in 1999. The final section, a further 3 km, to Giza Suburban (interchanging with the ENR services) is under construction. Unlike line 1, this route has third rail 750 volt d.c. power supply. It is mostly in bored tunnel, except for a short section at the northern end approaching Shubra El-Kheima, which is elevated, and a section just south of this by cut-and-cover. In consequence, construction costs per route-km for line 2 were much higher. In the first full year, 1997, an estimated 66 million passengers were carried (about 0.2 million per working day).

Table 1 shows a set of ridership and passenger density figures for a sample of metro systems. It can be seen that Cairo occupies a fairly high level in terms of passenger density, between the relatively low figures in western Europe, and the much higher figures of some large cities (notably Hong Kong). Systems in large cities of developing countries are characterised by high population density, low car ownership, and often severe congestion on the road system. In addition, the metro systems are often smaller relative to population than, for example, in London. Hence, the traffic density is much higher.

Note that the measure of passenger trips per route-km is a relatively crude one, since it does not take into account average trip length. Ideally, passenger-km per route-km would be a better measure of traffic density, but it is only available for a few

systems (such as London and Paris).

However, it does not always follow that better financial performance is always obtained in the large cities of developing countries, despite high ridership density, since fares may be regulated to below-cost levels, and high staffing levels may exist. Furthermore, if capital as well as operating costs are considered, cost over-runs and delays in construction often result in far high costs than initially estimated when systems were proposed, leading to poor (or negative) economic rates of return (1). Where fares are increased from a low initial level to cover a higher proportion of costs, substantial ridership losses may result, as in the Mexico City example quoted in table 1.

In the Cairo case, line 1 performed much better than many other systems examined in a comprehensive TRRL/HFA study eight years ago (2), mainly due to the fact that it mostly comprised existing surface suburban lines, with a short new underground section. Hence, total capital costs were low relative to total passenger volume. At 1986 prices, the estimated economic internal rate of return was 15.6%, the fourth highest in the study after Hong Kong, Singapore, and Seoul (but note that these examples, as well as being of high density, also display much higher income levels and hence values of time used in estimating benefits.

Note that the estimates were based on the likely use of the line, which was only just opening when the study was produced. It was assumed that the metro line 1 would carry 0.39m passengers per day in the base year (of which 0.16m would be generated), and 2.1m per year in the evaluation year (of which 1.4m generated) (ref 2, table 11-2). In practice, ridership is currently about 1.2m per working day at present, after almost ten years' operation.

2. Socio-Economic Conditions of Inhabitants of Cairo

In order to understand the situation in which the metro system operates, it is desirable to examine the broader socio-economic background in the city and conurbation as a whole.

The built-up conurbation (the Greater Cairo Metropolitan area, or GCM) comprises three sectors:

1. The city of Cairo itself, located on the east bank of the Nile, extending south to Helwan, north to Shubra, and North East to Heliopolis and Nasr City.

Map 1

The Cairo metro system

Line 1 (also known as the 'regional line') runs 43 km from El Marg to Helwan, the central metro section (cut and cover tunnel) between Mubarak (Ramses) and Sayeda Zeinab being shown by a heavy line. Line 2 (heavy dotted line) is now open between Shubra El-Kheima and Sadat (Tahrir), with the section to Giza approaching completion. A third line is proposed (Imbaba - Salah Salem). Also shown is the Heliopolis tramway, serving an area east of central Cairo.

The three stations at which surveys took place are:

A. Azbet Al Nakhl (close to El Marg) on line 1.

B. Shubra El-Kheima (northern end of line 2)

C. Dar Al Salaam (on line 1, south of the city centre)

[Map taken from Jane's Urban Transport Systems]

Table 1 : Comparative passenger volumes and densities for selected metro systems.

System	Passenger trips (m)	Route-km	Passengers /route km (m)	Passengers /station (m)
Tokyo (1)	2139	162	13.2	14.4
Hong Kong(2)	779	43	18.1	20.5
Mexico City (3)	1300	178	7.3	n/a
Cairo (4)	483	53	9.1	11.5
Calcutta (5)	80	16	5.0	5.3
Santiago (6)	200	27	7.4	5.5
Rio de Janeiro (7)	92	25	3.7	3.8
London (8)	832	392	2.1	3.4
Paris (9)	1534	302	5.1	3.5

Notes :

(1) 1993 data for TRTA system only. Source : London Transport Market Report, October 1996, page 44.
(2) MRT, data for 1993. Source : as (1)
(3) From Passenger Rail Management June 1998, p 9. NB In 1989 with a network of 141 km, 1,500m passengers were carried, a density of 10.6m/route-km, subsequently falling due to fares being increased from a low level.
(4) Following completion of line 2 to Sadat, 1997 estimates.
Line 1 carried 417.7m, and line 2 65.7m
(5) 1997 data. Line comprises only one route in central area. Source : Piyush Kansal 'Ridership estimate for Metro Railway Extension from Tollygang to Garia in Calcutta - a case study'. Paper in steam D1, World Conference on Transport Research, Antwerp, July 1998.
(6) 1997 passenger estimate
(7) Metro Rio de Janeiro. Anuario Estatistico 1996. Two lines, line 1 being a 'heavy metro' (average pax/route-km 7.0) and line 2 a 'light rail' route (0.9m pax/route-km)
(8) From London Transport Annual Report for 1997/8
(9) RATP plus RER regional metro, for 1994. Source : as 1

2. Giza. The district on the west bank of the Nile, effectively part of the city, developed at high density. This includes intensive office and residential development.

3. Shubra Al-Kheima. A district north of the city, located in the adjoining governate (although no further from the centre of Cairo than many districts within the city itself).

The Metro system is currently confined to the city of Cairo itself, apart from the short section of line 2 extending into Shubra Al-Kheima, although the forthcoming extension of line 2 will take it into Giza.

The total population of GCM rose from 6.70 million in 1976 to 8.63 million in 1986, comprising 18.2% and 17.9% respectively of the national population in those years. Within this total, the share represented by Cairo city itself fell from 75.7% to 70.1% - although still growing in absolute terms - as net growth was concentrated in the Giza and Shubra Al-Kheima areas. The city of Cairo population grew from 5.07m in 1976 to 6.04m in 1986, and 6.79m in 1996. Within the city, major differences are found in net residential density. The gross density over the city as a whole of 131 compares with net residential density of 394 per hectare. The net density is very high, and even the gross figure is about three times that of London, for example (of about 45 per hectare).

The residential zones of Cairo can be grouped by density as follows:

(a) 'Low density' (under 300 per hectare, net). Some of these rpresent affluent areas with smaller households (such as Maadi and Zamalek). Others are effectively part of the central area, such as Qasr Al Nil, and hence are used for office and shopping provision rather than being primarily residential.

(b) 'Moderate density' (300 to 500 per hectare) Most of these are around or within the central business district (such as Gamalia), with the exception of Al Marg (on the north east fringe of the city) and Helwan (the southern extremity), both served by Metro Line 1.

(c) 'High density' (over 500 persons per hectare). These lie further from the central area in most cases.

Cairo may be seen as similar to many other cities in developing countries, in that high-income groups tend to be located close to the central area, while lower-income, high density areas are

located further out. Hence, low-income travellers may be faced with relatively high transport costs (both in absolute terms, and notably as a proportion of disposable income), especially where distance-based fare scales are applied. A similar pattern may be found in India, for example (3).

Between 1986 and 1996, the city as whole grew by 12.3%, but many zones showed substantial declines, especially in the inner area, while some in the outer area, showed growth of over 100%. Growth of commercial and business activity in some inner and central zones may also have displaced residential population.

The average household size is about 4 persons, but higher in low-income high-density zones such as Basatin and Al Marg, and lower in zones in or surrounding the central business district. About 11% of the population are aged under 6 years, but only 6% are 60 years or more, a pattern in common with other developing country cities but in marked contrast to the older age structure in centres such as London.

Data is available from a comprehensive transport survey carried out in 1987 (4), indicating variations in car ownership and income by zone. Average car ownership at that time was about 0.053 (about one car per twenty people), or 0.017 per household (about one car per five households). Subsequently, average car ownership levels have increased to about 0.07 per head, but a similar zonal variation is likely to remain. The overall car ownership level could be seen as intermediate between cities such as Mumbai (about 0.04) and London (about 0.30).

If it assumed that metro lines have a catchment area 1 km either side of the route (i.e. walking distance to stations, plus some motorised feeder access), then the total catchment of the Cairo system is about 94 sq km. Assuming a net residential density of about 400/ha, they thus serve up to about half the city's population. Since the main aim of the study was to examine the role of the metro system in serving low-income groups, stations were selected within high-density, low-income zones for user surveys as follows:

1. Shubra Al-Kheima (northern end of line 2). A 1987 car ownership level of 0.018, and household income of 156 LE/month, compared with city-wide averages of 0.053 and 219LE respectively.
2. Dar Al Salaam, on line 1 south of the central area, in the Basatin zone (0.031 cars/person, income 174LE)
3. Azbet Al Nakhl, penultimate station from the northern end of line 1, within the Al Marg zone (0.021 cars/person, 132LE/month).

3. The existing public transport system

The existing system under public ownership is shown below.

Table 2 : Basic characteristics of publicly-owned transport in Cairo 1995/96

Modes	Operator	No. of routes	Total fleet	Operational*	Pax/yr (mill)	% of all pax
Bus	CTA	334	2807	1780	952	48.9
Bus	GCBC	122	927	600	318	16.3
Minibus	CTA	61	699	496	121	6.2
Heliopolis Metro	CTA	6	49	17	18	0.9
Cairo Tram	CTA	14	205	67	50	2.5
Riverbus	CTA	8	33	20	3	0.2
Metro	ENR	2	1362		483	24.8
Total		547	6082		1945	100

Source : Statistical Year Books for 1995/6 of CTA and GCBC.
Metro data is for 1997, including first phase of line 2.

* Average operational fleet per day

The Cairo Transport Authority (CTA) operates all tram, riverbus and most bus services. A second state-owned bus operator, Greater Cairo Bus Company (GCBC), is a subsidiary of CTA.

The Cairo city tram network has been greatly reduced in recent years, but the better-used Heliopolis 'Metro' (reserved track tramway) system provides a link between that part of the conurbation and central Cairo (interchanging with the metro), and local services within Heliopolis. The Riverbus provides a series of links across the Nile The conventional buses of CTA and

GCBC are single-deckers, conductor-operated, seating about 50 people, plus standees (often overloaded at peak periods), and together carry about 65% of all passenger trips. The minibuses of CTA are of about 20 seats capacity, and operate on a premium fare compared with standard buses. They may be seen as a response to the privately-operated shared taxis (small minibuses) described below.

For example, the single trip fares between Shubra El-Kheima and the central business district are as follows :

CTA or GCBC conventional bus	25 piastres*
CTA minibus	30 "
Minibus (shared taxi)	35 "
Metro (line 2)	50 or 60 "

The Metro fare varies according to the station used in the central area (50 pt to Ramses or Attaba, 60 pt to Tahrir).

Hence, the metro fare is about twice that by bus. In addition, passengers using a shared taxi as a feeder to the metro would pay a short-distance fare of about 25 pt. However, it is likely that metro users gain substantial time savings : a journey from Shubra El-Kheima takes only 11 minutes to Ramses or 18 minutes to Tahrir (it is likely that bus and shared taxi journey times are considerably greater, especially at peak times, but data are not available).

However, for many users, the average cost per trip can be greatly reduced by using travelcards. Period travelcards are issued by the CTA for its bus and tram services, and the Metro also issues travelcards, but they are not inter-available.

For example, for the Shubra El-Kheima to city centre journey the rates are as follows:

CTA bus - one month, on a single route	LE 2 (student)
CTA bus - one month, on a single route	LE 5 (adult)
CTA bus - whole network, one year	LE180
Metro - three months	LE12 (student)
Metro - " "	LE32(govt/army)
Metro - " "	LE56 (adult)

On a quarterly basis, a similar metro:bus ratio is found (e.g. LE12 : LE6 for students, a ratio of 2:1).

* 100 pt (piastres) = 1 LE (Egyptian pound). Current exchange rate 1 GBP = approx 5.5 LE, i.e. 100 piastres = about 18 pence.

It can be seen that the two-line Metro system, operated by Egyptian National Railways (ENR) carries about one quarter of all trips, and possibly a somewhat higher share in terms of passenger-km (trip length data are not available). It will represent a somewhat greater share within the city of Cairo itself, due to the Giza district not currently being served. It is likely that opening of the metro has caused considerable diversion of users from other public transport modes (conventional bus, CTA minibus, and shared taxi) due to its higher speed and quality of service (see passenger survey results quoted below). Some diversion of car journeys may also be expected (although since our survey was confined specifically to low-income areas with very low car ownership, the effect in those particular cases would be very marginal). It is known that the metro runs parallel to some of the most heavily-congested roads in the Greater Cairo area.

Unfortunately, detailed road traffic flow data, and data for specific bus services, are not available for the period since line 1 opened, and hence systematic 'before and after' comparisons cannot be made.

On those corridors which the metro serves it is likely that it represents about 50% of all public transport use. The major role of the metro - a 25% share of the whole public transport market - contrasts with that of the two-line systems in Santiago and Rio which represent about 13% and 4% respectively (5,6) of their cities' public transport markets, albeit in cases where a higher level of bus service is provided.

The overall use of 1945m passenger journeys implies a public transport trip rate per head for Greater Cairo (assuming a total population of approximately 10.6m) of about 185 per year. Data is also available for some earlier years. For example, in 1985/86, the public transport network (excluding the suburban railway precursor of the Metro, and the Heliopolis tramway) carried 1201m passengers (a trip rate of about 180 per head). This total rose to 1564m in 1991/92, and 1555m in 1993/94 (including the Heliopolis tramway, but excluding the metro), implying a trip rate of about 150, i.e. a decline on the 1985/86 figure.

It would thus appear that the opening of the Metro has not caused a marked growth in the overall public transport trip rate when 1985/86 and 1995/6 are compared (especially when ridership on the previous suburban line is also borne in mind). However, it has enabled the public transport system to cope with rapid population growth.

The average per capita public transport trip rate is somewhat lower than some other large cities (such as London and Mumbai, at around 275-300), despite the low car ownership levels, and may be attributed to constrained public transport supply, limited disposable incomes (affecting off-peak demand) and lower economic activity levels (proportion of the population in paid employment). For example, the 1989 Transportation Masterplan study (4) forecast that in the year 2000 the main purposes of internal trips (all modes, but probably confined to motorised trips) would be 'returning home' (48%), 'commuting to work' (21%), 'commuting to school' (16%), 'shopping' (3%), and 'other purposes' (business, leisure etc.) comprising only 11%. The limited off-peak market is evident from this (about 28% of all home-based trips being neither work nor education), a result of the age distribution and low real incomes.

The quality of the conventional public transport system may be a major factor in the growth of shared taxis. Garib and Abdelmegeed (7) indicate that over 25,000 shared taxis are in operation, carrying about 1.4 million trips per day in 1992, or a similar volume to the metro (on an annual basis, this would raise total public transport use by about 490m, and hence trips per head from about 200 to about 250). Strictly speaking, such services should be operated direct point to point under the laws by which they are authorised, but in practice they stop frequently for passenger boarding and/or alighting, about every 500 metres, i.e. performing a similar function to an urban bus. Few shared taxi vehicular trips exceeded 5 km, suggesting use mostly between the central area and inner zones, or locally within suburban areas.

Another important characteristic of the travel patterns in Cairo is the distribution of journeys by time of day. The typical working day is somewhat shorter than in Europe, of about 6 - 6.5 hours' duration (from around 0800 to 1430), but applies over a six-day week (Saturday - Thursday). This results in a sharp peak in demand around 0800 (coinciding with education travel, as in Europe), but a better spread and somewhat earlier afternoon peak. Data from metro line 2 stations illustrate this pattern in figures 1 and 2.

4. The Metro Users Survey

A survey of metro users was undertaken, at three selected stations, to identify user characteristics, and in particular, the extent to which use from low-income areas could indicate that metro users were representative of such areas. Ideally, a household survey could have been undertaken to identify use of all modes along a corridor, and the share taken by metro, but this was not practicable.

The survey was piloted in January 1998, and the main set of interviews completed on Monday 16 March 1998, covering a period between 1200 and about 1600, a total sample of 719(except where stated, conclusions below are drawn from this 'main survey'). This sample is referred to below as the 'Main survey'. In order to make comparisons with travel patterns at a different time period, a further survey was subsequently carried out at Azbet Al Nakl between 2000 and 2300 on Saturday 27 June 1998, giving a further 61 responses to produce a total sample of 780. The full data set is referred to as the 'whole sample'.

By stations the distribution (main survey) was:

Azbet Al Nakl	246*	(34.2%)
Shubra El-Khaima	232	(32.2%)
Dar Al Salaam	241	(33.5%)
Total	719*	

* In addition, the evening survey produced 61 responses from Azbet Al Nakl, giving that station 307 of the whole sample total of 780, or 39.3%.

By gender, data was obtained for 755 respondents (from the whole sample), of whom 72% were male, and 28% female. From the main survey, the proportion of trips made on single tickets by each gender was very similar (about 35% in each case), but a higher proportion of females were using the student travelcard (32%, compared with 19%), while females were less likely to be using the other travelcard types (34%, compared with 46% of males). This may reflect the degree of female participation in the labour force.

From, the whole sample, data was obtained for 761 respondents, indicating the following split by ticket type:

Singles	37.4%
Travelcards for the general public	6.9%
Travelcards for government and army	34.4%
Travelcards for students	21.1%

The travelcards are valid for three months. It will be noted that the proportion of such cards being used by members of the general public is small (6% of all trips), but such cards represent the majority of travel when government & army, and students, are concerned. This is associated with the much lower 'break even ratio' resulting from their low price. For example, if a person makes 12 single trips per week on the metro (i.e. to work or education over six days), and over three months makes such journeys on 12 weeks, they would make 144 journeys, leaving aside any additional travel that might be encouraged by use of the card (the overall average use is around 228 trips per quarter).

At 144 journeys, the cost of using single tickets would range from LE72 (at 50PT per trip) to LE115 (at 80PT per trip). Hence, one would normally expect all such frequent travellers to switch to travelcards, provided that they could afford the initial purchase price. For students, the ratio is even lower - for example, someone making trips priced at 50PT single, on a 9LE travelcard, would only need to make 18 trips to break even.

It is noticeable that of the passengers giving ticket type in the evening survey, 57% were on singles, indicating a much higher proportion of lower-frequency travellers, presumably for leisure and other personal journey purposes.

The attractiveness of the travelcard to groups such as students is supported by a cross-tabulation of ticket type and employment status from the main survey. Of the 28% of respondents classified as 'students', 76% were travelling with travelcards, the others on singles. Of the respondents classified as 'government or army' 75% were also using travelcards. Conversely, only 37% of 'private sector' and 'own business' respondents were using cards. Cross-tabulations by trip frequency likewise confirm this pattern. Of those travelling nine or more times per week, 79% were on travelcards.

Note that the form of the survey will tend to exaggerate the proportion of individual metro users who are high-frequency travellers, as such people are, by definition, more likely to be interviewed during a given period at stations.

Of the 700 respondents providing data on car ownership in the main survey, 91% were from non-car-owning households, 9% from one-car households, and under 1% from households with two or more cars. Hence, about 0.1 cars per household is the average, and, assuming an average household size of 4, this would imply a car ownership rate per head of about 0.025 (one in forty). This is very similar

to the rates found in the 1987 study for the low-income areas identified in the process of sampling stations (Basatin, Al Marg and Shubra: the unweighted averages for these three areas in 1987 were 0.088 cars per household, and 0.024 cars/head). Hence, it may be assumed that the users interviewed are fairly representative of the zones in which the stations are located (indeed, if car ownership in these zones has risen since 1987, they may represent a lower-than-average income group).

Car ownership and income relationships were also examined. The proportion of respondents in car-owning households rose from 7% where income was less than 200LE per month, to 27% for income levels of over 500LE per month. A chi-squared test indicates a significant relationship at the 0.001 significance level.

Respondents were also asked what modes they had used before the start of metro operation. It should be borne in mind that line 1 has been open for about ten years - hence, many users may have not made the equivalent trip prior to its opening, since experience in other cities indicates that a substantial 'turnover' in the urban public transport market is observed, i.e. many people will have changed their home and/or work location during this period, possibly in response to transport system changes. In addition, continued population growth in Cairo means that many users would be new to the city itself, quite apart from any particular route or mode.

This is confirmed to some extent by a substantial proportion of 'other' modes reported for line 1 stations (23% for Azbet Al Nakhl, and 17% for Dar Al Salaam) compared with the recently opened Shubra El-Kheima (line 2), where this proportion was under 1%. It may be that 'other' modes are, in practice, referring to the trip not being made previously, or on other routes, or use of the previous suburban rail service. Results are shown in figure 3.

The most common previous mode used (excluding 'other' as a category) was the CTA full-size and minibus services (64% overall, rising to 72% in the case of Shubra El-Kheima). Paratransit was generally the next most important mode (25% overall, rising to 41% for Dar al Salaam). The higher proportion for Dar al Salaam may be associated with its location closer to the city centre, making the cost of this mode for the main leg of the journey more affordable.

Access modes to stations are shown in figure 4.

As might be expected, the dominant access mode from the station to home (or other destination) for passengers departing from trains was foot, an average of 69%. The next most common mode was paratransit, at 23%, followed by CTA services, at 6%. A much higher proportion of motorised access was found at Shubra El-Kheima, at 41%. This is probably associated with the larger catchment area of the station, being on the northern edge of the built-up area of the city.

Given the high population density of the city, one might have expected an even higher walking proportion - the figure is, for example, very similar to that found for London Underground stations (an average of 67%) (8). The main difference is that the motorised element in London is comprised mainly of LT's own bus services (16%) and car (11%), plus 6% other, whereas in these districts of Cairo it is comprised almost entirely of public transport services, mostly paratransit.

In the direction toward the station, walking was also 68% of the total. However, the paratransit share was slightly lower (20% compared with 23%), while that of CTA was slightly higher (9% compared with 6%). The dominance of paratransit was markedly less at Shubra than for journeys from the station (29% compared with 41%). Observations indicate that the paratransit vehicles tend to gather near the stations, awaiting passengers coming off trains, so that a full load may be built up for each route. Conversely, on the journey toward a station, it may be less easy to stop the paratransit vehicle, or it may already be full, whereas CTA vehicles operate at slightly lower load factors, enabling passengers to board at intermediate points.

In the case of age distribution of respondents a direct comparison was made with the Rio data (9), showing a very similar pattern, probably typical of such cities and their overall age distribution. In comparison with the city-wide age distribution there is, as would be expected, a smaller share of the youngest age groups (under 15), who are less likely to travel independently on the metro or make journeys requiring its use on a 'working day'.

The comparison with Rio also indicates that travel to/from work comprises 63% of journeys in Cairo, and 75% in Rio : the latter may be affected by higher fares and the lack of equivalent travelcard facilities to those in Cairo, discouraging non-work trips (especially student travel).

A generally very favourable attitude was found toward the metro by users interviewed (by definition, some bias occurs due to non-users

being omitted). Ranked by descending percentage of those giving 'excellent', the characteristics are as follows:

Trip time and safety
Accessibility to stations
Comfort
Cleanliness and cost

The lower ranking in terms of 'cost' may partly reflect greater sensitivity to cost among low-income groups.

5. Price elasticity

A fares increase averaging about 20% was applied in October 1996. Data has been made available for monthly sales of single tickets and travelcards before and after this date.

Whereas single cash ticket sales grew by about 7% in January-October 1996 compared with 1995, this became a reduction of 8% in the equivalent period in 1997. Conversely, travelcard sales continued to grow at a very similar rate (about 7% per annum) throughout this period. It thus appears that single cash tickets display a greater price sensitivity, as might be expected, while that for travelcards is very low. The price increase might also have stimulated some passengers to shift from cash singles to travelcards, as well as shifts to lower-priced bus services, and possibly to walking for short trips in the central area.

A price of elasticity of about -0.4 may thus be derived for cash singles, or one of about -0.2 for the whole market (including travelcards). This is a very similar outcome to that found in Santiago (an elasticity of -0.24 for line 2, serving lower-income parts of that city) (5) and in London (an 'own price' elasticity of -0.43, and a 'conditional elasticity' of -0.17) (10). An elasticity of about -0.4 has also been observed for bus travel in Mumbai (10).

6. Conclusions

The Cairo Metro plays a major role in that city, comprising about 25% of all public transport trips, or around 50% in those corridors which it serves.

A survey in selected low-income areas confirms that users of the metro appear to be representative of the average income and car ownership levels in such areas, despite the metro fares premium vis a vis bus and shared taxi competitors.

The survey also indicates that most travel was previously made by other public transport modes. A substantial proportion (about 25%) of access to stations is by motorised modes, primarily bus and shared taxi.

A price elasticity of around -0.2 may be derived from recent fare changes, consistent with evidence from other metro systems.

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(3) D.A.C.Maunder Trip rates and travel patterns in Delhi, India. Transport and Road Research Laboratory Report RR1, 1984.

(4) Transport Planning Authority. Transportation Master Plan, Greater Cairo Region, 1989. Data shown in the text was also derived from that provided by the Information Centre of the Egyptian Statistical Department, Cairo

(5). Jara-Diaz, Sergio R. 'Differentiated Fares in the Santiago Subway System : Foundations and Experience' Fourth International Conference on Competition and Ownership in Land Passenger Transport, Rotorua, New Zealand, July 1995, pp 252-267.

(6) Balassiano, R. 'Vans - A new public transport alternative in a developing country city'. World Conference on Transport Research, Antwerp, July 1998.

(7) Garib, Atef M. and Adbelmegeed, Ahmed E.T. 'Effect of shared taxi driver characteristics on driving behaviour and performance in Greater Cairo Metropolitan area' Paper in stream E2, World Conference on Transport Research, Antwerp, July 1998

(8) Interchange in London. London Transport Planning, 1997, page 18.

(9) Data from a survey carried out in early 1998 by 'IBOPE' (a local market research company) for the new operating company responsible for the Rio metro, 'Metro-Rio' (a subsidiary of the Argentinian company Cometrans). Note that fares were increased sharply shortly before the transfer from the public sector operator, reducing total demand by about one third (and thus possibly changing the composition of the market served).

(10) Research Report R273 : London Transport Traffic Trends 1971-90. London Transport Planning Department, 1993.

(11) Modak,S.K. and Banushali,V.G. 'Demand elasticities for Public Bus Transport in Bombay' Proceedings of the 26th Annual Meeting, Transportation Research Forum, Jacksonville, Florida USA, November 1985, pp 175-183.

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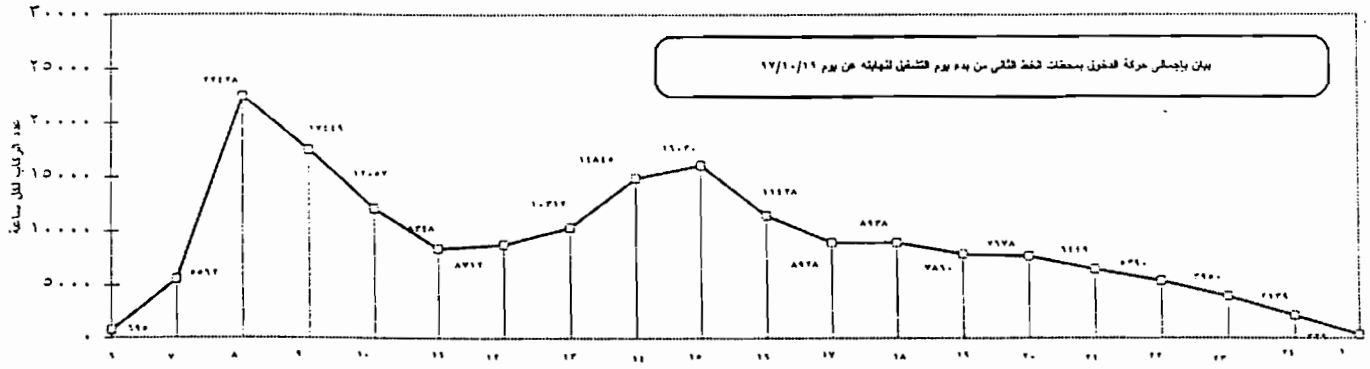
Figure 1. A Metro demand profile for a working day

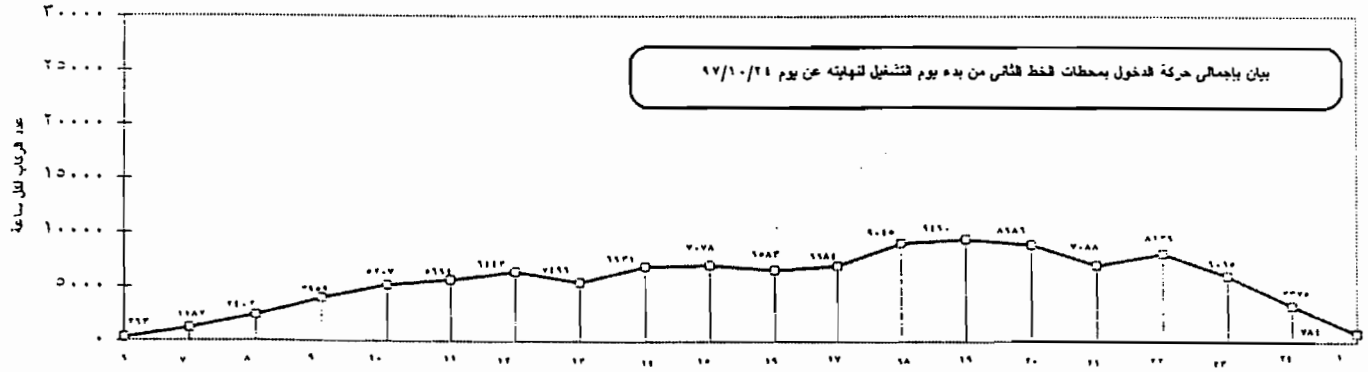
Sunday 19 October 1997 on line 2, provided by the Metro Authority. This is based on hourly counts taken from the automatic ticket barriers, showing total entry flows in both directions at all stations. Beginning with the hour commencing 0600, demand rises rapidly to the morning peak hour (commencing 0800), which corresponds to 22,400 passengers. It then dips to about 10,000 per hour, before rising to the afternoon peak (hour commencing 1500) of 16,000. A gradual reduction can be seen during the evening period, to end of operations at 0100. Total daily flow is about 180,000 (Source : Metro Authority).



Hour commencing

Figure 2. A demand profile for a Friday (line 2, 24 October 1997)

Compare with the typical working day profile shown in figure 1 (above). Passengers per hour are shown on the vertical scale, and hour commencing on the horizontal. Note the lower overall level, with a peak in the late afternoon (hour commencing 1900), and total daily flow of 111,000. (source : Metro Authority)



Hour commencing

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Figure 3. Modes used for the same trip prior to the start of metro operations, derived from the user survey. Note that the substantial proportion of 'other' for Azbet-al-Nakl and Dar-al-Salaam (both on line 1) may relate to passengers not making an equivalent journey before the line opened.

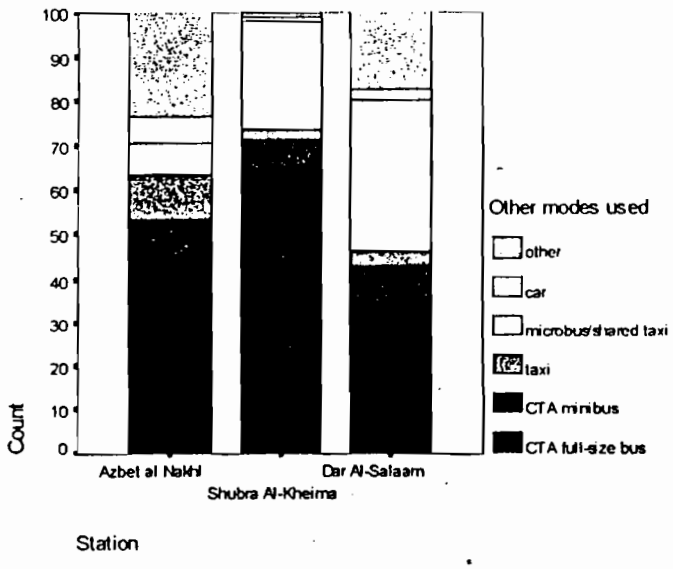

Figure 4. Mode of access to the station, from the passenger survey.