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POTENTIAL DESIGN FOR MASS TRANSPORTATION IN EGYPT

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DEDICATION

To my beloved country;
to the City of Cairo, in which I have been borne;
to my father and mother;
to my brother, Kamal El-Din Hussein;
to my wife.

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CHAPTER I

THE FORMULATION OF THE PROBLEM

A. Introduction

As the title of this research, "Potential Design for Mass Transport Movement in Egypt," may indicate, this work will only be concerned with the preliminary proposals for the design of movement and will not be concerned with the detailed plans to overcome the passenger movement problem. In other words, this work can point the way to systems of overcoming the anticipated congestion but cannot provide a detailed design of the means to this end. Although in many parts of this work I may discuss the Egyptian region as a whole, the emphasis will be concerned with the dilemmas of movement within the "Cairo Metropolitan Area." The reason is that this area is settled by about one sixth of the population of Egypt,(1) and their share of economic, cultural and social activities, other than agriculture, reaches more than thirty per cent of the country's activities.(1)

The mass transport movement of Cairo area alone - as the latest statistics indicate(2) - is about 742 million passengers per year, while the total intercity transport in Egypt is about 287 million passengers per year.(3) Moreover, the capital required to overcome the passenger transport needs for the metropolitan area may jump to a figure higher than that allocated for the total intercity passenger transport in the country. The Minister of Housing stated in July, 1963 that "a subway system for Cairo is under the study of a French and a British firm, the first estimate of constructing a part of the two main lines (14 Kms.) is twenty-eight million Egyptian pounds." This is only a fraction of the subway which must make up the ultimate system. This capital would

be allocated for an eight-year period of construction of the two main lines. On the other hand, the capital allocated for the total highway and bridge network for the country from the year 1952 - the year of the Egyptian Revolution - to the year 1964 - the last year of the first five-year plan - is about L.E. 41.8 million,(4) a large share of which could be attributed to freight movement needs.

A good approach to the solution of any problem can be achieved by defining and delimiting the problem itself. In other words, if somehow we can realize and point out "what is going wrong," then it will be possible to discover what part of the available technology should yield the logical solution. A good share of a skilled doctor's work is to diagnose the patient's illness. Knowing the complaints of the patient, his skill should direct him to make some checks as well as psychological, laboratory, or other tests by which he can define the illness, rather than anybody else who guesses at what it may be, taking any medicine on the shelf, if no improvement occurs he can try another until by chance he gets the right one; a procedure which can lead to a disaster. After defining the illness, the doctor can apply the up-to-date technology in prescribing the medicine and the routine to be followed. But what is the meaning of the tests applied? The doctor's skill is built up by knowing some standards that a normal persons have, e.g., normal temperature, normal blood pressure, normal blood analysis, etc. The major problem then is to know what properties deviate and how far they are from the means or standards which are well known to him.

A transportation planner has a more difficult job than a doctor because most standards in transportation are relative and cannot

be absolute. Although this may be the case, we can still adopt the doctor's procedure of testing the degree of achievement of goals that lie behind the standards. Knowing the geographical background of the area under study, the history of its development, and the evolution of its transport problem, as in the doctor's case one should know the background of the patient's life and the history of his complaints, then the planner should measure the degree of achievement of certain goals in order to define and delineate the problem at hand. The following ends or goals are proposed as suited to Cairo:

1. Minimization of traffic movement in number and length of trips while still maintaining an adequate standard of living. That does not mean that one's goal is to make the number of trips as well as their lengths equal to zero. Real life is nothing but movement, and transportation systems are the media for achieving movement. Our goal, therefore, is to reach the sites of all activities with the least number of movements and minimum cost in terms of expenditure of human time, effort, and money.

2. Reduction of the fluctuation of daily movement that can be made to fit the community desires. This aim would minimize the idleness of equipment and keep the seat vacancies at a low level.

3. Elimination of traffic concentrations, since a better traffic distribution within an area will reach higher utilization of street capacities.

4. Although we can have better distribution of traffic within an area so as to eliminate its concentration, we can face the problem of congestion due to hazardous movements or spot confusion. This could be

a reflection of the movement characteristics of people and vehicles, and the physical features of roads as well. This goal could be then entitled the elimination of hazardous movement and spot congestion.

5. Although we can reduce the traveling distance and eliminate hazardous movement and congestion as well as finding a better distribution of traffic, we can still face a speed problem. Mechanical characteristics of vehicles, distance between stops, system of ascending or descending the vehicle and the system of fare collection could be included among those other factors. So, our goal here is the attainment of higher average speed.

6. We can achieve all the above mentioned goals; but we may be blocked by a short supply of road and vehicle capacities to balance the traffic demand. A partial solution of a transportation problem may lie in more effective equipment or building elevated roads or underground subways.

7. Proper distribution between modes of transportation is important so as to minimize confusion, and the supply of modern equipment is relevant so as to improve comfort and convenience.

8. Public transportation should be provided at minimum cost to the consumer, but it should also yield a reasonable profit.

B. Background

All large cities of the world are becoming increasingly difficult to live and work in, mainly because of the problems of physical movement. The problem of overcoming the congestion and removing the obstacles to mobility threatens to make the metropolis an economic liability rather than an asset.

The crisis in transportation is largely the result of the growing concentration of population together with its economic, cultural, social, and political activities. If the rate of urban growth should continue, more than a fourth of the earth's people will be living in cities of 100,000 or more in the year 2000 and more than half the population by the year 2050. For places of 20,000 or more, the proportions at the two dates would be something like 45 per cent and 90 per cent.(5) In Egypt the degree of urbanization increased from 25 per cent in 1937 to 38 per cent in 1960.(6)

Agglomeration of people and activities in urban areas would have been impossible without the mobility and supply lines afforded by dependable and low cost transportation. People tend to concentrate more and more to seek the economic, social and cultural opportunities that urban living ideally provides. But paradoxically, metropolitan areas have now grown to the point where they threat to strangle the transportation that made it possible for them to become established.

The last several decades have witnessed more revolutionary changes in transportation than all previous history. These transportation advances were due to the rapid improvement in technology. We cannot determine whether people have been more apt to apply changes in technology to transportation than they were to adopt changes demanded by these modifications in transportation; or the techniques for solving problems generated by the advancement of transportation are advancing at a slower rate than the techniques of improving the transport media. Anyhow, it seems that urban areas have failed to adjust themselves to the changing conditions brought about so rapidly by the technological revolution in transport. The older urban

centers, with physical characteristics that were fixed in less changing times, have been staggered by the impacts of recent innovation, and the newer suburbs have compounded the transportation problem by repeating the land use errors of the downtown areas, thus creating problems of public administration that suburbs were not designed to meet.

Congestion is not a phenomenon solely of our era, nor is it only a Western problem. Congestion has been witnessed in the past as truly as it is now, and it has become a serious barrier to the cities of underdeveloped as well as highly developed nations. Cities everywhere are struggling with similar problems of achieving acceptable standards of urban mobility. Even where automobiles are few, the bus and truck, or the bicycle and horse, or even man driven vehicles combined with excess pedestrians, and sometimes still less modern methods of movement combine to create a degree of chaos comparable to the least penetrable crosstown streets of New York or London.

Although the urban transport problem is both long standing and world-wide, its characteristics are not alike everywhere. The problem varies widely among cities of different sizes, ages, types, and locations. Problems of large metropolitan cities are very different from those of smaller towns, and large cities differ widely according to their history, topography, wealth, and function. But the long standing nature of urban traffic congestion and its world-wide scope suggest, despite a variety of forms, that underlying factors may be universal and only partially related to modern methods of transport. Basic causes appear to be excessive crowding of population and economic activity into small areas of land and the disorderly arrangement of land uses that have maximized

transport requirements. The great bulk and density of urban buildings and the concentration of employment in the downtown area have created a volume of passenger and freight movement that has become increasingly difficult to accommodate effectively, regardless of the transportation methods utilized.

C. The History of Cairo

By virtue of its unique location as the meeting point of two continents at the heart of the world and the cross roads joining the East and West, Egypt has played a historic role of utmost importance since ancient times and which, for thousands of years has attracted adventurers, merchants, travelers, historians, and tourists from all parts of the globe. As Egypt has played an important role in the world, Cairo, by virtue of its unique location, has played a similar critical role in the Egyptian history.

Arabs were not the first to realize the importance of Cairo's location as the capital of Egypt, which has attracted the attention of every ruler through the history. This importance stems from the fact that at its site, the Nile diverges its course into two main branches creating the great Delta. So, Cairo's national importance is that it links Upper and Lower Egypt, while its international importance - at least before the construction of the Suez Canal (as it is known today) - is that it lies between the route linking the Mediterranean and the Red Sea. The Nile branch "Rositta" joins Cairo with Alexandria on the Mediterranean while it is connected with Suez on the Red Sea by a desert track and a man-made canal. Parallel to these two routes, the first two

main railroads were constructed to replace the water route until the Suez Canal was constructed. It is interesting to mention here that the same routes are still playing a main role of attracting tourists who are passing through the Canal and who find it is a pleasure to leave the ship at Alexandria or Port Said and have a pleasant time in Cairo, and re-board back at Suez or vice versa.

Even before the Pharaonic era the early inhabitants of Egypt realized the advantages of Cairo's location, but because the uncontrolled river was frequently changing its course, they feared flood and, therefore, chose a site nearer to the desert. The famous Babylon was the town, located in the district currently called "Misr El-Kadima" (Old Egypt or Old Cairo), to the south of Cairo. This city was dominant just before the Arab conquest of Egypt and was connected with the Red Sea by a canal.

Cairo as it is known now was established three centuries after the Arab conquest of Egypt. The Arabs established the city and gave it the name of "Al-Kahira," which is still its name by its native language - Arabic. By the same concept the native name of Egypt as it is pronounced there is "Misr."

The following is an outline of the history of the city since its establishment. For a detailed but a brief study of that history I refer to the fine and documented work of the "Planning Commission of Cairo," which has been published in the "Master Plan of Cairo" in 1956. Figure 1 is a vague sketch which may help together with Figure 2 - the existing map of Cairo - in following up the history and development of the city.

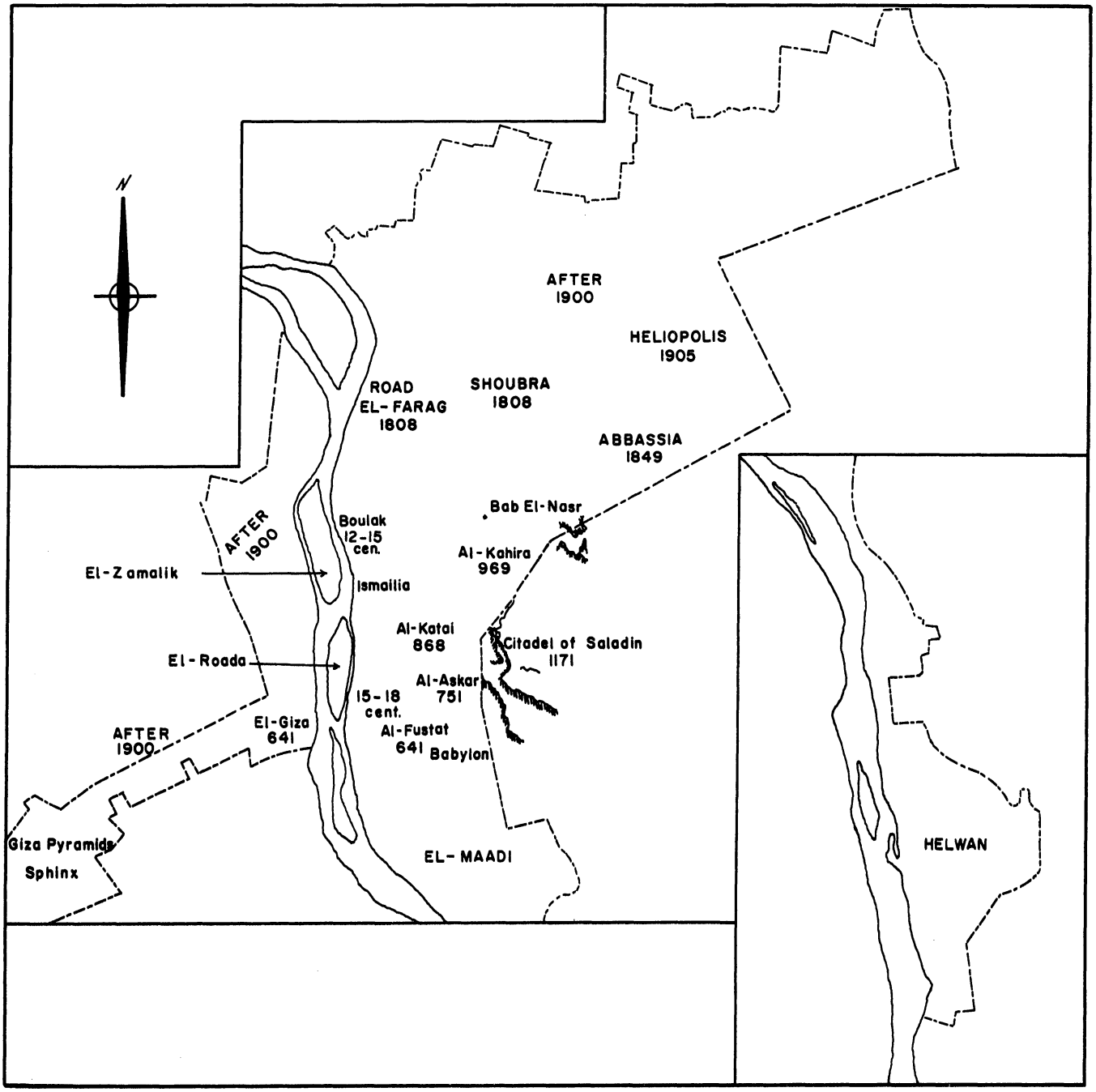


Figure 1. Historical Map of Cairo.

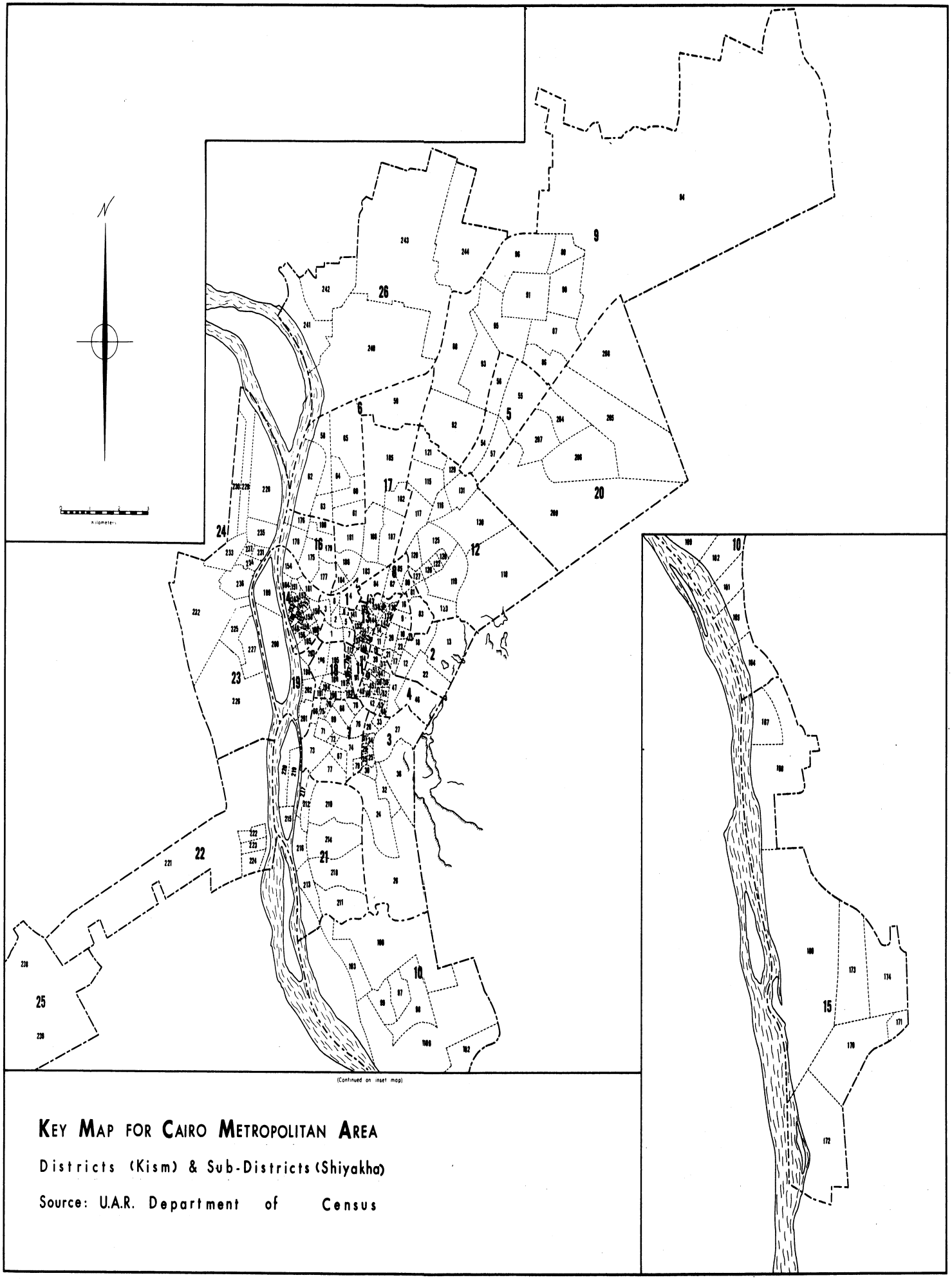


Figure 2. Key Map for Cairo Metropolitan Area.

Al-Fustat

The original Arab settlement was Al-Fustat (The Tents) in 641 A.D. ruled by Amr-Ibn El-Aass, who proposed to set up his capital in Alexandria, but the Kalipha ordered him to settle at Al-Fustat due to the strategic position of the site. This was in the neighborhood of the fort of Babylon.

Al-Askar

In the year 751 A.D. a northeastern city or suburb toward the hills was added. This settlement was the official residence of the governors and their troops, hence named "Al-Askar," which means the continents. In planning this capital they followed the same random settlement pattern as Al-Fustat, with its narrow streets and irregularity. Al-Askar grew till it joined with Al-Fustat.

Al-Katai

In the year 868 A.D. Ahmed Ibn Toulun found that Al-Askar and Al-Fustat were over crowded and unfit to accomodate his army and officials, accordingly in the year 870 A.D. he laid the foundations of his new capital city, Al-Katai. This name means the quarters and the city was divided into separate sections, each inhabited by a certain class or ethnic group. This was the first time a definite planning system was used by Arabs in Egypt. Touluns' administration followed the system of straight streets intersecting at right angles, forming a crude gridition plan. The city that evolved

was remarkable for the magnificance of its buildings, but it was completely destroyed by the Abbassides in 905 A.D. with fire so that hardly anything was left of it.

Al-Kahira

In 969 A.D. General Gawher El-Sickilly of the Fatimides of North Africa started to lay out the foundations of "Al-Kahira" which means "the conqueror." Al-Kahira included a Kalipha's palace, barracks for the army, stables for the cavalry, government buildings, etc. The site of this city was about 2-1/2 miles north of Al-Fustat and one mile from the Nile. It was enclosed by high walls which encompassed about 400 acres.

Studying the plan of this new Fatimid city we easily recognize that this is the same planning principle used by the Romans in the fifth century. The main street of Al-Kahira (Cairo) was called Karabet Al-Kahira. It lead to the gate of Bab El-Nasr at the north where it linked with the main route to Suez and Demietta, and to Bab Zewaila in the south where it linked with the main route to Al-Fustat and Upper Egypt.

The lateral secondary streets, intersecting the main city street at right angles, were mainly used to divide the different quarters of which the city was composed.

The city was a Royal city and Al-Fustat remained the business suburb. Each quarter of the city was assigned to a tribe or racial group that had joined the Fatimid invasion. Among these groups were Greeks, Turks, Berbers and Africans.

Cairo Under Later Dynasties

The loss of power by the Fatimid Caliphate during the eleventh century and the corruption of Wazirs, "Ministers" of different racial groups resulted in continuous fights and the spread of terror and destruction in the town. Cairo lost its capacity to rule Egypt when the famine of 1066 A.D., which stayed for seven years, cut off supplies from Cairo. Finally the plague spread death through the town so that the lives of about 200,000 inhabitants were lost. Badr El-Gamaly then took over and forced discipline and order upon the country, and began the reconstruction of Cairo.

Al-Fustat continued to be the business district until it was ruined by famine and plague and was finally brought to ashes by the fire set by Shawer in 1168 A.D. at its end of Fatimides. It was then that Al-Kahira became the main commercial city.

The great leader salah El-Din, known to Europeans as "Saladin," came into power during the Ayonbide era in 1171 A.D. The city owes its form and extent to him since his contributions have been retained until comparatively recent times.

Cairo Up to the 16th Century

In spite of the Mamlukes' extreme corruption, continuous intrigues, violence and savage cruelty, they, as had their predecessors, possessed a very exquisite taste in material civilization and an admirable devotion to art and architecture which we see in their mosques, schools, temples, etc. The cities' prosperity was

enhanced by the transit trade. Two major commercial diagonals of the world; the route from Baghdad to El-Maghreb - North Africa - through Damascus, Sahara Oasis, and Tripoli; and the route from Mediterranean Europe to India and the Far East through Alexandria. The port of Boulack[D14] (see Figure 2) was created at the Northwest when the river gradually shifted to the west becoming the main entrance of Cairo from Alexandria. At the same time Boulack became the center of business as well as the residence of people working in commerce, linked to the old city by two roads - each one mile long. Historians' estimates of population range from about 400,000 to 1,000,000 inhabitants. The streets were narrow and the buildings were of three or four stories, each house accommodating not less than one hundred persons.

From 15th to 19th Centuries

After the French invasion of Egypt, the city was accurately described as composed of three distinct parts separated by agricultural land, Cairo the City, and two suburbs, Boulack[D14] and Misr El-Kadima.[D21] The area of Cairo excluding Boulack and Old Cairo, was a little less than five square miles; its average length and breadth being about three miles by one-and-a-half miles, and in no part was it longer than 3-3/4 miles. The population was said to be 300,000 persons. The majority of the streets of Cairo were narrow and without pavements, their average width ranged between 15 and 20 feet. The introduction of carriages by the wealthy Turkish Pashas or Mamluke princes had at later years necessitated

that the new streets be wider and more straight. A "Shariah" was a great thoroughfare usually wide enough for the luxurious carriages, and generally lined on both sides with shops, especially in the part running through the center of the City. Such shops occupied the ground floor of the houses and a combination of assimilated shops formed a succession of markets or "Suk." These great streets had not one general name, but many different names, according to the nature of trade, the vicinity of a mosque or the like. Thus, we find Suk El Haddadin and Suk El Ghoriah combined in one street, the first following the trade of occupants of shops and the latter after the name of a neighboring mosque.

In Cairo, according to Ali Pasha Mobarak's book, "El-Khetat El-Tawfikiah" there were 26,063 privately owned houses, 12,390 privately owned shops, 528 Rabb, 441 dyeworks, 384 flour-mills, 159 bakeries, 293 wekallas, 83 silk weaving halls, 100 stables, 102 timber sheds and 16 hotels. Mobarak also estimated the number of skilled labors in Cairo at 94,487 including 1610 builders, 689 stonemasons, 589 plasterers (stationers), 27 swordmakers, 1053 butchers, 1079 oil manufacturers, 150 perfumers and coffee grinders, 1052 fruit sellers, 229 confectioners, 836 barbers, 491 upholsterers, 1231 tailors, 444 curtain makers, 172 shoemakers, 782 bakers, and 126 musicians.

Many of the quarters of Cairo were solely inhabited by Moslems, others almost exclusively by Copts or by Greeks, Turkish merchants, and Jews who occupied a western part of the original city, but the streets of their quarters were very narrow and irregular and generally

in a very poor condition although they held the sizable share of retail and monetary activities. The quarter of foreigners (Haret El-Efrank) was very small and it had its entrance near El-Mouski.

Modern Cairo

Modernization movement in Cairo started in the late nineteenth century at the end of the reign of Mohammad Ali Pasha, the builder of Modern Egypt.

Before Mohammad Ali, Napoleon's attention was given to the condition of streets and buildings and a provisional building and street regulations act was introduced by him. For military convenience he widened some of the streets and added new squares such as El-Ezbakia Square,[D1] El-Faggala Street, Baulak Street, etc. In addition, he removed the Gates which once divided different quarters to simplify his control on the City.

The most remarkable improvement made in Cairo by Mohammad Ali was the filling in of all the swamps which were in and around the city.

In his time, the overland route, which was known as the Wagham Scheme, between Europe and India through Cairo was developed. His industrial, agricultural and technological revolutions were the essential causes of the growth of Cairo.

Mohammad Ali divided Cairo into eight administrative sections: Darb El-Ahmar, Ezbakia, Abdin, Bab El-Shaaria, Misr El-Kodima, Baulak and Darb El-Gamamiz.

All added districts in the reign of Mohammad Ali and his accessor were intended to fill the gaps between the Old City and the Nile after it changed course or as an extension to the north or northeast, to replace the pools or to inhabit an island.

Shubra District[D17]

In the year 1808 A.D. Mohammad Ali built a palace at Shubra and opened a new street which is now known as Shubra Street linking this new district with Cairo. This was the commencement of a new suburb which grew tremendously in later years. Recently it was divided into two districts known as Shubra and Rode El-Farag[D16] which are among the largest and most densely populated districts of Cairo.

The Zamaliek District[D15]

Islands of Azar, Boulack and Mostafa Aga were linked together and formed Zamaliek Island. In the year 1830 Mohammad Ali built a new palace on this island. After the bridge was constructed this island became one of the best residential areas of Cairo where upper classes as well as foreigners live.

Abbassia District[D12]

This district was named after Abbass Pasha the First, who was responsible for its development in the year 1849. This district was, at an early date, a combination of the scattered villages of "El-Waylia," El-Demerdash, El-Mohamady and Kobba palace village. These villages grew and were linked together after the addition of Gamra[D8] and El-Sakakini[D8] and now together they constitute one of the largest administrative districts of Cairo.

The Ismailia District[D15]

Ibrahim Pasha, the son of Mohammad Ali, built a palace in the area now called Garden City and Kasr El Dobara, this area is now occupied by embassies and the upper classes.

Ismail Pasha the First started to build the district of Ismailia starting from today's center of the modern part of the city. This large area of land occupies the districts known now as Ismailia (or later Altehrire), Towfikiah,[D1] Maarouf,[D1] Bab El-Luke,[D18] El-Dowawine,[D7] El-Hawayati, El-Kasid, El-Insha,[D7] El-Monirah, Kasr El-Nile[D15] and Kasr El-Dobara.[D15]

Many facts played their role for the growth of the city during the reign of Ismail; the building of two railway lines to join the capital with Alexandria - the second capital - as well as Suez in 1856 and 1869, respectively. The second fact is that Ismail visited Paris and was impressed by its plans and he tried to adoptsimilar plans for Cairo in a new district, Ismailian District.

Heliopolis[D20]

Until the year 1905 Cairo extended only as far as Abbasia to the northeast. On May 23, 1905, Misr and AinShams Electric Railway Company obtained a license from the Egyptian Government with a 70 year lease to build a new town beyond Abassia which they named as Heliopolis or (Masr El-Gedida).

Heliopolis covered over 1,000 acres in the 1950's and the paved streets are 600,263 square meters. It was inhabited mainly by foreigners and the upper middle class as well as some of the higher classes.

Other Districts

There are also other districts which started on the west bank of the Nile recently, such as El-Duki,[D23] El-Giza,[D22] Imbaba.[D24] To the south the European District of El Maady[D10] was established and was mainly inhabited by the British.

Some Remarks Derived from the History of Cairo

1. Cairo is an old city and it is well known that modernization of an old deteriorated city is more time consuming to achieve and more costly to finance than to establish a new modern city of the same size. This may be one of the reasons why successive rulers of Egypt, with an exception of Salah-El-Din, had been inclined to establish new suburbs rather than rebuild the deteriorating districts. This does not mean that Cairo in our present time is not a modern city. In fact, a good share of the present districts are modern by virtue of the new or modern districts which have been established since the time of Mohammad Ali and Ismail Pasha. After the Egyptian revolution in 1952, many cooperative organizations, e.g., the University Staff Cooperative Organization, etc., started to add new and modern housing expansions to the west of the Nile, to the north and to the northeast of Heliopolis, Mokattum City and El-Nasr City between Abbassia and Heliopolis. After a few years, many measures have been taken to start the modernization of the old and deteriorated areas. These measures, although they are drastic compared to what has been done previously, they are not sufficient and most of the population of Cairo live in the older sections with higher densities and much lower standards than the newer more modern sections of Cairo. As a matter of fact, housing and modernization of urban areas are a major problem for

any growing economy; but Egypt needs to devote most of her capital to industry and agriculture. On the other hand, Cairo is the leading city of the Middle East and Africa; and for this leadership to continue, Cairo should adjust itself to become more efficient by providing a better economic base with greater physical mobility.

2. The idea of having a Royal City or District rather than a unified city dominated the minds of most of the Egyptian rulers, and led to the long negligence of most of the city's districts.

3. Cairo through its long unfortunate history, witnessed successive disastrous events summarized as: frequent invasions, frequent corrupt governors and selfish feudalists, and famines as well as serious diseases. Frequent invasions were accompanied by serious destructions, the invasions created long term unstability, and destructions made the catastrophes continuous. In addition, every invasion meant that the population was forced to reside in new areas away from the ruins. Frequent changes of governors, a phenomena continued up until 1954, did not leave a fair opportunity for most of the respective governments to establish reform programs. The corruption of many of Cairo's governors in the past, parallel to the selfishness of the feudalists, lowered the city's modernization and created discriminatory improvements, a matter which has its drawbacks regarding the city as a whole. Famine and diseases once took about 200,000 lives as well as spread terror in all parts of the city.

4. Nonhomogeneity of the population origins together with discriminatory policies, created differences in culture and behavior among the inhabitants of Cairo. Poverty and nonexistence of stable democratic

institutions caused by frequent invasions made the masses lose confidence in themselves and were unwilling to participate in activities concerning the society which created a gap between the people and the government. President Nasser described this society very accurately at the beginning of the revolutionary era in his book, "The Philosophy of the Revolution."

> "I sometimes consider the state of an average Egyptian family, one of the thousands of families which live in the capital of the country. The father, for example, is a turbanned fellah - a thoroughbred country fellow. The mother is a lady of Turkish descent. The sons and daughters attend schools respectively following the English and French educational systems - all this in an atmosphere in which the thirteenth century spirit and twentieth century manifestations interact and intermingle!"
>
> "I see all this and feel in my heart of hearts that I know the cause of this perplexity which is torturing our minds and this confusion which is destroying our very existence. I would then say to myself, surely our society will crystallize; surely it will be solidified; surely it will be welded into a strong homogeneous whole."
>
> "I had imagined that our role was that of a Command's advance guard, and that it would last only a few hours, when the holy march of the whole nation advancing in close orderly ranks to the great goal would follow...."
>
> "But the facts I faced after July 23 took me by surprise. The leaders had accomplished their mission. They stormed the strongholds of oppression, dethroned the despot and stood awaiting the holy march in close orderly ranks to the great goal. They waited long, however. The masses did come. But how different are facts from fiction!"
>
> "Every man we met sought nothing but the destruction of another man. And every idea we heard aimed at nothing but the demolition of another idea. Indeed had we acted on all that we heard we would have destroyed all men and demolished all ideas, and would have been left with nothing else to do but to sit among the dead men's bones and the debris, crying over our misfortune and blaming our bad luck."

In traffic forecasting the riding habit of the society concerned should be known, but seeing the history of our society I could

not even imagine any directional path of the people's behavior which could be called traditional. Dr. M. El-Barbary, the general manager of "Organization of Public Transport of Cairo," emphasized this point when I met him in August, 1963. On the other hand I believe that very soon we will have a crystallized and clear behavior because the vast change in the society, due to the new unified educational system, the nondiscriminatory policies which created discipline and equality among all groups has caused many large groups, of foreigners, who were backed with many unusual privileges, to leave Egypt.

Concerning the gap between the government and the masses, who have to carry on certain functions to lighten the burden on the governor's shoulders, this gap still exists and it seems that it will continue. So a prior assumption that the Cairo transport problem has to be solved in the government's quarters still holds true. The trend is unfortunate and should be stopped by any means and the masses have to carry out the functions which are their responsibility.

5. Types of markets or "shopping centers" which existed in early days were of different character than the Western markets. A complete block or blocks were devoted to occupants of the same trade after which the street or part of it was named. We found El-Sakkariaya or the market of sugar; El-Nahhassin where copper ware was sold; El-Haddadin or the market of blacksmiths; El-Sagha or the market of gold and silversmiths, and so on. These markets were separated and they are still existing in the old part of the city where the central business district is located. Now they function as a wholesale market as well as retail markets for the low income groups, the majority of the inhabitants of this area.

Because of their narrow streets and their significant attraction of a large crowd, traffic congestion is very serious during the day not only within the market streets but also in all roads leading to them.

Of course, this kind of business clustering is existing in most, if not all, the large cities of the world, especially around their respective C.B.D. areas where, for example, finance houses or international transportation agencies, or the like, gather in a certain area to gain some economy.

The new western C.B.D. of Cairo may have started since Ismail Pasha, when he built Ismailia District, but on the other hand, the shopping centers as they are known especially in the United States of America, do not exist in Cairo. More will be said about this particular problem later in this paper.

6. The problem of traffic congestion has been around since the existence of the city. Narrow and irregular streets, improper planning for the whole city, late existence of rules and regulations for buildings and movements, etc. were responsible for the accumulation of the existing unsolved traffic problems.

D. Climate of Cairo

The climate of the Egyptian providence is gently warm in the winter and hot but dry in the summer. Thus, it enjoys a wonderful climate by winter and unannoyable weather in the summer due to a low degree of humidity.

Cairo lies between two distinct climatic regions. The first region extends from the shores of the Mediterranean to the north of Cairo.

This region enjoys the general Mediterranean climate which is designated by its warm and rainy winter and comfortably hot and dry summer. The second region includes the rest of the country south of Cairo. It is designated by the desert climate except for a narrow strip of cultivated land on the two banks of the River Nile. Winter is characterized by scarce rain, warm weather during the day and relatively cool during the night. The summer is hot and dry during the day and moderate in temperature at night.

A clearer idea about the climate of Cairo relative to that of the rest of the country is presented in Table I.

The predominant surface winds come from the northern and northwestern sections. The wind changes direction from the northern part of the country to south and southwest during the passage of the atmospheric depressions in the Mediterranean. The wind also changes direction all over the country during the "Khamasiniah" winds in April, May and June. These winds usually carry dust and hot air from the desert, and occur for a duration of two or three days. The speed of the winds is not significant.

E. Population Analysis

Since the beginning of the twentieth century, Egypt's population has experienced accelerating rates of growth, these rates jumped from 1.2% per year in the period between 1927 and 1937 to 1.9% per year and 2.85% per year in the periods between 1937 and 1947 and 1947 and 1960 respectively. On the other hand, Cairo's population growth rates were increasing slightly at the beginning of the century and sharply since the

TABLE I

RELATIVE LOCATION AND CLIMATIC CONDITION OF CAIRO AND SOME OTHER CITIES(7)

City	Latitude North	Longitude East	Altitude (m)	Rain Fall m.m./yr.	Avg. Humidity %	Temperature Avg. C°	Temperature Min. F°	Temperature Avg. C°	Temperature Max. F°
Port Said	31° 17'	32° 14'	1	71.4	71	12.3	54	29.8	86
Alexandria	31° 12'	29° 57'	2	190.6	70	10.0	50	30 0	86
Cairo	30° 08'	31° 24'	68	23.8	55	9.4	49	35.0	95
Asuit	27° 11'	31° 06'	68	0.6	38	7.4	45	37.2	99
Aswan	24° 02'	32° 53'	111	1.0	31	10.8	51	41.6	107

TABLE II

CAIRO'S POPULATION GROWTH AS COMPARED TO OTHER AREAS*

Census Year	Pop. of Cairo as % of Pop. of Egypt	Urban Pop. as % of Egypt Pop.	Pop. of Cairo as % of Urban Pop.	Pop. of Alexandria as % of Urban Pop.	Increase of Cairo's Pop. as % of Increase of Urban Pop.
1882	5.9	19	26.1	18.0	--
1897	6.1	20	30.0	16.0	34.7
1907	6.1	19	31.6	16.5	43.7
1917	6.2	21	29.5	16.6	21.2
1927	7.5	23	32.5	17.5	46.3
1937	8.2	25	32.9	17.2	34.6
1947	11.0	31	35.4	15.6	40.7
1960	13.0	38	34.0	15.3	31.3

*Reduced from Table I, II and III in Appendix A.

TABLE III

MIGRATION TO CAIRO VS. URBAN AREAS

Year	Urban Pop. (000)s	Cairo Pop. (000)s	Growth Rates of Egypt	Pop. if Nat. Growth Rates are Applied: Urban (000)s	Pop. if Nat. Growth Rates are Applied: Cairo (000)s	Migration: Urban (000)s	Migration: Cairo (000)s	Cairo Mig. / Urban Mig. x 100
1917	2,678	791	--	--	--	--	--	--
1927	3,270	1,065	1.1	2,973	878	297	187	63
1937	3,983	1,312	1.2	3,662	1,193	321	119	37
1947	5,897	2,091	1.9	4,740	1,561	1,157	530	46
1960	9,912	3,736	2.85	7,578	3,493	2,334	243	10

start of World War II, see Table I, Appendix A. The rates were 1.5% per year up to 1907 while they were 6.1% per year between 1947 and 1960.

Comparing Cairo's population to the country's population, we find that Cairo is becoming more and more important as its share of population has increased from 5.9% before the beginning of the century to 6.2% in 1917, to 8.2%, 11.0% and 13.0% in 1937, 1947, and 1960, respectively, as shown in Table II.

While Cairo is now slightly less than one-sixth of the country's population, it makes up more than one-third of the total urbanized population in Egypt. Its share of urban areas is also increasing, ranging from 26.1% in 1882 to 37.7% in 1960; but it could be seen from the last column of the table that Cairo's share of the increases as a percentage of total urban increase dropped from 40.7% in 1947 to 31.3% in 1960. This column also indicates that Cairo's share of increase to the total urban increase is fluctuating according to the opening of new areas and activities in the other urban areas of the country.* In both the urban areas and Cairo, if population in respective periods are multiplied by the country's natural growth rates and then subtracted from the actual increase, we can obtain an estimate of the net flow of immigrants for both areas as indicated in Table III. We observe then that between 1917 and 1927, 63 persons out of 100 migrants leaving their villages or small towns to inhabit an urban area, choose Cairo as their preference. This

* Although there is a difference of natural growth rates between urban and rural areas which will change the figures shown in Table III, the abstracted idea of migration distribution is qualitatively but not quantitatively valuable.

preference dropped to approximately 50% between 1927 and 1937. In the last period, 1947 to 1960, only 10 out of 100 migrants chose Cairo. Other urban areas are becoming more important than before by offering new activities which are mainly concentrated along the sea shore at Alexandria, Port Said, Dimiatta, Ismailia and Suez. Since urban population is increasing with accelerating rates, and while Cairo's share of that increase is getting less and less in percentage, we can conclude that Cairo's relative importance is declining, although it will continue as the most important city in Egypt, and we must expect the rise of other important centers challenging Cairo.

One of the most critical problems we have to face in this study is the prediction of Cairo's population within our forecasting periods. In its "Master Plan of Cairo" the Cairo Planning Commission in November 1956, stated that its members strongly believe that Cairo's population will be 4-1/4 million in the year 2000, while the census of 1960 indicated that the population of Cairo in 1960 was approximately 3.4 million. In fact, this large deviation of the estimates of the Commission from expectations make us very cautious in our estimates.

As any individual can see, the Commission attributed the recent high growth rates to: 1) the increase of the natural growth rate of the country; 2) the outburst of World War II. The presence of the Allied Armies in Cairo made it possible for the city to supply these armies with many of their service needs. Many employment opportunities thereby opened up causing a rush of migration to Cairo; 3) Cairo is the capital city of a pre-industrialized country, and traditionally it attracts centralization of all sorts of activities as well as offering to the immigrant a higher standard of living.

In predicting the future population, the Commission found that:

1. By simple mathematical calculations and by assuming that the high growth rate of 1937 through 1947 will continue, Cairo will have approximately ten million inhabitants within 50 years. The Commission concluded that this figure was not reasonable and was beyond realism.

2. If they omit the high rates between 1937 and 1947 and use averages, the figure would be reduced to seven million which was, in the Commission's opinion, an unrealistic figure.

3. By curvelinear projection, the Commission came to a 5-1/2 mill. figure, but again felt it to be too high.

4. Neglecting immigration and adjusting birth and death rates to balance each other after advancement had been achieved under the New Regime, the Commission believed that the figure would be 4-1/4 million, but it concluded that Cairo's population should be limited to 3-1/2 million. The first assumption of the Commission was "... we have reasons to believe that the elements of immigration will have little effect on the future number of population. From the above mentioned reasons, we can safely deduce that the immigration to Cairo, which was one of the main causes for the past increase in its population, will decrease if not checked." The reasons were: 1) the unusual increase between 1937 and 1947 amounting to 60% due mainly to the war conditions which no longer exist, thus eliminating the possibility of the continuity or repetition of such an increase; 2) the improvement of living conditions in the villages and other towns that will reduce immigration to the capital city; 3) decentralization policy as well as the opening of new industrial zones which will also attract and absorb these immigrants.

On the other hand the Commission also assumed that the improvement of cultural as well as living standards, especially among the blue-collar class, would lead to lower birth rates which at least would balance the increase caused by declining death rates.

Due to the high densities and the complete deterioration of many districts, the Commission desired to limit Cairo's population to 3-1/2 million because of "...the fact that too large a city is undesirable both socially and economically, as it tends to become a heavy burden in the means of the Municipality or the authority responsible for the services...."

Commenting briefly on the Commission's conclusions and assumptions without diminishing the contributions of its members, I can openly say that they were too optimistic and behaved emotionally. They believed that decentralization meant an even distribution of activities regardless of uneven distribution of resources, a matter which has been challenged in the field of "location and space economics." A village or a town cannot prosper if it has an insufficient economic base to accommodate its population. The members did not make a comprehensive survey of the country and its potentials which led them to conclude that immigrants will be absorbed locally or in areas other than Cairo. Migration to cities is a phenomena dominating changes of the 19th and 20th centuries. The excess people of a base area should move to another area which can offer them accommodations. Their movement is useful to them as well as to those who have to stay in the mother land. This movement should be studied for the whole country on the basis of potentialities so that we can "safely conclude" how many should settle in Cairo and how many in other areas and where these other areas should be located.

The Commission's members believed then that the New Regime had magical properties which would improve the culture and the economy of the country within a day or so, and hence they did not ask themselves the question about what will happen while these changes are taking place, how long will it take to bring death and birth rates into equilibrium. Obviously they were quite sure that population equilibrium could be reached by a communique from the New Regime.

We conclude therefore that an essential part of defining our transportation problem will be the forecasting of Cairo's population as well as the population of other urban areas, i.e., to discuss the future of urbanization in Egypt so as to foresee the possible growth of Cairo which will determine, with other factors, the volume of traffic generated by its population. However, since the volume of traffic is also affected by the intercity traffic we have to have a complete picture of the population of other major urban areas of the country.

F. Anatomy of Cairo Metropolitan Area

Shape of the City

The city of Cairo is characterized by a very unusual shape (see Figure 1). It extends more than 43 Km. from south to north along the east side of the Nile, while its width varies from 5.9Km. at the suburb of Helwan, to 0.4 Km. north of Helwan, and 4.7 Km. at the C.B.D. to 17 Km. at Heliopolis to the north of Cairo. The existence of the mountains to the east has limited Cairo's width and forced extension to the south and northeast. A very large area adjacent to these mountains has been reserved for cemeteries because of its dry sandy soil.

On the western bank of the Nile and adjacent to the heart of Cairo, exists the city of El-Giza where the University of Cairo is located. (D22, D23, D25 on Figure 2.) To the north of El-Giza the district of Imbaba[D24] is established. These two urban areas are under the jurisdiction of the Governorate of El-Giza. This area has much closer ties with the C.B.D. than Heliopolis,[D20] Helwan,[D15] and El-Maadido.[D10]

To the north of Cairo and on the eastern bank of the Nile, the highly industrialized suburb of Shoubra-El-Khima[D26] was established before the New Regime took over. This suburb has always been under the jurisdiction of the municipality of Cairo, but now it belongs to the Governorate of El-Kaliobia.

Although the political boundaries of the Governorates as well as the districts of Cairo have been recently changed, I believe that these boundaries do not reflect the social interactions that take place. For example, it would have been a better idea if El-Giza had been added to Cairo because of their firm ties, while Helwan should become the Capital of the Governorate of El-Giza, the name of which could be changed to the Government of Helwan or any other suitable description of the territory.

Most of the heavy industry of not only Cairo but also Egypt is now located in El-Maadi and Helwan, but most of the laborers and professionals working in these industries still live in Cairo and commute to their work everyday, although the suburb of Helwan has an international reputation as a winter resort where mineral water exists. Helwan's reputation is widely known in Europe, and it also contains a national park where many people from Cairo spend their holidays. Therefore,

Helwan has as great a potential for serving as a capital of a Governorate as any large city in any other Governorate.

Sex Distribution

Although for the country as a whole the number of males to the total number of population is about 50.3% which means an almost even sex distribution. The ratio in Cairo rises slightly to 51.2%. The difference should be due to the male migrants leaving their families for new opportunities in Cairo. It indicates also that a good share of migrants are females as well as males.

TABLE IV*

SEX DISTRIBUTION IN 1960

Dist. No.	% of Males	Dist. No.	% of Males	Dist. No.	% of Males	Dist. No.	% of Males	Dist. No.	% of Males
1	53.6	6	51.1	11	52.2	16	51.0	21	50.5
2	51.5	7	50.8	12	50.8	17	51.7	22	50.9
3	51.4	8	52.4	13	50.9	18	51.0	23	50.2
4	51.2	9	51.2	14	51.4	19	50.8	24	50.7
5	50.8	10	54.3	15	52.3	20	49.8	25	51.1
								26	52.6

From the previous table we note that El-Maadi^{D10} and El-Azbakia^{D1} have the highest male percentage indicating high percentage of male migration. The former is identified by the existence of heavy industry, and the latter by its closeness to the main railway station since migrants locate themselves near the route to their families as

* Reproduced from Table IV in Appendix A.

well as near the route to all activities of the city.

The third highest percentage is Shoubra El-Khima[D26] to the north of Cairo which has two locational advantages, first its identification as an area with many industries, and secondly its existence on the main road to the Delta of the Nile from where most of the migrants come.

The fourth is El-Daher, an intermediate location between the main railway station, the military area, and Ain-Shams University.

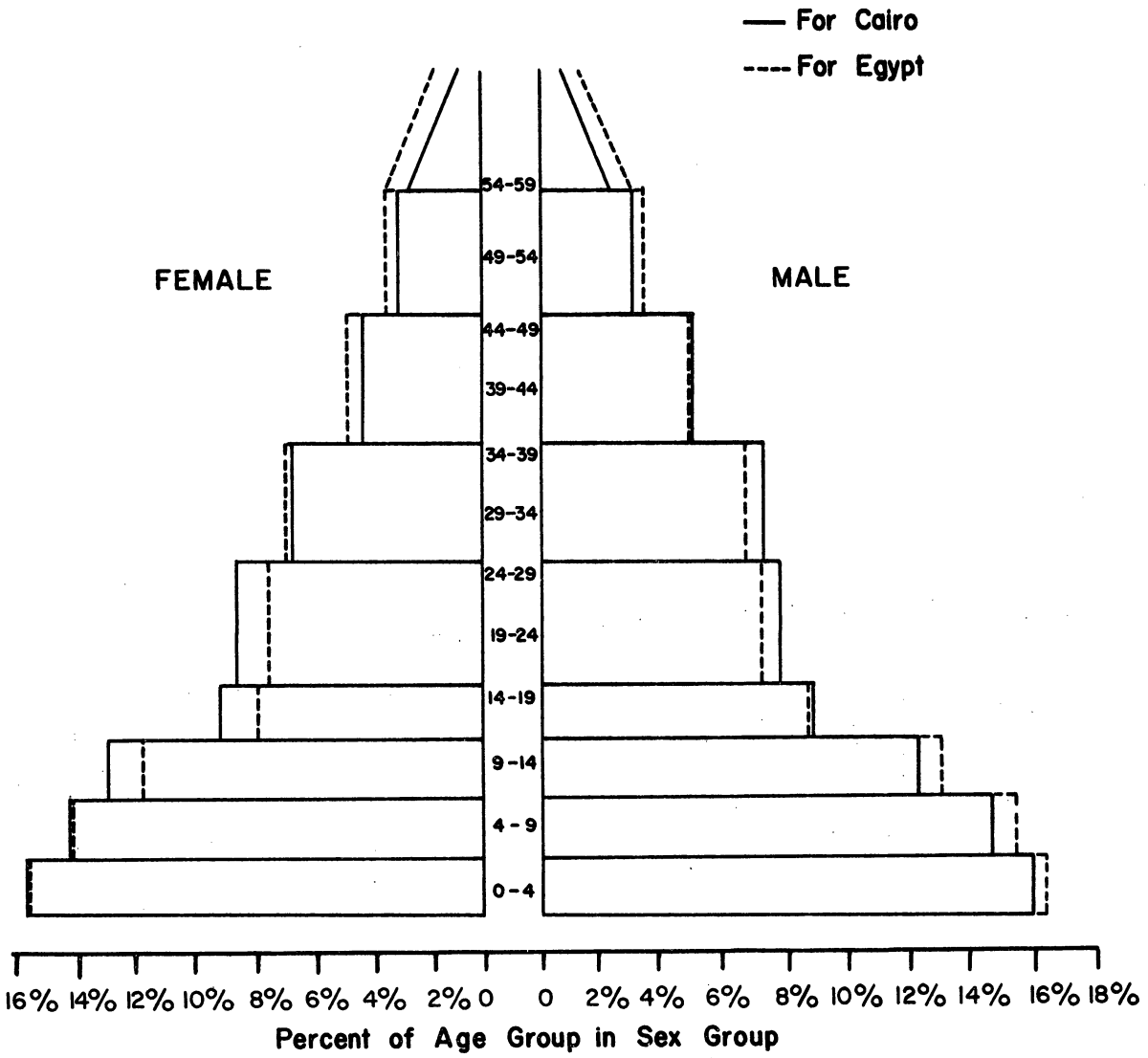
The fifth is Helwan which also contains many industries. The sixth is El-Moski where the University of Al-Azhar is located. Most, if not all, of its students are males, the majority being religious students from outside Cairo and from other Moslem countries. The other districts have balanced sex ratios.

Age Distribution

From the pyramid of age distribution of both Egypt and Cairo, Figure 3, we notice that this distribution is not abnormal for a country like Egypt.

On the male side of the pyramid we see that up until age 14, there are more males in the country, expressed as percentage of the total males, than the same percentage in Cairo. This is explainable, since the birth rate is higher in the country than in Cairo, we should expect that this age group of both males and females of 0 to 16 years should be higher in Egypt than in Cairo, and since the percentage of males is higher in general than females by 0.6% then, we expect that our figure of Cairo to be less than of Egypt.

The age groups from 19 to 49 have higher percentages in Cairo than in Egypt. This could be explained by the fact that college students



From Table No.5, Appendix A

Figure 3. Age Distribution Pyramid of Cairo.

leave their towns to continue their academic career in Cairo where three universities exist, and in addition there are the migrants seeking employment in construction and industry.

Above 49, Egypt again has a higher percentage than Cairo, indicating that the life span of urban communities may be less than that of the rural; but it is very likely that after retirement many of the migrants like to spend the rest of their life in their home villages.

On the female side, the country's percentage is practically the same as that of Cairo for age groups up to 9 years. For other groups between 9 and 29 years, the percentage is less in the country than in Cairo. This may be due to the fact that most of the middle as well as upper class families of Cairo and large cities employ female servants who live with them. These servants come from rural areas and usually stay until they get married, when they are 20 to 25. This servant migration pattern although it has dominated the Egyptian tradition for a long time, is now declining due to both female education and new opportunities made available by the industrial revolution.

Population Density

Tables VI and VII, Appendix A, indicate the density (in number of persons/sq. Km.) of the large divisions (districts) of Cairo as given by the 1960 census.

Figure 4 indicates the density distribution of small subdivisions of Cairo (in number of persons/acre) as I calculated it using the exact population figures of these subdivisions and their approximate areas. It should be noted here that densities are given in gross and not by net* terms.

* Net density: No. of persons per the purely residential area in acres used, including half the width of the fronting streets.

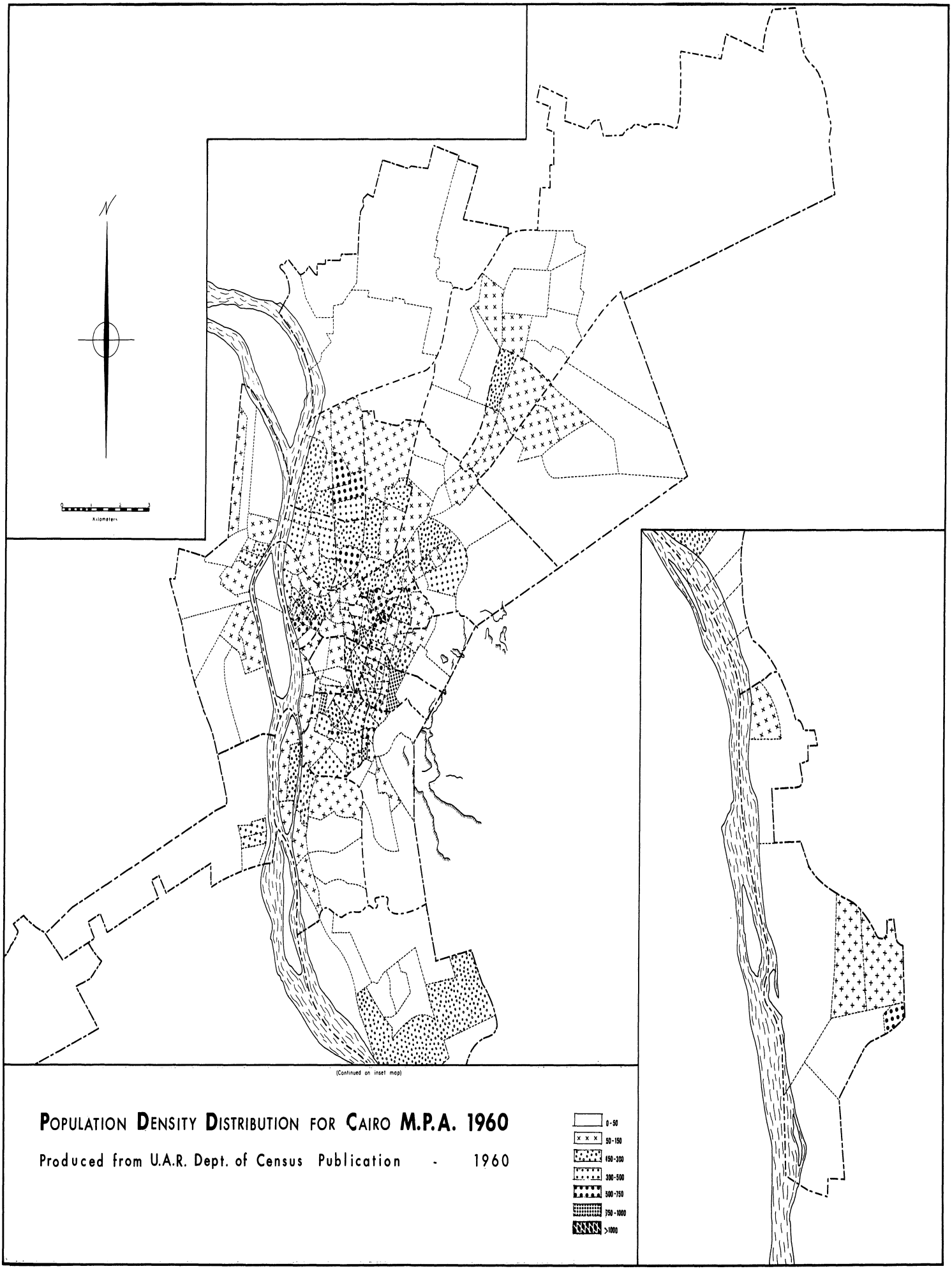


Figure 4. Population Density Distribution for Cairo M.P.A. (1960).

Anyhow, these densities together with the number of persons per room* can give a vague but close enough idea if they are analyzed carefully.

Population density of Cairo was 7,957, 11,704, and 15,634 persons per square Km., in the years 1937, 47 and 60 respectively, while the density for Egypt was 463,540 and 724 for the same years. In the United States the density for the country was 51 persons per square mile in the year 1950, the highest density found in New York City where it was 24,537 persons per square mile, i.e., 9,450 per square Km. The highest density in New York is at Manhattan which was 88,000 per square mile, i.e., 34,000 per square Km., while it was in Bab El-Shariyah[D13] of Cairo 112,182 per square Km. in 1947 and 139,210 square Km. in 1960.

Number of persons per room was 1.9 in 1960 for the country and 2.3 for Cairo. The highest figure was in Boulak[D14] 3.1.

An attempt was made to discover the residential movements and migration settlements in Cairo; Table VIII in Appendix A was constructed and the method is explained there. Since the political divisions have been recently changed, the new divisions cannot be analyzed and are omitted from the table.

We recognize from the table that El-Mouski[D11], which was once the heart of the old C.B.D. of Cairo, lies within the (-,-) group (final stage) for the two periods 1937-1947 and 1947-1960, indicating an outbound movement of a part of its inhabitants. Perhaps the newly high-school, institute or college graduates were seeking a better life in other areas.

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* Methods of defining rooms are not given.

El-Azbakia, El-Gamalia, El-Darb El-Ahmer and Bab El-Sheria (D1, D2, D4, and D13), which were once the outer ring of the Old C.B.D. has now moved to D1 and the new district Kasr El-Nile D19, D1, D2, D4 and D13 were in the (+, -) group (second stage) in the period 1937-47, they then reached their final stage in the period 1947-60. The old C.B.D. (exists in D11, D1, D2, D4 and D13) is now dominating the wholesale activities as well as such special trades as gold, copper, etc., and the retail sale for lower income classes.

Abdin^{D18} and Rod El-Farag^{D16} are still in their first stage (+, +), they showed this trend in the last two periods. Abdin should have passed this stage to the intermediate one due to its close contact to both old and new C.B.D. as well as the government buildings in "Lazoghly;" but since the average persons per family in D18 is 1.9, while for Cairo it is 2.3, then we can accept the above inferences. Although the low figure may be due to the existence of many stores and offices in the area and the vague definition mentioned before.

El-Saida Zeinab^{D7} has been in the second stage for the two periods even though it includes the main government office, but due to new openings created in the last period by some large scale renewals, it may take another period to reach its final stage.

El-Wayli^{D12} has passed from the first stage to the second in the period 1947-60. Therefore, D18, D7, D12, D14 and D16 as well as a part of D2 and D3 make up the intermediate ring of the city and they should be now approaching their final stage of oversaturation.

Masr El-Kadima, after long negligence, has witnessed a renewal and new extension program which brought it back to the first stage.

Shaubra,[D17] Heliopolis,[D20] El-Khalipa[D3] and Masr El-Kadima (by their old definition) are the most open areas which can receive new migration from outside Cairo. They make up the outer ring of the city. To this group El-Giza, Imbabah, El Maadi, Helwan, El-Zaytoun and El-Mataria should be included in the immediate future.

Culture

There is no doubt that Cairo is the cultural center as well as the capital of the country. While literacy in Egypt is about 30%, it rises in Cairo to about 54%. Moreover, the literate people in Cairo constitute 30% of the total of the country. Persons holding university degrees in Cairo are 55% of the whole of the country, although the population of the city is about 14% of the population of the county.(1)

Out of a total of five universities in Egypt, three of the largest are located in Cairo. Its population has greater access to cultural life, e.g., museums, libraries, theaters, radios and television sets. The following table shows this fact although it does not include the whole country, but includes the two adjacent Governorates which are better off than most of the other Governorates.

TABLE V

CULTURAL IMAGE OF CAIRO AS COMPARED WITH TWO OTHER GOVERNORATES(1)

Governorate	Families per T.V. Set	Persons per T.V. Set	Families per Radio Set	No. of Books in Libraries	No. of Readers	No. of Theaters	People Going to Theaters	Museums
(i) Cario	23	108	2	1,957,132	1,320,907	97	29,452	20
(ii) El-Giza	46	223	5	483,987	304,487	16	1,666	3
(iii) El-Kaliobiyah	1,203	6,015	14	19,659	19,659	9	315	3

(i) Only the Governorate of Cairo from D1 to D21.
(ii) Including among others D22, D23, D24 and D25.
(iii) Including among others D26.

High percentage of literacy in Cairo is found around the new C.B.D. and near Cairo and Ain-Shams Universities.* The group of districts having from 60 to 75% literacy (the highest) are: El-Azbakia Abdin, Kasr El-Nile, Kism Giza (2) and El-Saieda Zienab around the new C.B.D. and government buildings.

Kism Giza (1), Kism Giza (2), Saieda Zeinab and Kasr El-Nile have the University of Cairo and some government offices between them.

Heliopolis and El-Daher have Ain-Shams University between them, while Heliopolis includes a new C.B.D. and government offices.

Persons holding University degrees in general, inhabit the new modern sub-areas of the intermediate and new districts.

Culture centers then are focal points to which a large and seasonal daily traffic is attracted from everywhere in the city and its suburbs. For single students living in Cairo it is much easier for them to live near their cultural center; as a matter of fact, this has been found true. Other students living with their families in Cairo or elsewhere have the freedom of choosing the most accessible and agreeable site or location, for example, where minimum transport is needed. It occasionally happens that students live within walking distance of the University of Cairo at El-Giza but their grades force them to be enrolled in the University of Ain-Shams at El-Wayli, thus increasing unnecessary movement in the city.

Government buildings on the other hand are focal points of a fairly constant daily traffic. Usually cultural people dominating the

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* See Tables IX in Appendix A.

upper middle and higher classes do not have to be located around their daily work. Their location choice is a prestige choice based on a site, weather or relative locations, while lower and middle classes (not well educated) have their locational choice as an economic one, and by virtue they surround the government buildings.

Public mass transport is the dominating means of transport in Egypt as well as in Cairo, and even though it represents a small percentage of the moving traffic when it is calculated as number of vehicles per hour at any location in the city. The private automobile and the taxi are then the dominating systems which affect the traffic movement. The origin and destination of these transport systems are found to be of the C.B.D. districts on one hand, and the districts of the high degree of literacy (and in turn the high level of income and prestige).

The frequency of movement per day or per week of educated people is higher then that of less educated people as will be shown clearly in Chapter IV.

Economic Activity

As was mentioned earlier, the population of Cairo constituted about 16% of Egypt's population in 1960, but it swallows about one third of the nation's activities other than agriculture.

In manufacturing it has 33% of the nation's workers although it has only 20% of its factories.(8) In construction it has 34% of the workers, in electricity 40%, in trade 26%, in transport 29%, in services 34%, in mining only 13%, and 0.43 in agriculture.*

* Calculated from tables in the "Regional Census," 1960 Census. See Tables X, XI and XII, Appendix A.

For the Cairo area, about 66% of the population who are eligible to enter the labor force* do not work or have no economic activity, although official unemployment is only 1.6%. This high percentage of nonactive members of the society is due to the fact that students enrolled up to the end of the high school are included and constitute about 25% of that total. And due to that, only 8% of the females of Cairo who are eligible to work are economically active (constituting only 4% of the total; males are 30% of that total). Economically, active females of Cairo are 22-1/2% of the active females of the country.

Kasr El-Nile[D19] has an extremely high percentage of active persons (48%), this attributing to the high percentage of literacy in this district (74.6%). Comparing Table IX and X, Appendix A, we can see the high correlation between the distribution of active members and the degree of literacy, we notice also a similar correlation with the distribution of active females.

Turning to Tables X and XI, in Appendix A, for the functional distribution of active members of Cairo, we are able to discover the relation between the place of work and the place of residency.

Farmers are concentrated in El-Mataria,[D9] Shoubra El-Khima[D26] to the north of the city at its connection with the fertile Nile-Delta. To the south of the city, there is another concentration of farmers in Helwan[D15] and El-Maadi.[D10] In fact these four districts, although they attract a specially high class of families (except Shoubra El-Khima),

* Those above six years old. All percentages mentioned here are calculated from 1960 census.

still contain typically rural communities. Most, if not all, of these farmers live on the land which they cultivate. Other districts, which include relatively high percentage of farmers, have in fact some small farms or gardens publicly or privately owned. These agriculture workers in the internal districts may be identified as land owners who prefer urban living, or gardeners who take care of the privately owned gardens in the well-off districts, or some public gardens which do not exist in poor districts. So we expect that a good share of the last group of farmers move daily from one district to another in order to work. However, they constitute less than 40% of all agriculture workers of Cairo.

Mining (for construction materials) by nature should be in the desert and eastern mountains, we find the concentration of mining workers in the districts of El-Maadi,^{D10} then Helwan,^{D15} El-Wayli^{D12} and El-Khalifa.^{D3} We can then conclude that more than 50% of the mining workers live close to their work, while less than 50% have to make two trips daily.

Electrical workers have their highest concentration in El-Sahel,^{D6} Road El-Farog,^{D16} Boulak^{D14} and Shoubra^{D17} where the old and new power stations are located. These five districts attract slightly less than 50% of electricity workers; they are located to the north and northwest of the city. To the south are the main power stations feeding heavy industry and the electric railway line "Cairo-Helwan," but the three southern districts D21, D10 and D15 attract only 9.2% of the total workers engaged in the electricity industry. Most of the districts have less than 0.25% of their population above six years engaged in electricity.

Transportation workers have higher concentration in El-Sahel,[D6] Shoubra,[D17] Road El-Farag,[D16] Boulak[D14] and El-Wayli.[D12] These five districts contain about 49% of total workers in transport. El-Wayli has the main tramway (streetcar) yard from which they are distributed in the morning to most of the tramway network, also this is the nearest district that blue-collar types engaged in transportation in Heliopolis can occupy due to the high value of property in Heliopolis. The other four districts surround the main railroad station leading to Upper and Lower Egypt, the railroad yards, the railroad repair and maintenance work shops, the main intercity bus destinations of Lower Egypt, the intercity taxi destinations and the main intracity bus garage, repair and maintenance work shops.

Persons engaged in manufacturing, trade, and services are evenly distributed between districts indicating that a larger number of districts need their inhabitants to have a fair chance to be engaged in these three activities of which - in fact - a certain minimum should be maintained to support the population. For example, bakeries, food stores, and schools representing the three activities respectively should be quite evenly distributed in proportion to population.

The six districts which include the highest percentages of the workers engaged in manufacturing are D6, D7, D13, D14, D17 and D26. They have about 42% of the total with an average of 7% each. The next six districts are D2, D3, D4, D7 and D16 which have 32% of the total with an average of 5.3% each. Industries which employ large number of workers per firm are concentrated in Shouboa El-Khima,[D26] El-Sahl,[D6] Helwan,[D15] El-Maadi,[D10] and El-Materia,[D9] although the three former districts have attracted only 9% of the total with an average of 3% each. Astonishing

enough Imbaba[D24] carrying the name of "The City of Labors" where a complete new area was rebuilt in a somewhat modern fashion and devoted to blue-collar residence, has only 3.5% of the manufacturing workers representing only 7.7% of the district's population of more than six years of age, while services account for 12.5% of that population.

In trade D6, D7, D12, D14, D16 and D17 have 42% of total persons engaged in trade in the city, while D2, D4, D13 and D21 have only 21%, with an average of 7% and 5% each for the two groups respectively. Districts containing the C.B.D. are D1, D2, D4, D11, D15, D18 and D19 have only 25% of the total with an average of 3.6% each. Trade is dominating none of the 26 districts like manufacturing does in El-Gamaliyah,[D2] Bab El-Shariyah,[D13] Helwan[D15] and Shoubrah El-Khima.[D26]

Employment in services is dominating the activities of 22 out of 26 districts. El-Saida[D7] and El-Wayli[D12] have an average of 8.4% of services employment. Both have a large population with large educational centers as well as government buildings, especially El-Saida Zeinab,[D7] El Sahel,[D6] Road El-Farag[D16] and Shoubra[D17] to the northwest, Heliopolis[D10] to the northeast and Masr El-Kadima[D21] to the south which has an average of 6.1% each. Also they have a large population, they do not possess large government buildings, although Heliopolis is building up some centers this decade. We expect, therefore, that a massive flow of traffic will be generated in the northwest, northeast, and south which will move toward the government buildings in Abdin,[D18] Kasr El-Nile, El-Saida Zeinab, and El-Azbakia at the center. This is actually what is happening and will be seen later on. Kism Gizah (1)[D22] and Kism Gizah (2)[D23] have an average of 4.8% each. On the other hand we find that 33% of the population of

Kasr El-Nile[D19] and 26% of Heliopolis[D20] and Kism Gizah (2)[D23] population with ages higher than six years of age are engaged in services. Three of these districts have the highest income sector groups of the city.

Income Distribution and Land Values

There is no one district which is dedicated completely to the high income group, although there are many districts which are devoted completely to the residence of low income people, such as El-Mouski, Bab El-Sharia, and El-Gamalia. Major area of Heliopolis, Garden-City and El-Zomalik in Kasr El-Nile, El-Agoza and Madinet El-Awkaf in Kism Giza (2); El-Nile Street in Kism Gizah (1); Ahram Street (the route to the Pyramides) in Kism El-Ahram; part of El-Rodah-Island and the modern part in El-Maadi; El-Mokattam City in El-Khalifa; El Kobbah in El Wayli; part of El-Zaitoun and El-Matoria, all of these areas contain residence of the highest income groups, usually surrounded by the upper middle class, then the middle class and finally by the lower income class. El-Saida Zeinab, El-Wayli, El-Azbakia, Kism Gizah (2), Masr El-Kadima, Shoubrah, El-Sahel are inhabited by a variety of the middle and lower-income classes with a small percentage of the upper middle class. Figure 5 shows income class distribution. The method used to construct this map is explained later in Chapter III. Residential land value follows the same pattern of the income distribution.

Commercial land value presents another pattern, it increases along the busy streets of the old as well as the new C.B.D. districts. These streets have the highest traffic densities in number of passengers

Figure 5. Income Level Distribution for Cairo M.P.A. (1960).

or some times in number of vehicles. Land value declines rapidly within a short distance from the streets and remains relatively constant.

Land Use

Unfortunately, I could not obtain a land use map, although one was constructed by the Cairo Planning Commission in 1956. All maps have been taken off from the Commission's "Master Plan of Cairo." To construct one is a heavy burden and time consuming job. Moreover there is no sufficient data for its construction.

A detailed land use map should indicate final destination points as well as points of attraction. Residential area maps, showing the activities of the inhabitants, together with the land use maps can represent the force and direction of attraction causing urban movements.

Conclusions

1. Due to extremely high densities of population surrounding the old C.B.D., and due to its deterioration and narrow streets, a new C.B.D. has been created, leaving storage and wholesale activities in the old one, besides some retail activities for the low income classes which are concentrated around it.

2. The housing problem is a factor in the city and its suburbs and this problem may check the city's growth. There are many districts which have completely deteriorated and an outbound shift of population is taking place. At the same time there is rapid housing construction activity in the outside districts, but even this is not sufficient to accommodate the new settlers and the outbound shift. It will not be surprising to see the intermediate districts experience extremely high

densities which cause rapid deterioration as in the case of some parts of El-Darb El-Ahmar, El-Saida Zeinab and Shaubra.

The private sector in our economy has temporarily succeeded in solving the housing problem between 1937 to 1960 (between the last two censuses) when Cairo witnessed rapid growth of population and economic activities. Now housing is becoming more and more a public sector responsibility, a matter which if not resolved may reduce the rate of growth of the city.

3. More analytical discussion about the economic activities and their distribution in the city, concerning place of residence and place of work is required. Unfortunately data for this purpose is lacking.

4. Population and activity distribution for future projection years should be outlined as a primary work for our problem.

G. Transportation in Cairo

Connection with the Outside World

Cairo is the aerial terminus connecting Egypt with the outside world and is becoming increasingly important. Traffic volume for Cairo Airport was 370 thousand passengers in 1956. Due to the Suez invasion at the end of that year, the traffic dropped to 250 thousand passengers in 1957. Since that time traffic increased by 28%, 29%, and 25% in years 1958, 1959 and 1960, respectively. In 1961 it increased only by 16% but this rate should have been accelerated again by 1963 because of the opening of the new "Cairo International Airport" which is designed to receive jet and supersonic aircraft. Cairo's international yearly variation is shown in Figure 6.

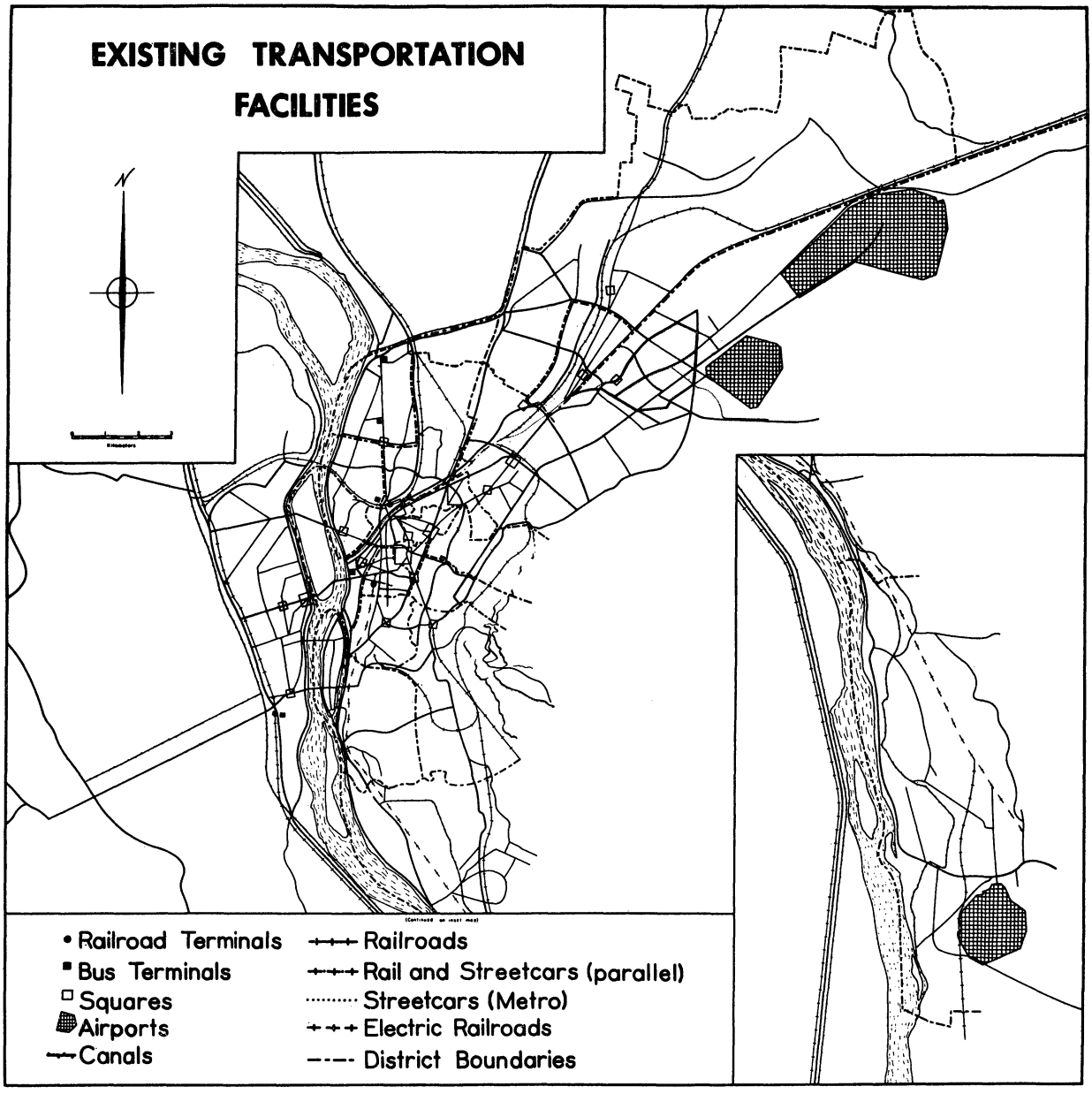


Figure 6. Existing Transportation Facilities (1960).

Figures 7 and 8 illustrates the seasonal fluctuations of traffic fo: 1959, 1960 and 1961. It indicates that maximum traffic volume is attained during June, July, August with the peak reached during September. A sharp drop always occurs in October and November, then the volume fluctuates at lower levels through December, January, February, March, April and May. This variation is somewhat surprising because it is well known that many tourists prefer the wonderful weather of Egypt in winter rather than in summer. The summer high traffic volume is nowadays partially explained by Moslem pilgrimage to Mecca in Saudi-Arabia.* Pilgrimage traffic span was during March, April, May, June and July.

It is also observed from Figure 8, that most of the yearly increase in the international traffic through Cairo is occurring in December to June, indicating a large increase in tourism in winter time. Table XIII in Appendix A and Figure 9 show the direction and intensity of traffic between Cairo and the rest of the world.

Cairo has other airports at Heliopolis, Imbaba, El-Ahram, and Helwan. Some of them are military airports and the others are used for civilian training and privately owned airplanes.

Connection with the Rest of the Country

a. Air

Other Egyptian airports have negligible connection with the international air traffic. Most of their traffic is local traffic which is still relatively small. Statistical information given for 1958, 1959, 1960 and 1961 included the traffic between Cairo and Damascus as local

* Due to the difference between Moslem and Christian calendars, the pilgrimage is rotating along the Christian Year.

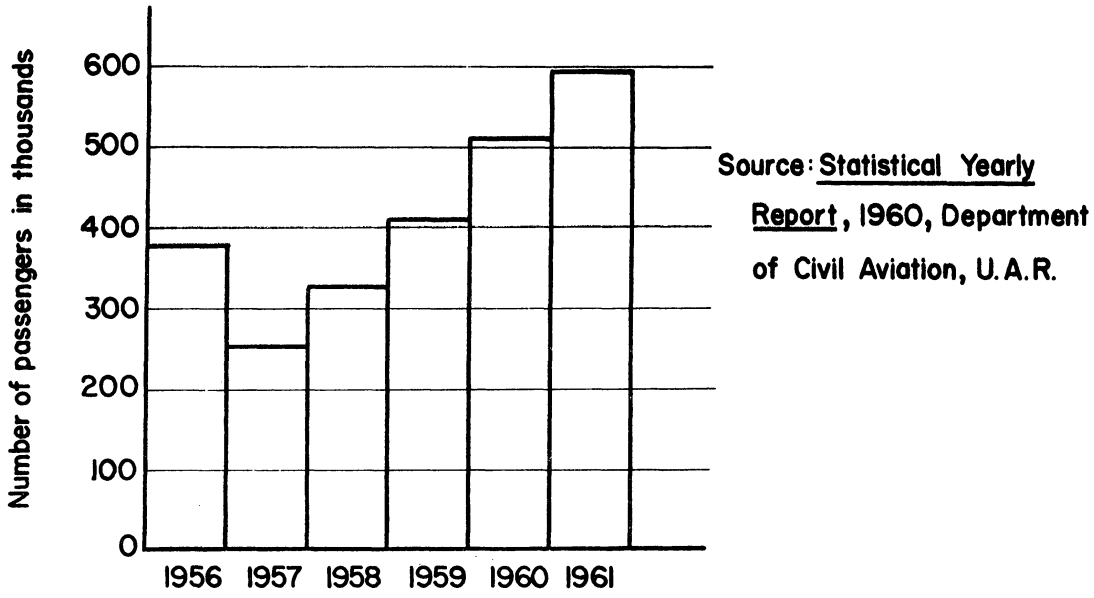


Figure 7. Increase of International Passenger Traffic at Cairo Airport.

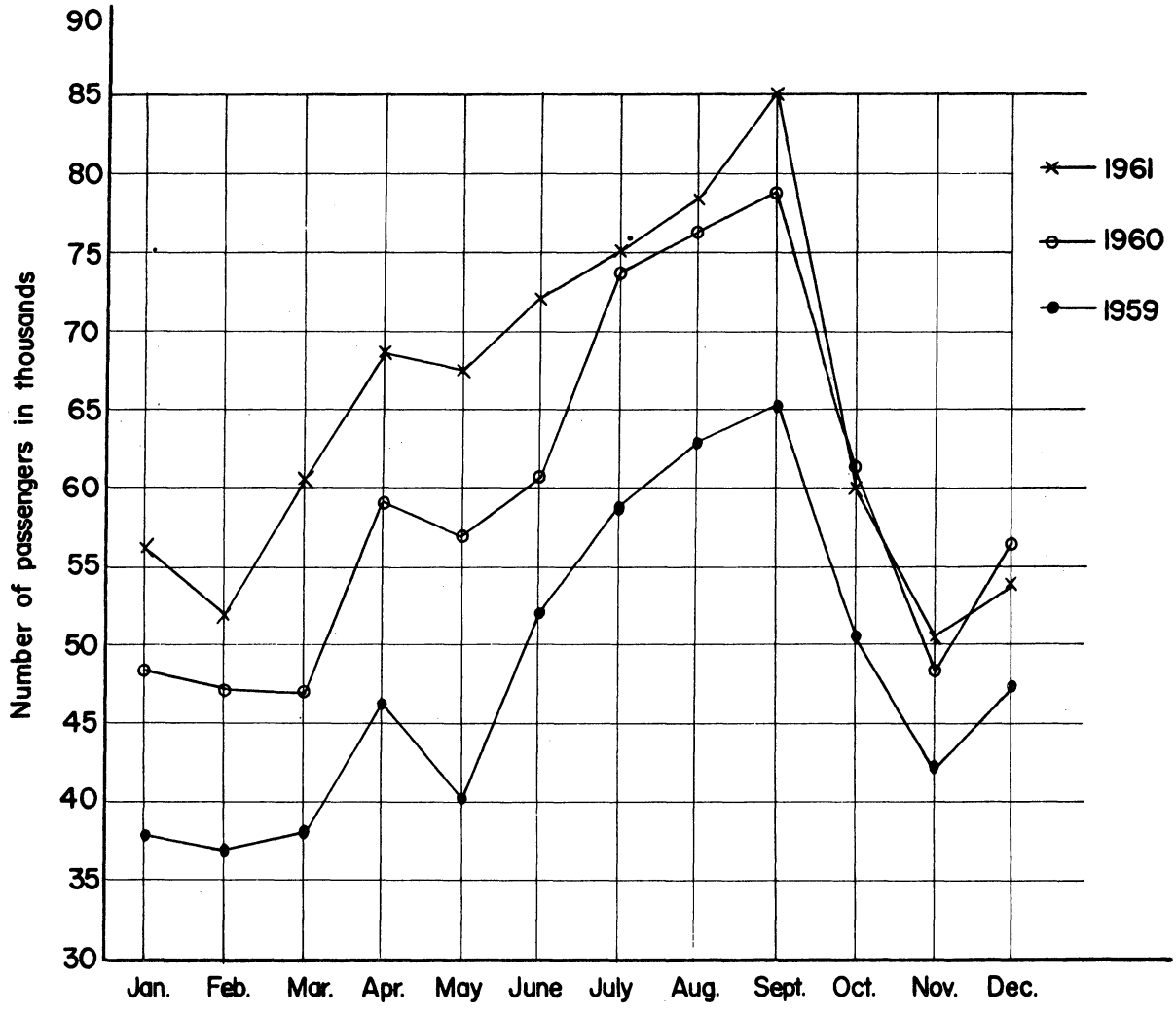


Figure 8. Monthly Variation of Passenger Traffic Volume to Cairo Airport.

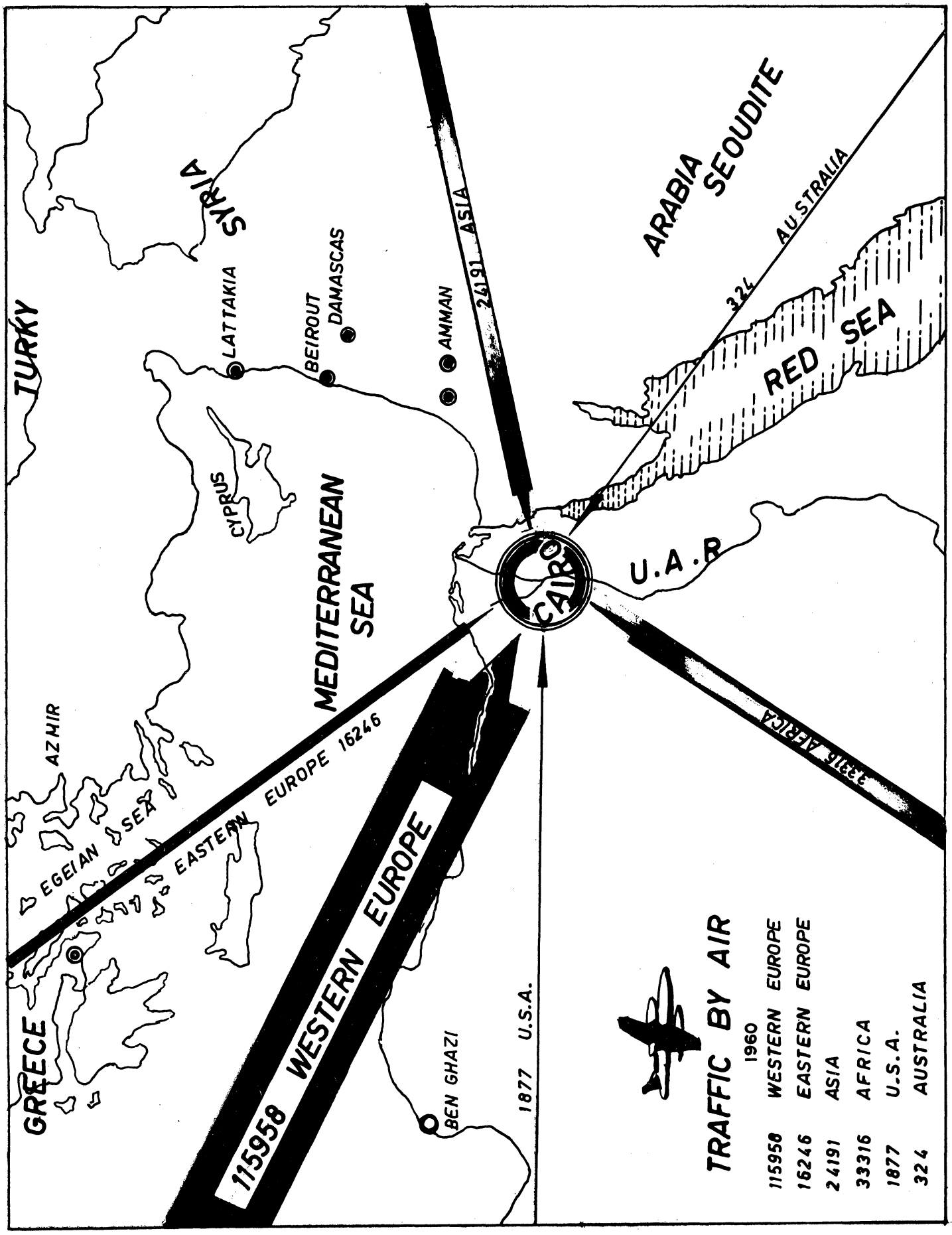


Figure 9. Air Traffic Volume Between Cairo and the Rest of the World.

traffic, this was during the Egyptian-Syrian unity. Since Israel is a barrier for the use of ground movement and since water transport is so slow, local air traffic absorbed most of the movements between the two regions.

The majority of local traffic is generated between Cairo and other cities, i.e., Cairo is the center of local traffic, even regional traffic between Egypt and Syria was between Cairo and Damascus or Cairo and Alippo or any other city in Syria. The local traffic in the Egyptian region originates mainly between Cairo and other cities. The following table indicates the traffic volume at each city.

TABLE VI

AIR PASSENGER TRAFFIC VOLUME AND ITS TYPE AT DIFFERENT EGYPTIAN CITIES (1960)*(9)

City	Total International + Local Traffic	Local Traffic	% Local to Total
Cairo	714,137	202,629	28
Alexandria	60,577	47,660	79
Lauxur	35,195	28,256	80
Port Said	9,016	8,575	94
Marsa Matronh	2,281	1,786	80
Aswan	9,468	8,685	92
Asuite	9,912	9,912	100
El-Tour	8,787	3,641	41
Total	849,475	311,094	37
% of Cairo Traffic to Total	84%	65%	80%

* Data collected from "Statistical Yearly Report," 1960, Civil Aviation Department, U.A.R.

Table VII shows the increase in local traffic - Egyptian-Syrian traffic is included - before and after Unity.

TABLE VII

INCREASE OF PASSENGER LOCAL TRAFFIC*(9)

Year	Local Traffic @ Cairo Airport	% Increase	Total Traffic for** Rest of the Country	% Increase
1956	17,250	--	126,021	--
1957	30,328	76	88,053	30
1958	113,913	275	87,629	0
1959	172,153	51	93,716	7
1960	202,629	18	135,338	45

Local traffic between Egypt and Syria (Regional Traffic), has not been represented as a third item in the Statistical reports, but this could be evaluated from the above table. The sharp increase of Cairo's local traffic between 1957 and 1958 (Unity was in February 1958), and the zero increase in the traffic of the rest of the country obviously indicates that added traffic generated after the Unity between the two regions is not a small fraction. Much attention should be paid to the study of future air traffic if the Arab Unity be achieved. Other airports in Cairo will be required and the best location for the new airport is near the Pyramids of El-Giza.

* Data collected from "Statistical Yearly Report," 1960, Civil Aviation Department, U.A.R.

**Total traffic is used for the rest of the country because the local is not shown in the C.A.D. report, and since local traffic represents more than 80% of total.

b. Rail

Cairo is the focal point of the countries railway network. It is the "rest-house" of any passenger travelling between Lower and Upper Egypt, or the new governorate of "El-Wady El-Gedid" in the Western Desert.

The first railway line in Egypt was operated in 1856 between Cairo and Alexandria. The Cairo-Suez line was constructed in 1956-57. Later the Cairo-Upper Egypt line was established

There are four passenger terminals handling the traffic on the main roads to the rest of the country. The main terminal is "Mehatet-Masr" located at the center of the city in El-Azbakia D_1 , facing "Ramsis Square" which is a key district to the city traffic. This terminal controls the main railroads of Cairo-Alexandria; Cairo-Tanta through Shebien El-Kom; Cairo-Port Said; Cairo-Kafr El-Sheukh; Cairo Demiatta and Cairo-Aswan. The second terminal is "Pont Limon" adjacent to the main one and controlling the desert railroad to Suez. The third is "Shoubra" to the north on the main line to Lower Egypt, feeding the northwestern boundries of the city. The fourth is "El-Giza" to the south on the main line to Upper Egypt. Unfortunately I do not have data for these terminals except a few for the main one.

Figure 10 shows the seasonal variation of passenger movement of the main lines for the first, second and the total of the three classes for the two years 1960-61 and 1961-62. Traffic increases sharply from September to October when it matches its peak, then gradually decreases through December. In January, and February in fluctuates sharply with

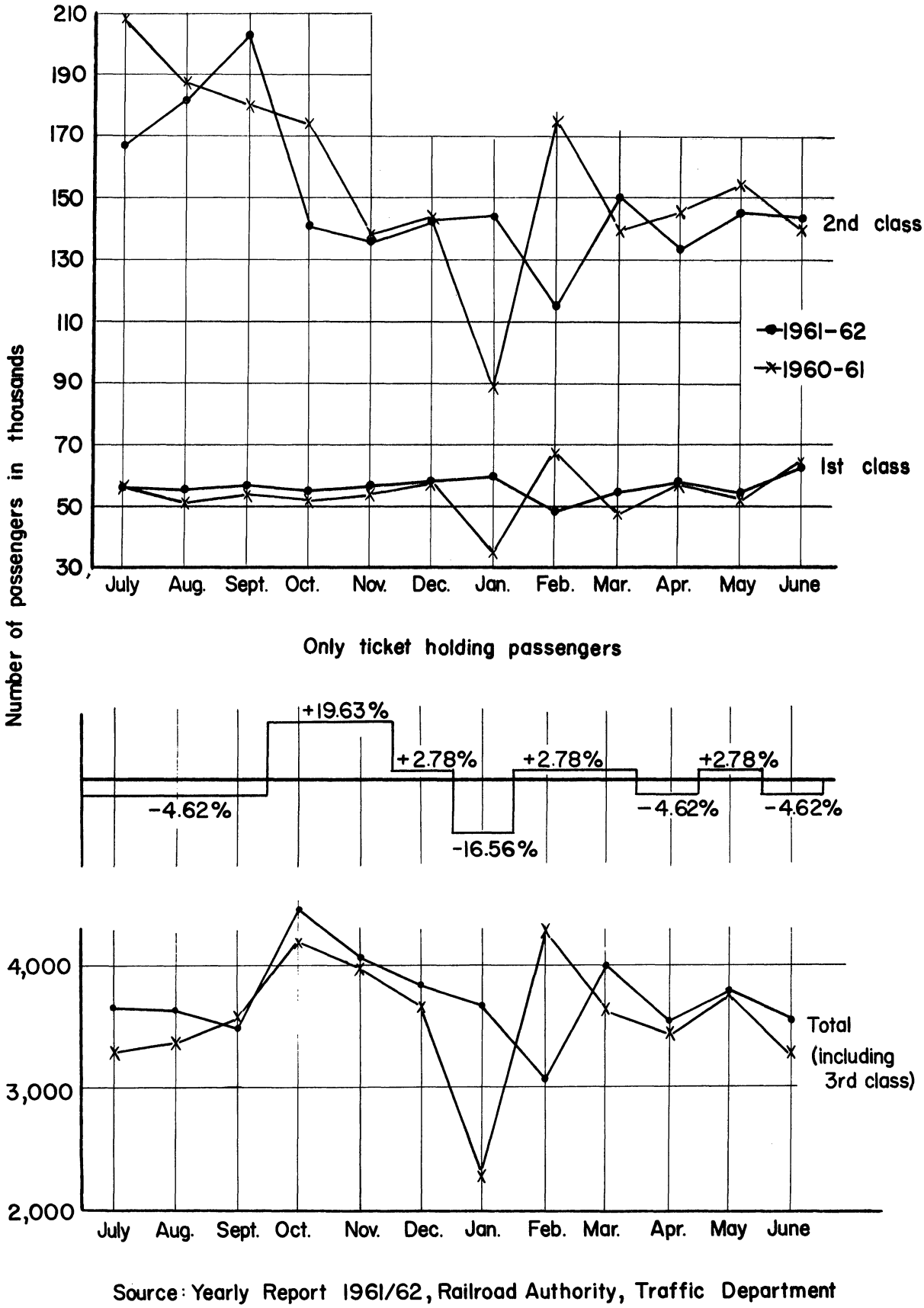


Figure 10. Rail Passenger Fluctuation for the Egyptian Region 1960-61, 1961-62 (Main Routes).

variations from one year to another but following the same pattern. Traffic decreases from March to April and from May to June. It seems that the pattern follows the school and college schedules. They open usually in October, then in January or February they have the midyear vacation and finally they close in June.

Figure 11 shows the inbound and outbound passenger trains at Cairo main railway terminal with a 1/2 hour interval, and Figure 12 shows the number of seats available in the peak hours with 1/4 hour interval. It is obvious that the inbound is higher than the outbound in the morning (7:00-7:30 and 7:45-8:15) and it is then reversed in the afternoon between 2:00 to 2:30. Seat capacity could be safely assumed to be more than 100% (all seats occupied and many are standing). This accounts for 5,500 and 4,100 at least, for the two periods respectively (only inbound in the morning and outbound in the afternoon). It is hard to estimate the seat occupancy of other trains with the available data. The peak of traffic period occurs in the evening somewhere between 4:00 and 6:15 P.M. Other data available show that the total number of passengers on the main lines were about 53.30 and 50.00 million passengers in the years 1962-63 and 1962-61 respectively as shown in Figure 13, i.e., 146,000 and 137,000 per day. For the same years the inbound and outbound traffic of Cairo, as they were given to me officially, were 40,000 and 38,000 passengers daily, i.e., Cairo traffic counted for 27.5% of the total intercity rail travel.

To conclude our problem here, the question should be; what will be the volume of traffic in Cairo's main railway terminal for the

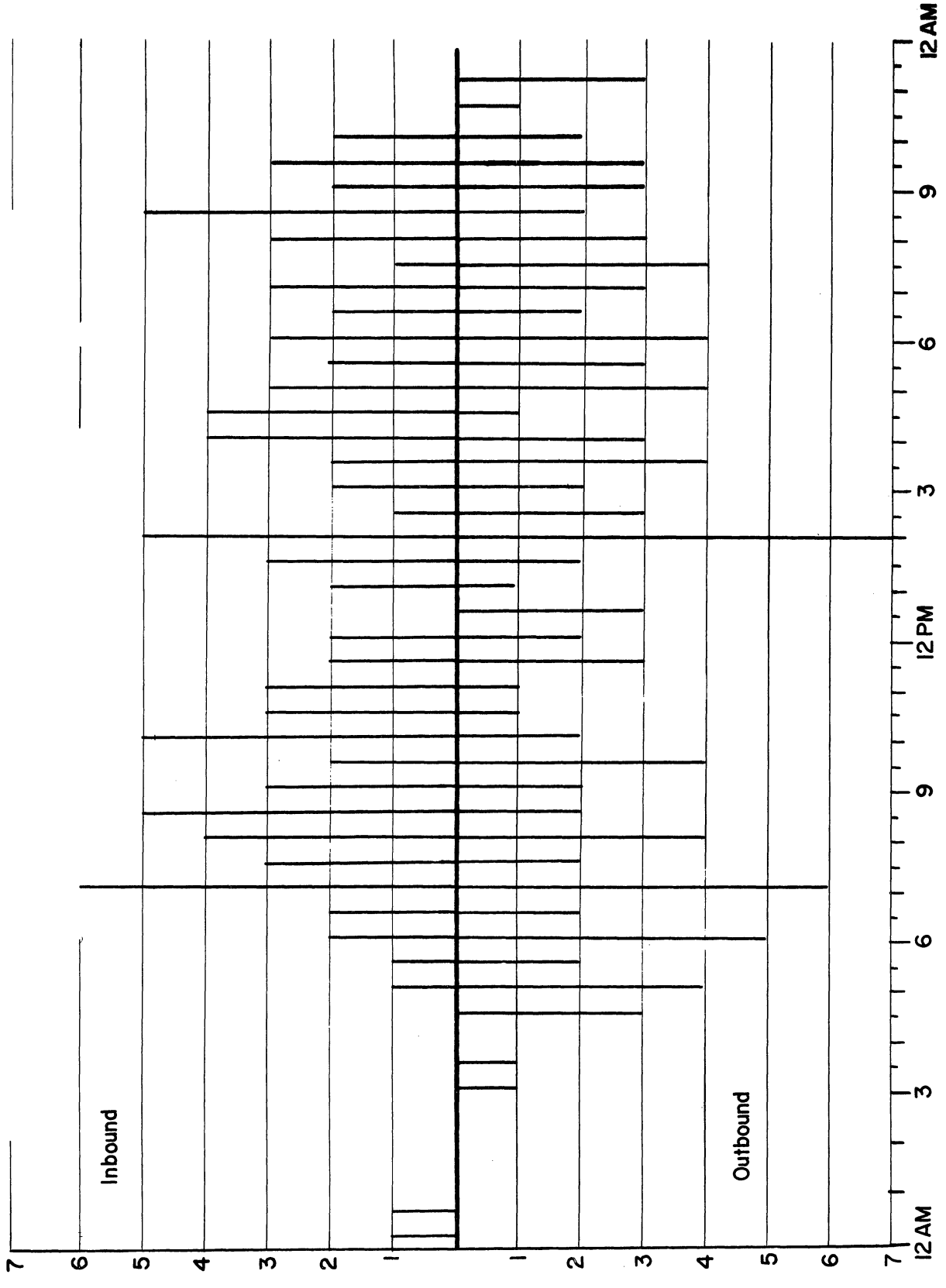
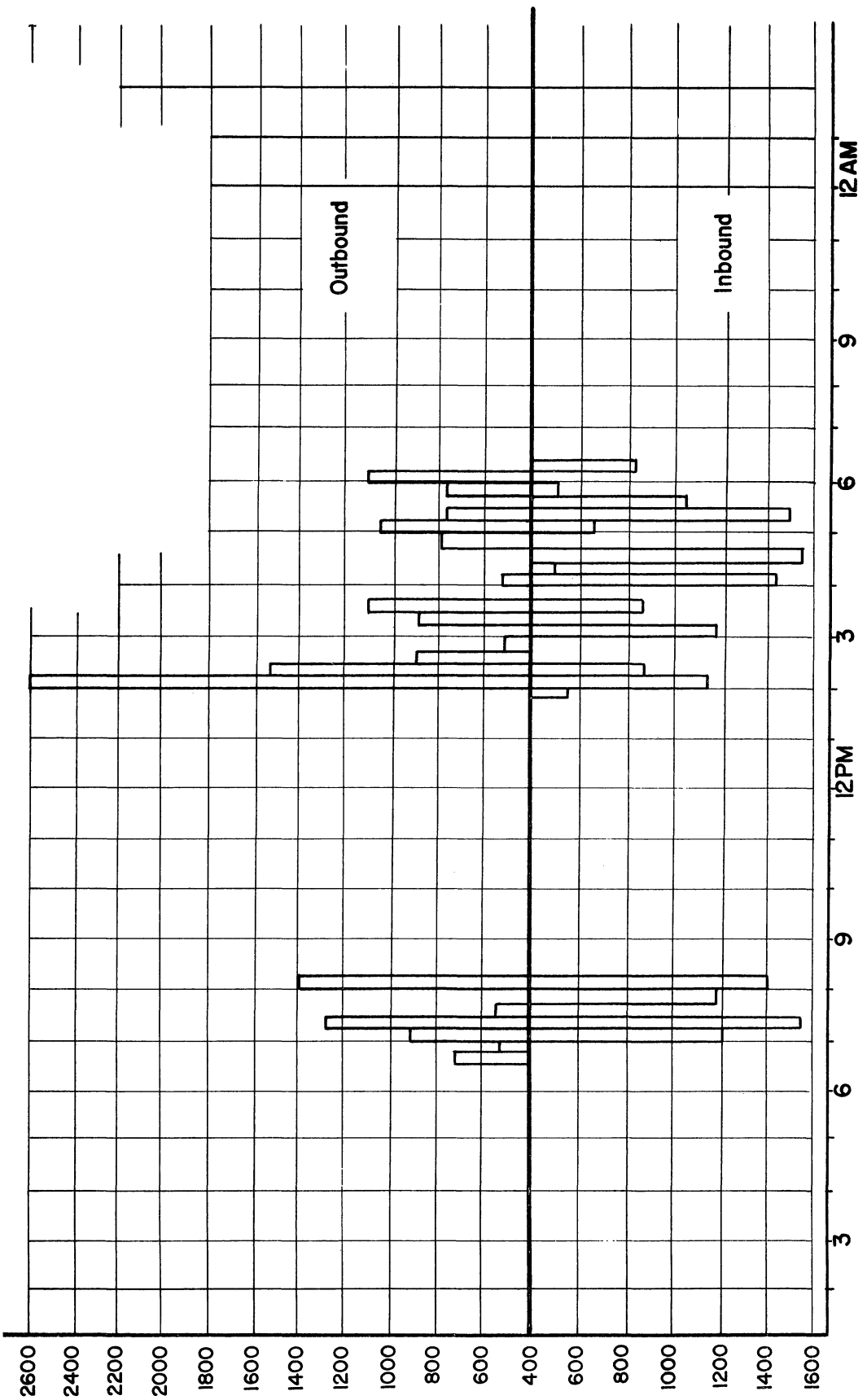


Figure 11. Number of Trains Arriving or Leaving Cairo Railroad Terminal Each Half Hour (Summer 1963).



Source : Personal Contact With Traffic Manager Of Railroad Authority, U.A.R., September 1963

Figure 12. Daily Traffic Fluctuation at Cairo Railroad Terminal Every Quarter Hour (Summer 1963, Number of Seats).

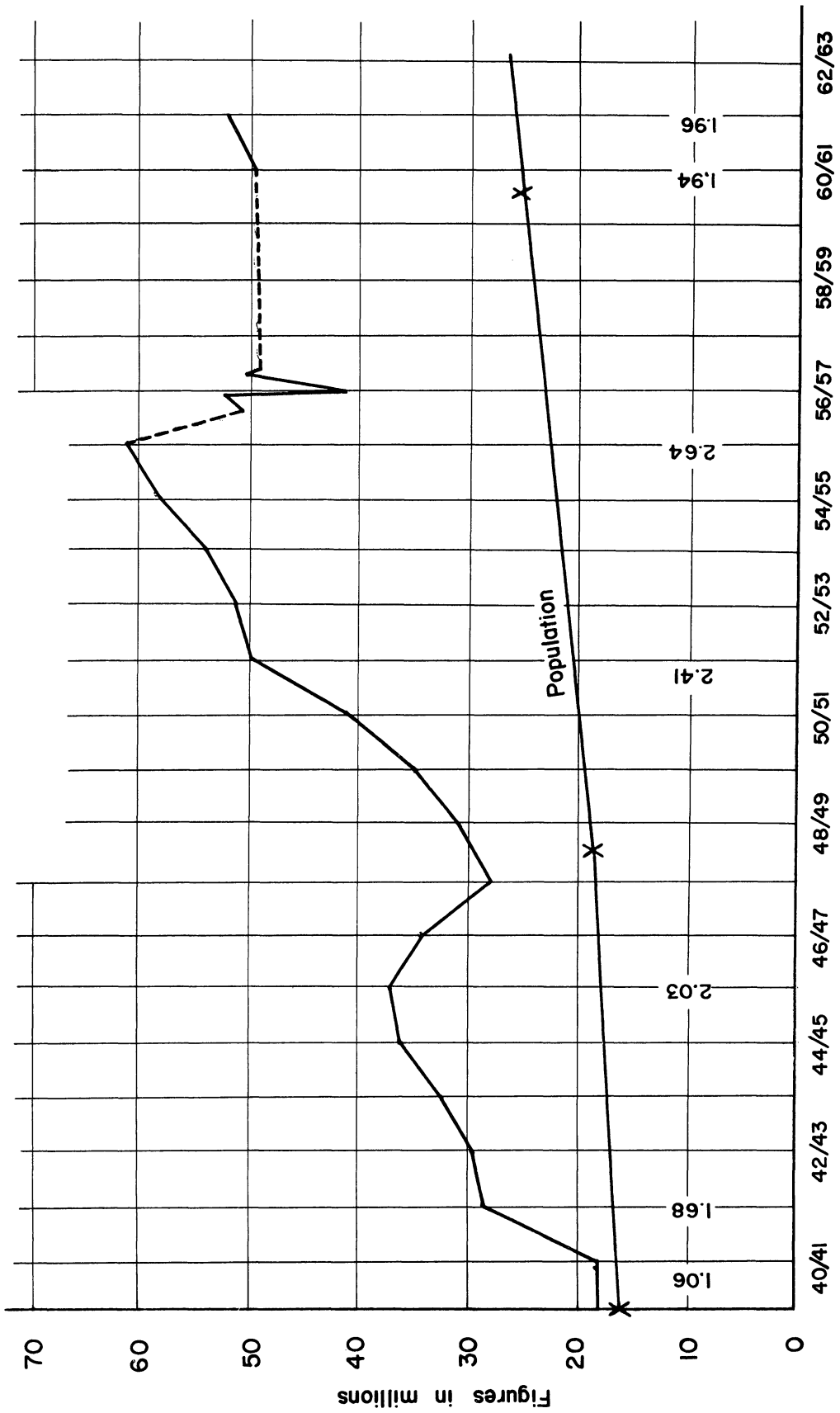


Figure 13. Increase of Number of Total Passengers Using Main Railway Lines Between 1939 and 1963.

specified projection years? What per cent of the daily traffic will be assigned for the peak periods in the morning, afternoon, and evening?

c. Road Transport

Road construction and improvement has required much attention on the part of our revolutionary government. Between 1952 and 1962, 38 million Egyptian pounds were spent on road construction and macadamization, whereas the total expenditure was 12.4 million between 1941 and 1952.(10) The Cairo-Alexandria express road, which was one of the most ambitious road projects in the Middle East, was constructed with a capacity of 10,000 motor vehicles, including 70 ton lories, daily at a speed of 100 Km per hour. Road maintenance cost averaged 0.145 million LE per year before the revolution and have mounted to an average of 0.82 million per year since then. Bridge spending for construction was 44,000 LE per year before, and now (1960) it is 730,000 per year. Their maintenance costs were 12,000 LE per year, while now it is 120,000 LE per year.

"Compared to most other developing countries the road system in Egypt is fairly developed. With few exceptions, the populated areas have direct, or relatively nearby, access to a paved road system which - as a rule - has been built to reasonably good standards and is well maintained.... On most paved roads the traffic densities are relatively heavy, ranging from a daily average of about 6,000 vehicles on the Cairo-Alexandria expressway to about 1,000-2,000 on a number of the first and second class roads."(11)

Nevertheless investment on road construction and improvement was but a small fraction - 10% - of the total plan allocation for

transportation and telecommunications implemented by the Ministry of Communications. Railways have absorbed almost 61%, inland water transport 5%, Maritime transport 5%, inland transport 5%, telecommunications 12% and mail 2%.

The heavy investments in railways have been largely for a program of conversion from steam to diesel traction, and for track renewals to meet both normal and expanded requirements.

Railway and road improvement will have the greatest effect in stimulating a large traffic volume. As we have seen earlier, rail passenger traffic has just begun to catch up with the 1955 volume due to the new policy of Dieselization, track renewal and reinforcement of embankments, and equipment renewal increase. Rail freight traffic is increasing tremendously. The growing output of the country should have a parallel growth of transport capacity. As I discovered during my last visit to Cairo in the summer of 1963, railroads may reach their full utilization sooner than expected; a fact which may put the railways in a position to cancel some traffic, especially passenger traffic. On the other hand the present inland water system may not be able to fulfill the growing freight traffic demand. It will be far longer before roads reach their full utilization. The principal highway transport problem, as I see it, is the lack of rolling stock and the lack of good service.

Table XIV, Appendix A, shows the yearly change of the motor vehicle registrations in Egypt between 1940 and 1959. It is very obvious that all types of motor vehicles, even buses and trucks, were less in

1959 than in 1951, although population output and income have increased greatly during that period.

Inter-city bus traffic for the country was 48.5 million passengers in 1955, i.e., about 44% of the total rail and bus passenger traffic.

For the last four years, traffic increased to 125 million passengers in 1960, and 150, 180, and 210 million passengers for the years 1961, 1962, and 1963.(4) The rate of increase is about 20% per year which is much higher than the population rate of increase. This is due to better service conditions, more buses, better roads, higher income level, and more economic activities.

Of course, this rate will not continue like that, and it should decrease after a period of stabilization. That period will depend on the rate of increase of economic activities and their relative locations, the rate of increase of new road construction and pavement, the rate of culture change, and lastly the period that railways can stand without losing passenger traffic.

Cairo is connected with other major cities by fairly fine expressways which are newly constructed. Excellent circular expressways are surrounding the city connecting its main entrances and making access to any of its districts.

Inter-city bus transport

Cairo has only one inter-city bus terminal and it is under construction. Most terminals are merely an open space where buses can be stored off the road. Passengers have to stand in the open air until

the bus arrives. If they are lucky they may find a place for both feet. The oldest bus terminal or bus storage space is located in Shoubra D_{17} in a place called El-Kazindara. Recently most of the buses were stored in an open area nearer to the C.B.D. and the main railway terminal at a place called "Shoubra Underpath" D_1 . In "El-Tahrir Square", the main square of Cairo, and in front of the Nile Hilton Hotel, a modern but small bus terminal is now being completed. First class and express buses to Alexandria, El Faume, and Suez start from that place.

Some years ago the Cairo Municipality built concrete shades and chairs at "Shoubra El Balad" to the far north of the city so as to get the inter-city buses out of the congested area, but bus companies opposed this and refused to move to the north. However, they are under tremendous pressure and I was fortunate enough to attend discussions with the officials of both sides as they attempted to reach a decision. Bus terminals, as well as any other ground passenger terminal, should be distributed around the center of the city while truck terminals should be activated at the boundary of the city. After full study of the unified transportation plan for the city, new locations should be chosen where the respective terminals could be built.

The following table shows the existing terminals and number of buses working between each of them and other cities of the country.

TABLE VIII

LOCATION AND SIZE OF INTER-CITY BUS TERMINALS IN CAIRO PER DAY

Terminal Location	Number of Working Buses	Estimated Number of Buses/Hour	Number of Passengers
El-Sabliyah	213	44	42,300
El-Khazindarah	71	24	26,500
Shoubra Shades	14	10	5,700
El-Tahrir Square	62	36	22,680
El-Gizah	25	9	6,100
El-Azhar	2	2	70
Imbaba	26	17	9,200
Total	413	142	112,550

The number of buses operating in Upper Egypt, in 1963 was 441, while in Lower Egypt there were 934. The number of buses working between Cairo and other cities is 413, i.e., about 2891 trips carrying about 120,000 passengers per day. Total number of passengers on the inter-city bus transport for the country reached about 584,000 passengers per day in 1963, i.e., Cairo inter-city bus transport is about 21% of the country's inter-city transport.

Average monthly traffic is about 14.35 million passengers. This occurs usually during May, June, and September. Traffic reaches its peak during October, November, December, and January. This increase is due to the opening of schools, institutes, and universities during this period. In February, when the midyear vacation starts, traffic drops to its minimum. It is very strange that during March and April, while students still travel to their institutes, traffic is lower than the average as is shown in Figure 14.

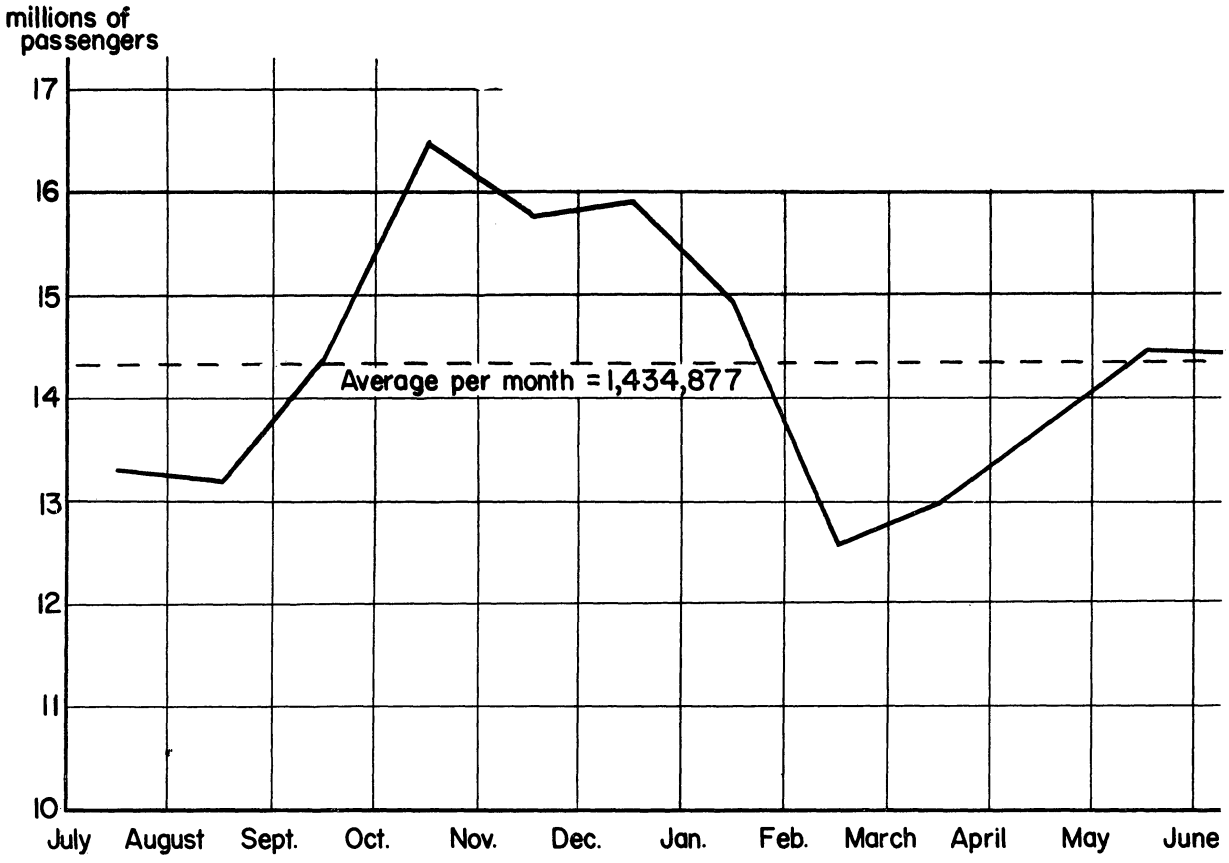


Figure 14. Monthly Inter-City Traffic Variation, 1962-63 Bus Transport.

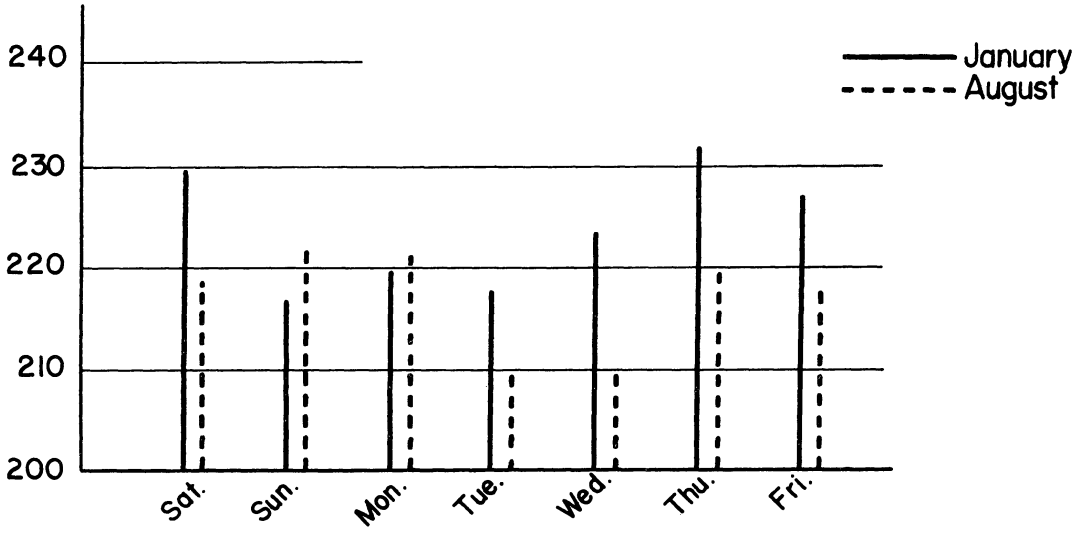


Figure 15. Daily Traffic Fluctuation for Inter-City Bus Transport, 1962-63.

Weekly traffic follows a general trend of reaching the peak in the day before the weekend and at the beginning of the next week as shown in Figure 15.

Hourly traffic variation is shown in Figure 16.

Taxi and Private automobiles

For almost all large cities in Lower Egypt and El-Gizah, there is a good business for inter-city transport by taxis carrying five to seven passengers. These taxis work, especially in the nearby governorates, between Cairo and these cities. There is no data on this volume of traffic which is growing rapidly. I used it frequently during my visit to Cairo.

Although some traffic counts have been made on the roads linking Cairo with other cities, I could obtain only one count on the Cairo-Alexandria expressway which is shown in Figure 17.

These inbound and outbound curves together look very strange, because in general the outbound curve is far below the inbound which is not realistic and cannot represent a typical day for traffic counts. Otherwise, since these curves are given without any table, it may be that there is a mistake in their drawing. Probably, the inbound curve continues downward at its intersection with the outbound curve and following the latter's path, i.e., to the right of the point of intersection, the names are reversed. The characteristics of these curves are also very strange, the peak traffic volume occurs between 11 A.M. and 1 P.M. which indicates that a high percentage of the trips do not represent daily working trips. The volume of traffic on this main highway cannot

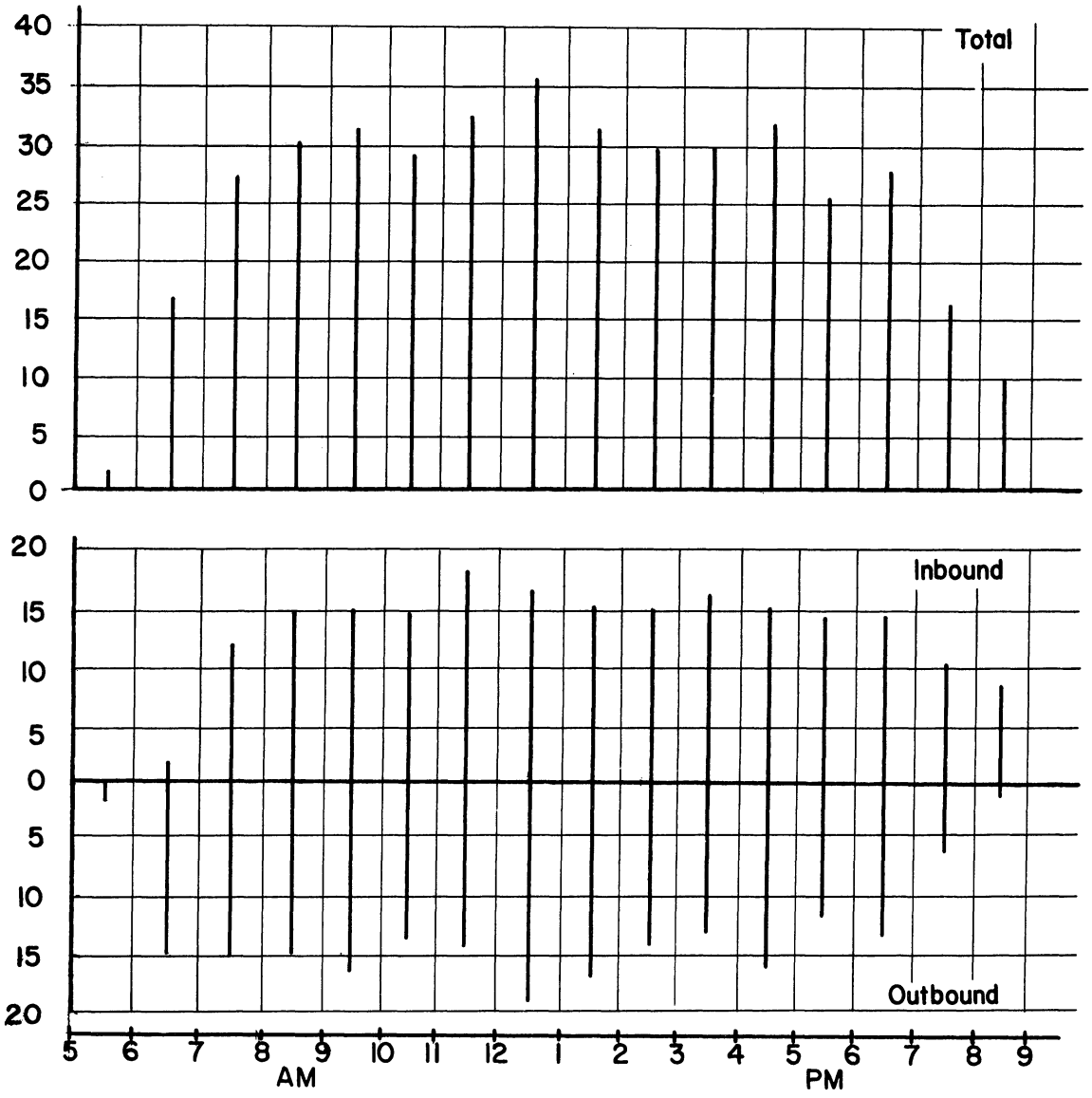


Figure 16. Outbound and Inbound Bus Traffic of El-Nile Company for Mid Delta.

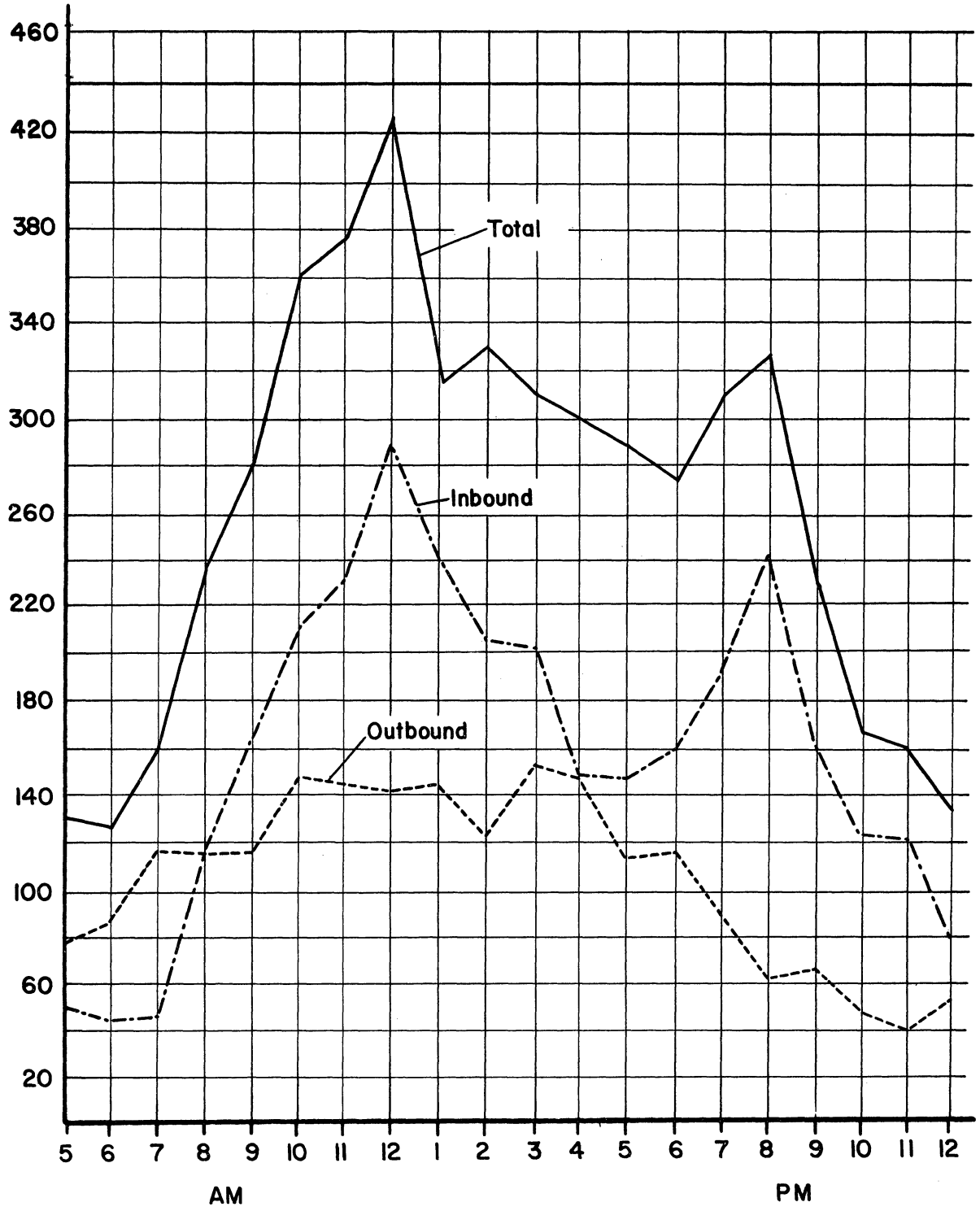


Figure 17. Hourly Traffic Variation on the Cairo-Alexandria Expressway at the Entrance of Cairo, Sept. 29, 1959.

reflect any congestion problems to the city traffic. The same thing could be applied for other highways joining Cairo.

Inland water transport

Inter-city water passenger transport is of a negligible quantity and is diminishing, but there is a growing movement during the weekends and holidays between Cairo and the Nile Barrage to the North-west of the city. There is no traffic conflict created by this type of movement, i.e., people using this type of transport do not create any traffic conflicts on the parallel streets to the Nile at the inland-water terminals.

We shall see later that a heavy axis of public transport in Cairo is coming from the north at Shoubra to the south (C.B.D. and Cairo University). There is a possibility then, for the use of hydro-foil water crafts at high speeds to carry the direct traffic between Shoubra and El-Tahrir-Square (in the C.B.D.) and Cairo University. This possibility should be studied to overcome the traffic problem - at least temporarily during the period of construction of the subway - for this axis.

Intra-City Transport

a. Rail

There are two main rail terminals in Cairo for passenger sub-urban movement, namely Pont Limon and Bab El-Louke. The former is serving El-Materia^{D9} suburban line and the latter serves Helwan^{D15} sub-urban line.

Suburban traffic has almost been doubled within the last few years as shown in Figure 18. Helwan and El-Materia traffic alone increased from 38.367 million in 1958-59 to 50.165 million in 1961-62 with a rate of increase of 16% per year for Helwan and 2.8% per year for El-Materia.

Seasonal variation in suburban traffic follows the same pattern as of the main lines as shown in Figures 19 and 20.

As the data was submitted to me officially in August, 1963 by the R.R. Authority, the number of trains working on the two lines at the high traffic pressure during the day was as follows:

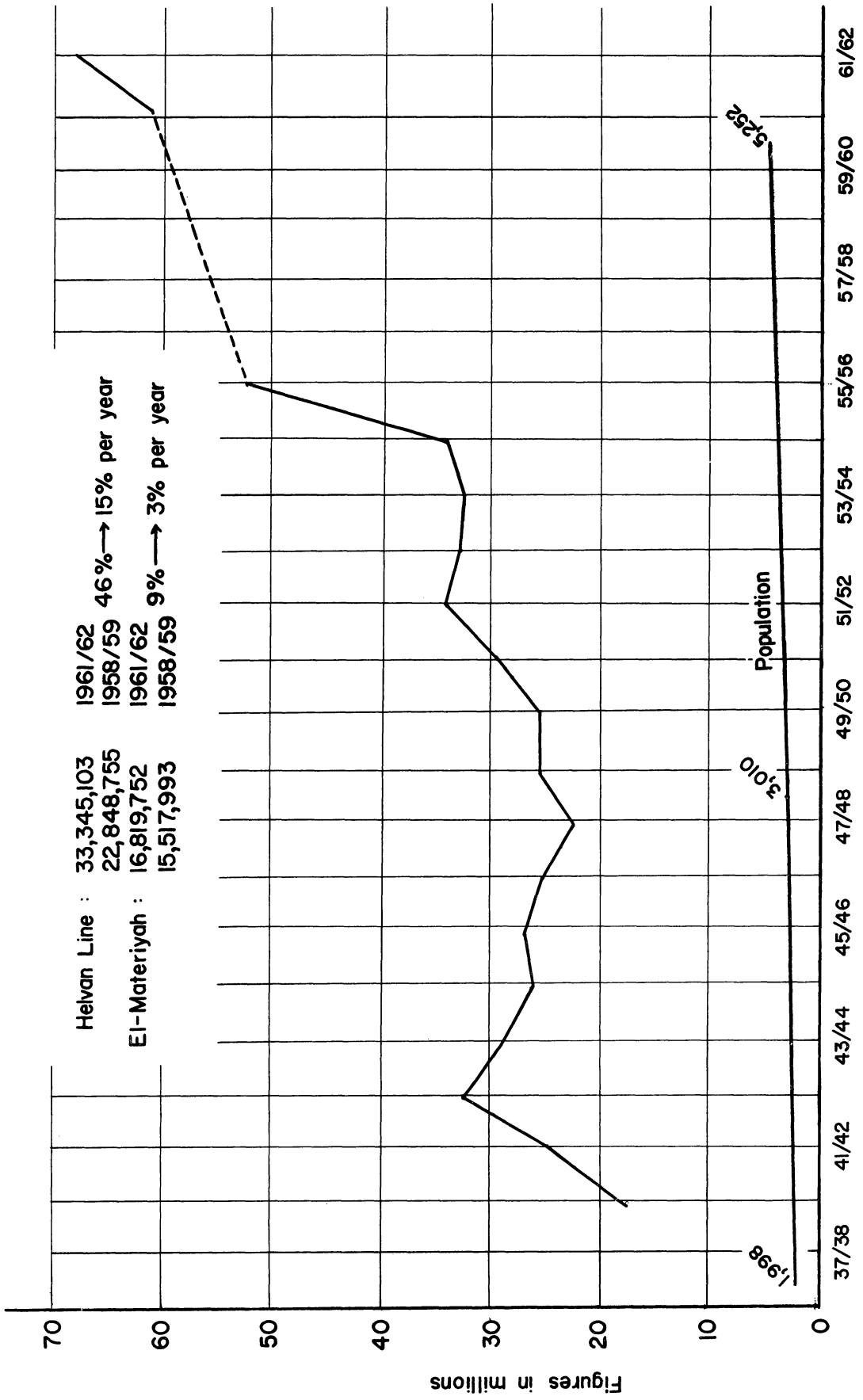
	Time	Number of Trains
i - Helwan	6:30 - 8:00 A.M.	19 inbound and 19 outbound
	2:00 - 5:00 P.M.	37 inbound and 37 outbound
ii - El-Materia	6:20 - 8:00 A.M.	10 inbound and 10 outbound
	2:00 - 4:00 P.M.	9 inbound and 11 outbound

Maximum number of passengers at the peak hours is 1000 passengers per train for Helwan and 750 passengers per train for the other.

Until further detailed data could be obtained, based on the working times for different active groups,* I can assume the following:

	Peak Time	No. of Passengers Per Train		Time Between Trains	No. of Passengers Per Min.
		Inbound	Outbound		
Helwan	6:30 - 8:00 A.M.	750	1000	4.7	370
	2:00 - 2:30 P.M.	500	1000	4.8	315
	2:30 - 3:00 P.M.	1000	500	4.8	315
	5:30 - 6:00 P.M.	1000	500	4.8	315

* See footnote Page 76.



Source : Ministry of Communication, Special Commitee Report For The Development Of Railroads, 1957, p.42

Figure 18. Suburban Rail Traffic Increase, (Yearly Variation).

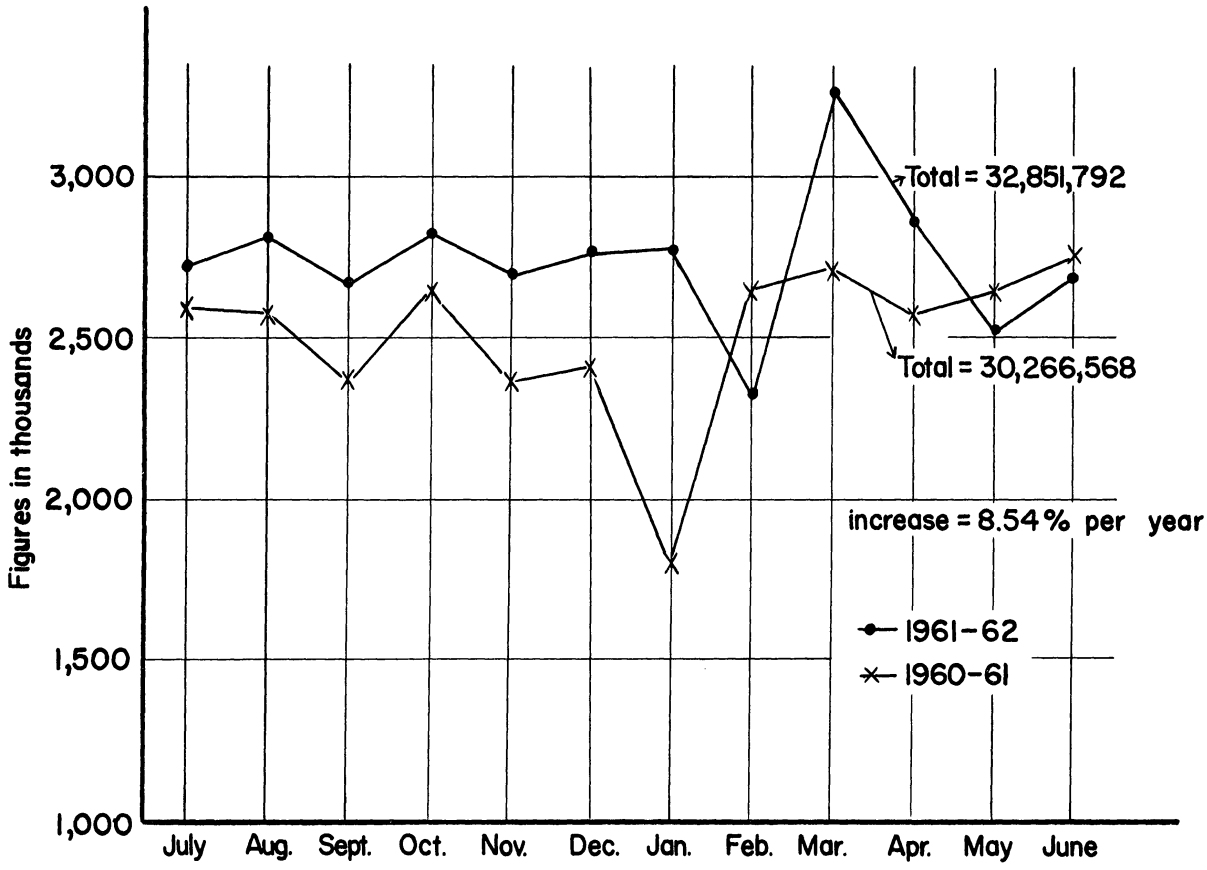


Figure 19. Suburban Rail Traffic (Monthly Variation).

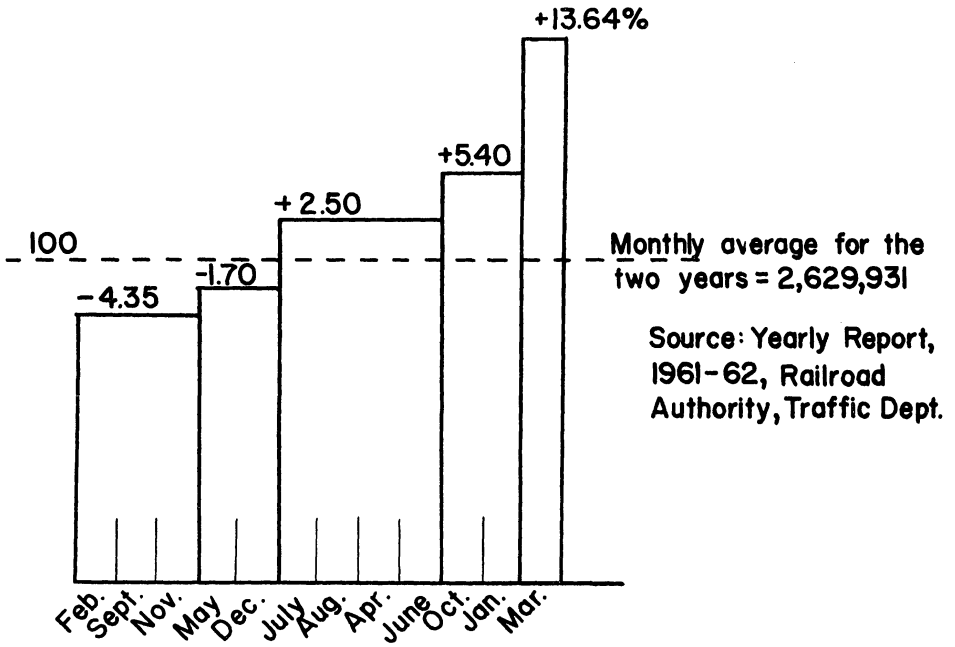


Figure 20. Per Cent Suburban Rail Traffic Variation (Monthly).

Still there is a lack of information to identify the full span and traffic volume of the peak hours. Our goal is to get this information and divide the daily traffic into periods of certain identical traffic levels which may or may not be valuable from the economic point of view.

So far it seems from the train schedule for both the suburban and intercity traffic that the high traffic volume is better spaced in Cairo than most of the large cities of the world, a fact which sounds advantageous.

* Government Employees 8:00 A.M. to 2:00 P.M.

Changed in September 1963: 7:30 A.M. to 1:30 P.M.

Shopping Centers and Business Companies

8:00 - 9:00 A.M. to 1:00 - 2:00 P.M.

and 4:00 P.M. to 7:00 P.M.

Changed to 9:00 - 10:00 A.M. to 2:00 - 3:00 P.M.

and 5:00 P.M. to 8:00 P.M.

Schools 7:30 to 8:00 A.M. to 2:00 P.M. - 4:00 P.M.

Changed to 7:30 for boys and 8:00 for girls to 2:00 - 4:00 P.M.

Universities 8:00 A.M. to 2:00 P.M.

and 3:00 P.M. to 7:00 P.M.

Changed to 9:00 A.M. and over

Industrial Firms 7:00 A.M. to 1:00 P.M.

and 3:00 P.M. to 5:00 P.M.

Weekends

Shopping Centers Fridays or Sundays

Others Fridays

b. Other Public Mass Transport

Other public mass Transport systems in Cairo are indicated as follows:

i) A bus network which covers almost each area in the city, and carries more than 65% of the intracity movement.

ii) A very old, slow and out of date Tramway (street cars) system which once dominated the traffic of the city. Some of the tramway lines were removed in the mid-fifties because they were considered an obstacle causing congestion.

iii) A trolly bus system erected in the mid-fifties for a few limited lines.

iv) A "Metro" system (fast street cars running partially in an open subway) connecting Heliopolis with the Nile at the C.B.D.

In 1954 three French experts(12) were assigned by the Egyptian government to study the transport of Cairo and make their recommendations for future plans. In their report the three experts severely criticised almost all the privately owned competitive companies which controlled public transport in Cairo. The main criticism was focused upon the administrative responsibilities towards the public, maintenance and replacement policies, level of bookkeeping and recording, and bus drivers and operator's responsibilities towards their companies and the public. They also criticised the private ownership of public transport systems and their inadequate integration. They recommended a unified system with public ownership, since this type of system has proved healthy for both London and Paris.

In 1960 public transport systems were nationalized, with three put under one administrative authority called the "Cairo Organization for Public Transport" while the "Metro" is under the "Heliopolis Organization." I could not believe that the two authorities would be running the four systems with such high degree of efficiency had I not witnessed the change in each aspect. I had long discussions with the general directors of both organizations and went through their records. Astonishingly enough their bookkeeping and records are more detailed, clear and adequate than those of the "Railroad Authority" which is better financed and was established earlier. Meanwhile, there are still some points for criticism. First, inadequacy of their present capacities to fulfill the public demand. Second, the lack of research. The first point, I realized, is out of their hands because of the shortage of foreign currency to import more units. The second may be thought of as a luxury.

Table IX shows a comparison of capacity and performance of the four systems between 1953-54 and 1962-63.

TABLE IX

PUBLIC TRANSPORT SYSTEMS IN CAIRO 1953-54 AND 1962-63

System	Year	Length of Network Km.	No. of Lines	No. of Units	Kilometers per year	Passengers per year	Passengers Kms./Units
Tramways	1953-54	144.425	19	536	27,644,661	179,215,900	6.05
Trollybuses	1953-54	1.255	1	1	59,327	--	--
Buses	1953-54	200.00	31	--	--	199,994,500	--
Metro	1953-54	20.500	3	39	4,523,000	25,000,000	5.53
Tramways	1962-63	166.65	20	567	1,993,000	119,700,000	5.5
Trollybuses	1962-63	40.23	4	108	819,000	77,090,000	8.7
Buses	1962-63	1055	92	755	7,437,000	494,000,000	6.2
Metro	1961-62	28.92	4	76	7,532,472	47,564,000	6.32

Total passengers for 1953-54 was about 404 million, increased to about 740 million in 1962-63, with a rate of about 9.2% per year, while the capacity did not increase by more than 4% per year.

Traffic Variation

Except for February and August, monthly variation ranges between 4% to 5% of the monthly average. The two months have -8% difference as shown in Figure 21. In general, we notice that for intercity transport, the variation ranges between -17% to +20%, for the suburban between -4% to +14%, i.e., the variation is higher in the intercity and lower in the intracity transport. This may be due to the fact that because student travel constitutes a good share of the passenger traffic on the main intercity lines that when the students have their midyear vacation they stay in their villages or cities, but students who live in Cairo continue to use the public transport for travel purposes other than going to their institutes.

Daily traffic variation for the intracity movement is also shown in Figure 22 having the following main features: a) traffic drops relatively sharply during the weekends (Fridays) and holidays when some people prefer staying at home and traffic drops to 87% of the daily average. On the other hand traffic increases up to 120% on days preceding weekends (Thursday) when people prefer to go shopping, visiting, or entertaining; b) traffic is higher than the average at the beginning of the month and then slows down through it, the cause is obviously an economic one; c) since the main shopping centers close on Sundays we notice that lowest traffic volumes on a typical week day is attained on Sundays; d) Saturdays and Mondays tend to be a little higher than the average.

Hourly traffic variation cannot be established except by traffic counts. As far as I know, the only traffic count for public transport in Cairo has been made by the three French experts in 1953-54.

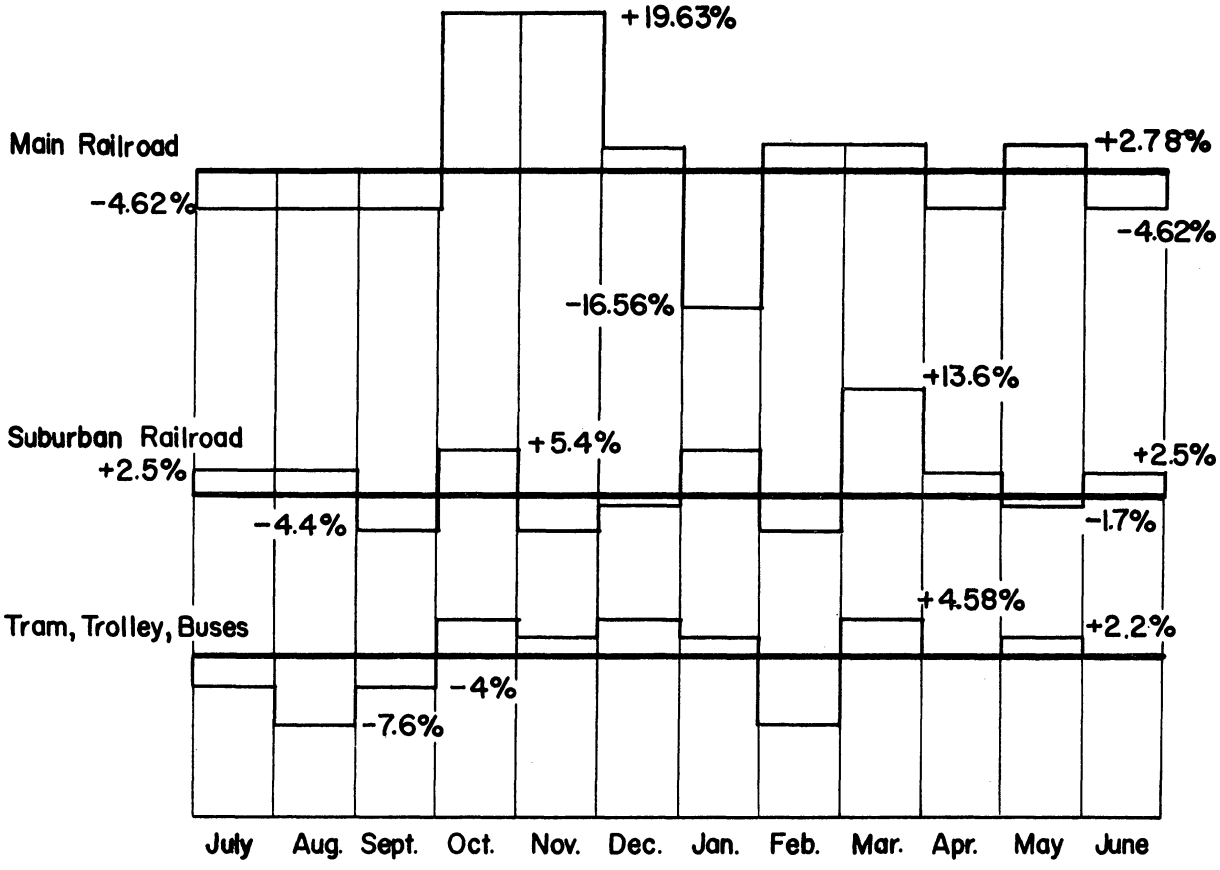


Figure 21. Per Cent Fluctuation in Traffic (Monthly) for All Passenger Transport Systems.

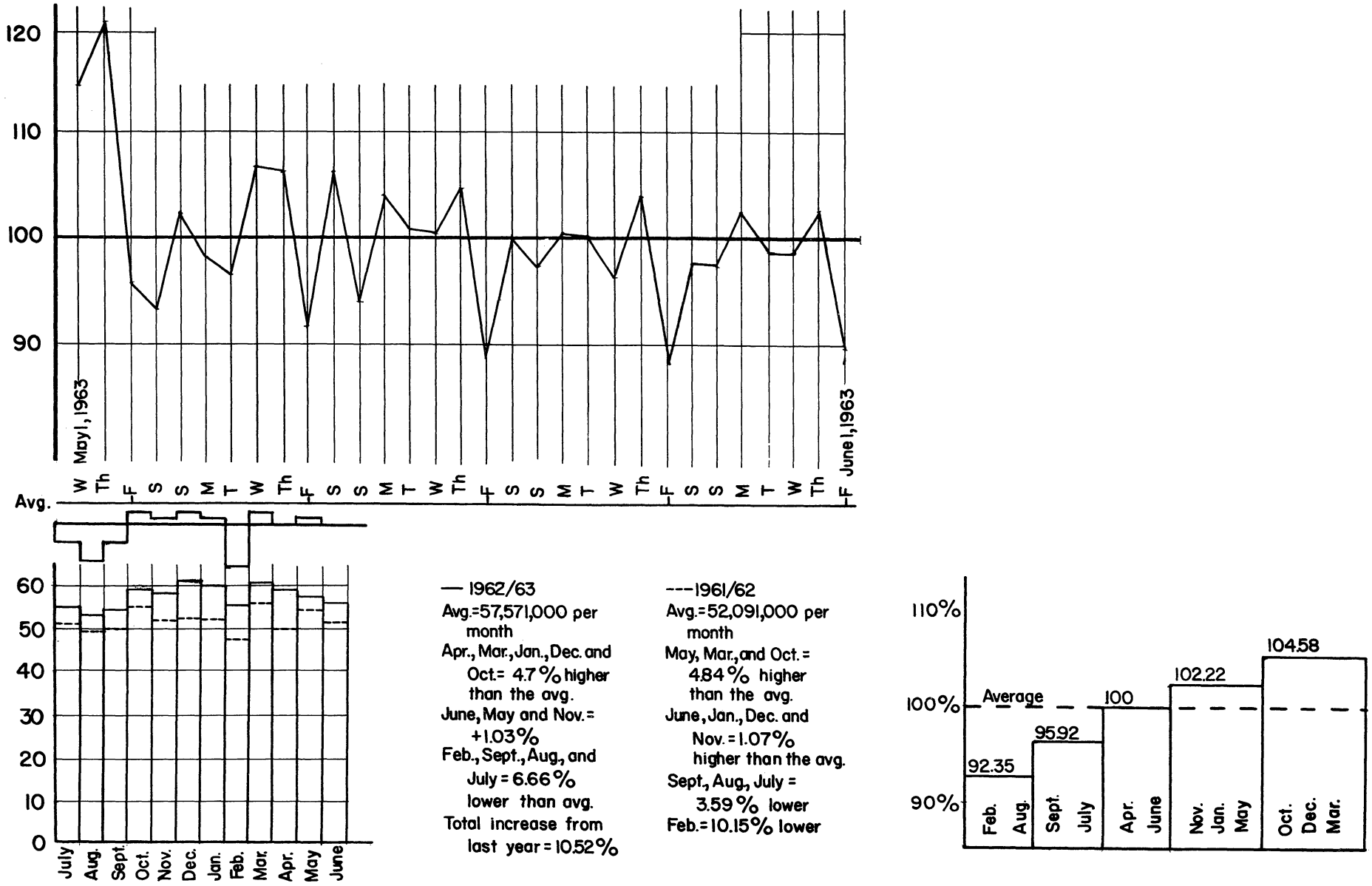


Figure 22. Daily and Monthly Traffic Variation Trainways, Trollybuses, and Buses.

They selected 25 points (Figure 23) where they made their counts and observations, a sample of which is represented in Figures 23, 24, 25 and 26. They significantly classified traffic intensity into the following:

peak hours volume (p.h.)

intermediate hours volume (i.h.)

low hours volume (l.h.)

Total length of the three periods is 16 hours from 7 A.M. to 11 P.M. Other than this period, traffic has no significance and could be called very low (v.l.h.). The following table shows the traffic volume at eleven significant points on the main traffic axis.

TABLE X

AVERAGE TRAFFIC VOLUME PER QUARTER HOUR AT ELEVEN SELECTED POINTS

Point of Observation	Length of Period	Average No. Passengers	Length of Period	Average No. Passengers	Max. Traffic on Reverse Direction for	Length of Period	Average No. Passengers
1	3	3,100	4.5	2,200	1,100	7.5	1,600
2	2	800	7	600	400	6	450
5	3	900	7	800	500	5	600
8	2	800	9	600	400	4	400
10	3	850	9	600	400	3	400
11	3	750	6	600	500	6	500
12	3.5	1,300	10.5	1,100	600	2	800
14	3	1,200	4	1,000	900	8	800
16	2	800	5	600	500	8	400
17	2	1,200	7	1,000	700	6	700
23	2.5	1,100	7.5	900	600	5	650

From this table and their observation they concluded the following:

i) There is a fixed intermediate load for seven hours.

ii) This load has only $\pm 30\%$ variation for the peak and low loads, while in Paris the variation is -50% to +150%.

iii) Time of the peak loads occurs between 7-8 A.M. in the direction of the center, and from 2-3 P.M. from the center towards the outer ring of the city, and a third between 6:30 and 7:30 P.M. in both directions.

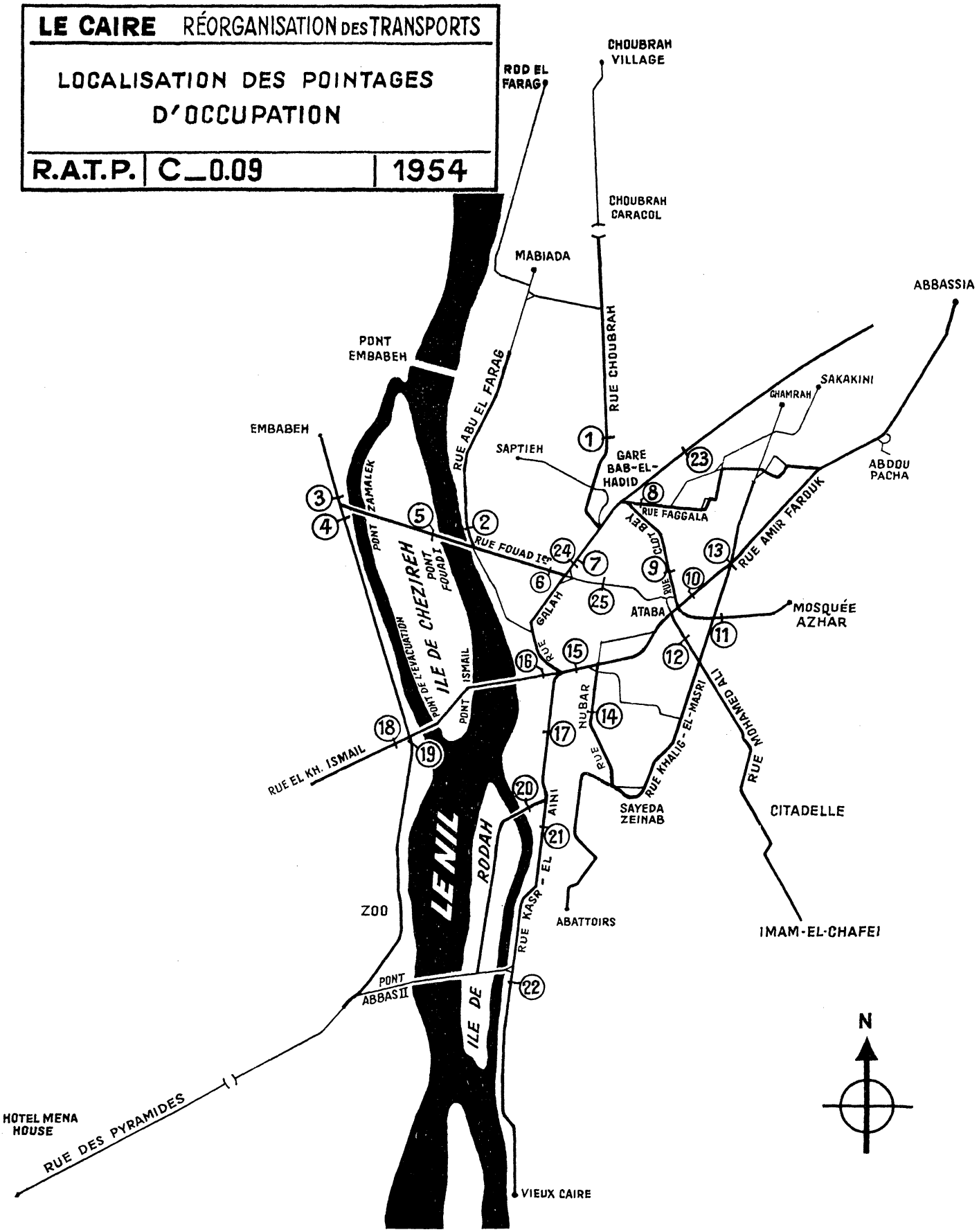


Figure 23. Localisation Des Pointages D'occupation (1954).

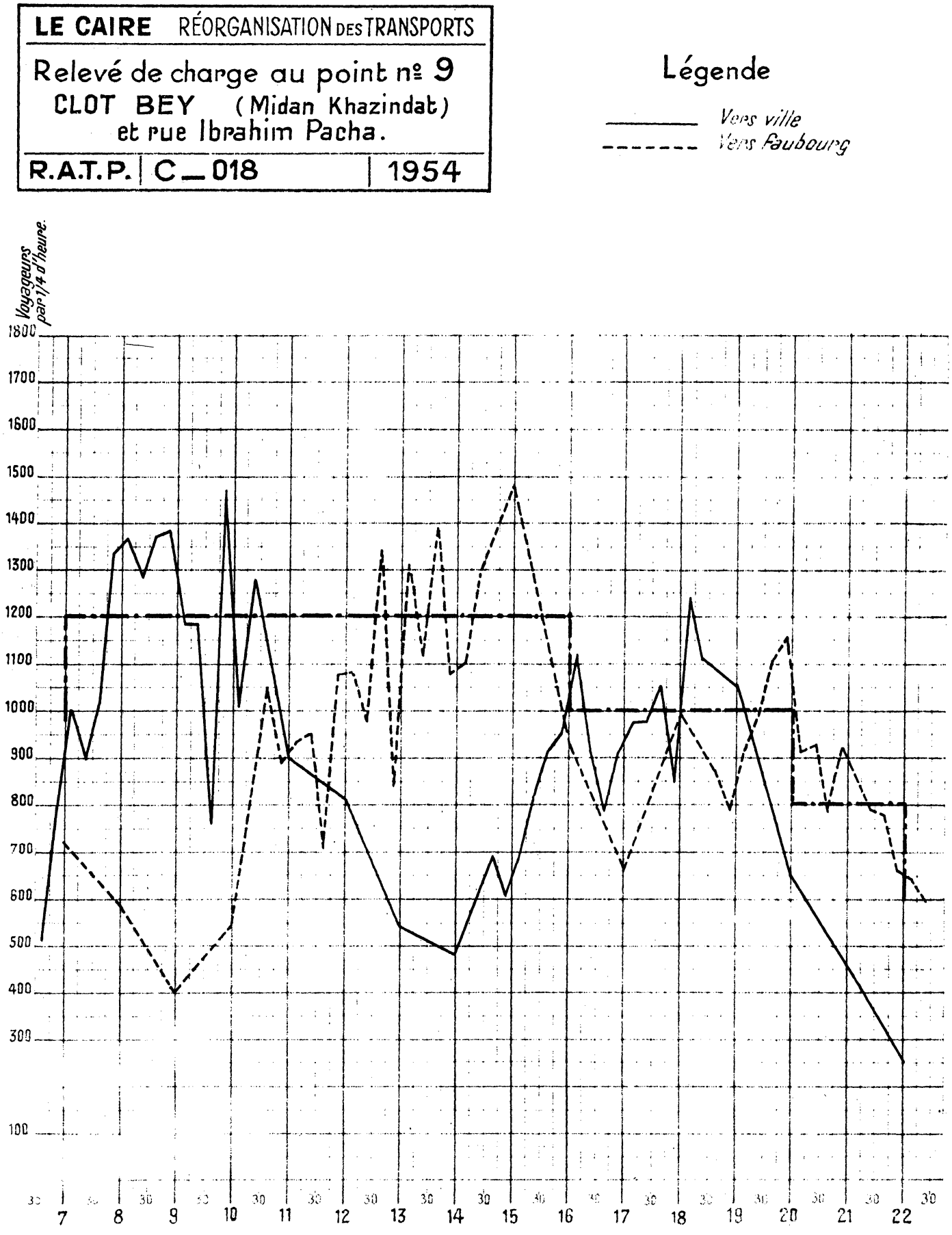


Figure 24. Releve de charge au point no. 9 Clot Bey (Midan Khazindat) et rue Ibrahim Pacha.

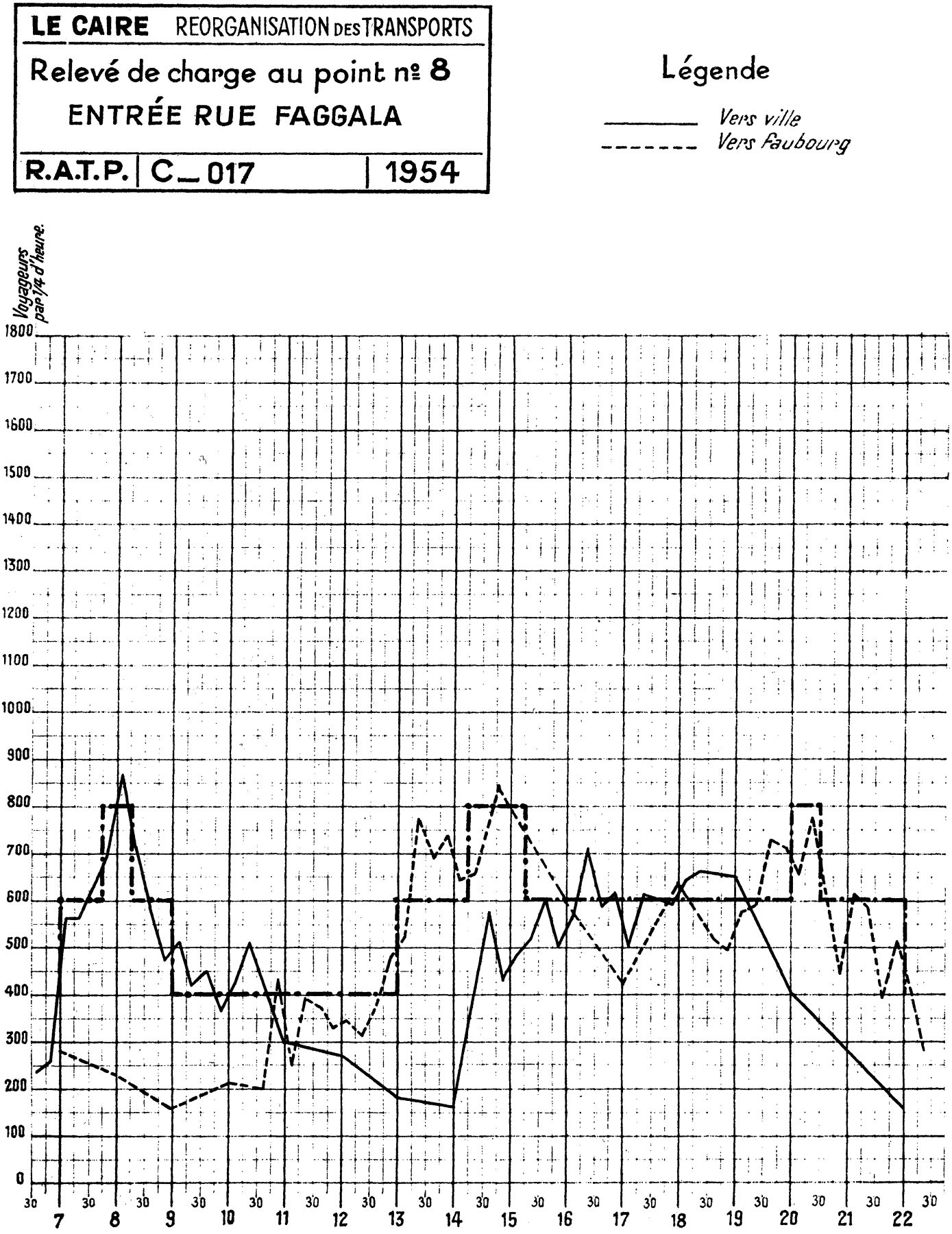


Figure 25. Releve de, charge au point no. 8, Entree Rue Faggala.

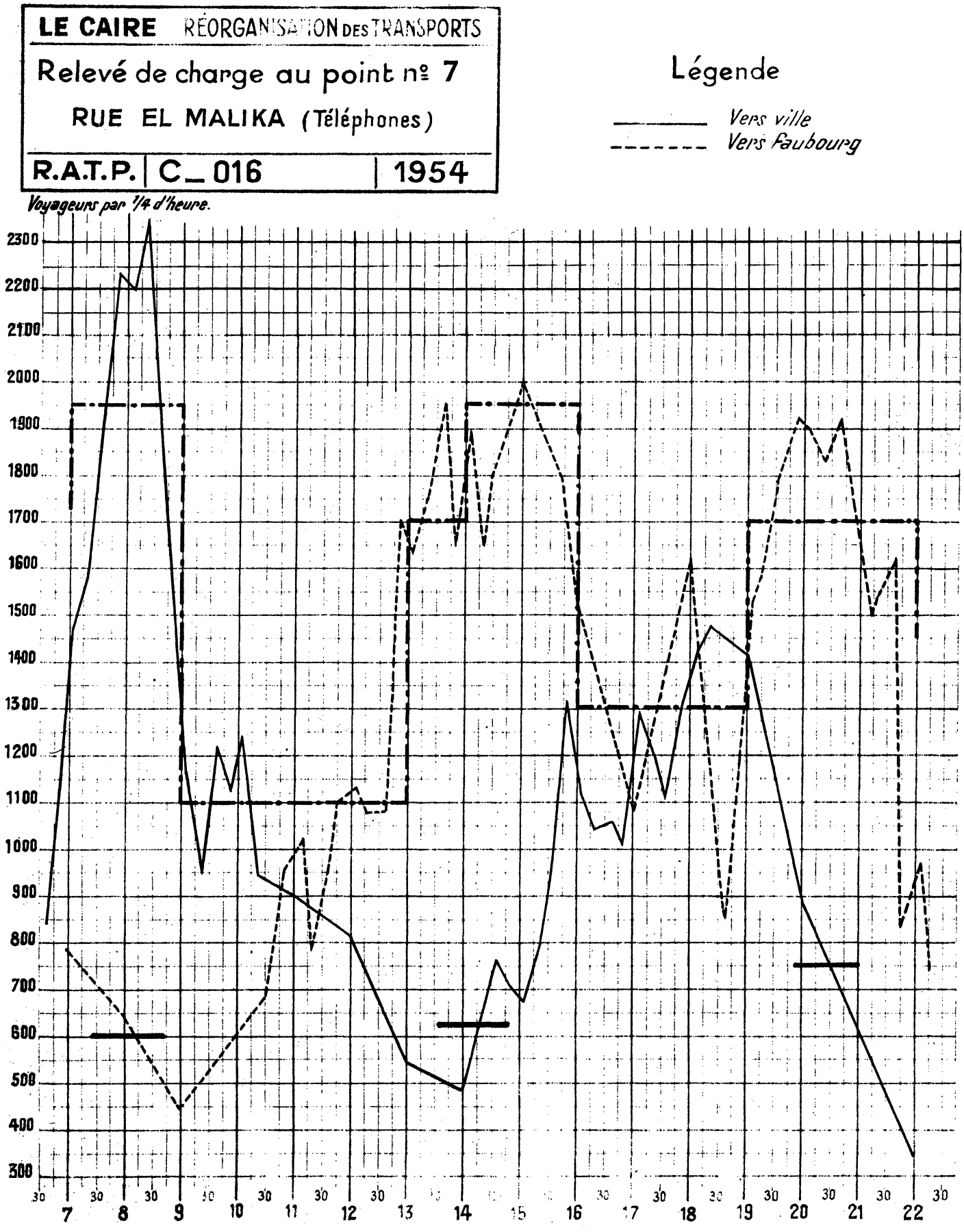


Figure 26. Releve de, charge au point no. 7, Rue El-Malika.

iv) Ratio between daily to the yearly traffic was 1/342.

v) The peak hour volume of traffic 67.5 to 8% of the average daily traffic. (yearly traffic)/342

Figure 27 shows what we can call an intensity of public transport network for Cairo at its peak hour. This figure has been constructed on the basis of the number of public transport units passing a given point on its path multiplied by the actual capacity of each unit. This actual capacity is not the number of seats available in each unit but on the actual number of passengers who use that unit at the peak traffic hours.

c. Other Transport Systems and Traffic Composition

Cairo used to absorb more than 50% of the nongovernment motor vehicles. In 1945, 75% of the country's motor vehicles were located in Cairo, in 1950 the percentage dropped to 54%, in 1955 was 53% and in 1963 was 51%. By the end of June, 1963, Cairo had 55% of the private automobiles of the country, 40% of the taxis, 45% of the buses, 38% of the trucks, and 56% of the motorcycles. Table XIV, Appendix A and Figures 28 and 29 show Cairo's share of the integrated motor vehicles of the country and their increase in Cairo, where there is a car for each 100 persons or 75 persons for a car and a motorcycle. In general, between 1955 and 1963, increases of motor vehicles for passenger purposes was slight. Although the country is rapidly accomplishing socialism, private automobiles and motorcycles are increasing relatively faster than buses, which have decreased between the two dates, although passengers of public buses have increased as mentioned before by little less than 150% between 1953-54 and 1962-63, while the carrying capacity increased by only 22%.

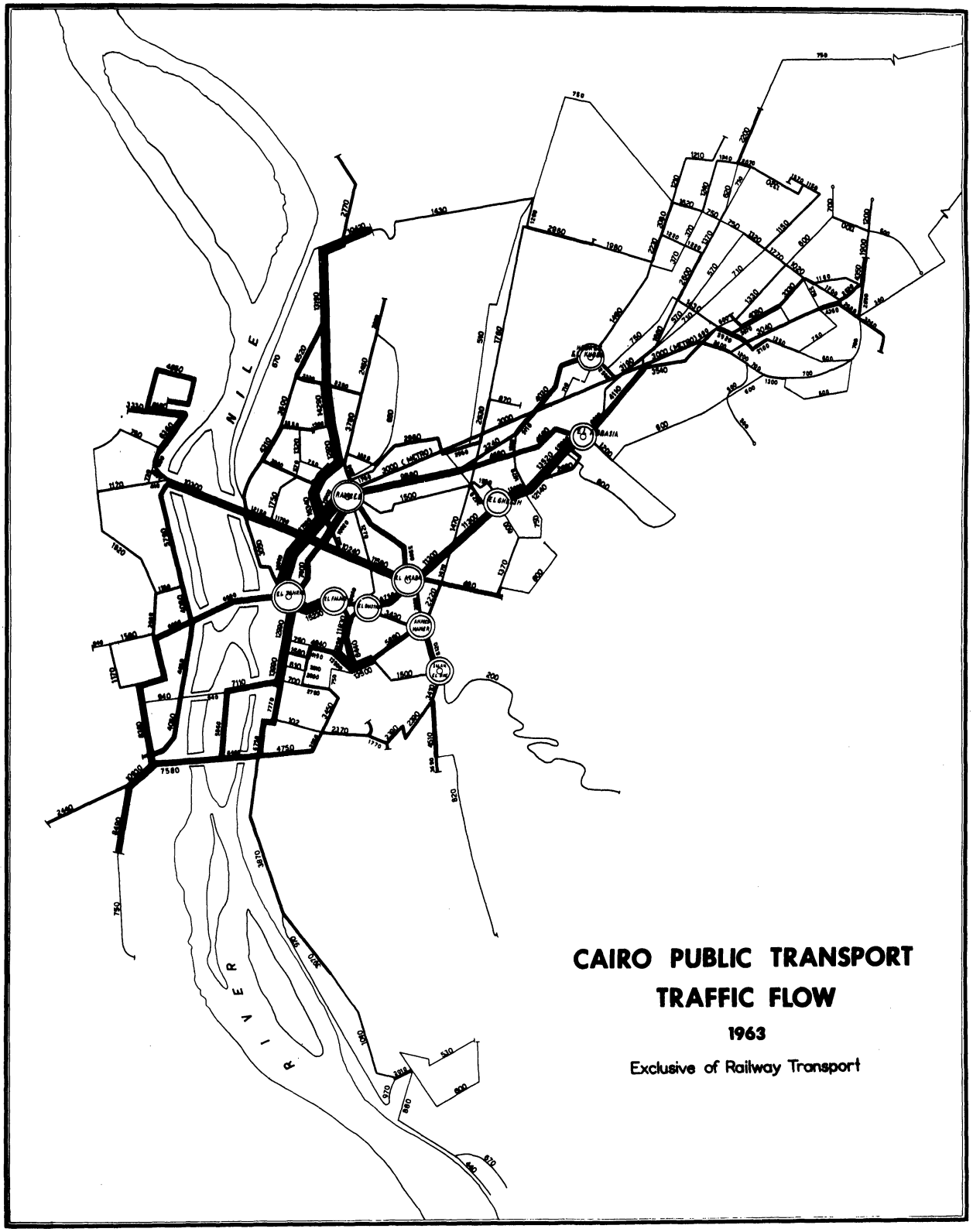


Figure 27. Cairo Public Transport Traffic Flow, 1963, Exclusive of Railway Transport.

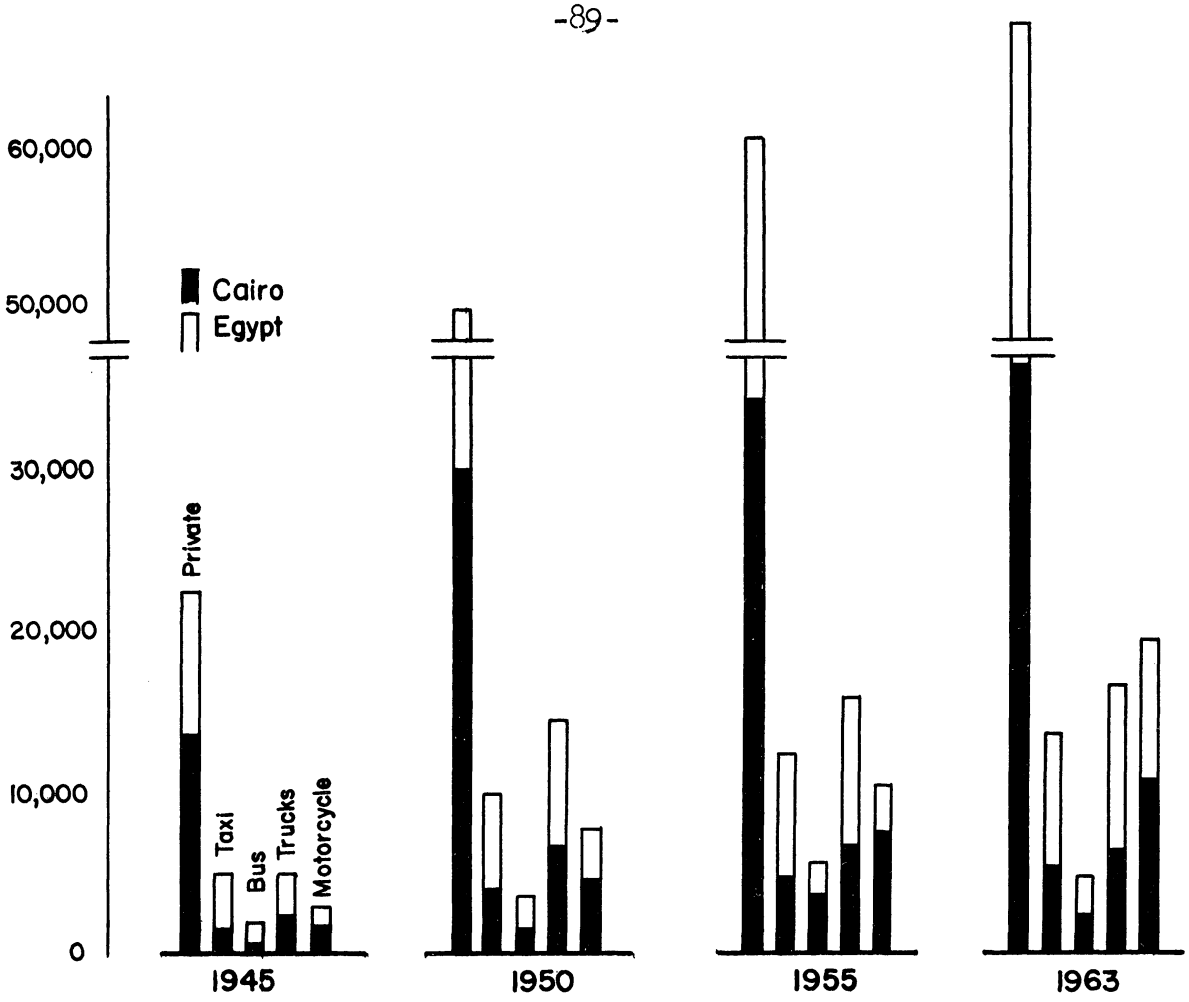


Figure 28. Motor Vehicles in Cairo and Egypt (1945-63).

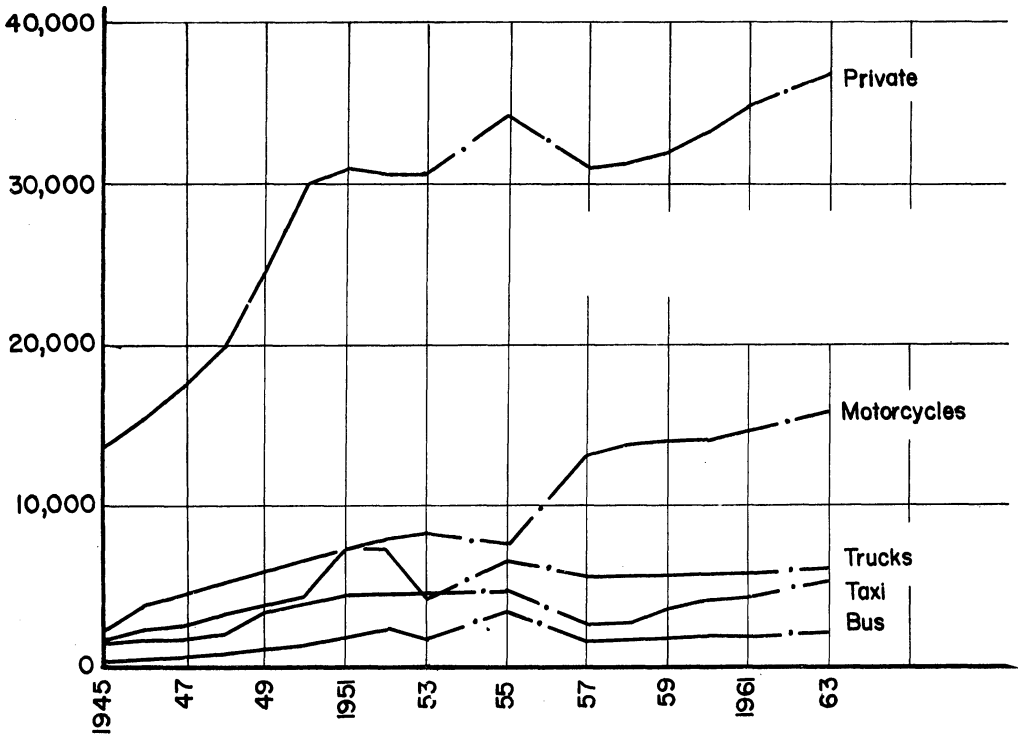


Figure 29. Motor Vehicle Registration in Cairo (1945-63).

The three French experts recommended a 30% immediate increase in the carrying capacity of buses in 1954 because of their over use. Now we can imagine how crowdedly they are being operated and how sardine-like transport is taking place in Cairo.

To have an accurate idea about the traffic composition in at least some major points in Cairo, I conducted, with a small group of engineers, a traffic count during August 1963, at three main squares of Cairo, two of which - Remsis and El-Tahrir - could be considered the main collective and distributary squares of Cairo within the C.B.D.; the third - Soliman - is in the center of the C.B.D. where no public transport systems are permitted to operate. A 15 minute count was used during the peak hours between 1:30 and 3:00 P.M., and the hourly traffic volume is calculated based on the following list which is based on my own observation and judgment.

Time (P.M.)	% of Max. Quarterly Volume
1:30 - 1:45	60
1:45 - 2:00	70
2:00 - 2:15	100
2:15 - 2:30	80
2:30 - 2:45	70
2:45 - 3:00	60

Results are shown in Tables XV, XVI and XVII in Appendix A, followed by a sketch for each square.

For the first two squares, private automobiles ranged between 33.8% to 44.2%, taxis from 22.8% to 31.8% with a constant percentage, 44% of them, running empty. Bicycles constitute 7.4% to 7.8%, motor-cycles 2.9% to 3.0%, public transport 13.1% to 16.9%, trucks 3.3% to 5.1%,

motorcycles with a box 1.5% to 2.0%, man or animal driven vehicles 0 to 3.5%. The third square has 49.1% private automobiles and 38.7% taxi (52% of them run empty). Bicycles and motorcycles have relatively the same percentage as before 7.7% and 3.6% respectively. Buses (tourists) constitutes only 0.6% and trucks 0.3%.

Traffic composition, as it stands now, is much better than 25 years ago when horse driven vehicles were widely used as public or private transport systems. For passenger movement these vehicles have nearly disappeared but for freight movement they could be seen frequently in old districts outside the C.B.D. and rarely seen (with some exceptions) in the major streets of the C.B.D. Traffic composition now has its drawback of nonuniformity of sizes and speeds which seriously effect actual street capacity and performance. It seems from the number of lanes for each street that most of them had, until now, sufficient capacity and they can absorb higher volumes. Unfortunately I do not know their capacities because of the nonuniformity of traffic. Cases like this have not been studied before and accurate conclusions should be based on actual and sufficient accumulation of data. Since this data is not available, it is difficult for any theoretical attempt to throw light on capacities in cases like this. A comment which is worthwhile, is that at both El-Tahrir and Ramsis Squares, where most of government employees have to catch a public transport vehicle to their homes between 2:00 to 3:00 P.M., are cleared up within 45 minutes and then go back to normal conditions, while my observation in London indicated that this movement cannot be accomplished with less than 60 minutes. The only difference is that in Cairo the passengers have to suffer

crowded conditions and have trouble finding a place for their feet in a bus that carries more than 100% of its capacity. Cairo passengers are used to this condition and I am sure that when the number of buses increases, passengers will over-occupy the early buses at rush hours leaving the following ones operating at less than capacity. When this time comes, the bus drivers should be instructed not to accept more than the bus' capacity or we will run in a vicious but more complicated circle. The main question now is when may we reach optimum street capacity?

General Traffic Conditions

The number of lanes mentioned in three of the above mentioned tables should be reduced by one for each street, because of parking vehicles or numerous bus or trolly stops.

Pedestrians are numerous and dangerously causing congestion everywhere in the city. They are not only occupying sidewalks but also occupying the streets themselves, they do not follow pedestrian traffic lines or traffic signals. Young kids often jump suddenly from the sidewalks to the street causing many accidents, which are seriously increasing as the following table indicates.

TABLE XI

TRAFFIC ACCIDENTS IN CAIRO*

Year	1957[13]	1958[13]	1959[13]	1961-62[14]	1962-63[14]
Death	119	106	107	180	150
Injuries	1442	1360	1470	3300	2200
Accidents	--	--	--	11,014	8005

* These represent only accidents made by public transport (buses, tramways and trolly buses).

Only recently, successful attempts have been taken, at least within the C.B.D. area, to control pedestrian traffic, giving tickets to those who do not follow regulations.

A part of the sidewalks within the C.B.D. and a sizable proportion of them outside the C.B.D. are occupied by merchandise, a matter which forces people to walk in the streets.

Street occupancy with wooden hand driven flat cars on which private merchants put their goods (vegetables, fruits, etc.) is also a serious problem, especially for major squares outside the C.B.D. and in densely populated districts. The most serious case is observed in a one block street connecting Helwan rail terminal with the jammed square of El-Falaki in the C.B.D. At least between 2:00 to 3:00 P.M., 20,000 passengers are using this terminal, one bus line is using this street and a trolly line with other bus lines are passing in front of the terminal. I passed along this street at 7:30 P.M. with a private automobile in about 12 minutes, that is, I could have made two round trips along this street walking in a shorter time. On one side of the street a large grocery center is located, and a movie theater and other shops are located on the other side. Both sidewalks are fully occupied as well as half the street itself leaving only 1-1/2 lanes for two way vehicle and pedestrian traffic. There is no wonder then that the average tabulated speed of some bus lines passing through densely populated districts goes down to 11.2 Km/hr, when they cross the C.B.D. and from 14 to 17 Km/hr when they do not pass it, while the speed goes up to an average of 30.8 Km/hr from the C.B.D. to the suburbs. Tramways have a speed as low as 9.16 Km/hr to a high of 10.94 Km/hr.(16) Trollys range between 14.12 Km/hr

to 16.16 Km/hr.(16) The metro between Heliopolis and the Nile runs with an average tabulated speed of 20 Km/hr and as low as 19 Km/hr in the peak hour traffic to 25.30 Km/hr in the morning and at night time.

Traffic Department

Unfortunately traffic is regulated, controlled and planned by a department of the governorate police. There is no single specialized traffic engineer working there. Although many of the officers running that department have been sent on missions abroad to study traffic for short times, but this is not enough.

H. Defining the Problem

Like doctors, after having a fast and brief background of the history, community life and movement characteristics in Cairo, we can begin to make our tests or examinations, - in the doctor's case blood pressure, temperature... etc. - trying to discover the defective parts causing pain and troubles. In the meantime we have to realize that the problem is not static nor is the solution. It follows that the problem formulation will not be accurate without taking into consideration future changes which causes dynamicacy. Testing Cairo's organization with the eight standard norms mentioned in the introduction set for an ideal transport planning we find:

1. Minimization of Movement in Length and Number

Presence of hills and large cemeteries to the east of Cairo has imposed abnormal expansion of the city to the north giving it an odd shape causing a long path to be cut daily by inhabitants of northern and southern fringes. An effort has been made to form a new district on

the Mokattam Hills called "El-Mokattum City," but it seems that it has not been successful until now because of the unsolved problem of a direct route to connect it with the C.B.D., since the existing routes pass through congested areas. The only good route is a new one connecting it with Kournaish Street parallel to the Nile but it is located to the South which seems to be far from the C.B.D.

Another city called "El-Nasr City" is under construction now on a large area which used to be an army barracks between Heliopolis[D20] and El Wayli[D12] in the desert. In this city the Olympic Stadium has been built. The U.A.R. foreign ministry with all the foreign embassies will be shifted to this area, and there is also a proposal of concentration of all or most of the government buildings in this city. This proposal may turn out to be very serious, because these buildings will be shifted from a central area with concentrations of population where travel to work used to be made by certain groups on foot, to a non-central area of low population density which will surely add more burden to the transport network. This policy then creates more movement which could be avoided and may affect a large low income group who have adjusted their residential location to their job location. Better distribution policy should be made for government buildings, and this policy should be in harmony with housing policy which will be discussed later.

Most of the cities of the world, having a suburban daily travel pattern, usually utilize an inbound direction in the morning and outbound direction in the evening. Cairo-Helwan suburban line have a reversed trend because many who are working in the suburb are living in Cairo although, as mentioned previously, it is a potential place for a healthy

beautiful residential area as well as a center for heavy industry. Since there is a serious housing problem now in Cairo, no one has a choice of his residential place except for a status or income preference, and since housing activity is becoming rapidly a public sector, then it seems that the obligation of the government to give priority of residency in a certain area should be given to those who work in that area.

Modern shopping centers as they are known in the United States of America, which create multiple purpose trips, are badly needed in most of the districts of Cairo, especially those of the outer fringe. This would eliminate their dependence on the inner districts and reduce distance and frequency of movement for shopping purposes.

Communications can be considered in some occasions as a substitute for transportation of certain purposes. Although telephone lines are increasing more rapidly than the increase of population in Cairo, there is a serious shortage of telephone lines. They are mostly absorbed by the growing business and service activities in the city, but at the same time there is a limited capacity for the "Public Authority of Communications." At least until this problem could be solved completely, public telephones should be distributed everywhere in the city.

The program of housing renewal should cover most of the old districts and should start from the new and modern residential areas towards the slums, cemeteries, and hills. This policy will give direct contacts to the newer areas avoiding a situation like that of "El-Mokattum City." Also it will give a free hand to planners to construct new streets or roads of regular and straight paths, and free hand in designing better crossings, or in general, better planning free of restrictions.

Concluding from this part, a new master plan of Cairo should be proposed as a first step of our long range solution, which is based upon dividing the city in autonomous parts each containing several districts of main shopping centers, government buildings and activities. The second step will be the choice of the forecasting years. The third is to determine the size of the city with respect to the country and finally the distribution of the population in different districts.

2. Better Fluctuations of Movement

We have seen that fluctuation of traffic in Cairo is highly advantageous because of the fixed intermediate traffic load which lasts seven hours out of sixteen daily and this load is exceeded or preceded only by ±30%. This characteristic of traffic is the outcome of the working time table for different working groups. Of course, the time table is also an outcome of climatic conditions. Since this policy is acceptable in Egypt then the best time schedule should be based on factual observations and analysis of accumulated data collected by sampling methods for place of residency of all groups and their place of work in addition to a general origin and destination and time study. Until this data is available, nothing can be done and the present new schedule will prevail.

3. Elimination of Concentration of Traffic

Although many efforts and many changes have been accomplished for the main routes and streets in or surrounding Cairo since 1954, heavy traffic concentration is still seen on all major axis especially that of Shoubra Street, Ramsis Street, 23rd of July Street, Ramsis

Square - El Tahrir Square connection ... etc. A study should begin soon for alternative parallel routes, the possibility of constructing elevated roads and the study of location of new bridges on the Nile. This study should be based on scientific expectation of traffic volume between major points of the city. This study will be the core of this research and our main trouble is the lack of information.

4. Elimination of Hazardous Movements and Spot Congestion

The main defects under this topic have been thoroughly discussed and the counter solutions can be summarized in the following few points:

a - Unification of transport systems, at least in speed, through elimination of hand and animal driven vehicles, provisions of special lanes for bicycles, and elimination of slow tramway lines.

b - More control of pedestrian movement in all squares and main routes.

c - Elimination of street occupancy by providing more modern shopping centers.

d - Reduction of accidents through better traffic control and law enforcement. It is worth mentioning here that there are no stop signs anywhere in Cairo.

Our job then will be that, through our solution we have to discuss the difficulties of accomplishing each of the above points and provide a solution for each.

5. Attainment of High Average Speeds

Also we have seen before how average speeds attained is too slow to be considered a cause of wasted time for passengers and a reduction of efficiency of the system. In addition to the above mentioned reasons, slow movement is due to:

a - Old equipments, poor use and maintenance.

b - Short distances between stops.

c - The non-use of express vehicles (stop only in few selected stops) at least at peak hours and some other selected periods.

d - Unreasonable length of time wasted in each stop, due to passengers behavior.

6. Adequate Capacity

Also we have seen that equipment has been over-used and its capacity lags behind demand.

Route capacity should be checked for projection years to determine when an underground transport is needed.

7. Comfortable and Safe Transport

Public transportation is a headache to all passengers due to shortage of capacity and slow movement. Both points have been discussed before.

8. Low Transport Cost

Although our public transport network is still a profitable business it could be more successful if higher efficiencies are attained and better services are provided.

In 1954 the French experts estimated that 5% of the passengers who were using the network did not pay because they would ascend and descend before the "conductor" or "operator" reached them due to the over-loaded vehicles. Undoubtedly this percentage is now exceeded.

The gain from this missed percentage may cover a good share of the lagged capacity. Comfort will stimulate more and more movement in demand which means more profit. Higher profits are always needed, at least to cover increasing labor wages and material prices.

We have seen before that taxi movement rises to 38.7% of the traffic in the heart of the C.B.D., and 52% of them are moving empty. Outside this area where public transport is provided, taxi constitute from about 23% to 32% with 44% of them empty. Many of the taxis are singly and privately owned. For this reason competition is too high among owners or drivers, so that each vehicle has to keep running until it picks a passenger. Efficiency is low and costs are high due to gasoline prices being so high in Egypt. It is worthwhile to find a solution for a better operating system to lower costs on one hand and to eliminate unnecessary movement.

CHAPTER II

DETERMINATION OF FUTURE POPULATION OF CAIRO THROUGH THE STUDY OF POPULATION GROWTH AND REDISTRIBUTION OF URBAN POPULATION IN EGYPT

A. Urbanization

Urbanization is a highly complicated dynamic phenomena of the agglomeration of people and services. It is mainly the characteristics of the nineteenth and twentieth centuries.

Anderson[14] in describing the urban communities, emphasized that for a person to be qualified as an urbanized one, there should be a change of behavior, culture, and social values when migrating from rural to urban areas. In this sense, people who also live in the rural areas and behave like those of urban areas can be also included as urbanized people. This approach has the advantage of not restricting urbanization to cities only.

A second approach for defining urbanization which ignores the role of behavior and concentrates on the pattern of activities of the entire population of a considered area. Instead of a shift in behavior in the first place, a re-organization of activities is to be observed. Urbanization then is defined as "the movement of people from communities concerned chiefly or solely with agriculture to other communities, generally larger, whose activities are primarily centered in government, trade, manufacture, or allied interests".[15]

There is a third approach which is mainly concerned with people and space. Urbanization then is defined as "the process of population concentration",[16] no matter how they behave or what activities they are involved in.

These three alternative approaches offer distinctive problems and possibilities. Each is suited to a different range of analytical questions and each presents its own difficulties in conceptualism and measurement. In general, the third approach is widely adopted and used because "it seems to offer the fewest ambiguities and the measurement problems that it entails appears closer to solution than those connected with either the structural or behavioral approaches".

In my opinion, none of the three mentioned approaches can solely explain the urbanization phenomena. In Egypt, for example, it is clear from the previous census that there are many concentrations of masses of people which were defined as urbanized areas but culturally and "structurally" were backward. It is true that agglomeration of people is in itself a stimulus for behavior and activity changes, but in many times, especially in the underdeveloped countries or the newly developing countries, this change is so slow due to illiteracy and low income, that it seems unrealistic to define those areas as urbanized.

I think that the demographic definition should be narrowed to some extent so as to specify a certain degree of literacy with a certain level of per capita income since both are basic factors for modernization and since both can be easily known in an aggregative sense.

Urbanization in the following work will carry its demographic meaning only.

1. The Measurement of Urbanization

Adopting the demographic approach, level, or degree of urbanization can simply be measured by the proportion of the total population

to be found in cities or cities of a certain size. This is the most familiar indicator to be found in the empirical literature.(18)

A feature that should be sharply distinguished from the level of urbanization, is the rate of urbanization which takes in consideration the change of its degree with respect to time.

2. Delimiting the "Urban Area"

The most common criteria, it appears, are size, density, (both are purely demographic indicators), and administrative status. The definitions of "urban" not only vary over time within census systems, but more important, differ radically at all times between census systems. At one extreme, for example, Denmark designates as "urban" all localities of "2,500 and more" inhabitants, while on the other end, a locality in Korea must have at least 40,000 inhabitants to qualify as "urban". Some countries base their classification not on the population size of a civil division but on such criteria--singly or in combination--as predominant forms of economic activity, legal or administrative status, the presence or absence of certain services or facilities conventionally associated with cities. Still other countries adopt a combination of size and qualitative characteristics such as "an administrative center with a minimum of 1,500 population." In the United States and Egypt, for most purposes, an urban place has a population of at least 2,500 inhabitants. As a consequence of these arbitrary differences even the United Nations cannot achieve wholly consistant categories although a compromise measure of 20,000 and over has recently come to be adopted by many students of the subject.(19)

A comparative science of urban phenomena for the entire world and which we have to observe in our study in this chapter is obviously impossible since the data is lacking for most of the world. If we always waited for perfect information before attempting to build a comparative social science we would wait forever. The program of urban studies at Columbia University, known as the World Urban Resources Index, is being made to gather and systematize basic data on all large cities. Davis and Golden utilized to some extent this work to have an index relating degree of urbanization and economic development. This index of urbanization is a measure of percentage of population living in cities of certain size (20,000 and 100,000) to the total population. They based their assumptions on a hierarchal classification of cities were the proportion in any major size-class tends to bear a systematic relation to the proportion in the other lower size classes.

B. The Origin and Growth of Urbanization in the World

As a hypothetical case, suppose a few children were left to grow in a large natural area where water streams, food and fruit trees were scattered everywhere. When this generation grew up they would accommodate themselves in a manner which was the most convenient to the individual to obtain his food, his water and a shelter. Since their demand was not scarce and the land was nearly homogeneous this society would be formed as a loose primitive society scattered everywhere.

Suppose water dried except in a few main rivers or streams, this society would gradually move nearer to the scarce but vital resource. The concentration then would be along the water streams.

If somehow methods of cultivating land and growing new products had been discovered as well as some hand tools, then this society would change its course of life and become more tied to their land.

When population grows and cultivated areas increase, water would be scarce for drinking and irrigation purposes, especially in low water level seasons, then this society would have to gather together to regulate the distribution of water in that period. They would set up some irrigation projects, perhaps constructing canals.

Following the distribution of cultivated land, this society cannot concentrate at one area and go to their fields and come back each day, but they could concentrate in small scattered groups to form villages.

Due to change of soil fertility, weather conditions, water availability and long experience of producing an agriculture product, then we can easily assume that specialization would take its place among this society. When specialization was clearly recognized, trade would start between the villages. The amount of trade would depend on the distance between the villages, the degree of specialization, and the degree of advancement of transportation.

Agglomeration of people in itself is a hard strata on which specialization in production other than agriculture can stand, and this would lead to more and more trade and central places to be formed.

Education, culture, advance in technology, ease of transportation and communications, utilization of natural resources and expiration of industry are all factors which change a rural society to an urban society and in the meantime would increase the degree and rate of urbanization.

The above hypothetical case reflects reality abstracted from the observation of origin and growth of urbanization throughout the history. A brief summary of that history is given below.

It has been observed also that the rates of growth are much higher during the past century-and-a-half than at any previous time in the world history.

For any country the rate of urban growth accelerates when a sudden innovation and industrial development start, this acceleration then progressively increases until a relatively new social rearrangement takes place then it begins to decelerate.

For the same state of development newly developing countries witness higher urban growth rates than these realized in old developed countries.

1. Urbanization in the World[20]

In the Neolithic* period population was more densely settled than the purely hunting or food gathering peoples, it was nevertheless chiefly engaged in an occupation--agriculture--which requires a large amount of land per person. The Neolithic population density was therefore not a matter of town concentration but rather a matter of tiny villages scattered over the land.

*Characterized by the use of polished stone implements, and many cultural advances, as pottery making, domestication of animals, cultivation of grain, fruit trees, linen weaving, etc.

Definite things had to be added to the Neolithic complex to make possible the first towns. Between 6000 and 4000 B.C. such inventions would be the ox-drawn plow and wheeled cart, the sailboat, metallurgy, irrigation, and the domestication of new plants. When this enriched technology was utilized in certain unusual regions, where climate, soil, water and topography were most favorable, the result was sufficiently productive economy to make possible urban existence.

The size of towns and cities therefore, required in addition to highly favorable agriculture conditions, a form of social organization in which certain strata could appropriate for themselves part of the produce grown by the cultivators. Such strata-religious and governing officials, traders, and artisians--could live in towns, because their power over goods did not depend on their presence on the land as such. They could thus realize the advantages of two livings, which gave them additional power over the cultivators.

The first cities, doubtless small and hard to distinguish from towns, seem to have appeared in the most favorable places sometime between 6000 and 5000 B.C. From that time on, it can be assumed that some of the inventions which made larger settlements possible were due to towns and cities themselves, writing and accountancy, bronze, the beginnings of science, a solar calendar, and bureaucracy. By 3000 B.C. when these innovations were all exercising an influence in Egypt, Mesopotamia, and India, there were in existance what may be called "true" cities.

Urbanization was so little in ancient times and it proceeded very slowly. The walls of ancient Babylon, for example, embraced an area of very roughly 3.2 square miles, and "Ur, with its canals, harbors, and temples, occupied some 220 acres; the walls of Erech encompassed an area of within 2 square miles. This suggests that the Jameus Ur could hardly have boosted more than 5,000 inhabitants and Erech hardly more than 25,000."

Less is known about the earliest Egyptian cities, for they were built with mud bricks and have long since disappeared beneath the alluvial soil. Tell el Amarna, the temporary capital built much later, about 1400 B.C., perhaps held something like 40,000 people. The wall of Hotep-Sanusert, an arbor capital built about 1900 B.C. on the Fayum, measured 350 by 400 meters, and enclosed an area of approximately one-twentieth of a square mile. Thebes, at the height of its splendor as the capital of Egypt about 1600, was described by Greek writers as having a circumference of 14 miles. By a liberal estimate it may have contained 222,000 inhabitants.

To the questions why even largest cities prior to 1000 B.C. were small by modern standards? Why even the small ones were relatively few, and why the degree of urbanization even in the most advanced regions was very slight? The answer seems as follows: 1) low agriculture productivity due to a low level of technology, so that many cultivators are required to support one man in the city, 2) the technology of transport was as labor-intensive as that of agriculture, 3) there were political limitations due to the difficulty of communications and

transport as well as the existence of multifarious local tribal cultures made the formation of large national units virtually impossible. The first urban-centered units were city-states, and when so-called "empires" were formed, as in Egypt, in Sumerian region, and later in Assyria, much local autonomy was left to the subordinated areas, and the constant danger of revolt prevented the exertion of the hinterlands of the cities very far or very effectively.

2. Subsequent City Development

The Greco-Roman world of Europe (600 B.C. to 400 A.D.) expanded urbanization with relatively higher rates. Iron tools and weapons, alphabetic writing, improved sailboats, cheap coinage, more democratic institutions, systematic colonization--all tended to increase production, stimulate trade, and expand the effective political unit. Towns and cities became more numerous the degree of urbanization became greater. A few cities reached a substantial size. Athens, at its peak in the fifth century B.C., achieved a population of between 120,000 and 180,000. The full potentialities of the ancient world to support a large city were realized only with the Romans. They were able to create Rome (with the possible exception of Constantinople some centuries later) the largest city that was to be known in the world until the rise of London in the nineteenth century. Yet despite the fact that Rome and Constantinople came to hold populations of several hundred thousands, they were not able to resist conquest by far less urbanized outsiders.

When finally towns and cities began to revive, they were small, as the following estimates suggest: Florence (1338), 90,000; Venice (1442), 190,000; Antwerp (sixteenth century), 200,000; London (1377), 30,000; Nurenbery (1450), 20,165; Frankfort (1440), 8,719.

In western Europe, starting at the zero point, the development of cities not only reached the stage that the ancient world had achieved but kept going on after that. It kept going on the basis of improvements in agriculture and transport, the opening of new lands and new trade routes, and above all, the rise in productive activity, first, in highly organized handicraft and eventually in a revolutionary new form of production--the factory run by machinery and fossil fuel. The transformation thus achieved in the nineteenth century was the true urban revolution, for it meant not only the rise of a few scattered towns and cities but the appearance of genuine urbanization, in the sense that a substantial portion of the population lived in towns and cities.

3. The World Trend from 1800 to 1950

Urbanization has, in fact, gone ahead much faster and reached proportions far greater during the past century and a half than at any previous time in the world history. The tremendous growth in world trade during this period has enabled the urban population to draw its substance from an even wider area.

The rapidity of urbanization in recent times can be seen by looking at the most urbanized country, England. In 1801, although London had already reached nearly the million mark (850,000), England

and Wales had less than 10 per cent of their population in cities of 100,000 or more. By 1901 this percentage increased to 35 per cent, and 58 per cent was living in cities of 20,000 or more. By 1951 these two proportions had risen to 38.4 and 69.3 per cent, respectively.

TABLE XII

PERCENTAGE OF WORLD'S POPULATION LIVING IN CITIES

	Cities of 20,000 or more	Cities of 100,000 or more
1800	2.4	1.7
1850	4.3	2.3
1900	9.2	5.5
1950	20.9	13.1

Britain was in the van of urban development. A degree of urbanization equal to that she attained in 1801 was not achieved by any other country until after 1850. Thereafter the British rate of urbanization began slowly to decline, whereas that of most other countries continued at a high level. From Table XII it can be seen that the proportion has tended to do a bit better than double itself each half century and that by 1950 the world as a whole was considerably more urbanized than Britain in 1800. Much of this increase has obviously come from rural-urban migration, clearly the most massive migration in modern times.

In 1800 there were apparently less than 50 cities with 100,000 or more inhabitants. This was less than the number in the million class today and less than the number of 100,000 plus cities currently found in many single countries. By 1950 there were close to 900 cities of 100,000 or more people which is more than the number of towns and cities of 5,000 or more in 1800.

As yet, there is no indication of a slackening of the rate of urbanization in the world as a whole. If the present rate should continue, more than a fourth of the earth's people will be living in cities of 100,000 or more in the year 2000, and more than half in the year 2050. For places of 20,000 or more, the proportions at the two dates would be something like 45 per cent and 90 per cent.

4. The Regional Pattern of Urbanization

The highest levels of urbanization are found today in northwestern Europe and in those new regions where northwestern Europeans have settled and extended their industrial civilization as it is clearly shown in Table XIII. Of the fifteen most urbanized countries in the world, all but one, Japan, are European in culture, and all but four derive that culture from the northwest and central part of Europe.

TABLE XIII

PERCENTAGE OF WORLD'S POPULATION LIVING IN CITIES BY REGIONS

Region	In Cities of 20,000 plus	In Cities of 100,000 plus
World	21	13
Oceania	47	41
North America (Canada, U.S.A.)	35	21
Europe (except U.S.S.R.)	35	21
South America	26	18
Middle America and Caribbean	21	12
Asia (except U.S.S.R.)	13	8
Africa	4	5
U.S.S.R	31	18

The rate of urbanization in the older industrial countries, however, is slowing down. During the twenty years from 1870 to 1890, Germany's proportion of large cities was more than doubled; it nearly doubled again from 1890 to 1910; but from 1910 to 1960 the increase was only 36 per cent. In Sweden the gain slowed down noticeably after 1920. In England and Wales the most rapid urbanization occurred between 1811 and 1851. Contrary to popular belief, the fastest rate in the U.S. occurred between 1861 and 1891. Since, as we noted earlier, there has been no slowing down of urbanization in the world as a whole, it must be that as the more established industrial countries have slackened, the less developed countries have exhibited a faster rate. In fact, such historical evidence as we have for underdeveloped areas, seems to show that their rates of urbanization have been rising in recent decades. This has been the case in Egypt, where the rate is higher after 1920 than before; in India, where the fastest urbanization has occurred since 1941; in Mexico, where the speed-up began in 1921; and in Greece, where the fastest period ran from 1900 to 1930. Asia, for example, had only 22 per cent of the world city population in 1900 but 34 per cent of it in 1950, and Africa had 1.5 per cent in 1900 but 3.2 per cent at the later date.

C. Urbanization and Social Change

We notice from the previous outline of the history of urbanization that at anytime any technical achievement was followed up by a chain of social change which finally contributed in one way or another

to urbanization expansion. Literacy is the soil in which know how and innovations grow. Illiterate societies are underdeveloped and less urbanized.

Developed countries are defined as those countries which have less than fifty per cent of their economically active males in agricultural pursuits, including hunting, fishing, and forestry; underdeveloped countries or the pre-industrial countries are those having fifty per cent or more of their gainful males working in agriculture.

1. Economic Development and Culture Change

Hilda Golden found that underdeveloped[21] countries are highly illiterate with the striking exception of those in Europe. This has been indicated in Table XIV. The correlation coefficient equals to .87 while, if we measure the degree of development by the per capita income, the coefficient equals to .84.

There are two groups of countries which deviate from the expected regression line by 20 per cent or more. The first group includes countries which are "more literate than industrial." Those countries are: Bulgaria, Columbia, Costa Rica, Ecuador, Finland, Panama, Philippines, Poland, Romania, and Thailand. The second group includes countries which are "less illiterate than industrial" among which are: Egypt, India, Indonesia, Iran, Iraq, Libya, Nepal, Union of South Africa.

TABLE XIV

PERCENTAGE OF ILLITERATES IN THE POPULATION AGED 10 YEARS AND OVER

	All Countries	Developed Countries	Underdeveloped Countries
World	47	6	70
North America	2	2	--
Oceania	8	3	20
Europe	11	1	88
U.S.S.R.	11	11	--
South America	42	17	51
Middle America	48	20	52
Asia	70	2	75
Africa	88	55	91

The growth in diffusion of literacy in pre-industrial countries is closely tied to the growth and diffusion of an urban-industrial civilization. In brief, the diffusion beyond a comparable point of economic development, or the retardation behind that point, derives from factors relating to national goals and the cost of achieving widespread literacy and education. In Bulgaria prior to independence, for example, wealthy people considered it their duty to open and maintain schools despite the opposition of the Turkish State; on the contrary the elite of the Arab states of the Ottoman Empire showed no such interest.

The modernization of peasant-agricultural countries is usually conceived of as a moving equilibrium in which no one element can for long be out of line with the others because they are functionally interdependent. On this basis we would expect that countries in which educational retardation was considerable and has lasted for some time would now make relatively greater headway educationally than economically.

In the nineteenth century Egypt's economic development, though spasmodic, took place faster than educational change. During the first three decades of this century both industrial and educational advances were slight. Since about 1930, educational progress has been faster than economic development, despite the fact than during the period of World War II economic change was rapid. Egypt seems to have entered the phase in which for some time educational advance will remain faster than economic development which may turn later into equal rates of economic and educational development. Of course, there is a drastic change that has taken place since 1954 which will be covered later.

Table XV shows the diffusion of some countries from their expected regression line.

It should be clear that urban-industrial civilization depends on educational achievement. We may find as in the case of Egypt when educational growth was faster than economic growth, urbanization was taking place but it was only a demographic urbanization and by no way can we apply the structural and behavioral definitions of urbanization to our case. If, as I proposed in Chapter I, we can narrow our demographic definition by some restricting elements as degree of literacy and level of per capita income, we can have another and a true picture of urbanization in Egypt.

TABLE XV

PER CENT ILLITERATES IN POPULATION AGED 10 YEARS OR MORE

	Actual	Estimated	Actual-Estimated
India			
1911	93	64	29
1921	92	65	27
1931	91	64	27
1941	85	67	18
1951	80	61	19
Egypt			
1907	93	67	26
1917	91	62	29
1927	86	56	30
1937	85	61	24
1947	75	51	24
1960	56	40	16
U.S.S.R.			
1926	49	80	-31
1939	19	39	-20
Brazil			
1940	57	61	- 4
1950	52	52	0
U.S.A.			
1870	20	37	-17
1910	7	5	- 2

2. Urbanization and Agricultral Density

From the last paragraphs we found that when literacy spreads, economic development is stimulated in a fashion of a moving equilibrium point so as to close the gap between them when one moves with a faster rate than the other. Literacy in itself, working solely or together with economic development, stimulates also a migration movement from rural to urban areas. Literacy usually changes the status and behavior

which reject the rural life leading people of the new class to move to urban areas and not come back anymore.

Not only the status and behavioral change stimulated from a spread of literacy of education makes a shift from rural to urban migration, but also this shift is a matter of efficiency which increases when technology increases and a surplus of labor is accumulated which diminishes the return of land if this accumulation continues.

Kingesley proved that there is no relation existing between the degree of urbanization and the average density of population. But there is a negative relationship between urbanization and what we call agricultural density which is defined as the number of gainful males occupied with agriculture, hunting, and forestry per square mile of cultivated land. Table XVI explains proof of this fact.

TABLE XVI

RELATION BETWEEN DEGREE OF URBANIZATION AND AGRICULTURAL DENSITY

Percent of Population in Cities of 100,000 plus	Agricultural Males/sq mile
0 - 9.9	136
10 - 19.9	72
20 - 29.9	67
30 and up	13

It is also true that farmer population may diminish not only as a proportion of the total population, but also in absolute terms as it has happened in the United States and several other industrial

countries in recent decades. This actually happens when profits or wages from industry are higher than from agriculture so that farmers who have to keep their living standards matched with those who moved to urban areas to increase their cultivated land.

D. Urbanization and the Development of Pre-Industrial Areas

Three-fourths of the world's population lives in the pre-industrial countries. Although these countries are mainly rural, they are all urbanized to some degree because of the commercial impact of the industrial nations. Consequently, we find that the pre-industrial countries contain as many cities as do the industrial countries as in Table XVII.

TABLE XVII

DISTRIBUTION OF WORLD'S LARGE CITIES AND CITY POPULATION BY DEGREE OF AGRICULTURALISM OF COUNTRIES (1950)

% of Active Males in Agriculture	No. of Countries	No. of Cities	% of all Cities	Pop. in Cities (000's)	% of Total City Population
0 - 29	22	286	31.9	101,438	32.2
30 - 49	14	148	16.5	53,721	17.1
50 - 69	33	257	32.0	97,429	30.9
70 - plus	86	176	19.6	62,478	19.8
Total	155	867	100.0	315,067	100.0

We have seen before that there is a positive correlation between urbanization and industrialization and the negative association between urbanization and agricultural density.

In 1800 the population in large cities was distributed over the earth in much the same fashion as the general population. When shifts in technological advances happened, this was followed by simultaneous shifts from agricultural to industrial activities. Also, industry itself was affected by those technological changes which opened the way for its development and spread. This was also followed by an increase of degree of urbanization, which led to widening of the gap between advanced and unadvanced countries due to the time required for the geographical cross-cultural spread of radically new type of equipments and social organizations.

In advanced countries, as the proportion of the population living in cities becomes greater and greater, the chance of maintaining the rate of increase in that proportion becomes less and less. Furthermore, we know that the growth of cities has been mainly a result of rural-urban migration, which has contributed in times, far more to urban numbers than the natural increase in cities could ever contribute. As the rural proportion declines to a small fraction of the total population, the cities have an ever smaller pool of people to draw on for the maintenance of growth rates. In the same time the rate of urbanization has been increasing in most underdeveloped regions. There is, thus, going on today a balancing of accounts throughout the world. As a result the next fifty or one-hundred years may find the city population once again distributed roughly in proportion to the world's total population.

There are few (out-of-the-way) places as Saudi Arabia, Yemen, and some African territories who have urban expansion failure to make much headway. These countries are few in number and population. As a group, pre-industrial countries have 7 per cent of their population in cities of 100,000 or more, and 11 per cent in 20,000 (1950). The general picture is, therefore, one of fast urbanization comparable to that experienced at earlier periods in the new industrialized nations.

Pre-industrial countries are not all alike. Some are more urbanized than others because of differences in demography, economy, and society. It therefore, becomes instructive to consider particular countries which present types of cases, types that may re-occur in various underdeveloped countries but are not found everywhere within the pre-industrial category.

1. The Case of India

Other than the direct results noticed in Table XVIII, we may say that there is some tendency for urbanization to run ahead of other aspects of development, but not noticeably except with respect to

TABLE XVIII

INDIA'S RELATIVE POSITION ON SELECTED INDICES

	% of World's Pop. in Countries Ahead of India	% of Countries Ahead of India
Non-agriculture employment	51	43
Agricultural density	57	69
Urbanization	59	51
Literacy	92	68
Per Capita Income	57	73

educational development. The per cent of India's population living in large cities is about the same as that of the United States in 1855. But urbanization is proceeding somewhat more slowly in India than in the United States at that time, and it went much more slowly in the early periods. From the year 1820 to 1860 in the United States, the average gain per decade in proportion of living in large cities was 63 per cent, while in India it was 22 per cent from 1891 to 1951, in spite of the fact that progress can be faster the more recently it occurs. This is not proving to be true in India, at least so far as urbanization is concerned. In 1891, India was about 55 years behind the U.S., by 1931 she was over 90 years behind. After 1931, however, India's rate of urbanization increased remarkably, almost equaling the U.S. gain at similar levels. How long she will continue to do so is hard to say, and if she does continue, it may be a coincidence of "over-urbanization" such as seems to occur occasionally in other densely populated agrarian countries. This possibility is suggested by the apparently static character of India's occupational structure for the proportion of occupied males in agriculture has shown virtually no sign of change for several decades.

2. Revolutionary New Urbanization in Africa

In cases such as in India, Egypt, Korea, and Greece we are confronted with countries that have long experienced the phenomenon of cities and which have old and complex civilizations. In central and west Africa, on the other hand, we find ourselves in a totally different

kind of underdeveloped region--one in which primitive tribal life, completely rural in character, has been the dominant mode of existence until very recently. It is still a region of unlettered rurality, its people getting their subsistance mainly by hoe agriculture, by herding, or by hunting and fishing.

Yet, into this still heavily primitive region is now being thrust an extremely rapid and patently modern city development. The urbanization that is rapidly taking place is not the urbanization of the late medieval period in Europe, not the urbanization of the 18th century and 19th century; it is rather the urbanization of the 20th century. This sudden juxtaposition of 20th century cities and extremely primitive cultures gives rise in some respect to a cheaper rural-urban contrast than can be found anywhere else in the world. Table XIX shows the unbelievable rates of growth of many rising cities in these areas.

Most of these areas have been opened to European economic penetration only since World War I, and the area has more virtually unexploited primary resources than any other major area of the world. Both agricultural and mineral products commanded high prices during the war, so that it was worthwhile to expand their exploitation with modern scientific techniques at the most rapid pace possible.

There was a flight of private and public capital from the politically insecure countries of Europe to the potentially rich colonies of Africa.

What will be the result of this process of rapid and revolutionary urbanization in central and west Africa? On the whole, the

TABLE XIX

POPULATION OF SOME MIDDLE AFRICAN CITIES

	Population (in 000's)		
	1930	1940	1950
Abidjan	22		162
Accra	70		136
Braggaville		25	83
Dabar		165	209
Elisabethville			101
Kane	89		102
Lagos	126		230
Leopoldville	34		211
Luanda		67	159
Nombasa		57	85
Nairobi		65	119

prospect for complete and early male migration would seem better than in India and Egypt, because the area possesses huge potential resources and a relatively sparse population. The rest of the world, crowded and hungry for industrial raw materials, needs these resources. Thus, there is every indication that, barring a world catastrophe, the demand for Africa's primary products will increase and that the region will continue its fast pace of city building. The efficiencies created by wholesale importation of urban and industrial technology will probably provide an adequate economic base for a quick transition to modern conditions. Doubtless, as the tribal peoples recover from the initial shock of quick and massive contact with twentieth-century culture, their natural increase will be great and populations will grow for a while, but the urbanization process may be so rapid that before overwhelmingly dense rural populations are built up, fertility will start

declining again and the natural increase will be lowered to manageable proportions. In other words, there is a chance for urbanization to acquire an early predominance as it has done in prosperous new areas such as Australia or Argentina rather than be bogged down in a swamp of densely settled peasant-agriculturalism as in most of Asia.

3. Case of Egypt: An Over-Urbanized Country (Up to 1950)

If we represent the relationship between urbanization, and degree of non-agriculturalism, by a regression curve, certain countries are found to be off the line to a significant extent. One of these is Egypt, which has far more urbanization than its degree of economic development would lead us to expect. In this sense, Egypt is "over-urbanized." This case is also found in certain underdeveloped areas (notably Greece and Korea, and probably Lebanon). How far out of line Egypt is, can be seen from the following figures in Table XX.

TABLE XX

URBANIZATION IN EGYPT AS COMPARED BY SOME OTHER DEVELOPED COUNTRIES

	Percent of Population in Cities	
	100,000 plus	20,000 plus
Switzerland - 1950	20.6	31.2
Egypt - 1947	19.3	28.5
Sweden - 1945	17.4	29.2
France - 1946	16.6	31.9
Egypt - 1960	27.4	36.8

There is no doubt that Egypt was not industralized as well as or by no means approached the three other countries. Yet, she is

nearly as urbanized as Switzerland and is more urbanized on the 100,000+ level than Sweden or France. This case is not of recent origin, but has characterized the country for at least forty years as Table XXI shows.

TABLE XXI

EXPECTED AND ACTUAL URBANIZATION IN EGYPT 1907-1960

	Per Cent of Occupied Males in Non-Agricultural Activities	Per Cent of Population in Cities 100,000 plus	
		Expected	Actual
1907	27	6.6	8.7
1917	30	7.9	9.7
1927	34	9.7	12.2
1937	31	8.4	13.3
1947	38	11.4	19.3
1960	44	16.2	27.4

In fact, Egypt's cultivated rural area is to an extraordinary degree densely settled and impoverished. The density is a product of rapid population growth for a century and a half and the inability of the economy to expand its non-agricultural sector proportionally.(22) The poverty is due to the same factors plus the familiar pattern of tenancy associated with large landholdings where absentee owners live in the cities or live outside the nation. The city gathers to itself practically everybody who does not actually have to work the land to get a living. On the basis of the 1947 census, it has been estimated that only 10 per cent of the occupied males living in rural places, are engaged in non-agricultural pursuits. The data indicate, that about 92 per cent of women aged 15 and over in Cairo and Alexandria are economically inactive.

Such facts show that the densely settled and impoverished countryside in Egypt is pushing people into the cities because they have no other alternative. When they get into the cities, it is perhaps harder for the government to let them starve, and may run some chance of picking up some crumbs from the wealthy who inhabit only the cities. Issawi has presented evidence showing a sharp decline in the per capita consumption of staple items in Egypt from 1920 to 1937. Much of the migration to the cities seems, therefore, to be a refugee migration to the country side where increased population, diminished size of holdings, and absentee landlord exactions have gradually squeezed out families by the thousands.

Our case of over-urbanization gives also significance by virtue of the fact that some other underdeveloped countries exhibit the same phenomenon. T. O. Wilkinson, working in the comparative urban research program at Columbia University, has shown that Korea after Japanese occupation in 1916, had its economic development lag far behind urbanization.(23)

A similar tendency toward over-urbanization seems to have occurred in Greece and may occur in the future in India and some other underdeveloped areas.

Davis, K. and Golden wrote from the standpoint of future economic growth "...those considerations standout. First, over-urbanization surely has its limits. It is possible for city growth to get ahead of general modernization, but not very far ahead for very long. If there is economic stagnation, urban growth itself must ultimately close. In Egypt

we can expect, then, that either the rate of urbanization will fall off sharply or industrialization will gain a new impetus. Second, over-urbanization may have some effect in stimulating economic growth. Insofar as the city represents an efficient locale for non-agricultural production (as we believe it does), the accumulation of people in cities represents at least a potential setting for enhanced output. Also, in the process of modernizing agricultures, the more people who can be moved off the land, the better. Third, it is primarily in the cities that the leadership and the mobile following for revolutionary activities are to be found. Over-urbanization, as we have analyzed it, is well calculated to provoke the maximum discontent in the population. Faced with idle, impoverished, and rootless urban masses, the government is forced to take drastic action or to allow itself to be displaced by a new revolutionary group. Since economic development is often hindered by out moded institutional and political arrangements, the rate of urbanization in fostering revolutionary activities (whether communist or not) can be said to be potentially favorable to change.* It should be emphasized, however, that we are speaking of potentialities. Whether or not these potentialities are in fact realized depends on other factors in the situation. Urbanization, and particularly over-urbanization is only one of several major variables in industrial change, and so it is wise to avoid the appearance of determinism with reference to its role."

Comments on this analysis will be carried on through the following discussion.

*It has been shown for example, that communist revolutions are largely implemented by the urban intellectual leadership and not by discontented peasants. The urban leadership is needed to mobilize and direct the revolutionary energy which peasant discontent supplies.(24)

E. Classification of Urban Areas in Egypt

In looking for the future of urbanization in Egypt, we shall be mistaken if we generalize the concept of over-urbanization to all urbanized areas in the country. Some urbanized areas in Egypt, in most of their main parts, can compete with the western standards in the degree of modernization and living, at the same time, most of the urbanized areas, as it was mentioned before, lost their roots of urbanism. I think it will be more healthy if we try to put our fingers on the weak points which are waiting for some solutions, and the other prosperous areas which may be the nucleus for most of the new population and activity shifts to build up and parallel with the new phenomena of the twentieth century of the creation of the great metropolis. Of course, this is a tough assignment especially when statistical information is lacking. What is needed here is something relating the urban areas with their activities and income.

1. Rank Size Distribution

Using the 1960 census of population of Egypt, we can rank the agglomeration of the Egyptian population according to the size of each settlement in rank size classes according to their population. Table XXII together with Table I in Appendix B indicates the results of this process.

Figure 30 shows the rank size distribution of cities and towns as well as small villages when plotted on a log-log paper; population is indicated on the vertical axis and the rank of the city on the horizontal.

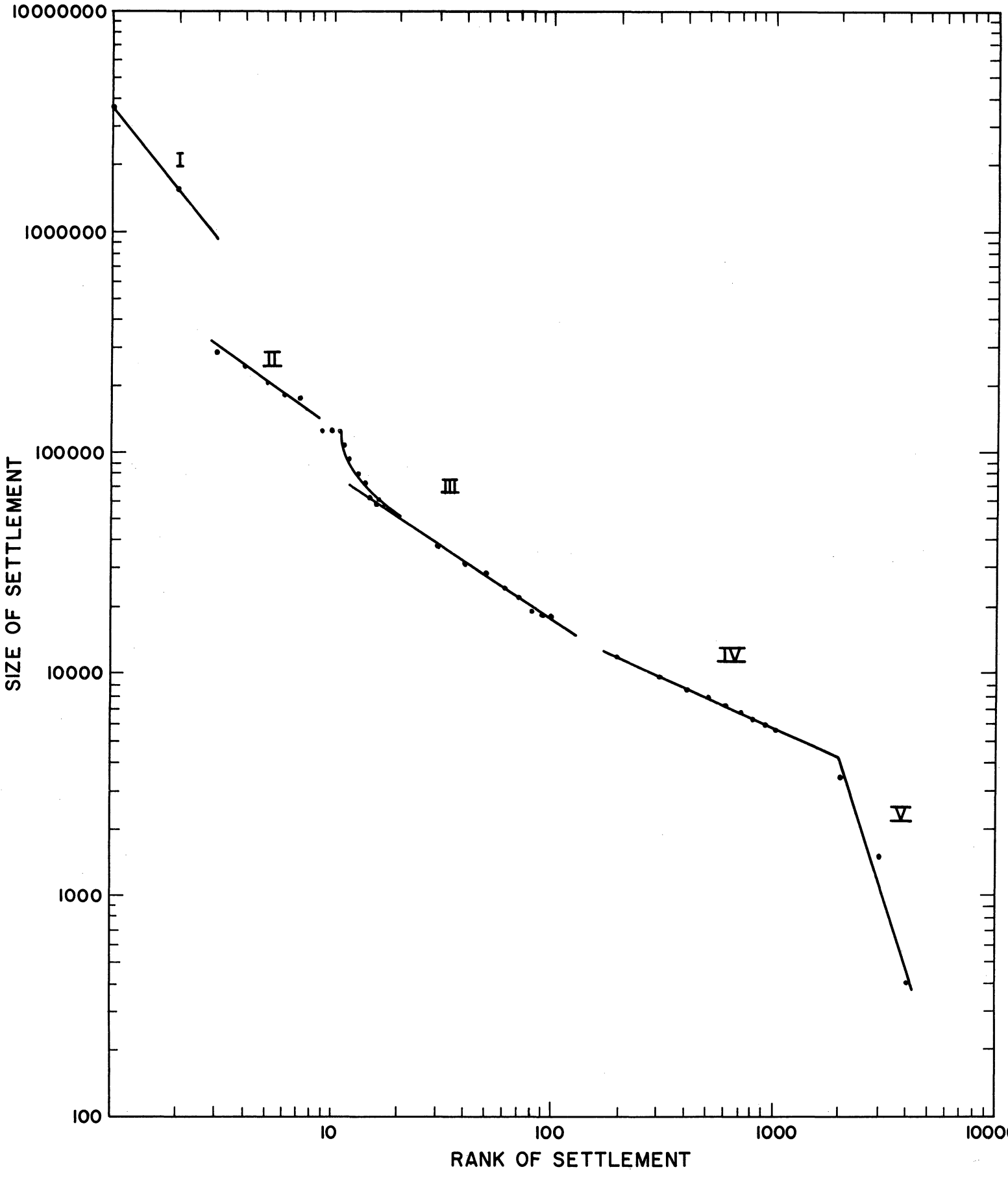


Figure 30. Rank Size Distribution in Egypt.

TABLE XXII*

RANK SIZE DISTRIBUTION OF POPULATION SETTLEMENTS
IN EGYPT (1960) CENSUS

Class	From: / To:	0 / 1000	1001 / 2500	2501 / 5000	5,001 / 10,000	10,001 / 20,000	20,001 / 50,000	50,001 / 100,000
Population (000)s		239	2107	4925	6291	2,708	1,889	522
Per Cent of Total Population		0.9	8.2	19.1	24.5	10.5	7.3	2.1
Number of Settlements		378	1194	1358	922	210	65	8
Average Population/Settlement		631	1765	3765	6833	12,894	29,058	65,267

Class	From: / To:	100,001 / 250,000	250,001 / 500,000	500,001 / 1,000,000	1,000,001 / 2,500,000	More than 2,500,000
Population (000)s		1,642	835	--	1,516,234	3,348,779**
Per Cent of Total Population		6.4	2.1	--	5.9	13.0
Number of Settlements		10	2	--	1	1
Average Population/Settlement		164,646	267,325	--	1,516,234	3,348,779

*Source: 1960 Census of Population.

**This is the population of the city of Cairo and not its M.P.A. which reaches up to 3,848,033 including Border: El-Giza (1), El-Giza (2), Imbaba and Shoubra El-Khima as well as Kism El-Ahram.

This figure indicates that there are four or five types of population in Egypt. The first is that which lives in Cairo and Alexandria, the two great metropolis of Egypt, and could be distinguished by Part I in Figure 30. This population is completely urbanized and they maintain almost the highest level of living standards in Egypt. The second group of people is identified by the upper section of Part II which include some relatively large cities which have a great potentiality of becoming great metropolis, that can fill the gap between Parts I and II in a long period of time. Part III of the figure indicates a mixed population approaching complete urbanization at the upper part and a great deal of ruler population in the lower part. The upper part of Part III indicates also that the cities included in that portion are trying vigorously to divert from the traditional trend which is signified by the straight line trend of the lower portion.

Part IV of the figure includes a great portion of the Egyptian population which inhabits large rural towns living under a great pressure to move outwards to large cities. Part V includes the rural villages ranging from an average of 600 to 4,000 inhabitants.

2. Administrative Classification of Regions in Egypt

Administrative classification of the Egyptian regions could be summarized as follows:

a. The "Governorates."

Egypt is divided into twenty-five political and administrative areas called "Governorates" which are similar to the "States" in the U.S.A.

Each has an appointed Governor which has special political leadership. He holds some local administrative and planning powers but not as complete as in the case of U.S.A.

Five of these governorates are the only major cities of Egypt: namely, Cairo, Alexandria, Port Said, Ismailia and Suez. They are truely urban areas and their total population is 5,598,056.

In the last census of 1960 the Governorates of Red Sea, New Valley, Matrouh and Sinai were considered urban although they include many areas which could be safely considered as rural. These four governorates are the east and west borders of the country and their population is only 212,606.

The Delta of the Nile includes eight governorates which are inhabited by 10,932,361 persons, 20 per cent of which are urbanized. The governorates of the Delta are large and the people are more cultured than are the people of Upper Egypt. The mid-south of the Delta is more prosperous and people are more educated, but when we go north, east or west, income and culture reduces with distances.(25)

Upper Egypt includes also eight governorates which are inhabited by 9,260,878 people; about 20 per cent of them are urbanized.

The first five mentioned governorates are truly urbanized. Although they include only 21.5 per cent of the countries population they have about 70 per cent of the industrial establishments of more than five persons in each establishment. Table XXIII indicates the distribution of industry among these five cities and the rest of the country.

TABLE XXIII

DISTRIBUTION OF INDUSTRY BETWEEN THE URBANIZED GOVERNORATES AND THE REST OF THE COUNTRY(26)

Governorates	Population	Numbers of Establishments of 5-9 Persons	10-49 Persons	50-100 Persons	200 Persons	Total
Cairo	3,348,779	816	1,233	245	93	2,387
Alexandria	1,516,234	251	411	114	99	875
Port Said	245,318	34	22	10	6	72
Ismailia	284,115	11	13	4	1	29
Suez	203,610	7	23	-	4	34
Total	5,598,056	1,119	1,702	373	203	3,397
Total as % of Country	21.5%	72%	76%	61%	60%	70%

(26) Source: "Dalile El-Sinaat", Industrial Index; Ministry of Industry, June, 1963.

For establishments of more than 200 persons, the five governorates contain 59% of these establishments, only about 50% of the number of workers and 44% of the total investment.

Table II, Appendix B shows the distribution of economic activity in each governorate as well as the degree of literacy. It could be easily identified from this table that Cairo, Alexandria and Port Said are leading in the degree of literacy. Except in Cairo, Alexandria, Port Said, El-Suez, Red Sea and Sinai, agriculture is the leading economic activity within the governorate's population. Because of their location El-Giza as well as El-Kaliobia (the newest governorates to Cairo), Dimiatta (on the Mediteranean), and Aswan (the southern border governorate) have the least proportions of agriculture activities among other governorates excluding the exceptional ones. Only one governorate, Alexandria, had manufacturing as a leading economic activity. In general, with exclusion of agriculture activity, services are the highest economic activity for most of the governorates; its degree increases with literacy and degree of urbanization.

Cairo and Alexandria are the two largest industrial centers in Egypt. There are several reasons for the concentration of industry in these two major cities which, according to the 1960 general census of population, have between them 20% of the country's total population.

First of all, as large urban centers, Cairo and Alexandria have a higher concentration of effective demand than elsewhere in Egypt, and at the same time they provide the human resources needed for industry as the skilled technicians and professionals such as the

scientists, consultants, administrators, engineers, entrepreneurs, accountants, clerks, other office workers, and the industrial labor force.

With respect to industrial workers, both cities offer a more dependable and more flexible supply of workers than do other parts of the country and especially more than the rural areas. Continuous migrations of workers from adjacent and far away provinces in both Lower and Upper Egypt to Cairo and Alexandria keep feeding the labor market. Moreover, as the rate of literacy in the two cities is significantly higher than in the rest of Egypt, the supply of skilled and semiskilled labor is more elastic and the workers more economical to train for industrial operations.

At the time of the introduction of modern industrial development in Egypt, both Cairo and Alexandria were focal points for the railway system. Moreover, Cairo was an important inland Nile port, the pivotal point between Upper and Lower Egypt. As the largest and best equipped seaport in the country, Alexandria commanded for centuries, a position as one of the world's dominant commercial cities,(27) and as such, was the center of the imported equipment needed for industry in Egypt on the one hand, and for the export of agricultural and finished products, such as cotton, rice, onion, cotton yarn, textiles, leather, and cigarettes on the other. Also, certain industries appear to flourish particularly in Alexandria. These industries include the extraction of salt (from Lake Mariout), cotton pressing (near the shipping quay) and leather tanning (near the slaughter-house).

While both Cairo and Alexandria were known to have the heavy concentration of skilled workers necessary for industries, in some ways Alexandria showed advantages even over Cairo. Part of this may be attributed to the opportunities Alexandrian workers had for learning their trade as apprentices under the supervision of foreigners. Alexandrian workers enjoy relatively high wages, which may have contributed to the migration of skilled workers from different parts of Egypt.(27)

Looking eastward, we find a chain of modern cities which owe their modernization to the construction of the Suez Canal. The Canal business was very properous and in turn it reflected its prosperity on those urbanized areas built up by the imaginary high income groups of Europeans who settled there. All but a negligible fraction of the high salary workers and employees of the Suez Canal Company were foreigners, while the trivial jobs were given to Egyptians, a matter which created a high contrast between the standard of living of the two groups living in the same urban area. It was natural, therefore, to hear about the "European District" which had been ultra-modernized surrounded by the "People's Districts" or the slums. Anyhow, the Suez Canal offered many job opportunities for natives who were better off than the "fallahine" in the rural areas.

Port-Said and Suez became two main ports offering other opportunities for minor maintenance and repairs for passing ships, also they providedships with water and food supplies as well as some trades with passengers.

Ismailia is the administrative city for the Suez Canal Company; it is in the midway between Port-Said to the north and Suez to the south. Also, it has a better connection with the Nile Delta through the navigable Ismailia Canal to the north of Cairo.

The three cities are connected with Cairo and other parts of the Delta by railroads and good highways.

b. The "Bander"

This category of administrative classification indicates the central urban cities for agricultural areas. Consequently they contain all the capitals of the governorates and all industrial cities or centers. Table III in Appendix B shows the distribution of economic activities among the populations of these cities as well as their degree of literacy. According to that table, there are 23 "Banders" in the Nile Valley area inhabited by 1,950,593. The labor force is about 26% of the total population, 6.3% are engaged in agriculture, 22.0% in manufacture, 44.0% in services and 27.7% in other economic activities. These cities have relatively fair degree of literacy with the exception of those which hold the highest percentages in agricultural and manufacturing activities. Only one city has a university and two others are on their way of building up universities, but most of them have technical institutes. These cities also provide the best high schools of each governorates.

Since most of these cities are administrative cities, service activities are extremly high, higher than any other activities with the exception of Dimiatta, El-Mahalla, El-Kobra and Shoubra El-Khima where manufacturing is leading all other economic activities

The most characterized two cities are Aswan and Dimiatta. Both have their location as well as other potentialities which make us believe that they will grow too fast. It became a fact now that Aswan will be one of the cities of the future. The High Dam as well as its location near the southern borders and the presence of some natural resources lead us to that conclusion. Also because of the politics which it was and still is involved in. According to the 1960 census there were about 13,400 workers in that city involved in non-agriculture activities. In May, 1964 more than 30,000 workers were engaged in the construction of the first stage of the Aswan High Dam. Plans are now prepared by international experts to create a highly industrialized region in Aswan to consume the laborers of the High Dam after its completion. Dimiatta has the potentialities of its location and the many skills among its population especially furniture industry.

In general most of these cities (Banders) are not providing a respectable standard of living and they were almost neglected before the Revolution and its following years up until the creation of the local administrative powers in 1960. These cities have a good chance of modernization and growth; if they are given an economic base and their population growth can be limited.

c. The "Markaz"

Each governorate in Egypt has been divided into a number of counties called "Markaz". The central town or city of each county is also called a "Markaz" which means a center. Usually these cities have population ranging from 5,000 to 20,000 and their functions are:

educational centers, commercial centers where the crops (mainly cotton) are collected and ginned, then sent to other manufacturing process in a "Bander". They are also financial centers for agriculture purposes, and lastly they serve as administrative centers.

These types of cities are growing too fast on a loose economic base of growth. Their population line is a mixture of urban and mostly rural way of life, and the standard of living is too low.

d. Others

The last and the most important group is that which include the large villages of purely rural areas. These cities are numerous and their populations range from 2,500 to 20,000 persons each. Most of the people are agrarian workers or small land owners or even jobless people. This group with some parts of the second and third groups are responsible for the "over-urbanization" and over-population of Egypt.

F. Forces Governing Urbanization in the Future

As Davis, K. and Golden mentioned before, "Forced with idle impoverished, and rootless urban masses, the government is forced to take drastic action or to allow itself to be displaced by a new revolutionary group (whether communist or not)."

Thanks for the new nationalist -socialist revolutionary group who saved our necks, we began a new hopeful era starting from 1952.

In 1955, "The High Council of National Production" was set up. Its purpose was the planning for the social and economic development. In general, the primary aim of national planning is to insure

the welfare of the people by raising their standard of living. This aim is attained by social and economic development, co-ordination of efforts in the public and private sectors and social institution, and by constructive, analytical and statistical research. These researches are of two categories. The first one is concerned with the static or natural elements, such as the volume of the population and their subdivision according to age and sex; the raw materials, natural resources, and other consumption resources; the second one is concerned with the organization and orientation of efforts to utilize these elements wherever needed.

The volume and distribution of population is a principle factor in the organization and planning tasks. The realization of a sound system of a nation is: welfare cannot be attained unless social and economic development progresses at the same pace as the increase of population in order that the standard of living be raised parallel to other changes which leads us to the roots of true urbanization and modernization.

Although material production was continually increasing, yet the productive capacity was not keeping pace with the increase of population, and consequently, the per capita income dropped by 7% during the seven years which preceded the Revolution.(28) Naturally this drop led to the decline of the standard of living. The increase of population affects the national economy in two ways. First, the increase of consumption demand of products and commodities; second, the increase of the productive capacity of manpower. If this increased

capacity is properly invested, the increase of population will become a factor of development of the social welfare, instead of becoming a menace to the national economy, so long as proper planning takes into consideration the prospective increase of population and their classification according to age and sex.

In order to build up our "model" of "style" to study the forces acting to direct the future trends of urbanization in Egypt., three assumptions seem to be relevant in this stage.

The first assumption is that the Egyptian national goal (peoples and government), is the general welfare of the entire population through economic efficiency and equity. In fact, the discussion of this assumption is very difficult because it is very obvious. At least, I can refer to the "New York Times", Jan. 25, 1965, which may throw some light on the degree of progress achieved during the last 13 years. Yet, it may be preferable to use some statistical information to sketch quickly the change of Egypt's picture since 1952, which is a reflection of the people's goals, although the data are not complete and are not 100% reliable.(29)

1. Education

Although education moved sharply at a faster rate since 1930, as was mentioned before, than economic development did, we find that since 1954 extremely faster rates of education and culture changes have been pushed out by the government. It was the nation's desire that free and compulsory education must be put in effect. Primary education increased from one million and a half students in 1952 to two million and a half in 1960, i.e., 8.5%/yr. while population increase was 2.5%/yr.

Technical education increased from 25,023 to 199,663, college education from 35,500 to 87,000 between 1952 and 1960. During the 10 years beginning from 1942 to 1952 only 55 primary schools were built, while between 1952 and 1960, 1,308 modern schools were built even though their capacity was 77.10% of that needed for compulsory education. This percentage of those who are eligible for compulsory education and can enroll in schools will be raised up to 87.30% in 1964-1965, and 100% in 1969-1970.

Some efforts also were put to increase literacy among adults who have not the chance to enroll in schools. This has been done through education for the "Armed Forces", night schools and semi-official associations for laborers and farmers.

Rapid culture change, other than education, has been widely spread through the tremendous influence of the newspapers, broadcasting stations, television, and the huge amount of new books published (edited or translated).

It seems to me that education and culture change will play one of the main roles in the future mechanisms of urbanization.

2. Public Health

Table XXIV can give an idea about the progress in one part of the public health sector. Consequently, the death rates decreased from 25 per thousand persons to 20, which had its effect on raising up the population growth.

The growth of services in this sector is expected to grow faster due to many reasons.

TABLE XXIV

INCREASE IN HEALTH SERVICES 1952/60

	1952	1960
Number of Hospitals	90	150
Number of Beds	6,147	10,278
Number of Outpatients	5,250,000	12,000,000
Number of Patients Using Beds	133,000	256,000

3. Production Sectors

National Income was about 1300 million Egyptian pounds i.e., 52 L.E. per capita in 1960, compared with 39 L.E. per capita in 1952. Industrial increase can be seen from Table XXV (agriculture production is not available).

TABLE XXV

INCREASE IN INDUSTRIAL PRODUCTION 1952/60

Production	Value of Output in Millions 1952	1960
Extraction (minerals)	266 L.E.	552 L.E.
Extraction (others)	4	8
Petroleum	34	66
Electric Power	10	30
Total Production	314 L.E.	656 L.E.

In other sectors where revolutionary actions were taken for the sake of equal opportunities and public welfare, it is needless to calculate the advantages of the "land reform" laws in 1952, nationalization

of major industrial, financial and commercial establishments in 1956 and 1957; and finally, the social laws in 1960 for progressive tax reform, minimum wage rates, labor, share of profits by 25%, and further nationalization of some sectors.

The second assumption is that decentralization of industry and other activities will take place in Egypt. In any society, the central government's machinery should not be impeded with the considerations of details at the time when it should concentrate its effort on more important duties such as planning, elaborating programs and following up their progress. The more efficient local authorities become, the lighter the responsibilities of the central authority will be, and thus will be able to proceed with realization of its major objectives.

Complete centralization of all authoritative, political, industrial business, and all other sectors, with Cairo as the domaining center has been practiced. Between 1959 and 1962 there was a vast change in most of the sectors and the idea of decentralization has been put in effect. A law of "formation of the councils of local administration" has been established and was put in effect since then for the first time in our modern history. The law has conferred on the councils of the local administration, certain perogatives in education, municipal, health, social, supply communications, cultural, economical, financial, legislative, and security affairs. Of course, the law put some limitations on their power. It is a long way to discuss the law and its effects, but one thing which is worth mentioning is that the governors of the governorates, cities, and towns were selected from a

revolutionary group and technicians. Those governors by their motives created in their areas the resistability for central authorities and the insistance for the local authoritative rights.

The third assumption is that Egypt will continue to be a non-aligned country, looking towards better relations with all countries, the policy which is very fruitful for its own economy. Also, I assume that Egypt is continuing to push Arab nationalism and Arab unity towards reality. In the same time Pan Africanism or at least a co-ordinated economic policy between African nations should be emphasized.

The three above assumptions, as we shall mention in the following discussion can play a main part in changing the factors which seem to affect future urbanization in Egypt. There are two types of forces; those which are accelerating the outward movement of the population, it is meant by outward movement, the movement towards the boundaries of Egypt or the movement off the "Nile Valley". By the people, I mean those who are living in the valley exclusive of those on the sea shores and Cairo. The second type of forces are working as magnetic forces pulling the people inwards to the valley or working as barriers for people to move outwards.

G. Pressures for Outward Shifts

1. Education and Culture Change

Before, we have seen the close relation between culture change and economic development, which in terms correlates the degree of urbanization and modernization. Education, training, and culture change

will motivate drastically the outward movement; those three elements when exercised in most of the pre-industrial communities can result in feeding these communities by more and more information leading to status and technological changes. In communities like that, educated children, as they grow, feel their superiority on the illiterate people whom, in most areas, can be their own family members who had not the chance of education. Usually, high schools are not provided in the group "D" of cities of rural areas.* A large percentage of the students graduating from primary schools enroll for high schools in superior towns or cities, county centers or governorate capitals which are better off than their own towns. There, by their contact with better modernized life, the behavior will gradually change and become really urbanized especially when they continue their education career through college in Cairo or Alexandria. Their new status will push them outwards from their own towns even if they do not have work to do. For sure, their first choice will be the Group A cities, the most modernized cities, assuming the same work opportunities in all cities of all groups. If better opportunities were provided some of them in lower hierarchy cities then their settlement will be a cause for some of the original residents to move outwards.

Technological changes by training or technical education will lead to high efficiencies in the agriculture sector which means that lower agriculture labor force will be needed for the same cultivated area, and in turn will create idleness or a cumulated surplus of workers pushing them outwards searching for inferior work or new potential agriculture area.

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* See page 141

In urbanized areas technological change will lead also to higher efficiencies causing lower demand for labor force, as is the case of our railways when diselization of all tractive units was completed, a surplus of workers working by steam units was created. Even through technological changes may lead to a greater total demand of labor forces in the industrial sector by a horizontal increase of industry when using superior materials for new industry, but on the other hand, it leads to more automation, the enemy of labor unions, creating this surplus.

2. The Rate of Growth of Population in Egypt

According to the official census, increase in population was as shown in Table XXVI.

TABLE XXVI

POPULATION GROWTH RATES

Year:	1927	1937	1947	1960
No. of People	12,147,169	13,813,120	16,381,950	26,059,000
Average rate of growth/year		1.4%	1.93%	2.8%

Minimum and maximum official estimates for future population are shown in the following Table XXVII.

TABLE XXVII

OFFICIAL POPULATION PROJECTION

Year	Minimum	Maximum
1962	--	27,373,000
1967	28,611,000	30,809,000
1972	31,583,000	34,762,000
1977	34,863,000	39,358,000
1982	38,473,000	54,682,000

We see from Table XXVI that the rate of population growth has sharply increased between 1947 and 1960. The only reason which we can derive from the prevailing source data is that death rates dropped due to enthusiastic policy in the public health sector. In Table XXVII the official estimates are based on the analysis of death and birth rates which could be trusted with the inclination to the adoption of some figures in the neighborhood of the maximum estimates since the birth control efforts will not be effective except after two of three generations when some levels of education and culture as well as standards of living are reached.

The sudden upward shift between 1972 and 1982 is unexplainable.

Hawley[30] indicated that, "A circumstance which seems to attend all occasions of migration is what may be called overpopulation. The term over-population is used advisedly, for it describes a relative condition; it is a matter of the ratio of number to the opportunities for life. A surplus number of people may come about through excessive

natural increase such as occurs in each genration in many old agrarian areas. Excess population, however, is often produced by an abrupt reduction in the food supply." It seems to me that over-population in itself acts only as a great potential towards migration. Over-population needs a start or a push to begin its work. This push should be initiated through education and culture change. In the case of Egypt, by definition, it has been over-urbanized since the beginning of this century but migration has not proceeded as well as over-population, when education, culture, and exploitation of new resources, which stimulate beside their manufacturing other service opportunities through a multiplier effect, then the potential over-population will start its motion. Over-population by definition is more vigorous in Egypt in "central service", county centers, and government capitals than that of the first group of cities. Our expectation then is a change from disequilibrium state to an equilibrium state through an outward push or migration.

3. Scarcity of Resources in the Nile Valley

W. W. Rostow's stage theory of economic development, distinguishes five "stages of nations"(31): "The traditional society; the transitional society in which the foundations of change are being laid; the society in the crucial state of "take-off"; the maturing society, in which new methods and outlooks are spreading through the whole economy; and finally, the society which has reached the age of high mass consumption." The role of resources can be sighted in the section on the transitional society in which the pre-conditions of the takeoff are established.

In this stage resources are important because they "offer a quick yield of increased productivity to new techniques" and permit the application of the "hitherto unexploited backlog of innovations" which increase output and thus, provide means to service capital imports. Capital imports in turn help to speed the modernization of the economy.

The importance of resources is mentioned once more in the discussion of the take-off stage which is marked by a "decisive shift" in the rate of investment from 5 percent to 10 percent of the national product. Three sources of increased capital formations are discussed: land reform which diverts income to the state and into commerce and industry; inflation which shifts resources from consumption to profits and thus, enhances capital formations and finally, foreign trade based on the exploitation of natural resources. "Developing economies have created major export industries from their natural resources, and the expanded yield of these has financed the import of capital equipment during the take-off."

Adler(32) summarized the propositions of resources in economic stage developments as follows:

a) the importance of natural resources diminishes as economic development progress;

b) accessibility is conductive to economic growth;

c) resources are important in pre-industrial stages because they permit the introduction of new techniques of production; and

d) resources form the material basis for expanding exports.

Then he added,

e) the presence of resources stimulates the development of new techniques for their exploitation,

f) resources attract foreign capital, particularly foreign direct investment, and

g) the more abundant the supply of natural resources, the less the need for other factors of production to assure growth.

Concluding from the above discussion, that resources have to play a major role in our stage of economic development. Except in some parts of Upper Egypt, the Nile Valley is empty of mineral resources with the exception of limestone and aggregate quarries. Limited agriculture land with excess of labor force and presence of respectable level of theoretical classical technology are the primary factors of production in the valley.

The increase of our national output, by ultimate exploitation of the valley's potentials through technological advancement, does not seem then to match with the increase of demand of population growing with extremely high rates of human increase and culture change. This will increase tremendously the pressures for outward movement of population.

4. Cost and Speed of Modernization

In order that regional centers could be modernized, new functional activities should be imported to the region which increases job opportunities causing a chain of economic pulses in the community.

Initial growth of industry calls for many subsidiary branches catering to its needs. Thus, an accumulative process operates. The growth of industry leads to the development of subsidiary and complimentary industries and services which in turn leads to more concentration of industrial enterprises which were encouraged by these available handy services. In my opinion this phenomena cannot be held true in each locality. It will be more successful in regions of low or moderate population concentrations, while it will be less successful in highly concentrated urban areas especially those poor and illiterate localities. In Egypt all the "type 'D' Centers," as well as most of the county centers, can be categorized in the second class where masses of rural population live. The structure of these centers is completely unsuitable for new factories to be established, except for some favorable locations on the main railroad line. Noneconomies of these centers are:

a) Isolation of these centers which are not usually connnected by highways, so far any industry to be established should pay for the construction of new highways.

b) Cost of importation of materials, power energy, and labor from outside the center due to the lack of resources and skilled laborers in these centers.

c) A large capital should be invested in housing for imported laborers since usually the people of the centers cannot afford the housing business due to shortage of capital.

d) Since these centers are numerous their hinterlands are relatively small, and since the input of industires which could be

established there are agriculture output, then we expect that these industries will be small in their scale, consequently, they lose the advantage of large scale production.

e. Land available for agriculture will decline, because all establishments have to cut large cultivated areas for construction of factories, storage areas, and housing for labor. Also, due to modernization all these centers should be connected with a suitable network of highways which will cut more cultivated areas. If these centers are to be left to grow indefinitely while efforts for modernization are taking place, a large area should be cut off for new housing since the increase is traditionally and financially moved in a horizontal direction and rarely moves in a vertical direction.

From the above we see that if industrialization should take place in these centers, modernization will take place outside them, maybe two or three miles out. Modernized communities will start with a small imported group and slowly some of the old communities' citizens will move and build around the new areas. The volume of this new shift will be proportional to the size of industry and its type. The process of this shift, as it is experienced in Egypt, is too slow. The slowness and the limitations of modernization process will not solve the over-population problems as it was defined before. Over-population then will increase the pressure for outward movement. Mostly the new generations, who have the opportunities of education and culture change, will be eligible for this migration leaving the older generations to diminish gradually.

Summing up, under the assumption of a national goal of working for the welfare of our population to reach a standard of living comparable with western standards, and under the ideal conditions of planning of the distribution of population in proportion to opportunities in each area; then assuming rural density were property designed to meet some specified standards the next step is to delimit the "rural service centers" which will provide their hinterlands with the minor services like primary education and training, grocery, medical, and social care, security, and co-operative center which provides people with machines, fertilizers, loans, and agriculture information, also these cooperative centers provide hand craft industries like carpet industry and others in the same time their functions are extended to collective and cooperative trade of their outputs.

Following this path of community design to meet the required standards of living, we can build up the schema of higher order centers which provides higher order services and functions. This ideal design, in fact, stems from the initiative to achieve certain goals. This process of design will create a massive surplus of population which has to move outwards. Even if in reality, we cannot achive our goals, our obligation towards our society is in itself an encouraged must for migration to potential areas.

To reinforce the above statements, Dr. A. El-Baki Ibrahim * states that 18 millions of rural population were living on about 6 million "Faddans."** The Ministry of Land Reclamation, claimed that

* Dr. Abd El-Baki Ibrahim, Assistance Professor of Planning, Collge of Engineering Ein Shams University. "Takhtite and Tazine El-Karia El-Arabia," Organization and Planning the Arab Village, 8th Arab Engineering Convention.

** One Faddan N 4400 m.sq.

three faddans could be taken as an economic unit for agriculture land, which can accomodate a family of six persons using local agriculture tools. This economic unit can make a good living standard for this family, i.e., 6 million faddans absorb 12 million persons. Dr. Ibrahim then concluded that at least 30% of the rural population living only on agriculture are idle. The old European estimates were on person for one economic unit which is one crop faddan. Since the prevailing crop area is about 10 to 11 million, then this area can accomodate 10 to 11 million persons by that standard which naturally is excepted to be the standard 25 years from now. The new High Dam of Aswan will increase that area to maybe 14 million crop faddans, i.e., 14 million persons to be actually living on agriculture. By an optimistic population estimate of 35 million persons in 1985, we can see that 21 million persons have to live on some other activity rather than agriculture. Most of those activities will not be available in semi-urban areas which are now over-populated and over-urbanized.

This leads us to conclude that a massive surplus of the population of the Nile's Valley have to move outwards.

5. Pulling Forces for Outward Movement

Migration involves, however, a destination as well as a starting point. Over-population is the stimulus; it describes the conditions in the home area which made migration advisable. For the stimulus to become effective there must be a destination, a place or area in which circumstances are favorable to the absorption of additional settlers. The cause of migration, in other words, appears to be twofold.

It consists in an excess of numbers in the area of origin and under population in the area of destination. The operation of "push"and "pull" influences is very nicely illustrated by the ebb and flow of European migration to the United States. Harry Jerome observed close correlation between minimum egression and the business cycle as measured by pig iron production. He found that changes in the flow of overseas migration lagged approximately six months behind business cycle alternation.

In our case, in Egypt the pulling forces for outward movement could be summarized as follows:

The exploitation of new natural resources (minerals and land for cultivation), power sources, as well as the "man-made" resources as monuments.

a. In the agriculture sector. Research has proved the existence of subterranean waters in an area stretching several million acres around the Western Desert in the sector extending parallel to the Nile course from Aswan to the Quattara Depression. The area covers the oasis of Kharga, Dakhla, Beharia, Siwa, and Frafra; it has been given the name of the New Valley. The Project envisages the cultivation of 35 million acres, increasing total cultivated area by about fifty percent. A railway line and a highway have been constructed joining the New Valley with the Nile Valley. Also an airport has been built in Kharga, the Valley's capital. Agriculture and livestock output will also create a chain of industries which will attract more and more population. Urban centers will be established in location of relative advantage connecting the main old urban centers.

The second main project is the supply of Sinai by water for the cultivation of a sizable area which will absorb some agriculture migration as well as strengthen the existing modern industrial centers there. Other agrarian projects have begun in the area of northeast and west to the Delta and Upper Egypt strengthening modern urban centers close to them.

b. In the mineral resource sector tremendous effort has been devoted for the discovery of the richness of our soil. The main areas where minerals have been discovered and will be exploited are: Upper Egypt around Aswan (iron and steel industry have been established there), the New Valley, area parallel to the Red Sea, and Sinai. All of these areas have the potentiality of growing too fast except for the southern area parallel to the Red Sea which needs accessibility to agriculture and service areas.

c. Fishing and its industry. Fish and other sea products will constitute one of the country's most important and richest sources of natural wealth. The country has coastal lines about 1,500 miles in length. There are also many lakes in various parts of the country. With the objective of increasing the country's wealth in fish and other sea products, the authorities decided to introduce various kinds of fish from abroad to be acclimatized in Egyptian waters. Three government fish rearing forms have been established at Delta Barrage (north of Cairo) Alexandria and in the Saron District, near Manzala Lake. Also, Naser's Lake, created by the construction of the High Dam will be a rich source of fish.

d. Power resources. Aswan will be the main source of hydro-electric power in Egypt. The Aswan Dam provides the country now with two million K.W.H. per year (two thirds of this power has to be consumed in the industry of fertilizers in the area). The High Dam promises another ten million. Long distance transport of electric power is expensive, so most of this power should be consumed within the area, (Upper Egypt, New Valley and Red Sea), consequently, it will attract many industries to be established, which will initiate the pull for new manufacturers and other activities. Quattara Depression promises half the power of the High Dam. Petroleum oil is the second source of energy. Now it constitutes 93% of the motive power utilized in the country. The country's consumption of petroleum products was about 100,000 tons a year in 1910, but it has been gradually increased until it reached 3,200,000 tons in 1959.

The existing oil wells are located in Sinai and on the Red Sea shore. The most promising areas which may exploit large oil industry are the Suez Gulf and the Western Desert near Libia.

6. Attractive Powers of the Existing Modernized Metropolis

It has been pointed out in viewing industrialization of Cairo and Alexandria, as well as the modernization of other cities like: Port Said, Ismailia, and Suez, that external economies have worked out for the attractivness of industry and other establishments to these cities. Domination of market demand, elasticity of skilled labor supply, availability of research and technical advisory institutions, opportunities of subsidiary establishments, economies of large scale production,

availability of financial institutions, accessibility for international exchange, etc., have also been mentioned.

In the economic stages of "take-off" and "maturing" societies, stated before by Rostow, much attention should be devoted to imported capital (other than loans) through expansion of foreign exchange or trade. I believe that Egypt is in a situation where she can close the technological gap in many areas between it and the most advanced nations in the respective fields. The Suez Canal administration is the best example. A second example is the textile industry. Now we are exporting our textiles to the advanced countries which were importing textiles to us. Our exports increased from 1,068,006 tons in 1955 to 3,744,831 tons in 1957. I believe also, that the cost of importation of the latest technology is much lower in some fields than the differential labor cost between Egypt and the most advanced nations. The geographical location of Egypt between the matured and the pre-industrial underdeveloped countries gives here excellent locational advantages with respect to market and resource areas. So, if we recall the third assumption of out international relations, then we can play a respectable role in the international trade. The city of Dimiatta gives an excellent example, although it is on a small scale. Timber is very expensive in Egypt. Most, if not all, of our timber consumption is imported from Europe. Dimiatta specializing in furniture industry and located on the sea, exports a sizable amount of its output to the international market of the furniture industry.

7. The City of the Future

Professor R. L. Meier, when outlining "The City of the Future" pointed out some forces which will determine the location of the city of the future, as follows:

a. The physiography of the land rules out perhaps 90% of the land area as suitable for centers because construction and movement on steep slopes and uneven surfaces are abnormally expensive. As a result, the northern part of Egypt is the best to fulfill this requirement.

b. The present location of centers and passenger movements will also be a factor in the location of the future centers, although some of the existing centers can die and disappear from the scene. Thus, as we mentioned before the areas which have a hard strata to grow up on is the area on the Mediterranean and Suez zone and that of Aswan.

c. Climate has recently been an important attraction for the more educated people. They prefer a mild but variable climate. Population movements in all parts of the world with medium to high income show migration to places with a climate like that of California, Florida, Eastern Australia, the Mediterranean, the Black Sea, etc.

d. Accessibility to the main commercial routes provides a basis for more than average growth. Thus, population on the Atlantic side, Latin America, on the whole African Coast, the Mediterranean and places in South Asia may be expected to grow following Djakarta in recent times.

e. The limitation upon the expenditure of energy requires that a low population density exist in areas that require much seasonal

heating of living areas or air conditioning. Again the Mediterranean area of Egypt as well as the Canal Zone are the best places to fulfill that requirement.

As we see, all the above mentioned factors which Professor Meier pointed out, have emphasized my findings about the outward movements of the Egyptian population in the future.

H. Forces Working as a Tie to the Nile Valley

This set of forces is working in a counter balancing way against the previous two sets of forces. The new set of forces is that which pulls population to their home land resembling the gravity and friction forces. These forces are as follows:

1. Egyptian rural communities are independent and immobile communities. They are producing their own sustenance directly from local resources. They are bound to the land by a routine of long-run processes, such as the maturation of plants and the breeding cycles of food and animals. The attachment to places which arises in the isolation of selfsufficient existence is in itself a powerful deterrent to movement and resettlement elsewhere. Many illiterate peoples regard themselves belonging to their lands.(33)

Not only is there a fixity as to place, but the very cohesiveness of the community enables it to withstand many migration stimuli. The independences among its individuals are overlaid by sentiments of rights and duties and cemented by common loyalities. It is then logical to say that this group cohesion should be a mass movement if it is to occur at all.

2. The cost of movement and resettlement is an essential force working against migration. The burden of this cost is on the shoulders of the government when it takes the responsibilities of land reclamation, transportation of migrants, and providing housing and other facilities for them. Even when applying the latest techniques for cooperative self-made housing and land reclamation, the capital required will be too high for the Egyptian budget to provide in a short period.

3. The benefits from the construction of the High Dam will increase the existing capacity of the Nile Valley which means an additional labor demand in agriculture.

4. Decentralization of governmental, political, industrial and all other service activities.

5. Land reform laws which redistributed the land of the Valley among peasants made them closely tied to the land. Also, it increased the total purchasing power, which helped in the mechanics of the business cycle and in turn, increased in service activities.

6. The establishment of institutes of technology and, sometimes, universities in the governments will provide laboratories and technical advisory which will attract new establishments.

I. Conclusions

Summing up this chapter, we have to determine the following four points:

1. The future growth of Egypt's population.

2. Future growth of urbanization in Egypt.

3. Potential areas of urban growth in Egypt.

4. Population growth of Cairo.

1. The Future Growth of Egypt's Population

This part has been discussed thoroughly in the first chapter, and was related to the official estimates derived from a large study of the population trends in the U.A.R. in 1962. When I wrote the first section I was very pessimistic about something being done to lower the fertility and birth rates, and my choice of the first mentioned estimates was in the neighborhood of the maximum estimate. Now the picture has changed a little bit since new devices have been adopted and successful research has been conducted in the University of Michigan on birth control. We should not be too optimistic about the results of these new devices, if adopted by the Egyptian population, because it would take sometime to reach fruitful results. But at the same time, we should not be as pessimistic as before.

We must assume that the current rates of population growth in 1960 will continue as they are until 1970. It is during this period that the government must consider the new birth control devices and propagate them and their advantages to the Egyptian population. Since the expectation is that these new devices will be adopted more faster among urban communities, the drop will be slight between 1970 and 1975. After 1975 we assume that these devices will be utilized by all population and as a result new growth rates will decline more and more.

Estimate IV is the best estimate to coincide with these assumptions and will be adopted through the following work.

2. Future Growth of Urbanization in Egypt

We have seen from the historical presentation that technological advances have stimulated the existence and continuation of cities. There is a correlation between literacy and economic development and another correlation between degree of development and urbanization. If one of these social changes occur faster than the others, the equilibrium point will move faster to reach a point where it can regain a steady speed. Egypt up until the 1950's was a state of dynamic non-equilibrium which created the so-called over-urbanization. It was in a state where urbanization was moving faster than culture and economic changes. By the middle 50's and 60's, culture and economic developments were going also too fast and as a result, urbanization is now regaining higher accelerations. How far this race will continue is a matter of time when reshuffling of the community will be completed after a stable and steady stage of culture and economic change is reached.

As we mentioned before, if the community has been properly designed, by 1985 only about 14 million persons will be engaged in agriculture in the Nile Valley, if the New Valley and Sinai will consume, by that time, another 4 million persons, then total rural population should be not more than 18 million out of the acceptable estimate of 43.6 million by 1985.

The responsibility is in the hands of our regional and national planners, then trials to design our rural communities to be modernized, will result in a complete failure if they let a surplus of rural population accumulate. If things go as they are, no matter how fast we modernize, the speed of deterioration will be much faster with the presence of

accumulated surpluses. The best way to serve our complicated rural communities is to limit their absolute population which will create a better opportunity for higher incomes. The first step for our community design is to create great urban centers where the real roots of urbanism could be found; make this urban area attractive to the surplus of rural and semi-urban communities, supply the rural areas with water, energy power, technological institutions as well as resonable means of transport and then we can make our plans sound and realistic.

Unfortunately, I cannot be too optimistic and dream of a rural community that will be stagnant during the period 1960 to 1985 of 18 million inhabitants.

In Figure 31, if we join the two points of urban population of 1947 and 1960 by a straight line, then continue this line to estimate the urban population in 1985, assuming this straight line relationship will prevail, we will come to an urban population of 23 million and a rural population of 20.6 million. Again this result seems to be too optimistic.

In the case of the adoption of the new birth control devices, we can expect that by 1985 the urban population growth will taper down reaching 20 million inhabitants by 1985 while rural population will be 23.6 million. This seems to be a reasonable estimate that could be adopted.

3. Potential Areas of Urban Growth in Egypt

It has been illustrated before that there are three types of forces affecting the mechanism of urbanization in Egypt. Internal pressures trying to push the dense population of the Nile Valley and

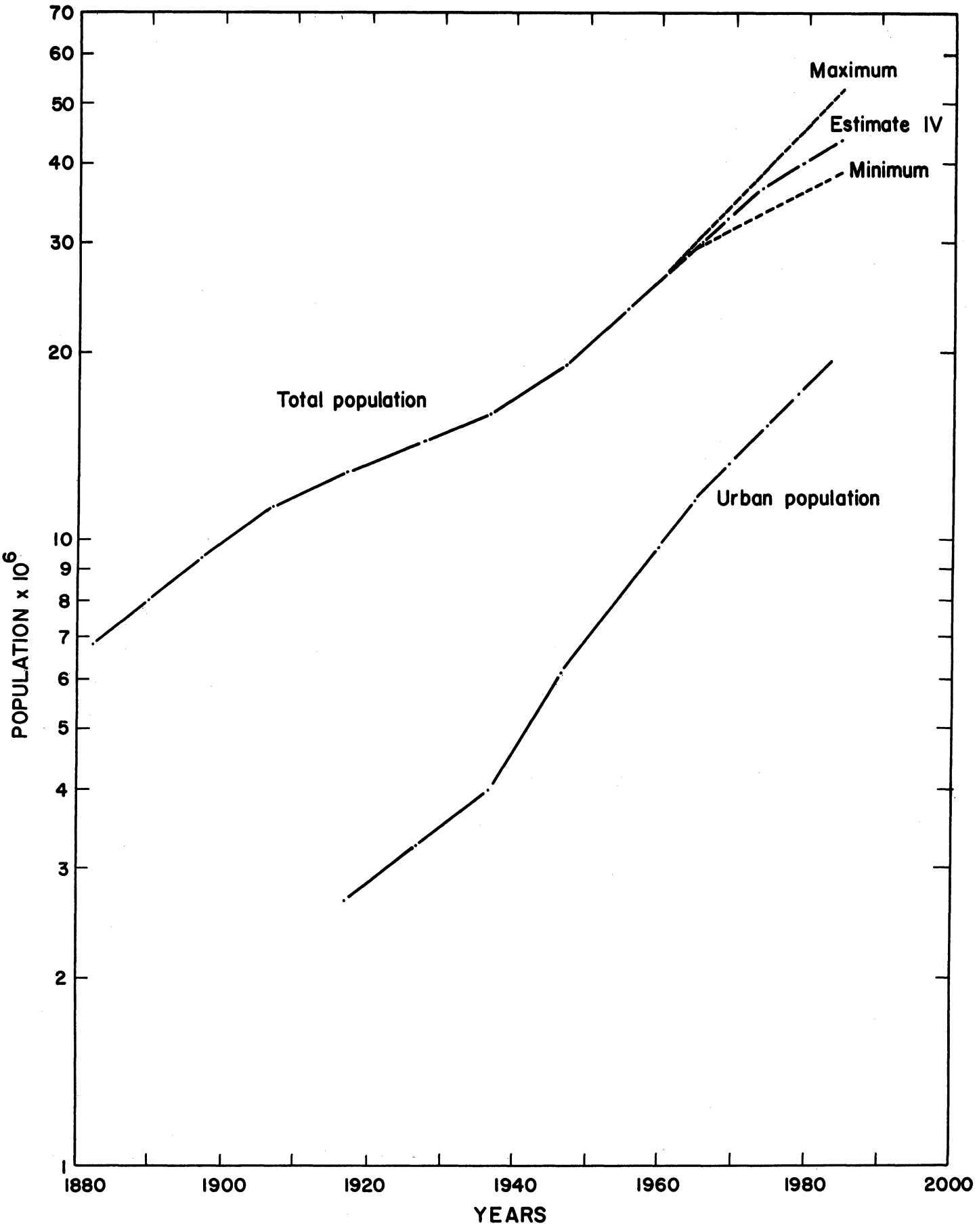

Figure 31. Total and Urban Population Growth in Egypt.

external forces of modern urban areas and resource potential areas working to attract and pull those people outwards. The third type of force are friction forces preventing the outward movement. The outward movement should not only reach the Egyptian borders but also exceed them. Immigrating to the Arab and African countries should be encouraged. The high demand for teachers, administrators, industrial as well as agriculture workers, professionals and religous, etc., is increasing rapidly in the newly developing countries in these areas, while an increasing surplus of these people is occurring in Egypt. The immigrants themselves will be a potential for attracting other phases.

There is strong evidence that some modern cities are growing very fast because they have the roots of urbanism and modernization. These cities are those located on the Mediterranean and in the Suez Canal Zones as well as Cairo, Aswan, and maybe later on El-Kharga, the capital of the new Valley.

The second group of cities which now have some root of urbanism are the governorate capitals and the industrial centers, mentioned before as "Banders", as well as some cities in Sinai and the Red Sea, if a reasonable means of transportation is provided to them.

In an attempt to calculate the population in the potential urban centers in the future, Table IV, Appendix B has been constructed. From that table we notice that the potential urban areas suitable for the creation of great metropolis constitute about 65% of the total urban population in 1960. Then our first approximation of the future population in 1985 should be 65% of 20 million or 13 million. Since we have

found that an outward shift of population will occur then this figure should be taken as a minimum estimate.

On the other hand, the urban population in the Nile Valley, after substituting Cairo M.P.A., and Aswan, has increased from 1947 to 1960 by 40%. If we allow the same rates to occur for the other 25 years, then their population will increase from 3.41 million to about 6.5 million (compound rates). This estimate should be the maximum limit for the population of those areas. If this limit is reached then it will be a disaster, because that means that those cities will compound themselves in 25 years.

I repeatedly emphasized that these cities may be defined as urban areas but in many ways completely lack the roots of urbanism. If the population of these cities remains as it is now, then it will be a miracle if we get them all to be truly urbanized and modernized within 25 years.

Other potential areas for urban growth are those expected areas on the border governorates. The best of these is Sinai, especially the part parallel to the Mediterranean.

Total population of these governorates is only 212,606 and is considered to be urban. It is very hard to make more than rough estimates for future growth of these areas.

Sinai is under consideration by our government. There are some projects designed to irrigate some hundred thousands of "faddans" there. There are some mineral resources and it is a military zone where service activities could be easily found. Also, its climate could be

considered as wonderful. Very easily we can allocate from 250 to 500 thousand by 1985 in the urban centers in Sinai (1960 population = 50,000).

Matrouh has a population of 103,453 people, a good many of them are engaged in agriculture. Since Matrouh is also parallel to the Mediterranean, it can also create urban centers which can live on Summer Tourism. Without the discovery of oil, true urban population can hardly reach 100,000 or more.

The New Valley may have about 3 million crop faddans to be cultivated, which we can assume to absorb 3 million rural population which may create about 500 thousand of urban centers to serve them.

The Red Sea has a population of only 25,452. The cities of this area are now connected with Suez by newly constructed highways. The population may increase to about 150,000 if Aswan is to be connected with the Red Sea.

Aswan is a powerful potential of urban growth for many reasons as mentioned before. Its urban growth may reach to about 250 thousand by 1985 since its population was only about 50 thousand in 1960.

The total of these urban areas then could be assured to be something between 1 to 1.5 million persons while the remainder of the 20 million estimated urban population is only 500 thousand
(20 - (13.6.5) = .5).

4. Future Population of Cairo

We concluded in the population study of Cairo in the first chapter that, "although it will continue as the most important city in Egypt, its relative importance is declining and we must expect the rise

of other important centers challenging Cairo." Figure 32 shows that Cairo's population was about 8.2%, 11.0% and 18.0% of the total population of Egypt. It is expected that this share will be around 15% by 1985 which raises the population of the City of Cairo up to about 6.6 million. On the urban population share, if we omit the percentage of 1947 because it is too high, then the Cairo share of urban population may rise to about 37% giving a population of 7.4 million (neglecting also the increase of suburbs in Cairo). In Figure 33 if we plot the population of Cairo on a semi log. paper then we get about 6.6 million for the city of Cairo (lower curve), and 11.5 million for the whole M.P.A. of Cairo (upper curve). I feel that both could not be realistic and the intermediate curve will be adopted which gives us a total population of about 7.5 million by 1985 according to the Table XXVIII, bearing in mind, that if we calculate Cairo's population only on the basis of natural growth of 2.4%/year then we reach a figure of about 6.0 million by 1985.

TABLE XXVIII

POPULATION PROJECTION (1960-1985)

Year	1960	1965	1970	1975	1980	1985
Projected Pop. for Cairo M.A.	3.8	4.7	5.6	6.4	7.1	7.6

Figure 34 also indicates the proposed distribution of urban areas up until 1985.

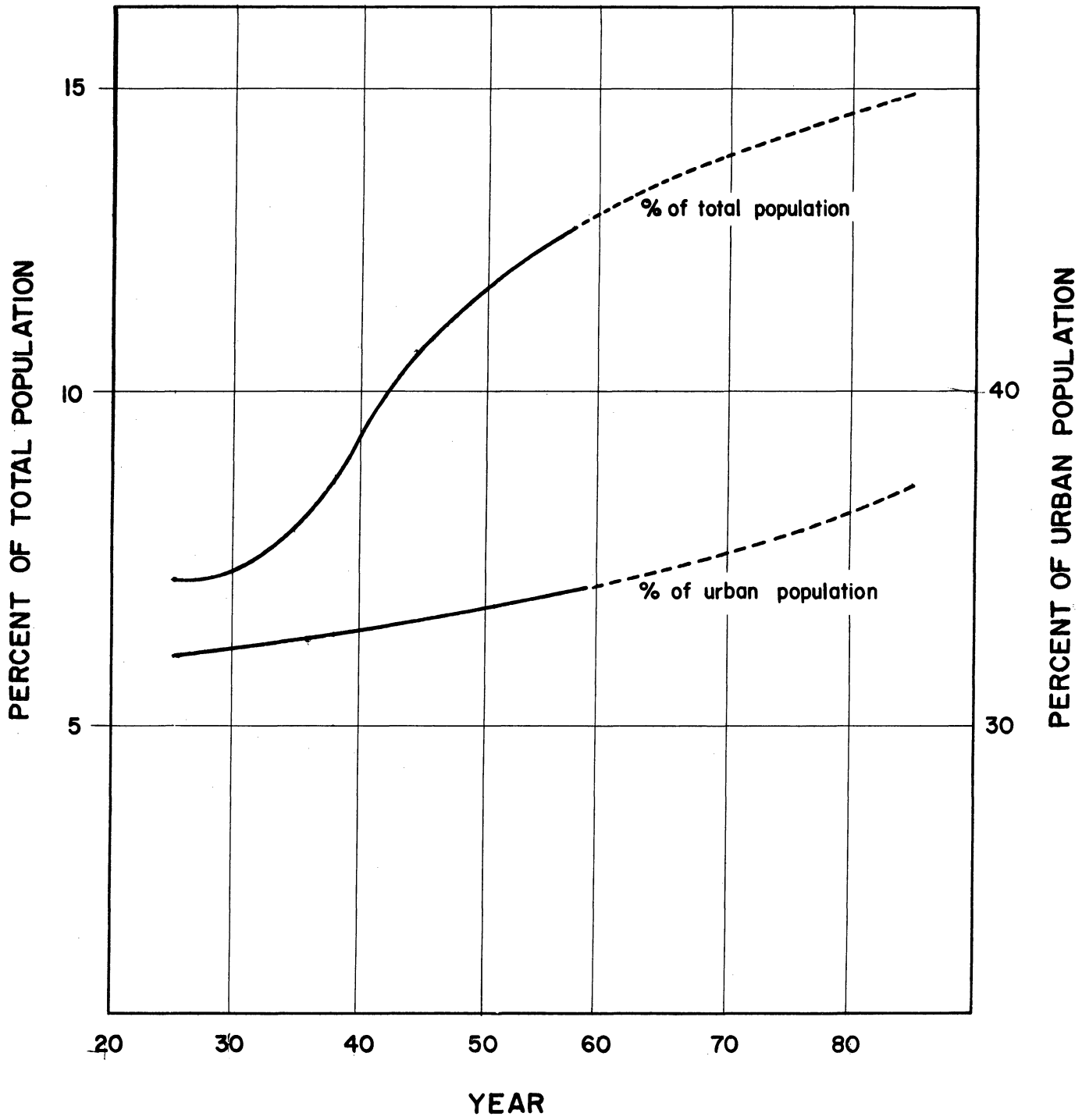

Figure 32. Cairo's Share of the Total and Urban Population.

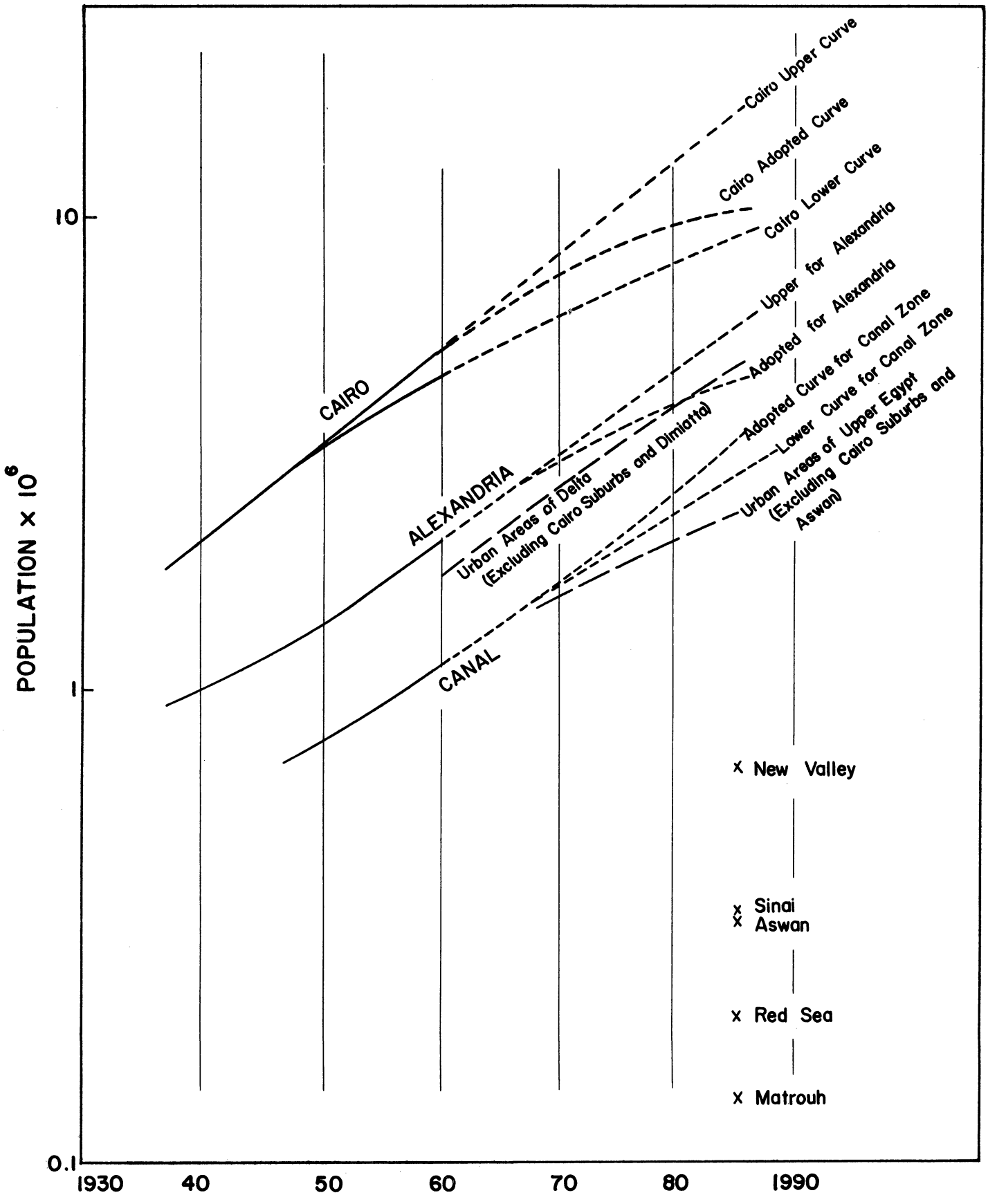

Figure 33. Projected Distribution of Urban Population.

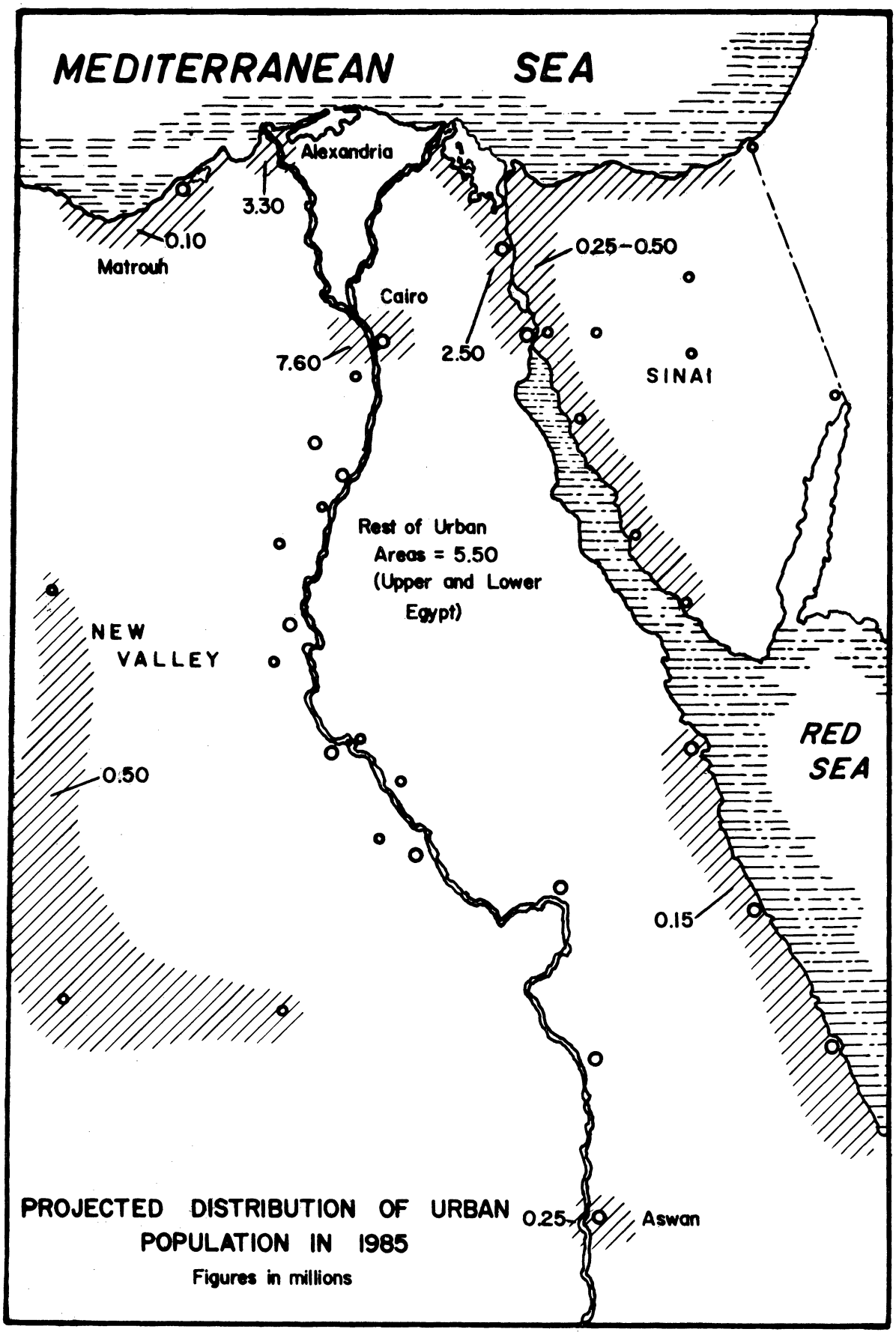

Figure 34. Projected Distribution of Urban Population in 1985.

CHAPTER III

POPULATION DISTRIBUTION AND SOCIAL CHANGE PROJECTION

A. General Approach

In previous chapters our job was to build up sufficient background about the area under study to pin point the transportation problem as well as to establish a base for the projection of its population.

In this chapter our task will be rather difficult and more delicate since we are going to draw the picture of the future of that area taking into consideration the past and existing situation and history. Since that picture will dictate a specific trend of traffic flow for which transport facilities will be designed, then we have to be very cautious in drawing it. Traffic flow or movement is nothing but a resultant of a complex of all demographic, economic and social interactions. Any change in one of the forces acting in that complex will undoubtedly change that resultant through the same type of interaction, this is why our job here is rather delicate.

Although city planning and urban transportation planning are two complementary tasks, each is completing and influencing the other; but there is no doubt that city planning is a prerequisite for transportation planning. On the other hand, transportation may dictate some changes in city planning. That means that final plans for an area should not be adopted except after super-imposing the two plans to fit each other after making proper changes in each plan. Unfortunately, the Master Plan of Cairo, which was set up in 1957, is now obsolete. Even though it is not complete and is lacking in details which we need to feed into our projection and planning. This is why our task here is rather difficult.

City planners are usually optimistic when they adopt the ideal way of thinking for an ideal plan for the city under study. These planners base their projects on: What should be done without any restraints on the budget or the political forces. If planners are the policy makers or if they have great influence on the policy makers, then this ideal plan could be reasonable because these planners could force all other factors together to bring their plans to reality and success. Unfortunately, reality is usually far behind wishful thinking.

In our case, I prefer to base my projection on what is most likely to happen rather than what should be done. Otherwise, I will find myself dealing with a city other than Cairo.

Our country is now witnessing an economic development passing in a stage which now it is premature to predict when and how the housing problem will be solved; but it is becoming more and more severe, which may result, in the case of Cairo, in checking its population or its capabilities in accommodating more emigrants to reach a total population as I predicted in the previous chapter. Since the housing problem is a national one and not a local one, then the social and economic change will create the same forces mentioned previously, which will result in the same population figures I reached before. It may be changed slightly, but without a markable deviation.

B. Projected Population Distribution

There are many scientific methods and theories of population redistribution[33-42] but only a few could be applied in each specific

case. Since none could be applied to our problem, especially with a lack of refined data, then I will release myself from the burden of outlining them but as a matter of reference I am going to mention some of them in the bibliography of this chapter.

For Cairo I have a different approach. I repeatedly emphasized the housing supply as the most decisive factor which will determine the realistic distribution of the inhabitants of the city. Since insufficient funds are being allocated for housing and since the private sector in our economy is now reluctant to participate in this activity, it is logical to assume that the supply of new housing will fall far behind demand. In the first five year plan (1960-64), construction of 20,000 housing units per year[43] in the urban areas (of which Cairo constitutes about 32%) was proposed. Thus about 7,000 housing units per year was Cairo's share, since it is better off than most of the rest of the urban areas. However, there is no evidence that this program of housing has been accomplished, due to shortages of funds as well as shortages in building materials. An increase of prices, and non-participation of the private sector, even though it is inadequate, also held back construction. Consequently, I do not expect more than an average of 10,000 housing units to be built each year during the period of 1960-75. Assuming 3 rooms/unit and an average capacity of 2.5 persons/room (the 1960 figure), by 1975 the number of inhabitants who would occupy the newly constructed buildings is about 1,125,000.

Municipal engineers of Cairo once declared that at least one third of its houses could collapse at any time. Assuming an optimistic

figure of 4,000 units to be evacuated for renewal each year, then for the same period 450,000 persons would move from old buildings to newly constructed ones, leaving room for only 650,000 new inhabitants to live in these buildings. Since we have forecast that Cairo's population should reach 6.4 million by 1975; therefore, 5.75 million people (6.4 less 0.65) should live in the same number of housing units which were existing in 1960. This can only be done by increasing the average persons per room from 2.3 to about 3.5 by 1975. As an average, this figure seems to be too high but it may prove to be necessary. This crowding will create very severe social, economic, health and political problems which I expect will be experienced before 1970. From 1970 to 1975 adjustments in our plans will take place, and from 1975 to 1985 I hope that corrective measures planned in the previous period (1970-75) will be taken and new large scale projects for renewal and extensions will be carried on. If this expectation is realized, Helwan D_{15}, El-Maadi D_{10}, Kism $Giza_{(1)} D_{22}$ on the route to the Pyramids of Giza, Masr ElGedida D_{20} and El-Mataria D_9, as well as a strip of one or two blocks along the two banks of the River Nile, should logically be the locales where these projects would be located.

For population distribution projection, a cumulative distribution curve for the districts and subdistricts of the area has been set up according to 1960 Census, with the "x" axis representing the number of persons per room, and the "y" axis representing the cumulative percent of the whole population having an average number of persons per room less or equal to the average on the "x" axis. From this curve we

can set up two other curves representing the 1975 and 1985 distribution by fixing three points for each curve, then connecting them with a smooth curve having the same characteristics of the original one or the characteristics of another subdivision which I feel that the original one will follow. These three points could be established by: Calculating the average number of persons per room for the two projection years as mentioned previously, the max point is an assumed point representing a social limit, and the third point is a calculated point representing the existing population having an average of one person per room plus the expected additions of housing units for the high income level group. This method is illustrated as an example for my work in Figure 35.

For each district, knowing its average persons per room for 1960, we can get its new average persons/room for the projection year. Multiplying this obtained figure by the number of rooms available, we reach the projected population which in turn is subject to some modification according to density, site, location, degree of literacy, type of economic activity, income level and finally the other subarea which the original subarea expected to follow. The new adjusted population is called the anticipated population. Following the same path, then the anticipated population for each subdistrict has been calculated and illustrated in Appendix C.

C. Population Density

From the anticipated population distribution we can easily calculate the new population density which has been illustrated in Figures 36 and 37.

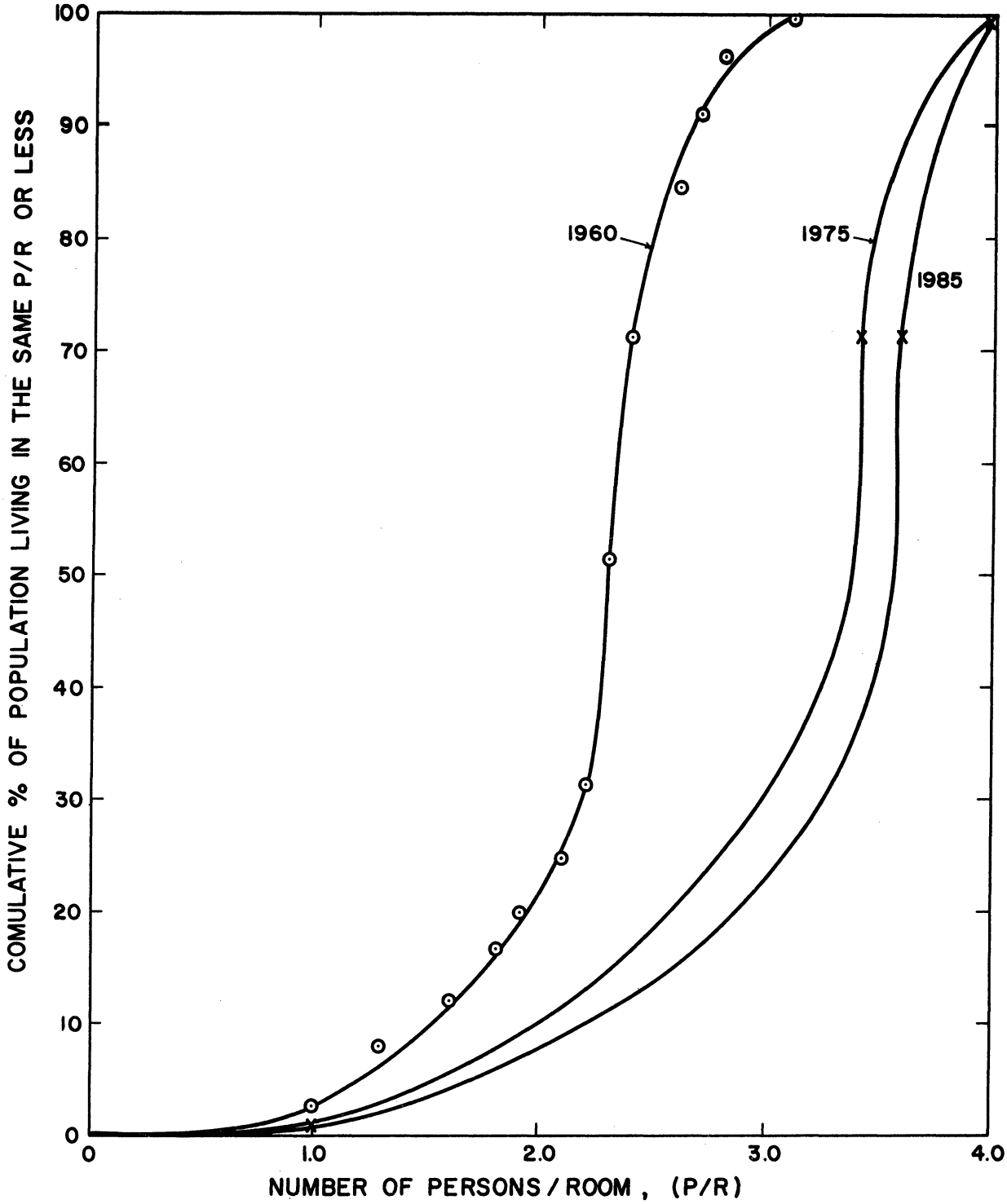

Figure 35. Existing and Projected Cumulative Curves, for Population Living in Specific Levels of Persons/Room.

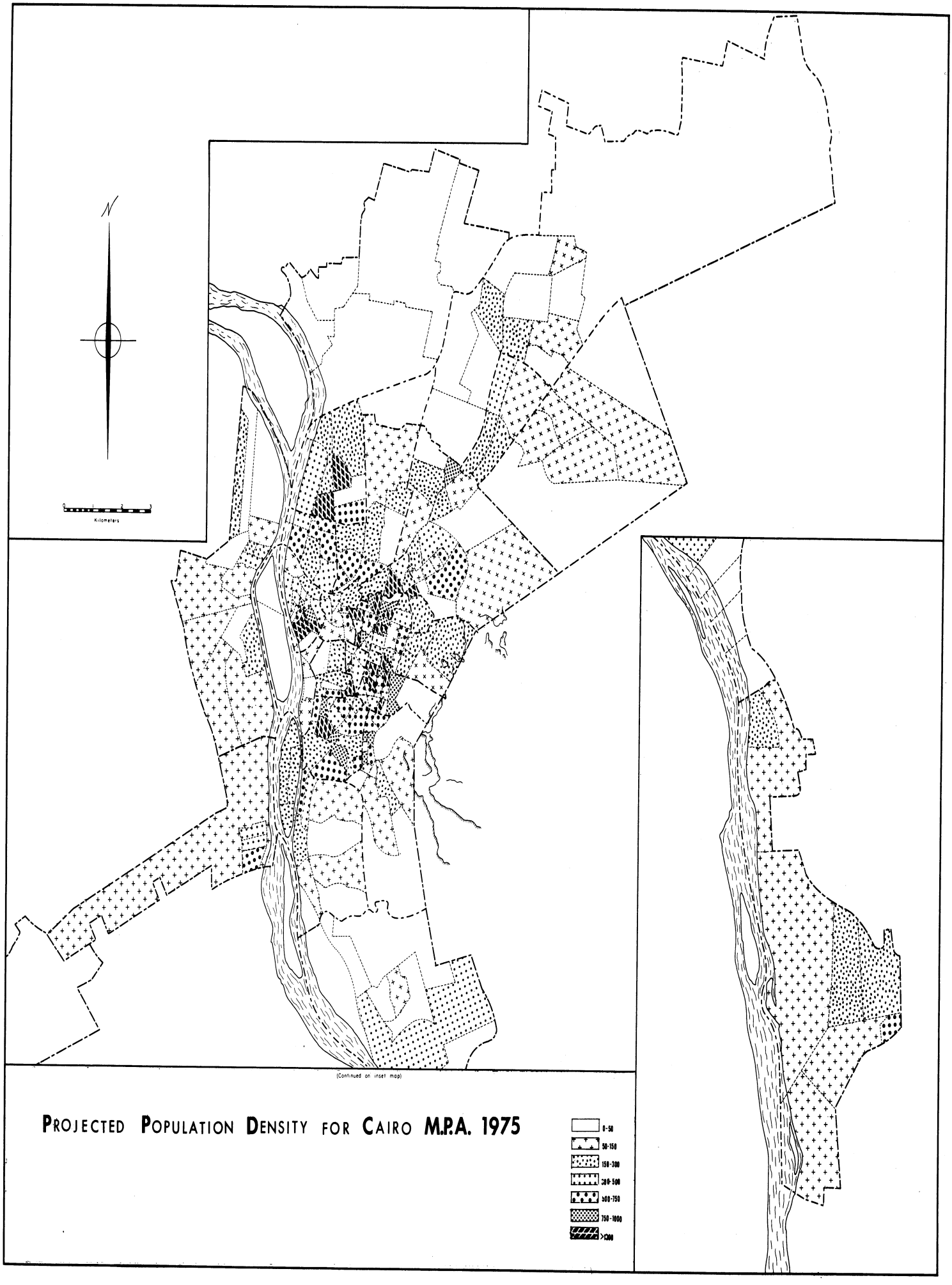

Figure 36. Projected Population Density for Cairo M.P.A. (1975).

Figure 37. Projected Population Density for Cairo M.P.A. (1985).

D. Income Distribution

It is a difficult task to draw the picture of income distribution for an area without some direct sampling research, a matter which is missing in our case. That does not mean that we have to stand idle waiting for such research to be done, but it is our job to use and gather all available information to reach sound conclusion. As I lived in the city for almost twenty years and since I am fully acquainted with some of its subdistricts, then as a first effort, all subdistricts which I know well, have been ranked, then assigned to one of the following classes: Upper Class - U.C., Upper Middle Class - U.M.C., Middle Class-M.C., Lower Middle Class - L.M.C., and Lower Class - L. C.

For each subdistrict in each group I indicated its degree of literacy as percent of literate people to total population of more than six years old. Also indicating the percent of economically active members to total population older than 15 years.

For either measures I could not find any correlation between them and income levels of these subdistricts.

The best results were obtained after a second trial by measuring the percent of professionals and administrators (engineers, doctors, etc.) among the economically active members and actually participating in each subdistrict. I found that: Upper Class districts have more than 30% of their active members as professionals and administrators, Upper Middle Class have between 20% to 30%, Middle Class between 10% to 20%, Lower Middle Class have between 5% to 10% and finally Lower Class districts are those having less than 5%.

Income level distribution is tabulated in Appendix C and represented in Figure 5.

Studying the expected number of persons per room, expected density, the present income level, site and location of each subdistrict, the expected income level distribution for each respective projection year is concluded and presented in Appendix C and Figures 38 and 39.

For the distribution of those who are participating in both clerical and commercial activities, I found by grouping these subdistricts according to their percentages engaged in both activities and representing that on a working map for each, I found that location with respect to main roads, government buildings and commercial areas as well as income level are the major factors affecting the level of participation in respective activities. Projection of these activities are only shown in Appendix C.

Accordingly, each subdistrict can be identified as follows:

I - Professionals and Administrators

Upper Class	I_A:	> 35%	with an average of 45.2%
	I_B:	30% - 35%	with an average of 33.0%
Upper Middle Class	II_A:	25% - 30%	with an average of 26.7%
	II_B:	20% - 25%	with an average of 22.7%
Middle Class	III_A:	15% - 20%	with an average of 17.2%
	III_B:	10% - 15%	with an average of 12.5%
Lower Middle Class	IV :	5% - 10%	with an average of 7.4%
Lower Class	V :	< 5%	with an average of 2.8%

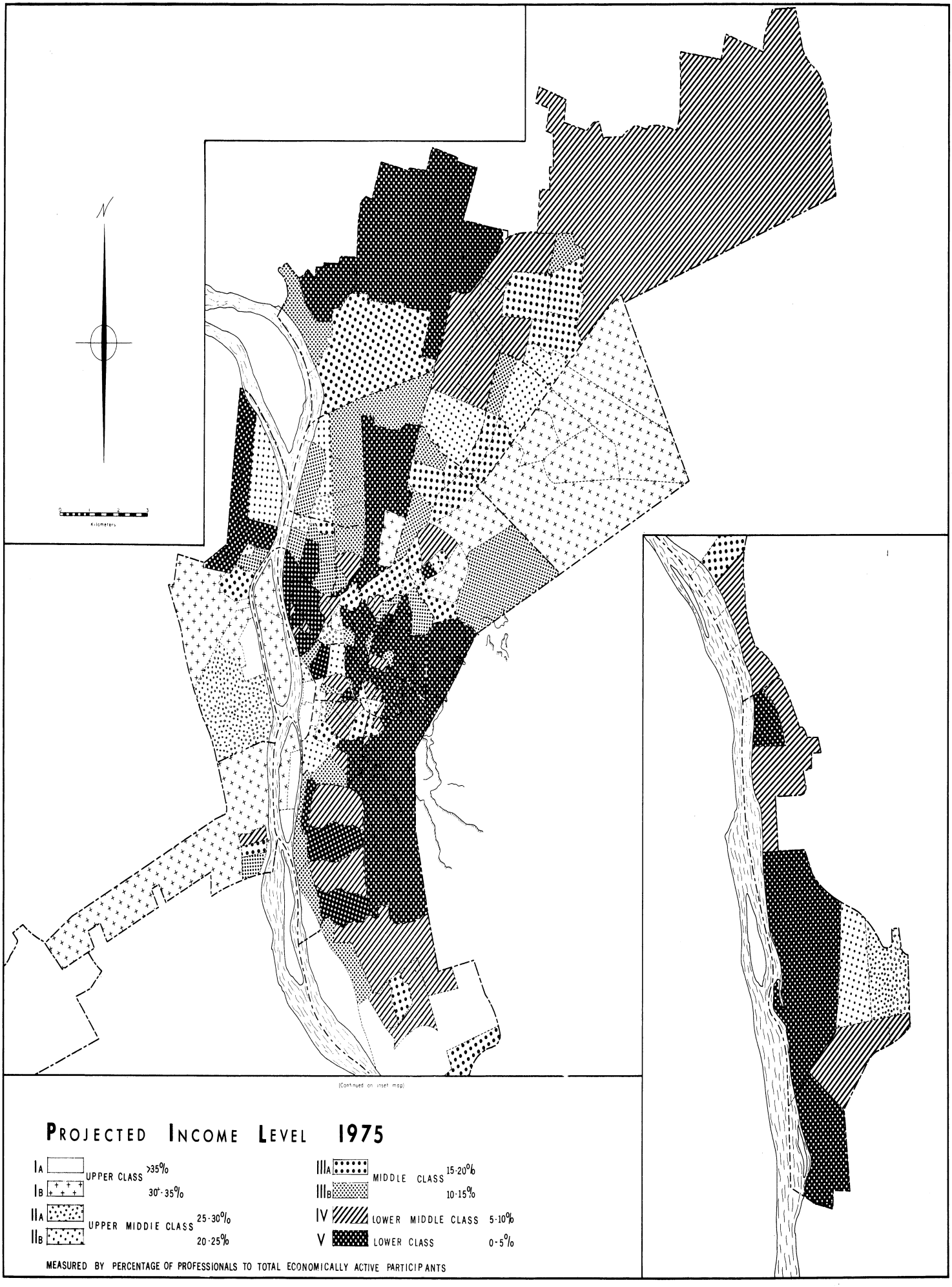

Figure 38. Projected Income Distribution (1975).

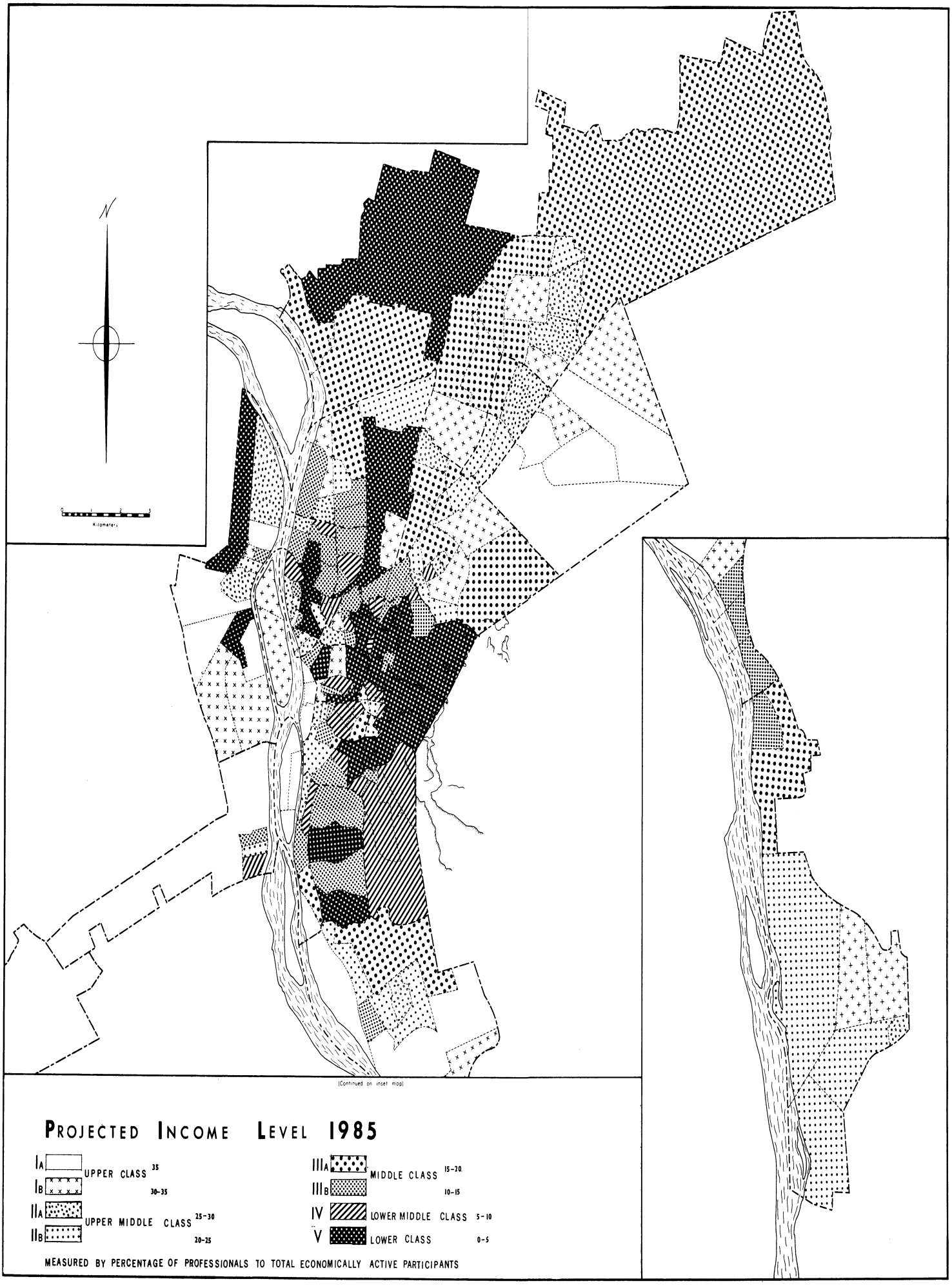

Figure 39. Projected Income Distribution (1985).

II - Clerks

7 : > 30% with an average of -

6 : 25 - 30% with an average of -

5 : 20 - 25% with an average of 21.2%

4 : 15 - 20% with an average of 17.3%

3 : 10 - 15% with an average of 12.5%

2 : 5 - 10% with an average of 7.4%

1 : < 5% with an average of 3.4%

III - Commerce

7 : > 30% with an average of 30.1%

6 : 25 - 30% with an average of 27.4%

5 : 20 - 25% with an average of 21.1%

4 : 15 - 20% with an average of 16.3%

3 : 10 - 15% with an average of 10.8%

2 : 5 - 10% with an average of 7.9%

1 : < 5% with an average of 4.5%

CHAPTER IV

TRAFFIC PROJECTION

A. Introduction

At last we have reached the heart of this research. Under ideal circumstances, this dissertation should have been started from this chapter and this would have saved 11/12 of the time spent on the whole effort. The work done in the previous chapters should have been done by many specialized complementary departments which have more time, personnel and facilities than a single person. Very likely they would have obtained more accurate results than I, if they had the patience and the proper research methodology.

I confess that my results, as obtained in the previous chapters, could be more refined, perhaps not from the methodology point of view, but from the point of view of accuracy. The following examples demonstrate where more accuracy could be achieved:

1. All map work and accurate political boundaries could be improved since there were some problems raised in reaching that as will be seen on the next page.

2. The center of gravity of the subdistricts could be obtained by slow but more accurate methods than I have.

3. The projected cumulative distribution curves could also been drawn more accurately, since more points could be calculated.

4. The areas and densities of all subdivisions could be more precise since their values were not given. I have chosen a rough and long path seeking analysis capable of achieving better results, but I intended to do so primarily to establish a comprehensive methodology which I hope

may be followed by the planners for Cairo. For example, I devoted a complete chapter to an analysis which enables the investigator to reach an approximate figure for the population in Cairo. The study of urbanization phenomena and how they work in Egypt tells us how much they will affect the size of the city. Even though I chose this method, I must report that our city and regional planners who made their studies and plans for the renewal of our rural communities, only concentrated their efforts to reach a design of our villages and only studied their relations with the second higher rank communities "the Markaz", see page 140

They were concerned with the layout of villages of different sizes in relation to the region they are located in without studying the potential economic base of each group of villages having the same size, and how much people can live efficiently on that basis and how much people have to go elsewhere in an area which has an economic potential to accommodate them. In other words, they did not come to a conclusion for a recommended policy to be followed by the government concerning village renewal and its affect and connection to urban renewal or extensions.

B. Available Information

Although the data required for traffic projection depends on the methodology of calculation, it is specifically true that the method adopted is wholly dependent on the available information. The available and the calculated information up to this stage is:

1. Population and density distribution in Cairo metropolitan area as it is divided into 244 subdistricts* for 1960 and those projected for 1975 and 1985.

2. The coordinates of the center of gravity for the area of each subdivision.

3. Numbers of families and the average of their size for each division in 1960.

4. Percent of economically active members and actually participating for each subdivision for 1960 and the projection years.

Population, among other things, has been used as the main independent parameter in all equations used to compute traffic expectation. Of course, this parameter should be modified to give better results since the demand of the people from this service varies according to many factors among which age, degree of literacy, income level, and economic activity.

The new trend, especially in the United States of America, is to modify this parameter to the number of families. It is very clear that this new parameter is applicable in a rich society where almost every family owns a car, which is widely used as a travel media, while

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* Some trouble has appeared because accurate maps of Cairo metropolitan areas and its subdivisions are not available. My only source, in this respect, is a map sent officially after my request by the U.A.R. Census Department. From that map it is clear that some mistakes have been made by the persons responsible for its construction. The exact location or exact boundaries of some subdivisions of the following districts have been found to be wrong but I could not correct them: d_{24}, d_{30}, d_{40}, d_{49}, d_{68}, d_{69}, d_{78}, d_{106}, d_{107}, d_{108}, d_{124}, d_{192}, d_{221}, d_{226}, d_{232}, d_{238}, d_{239}.

public transport is of a negligible need. Usually, in this case, our measure of traffic flow is the number of cars passing a certain section in a certain direction during a specified time. Since all active members of each family or the entire family move as one unit in a car or in other words, since car ownership is a factor of the number of families rather than a factor of number of people, then traffic movement could be also related to the number of families rather than the number of people. It follows that, if each person who can drive a car in the U.S.A. owns it, then the criterion of the family as a parameter should not be valued.

Rejecting the population and the number of families as an independent parameter in the case of Cairo, I chose the number of economically active members and actually participating members as my parameter. Of course it is not the best choice since it neglects the housewives as well as university students who are actually participating in the traffic for different purposes. This difference could be tolerated due to the fact that not all of the economically active members are actually participants in traffic.

5. Fortunately, among the valuable data which is available, is a decent research on the family budget - "consumer behavior" - conducted by sample methods under the supervision of the U.A.R. Central Committee of Census in 1958-59, which have been published in April 1961.(44)

The following table represents a level of spending on transportation (per capita spending/year in piasters - raw (2)) for various groups according to some social differences in urban areas.

From Table XXIX we can notice a definite correlation between level of transportation spending (or demand) and income or literacy level. Also, if we combine professionals and administrators in one group and call them professionals, clerks in another group, those engaged in commerce in a third group and finally all other activities in a fourth group, we can notice also a correlation between economic activity and transportation consumption behavior with an average spending of 625, 301, 142 and 102 for each group respectively. That is according to a ratio of 6.13 : 2.96 : 1.39 : 1 respectively.

Since we have identified each subdistrict by income groups, as related to its participation in economic activities to which we have a correlation between that activity and investment or transportation, then we can get a factor identifying the population of each subdivision as participants in public transportation.

If: f_i identifies those participants in professional activities in the i-th subdivision

k_i identifies those participants in clerical activities in the i-th subdivision

m_i identifies those participants in merchant activities in the i-th subdivision

O_i identifies those participants in other activities in the i-th subdivision

or

$$O_i = 1 - (f_i + k_i + m_i) \, . \qquad (1)$$

TABLE XXIX

AVERAGE PER CAPITA YEARLY SPENDING ON TRANSPORTATION (IN PEASTERS) IN URBAN AREAS

a - Income level of the head of the family - raw (1) in Egyp. Lbs./Yr.:

(1)	25	50	75	100	150	200	250	300	400	600	800	1000	(Income level)
(2)	2	3	57	80	113	114	168	210	354	600	757	1745	(per capita spending)

b - Economic Activity of the head of the family:

(1)	Professionals	Administrators	Clerks	Commerce	Agriculture	Transport	Craftsmen	Services	(Economic activity)
(2)	636	589	301	142	88	97	106	98	(per capita spending)

c - Level of education of the head of the family:

(1)	Illiterate	Reads Only	Reads and Writes	Less than High School	High School or equal level	University 1st degree	University Higher than 1st degree	(Level of education)
(2)	74	87	159	229	456	821	2201	(per capita spending)

d - Number of persons per family:

(1)	1	2	3	4	5	6	7	8	9	10(Number of persons/family)
(2)	262	375	259	234	202	153	149	117	216	170(per capita spending)

Bearing in mind that in the previous chapter we have identified each subdivision by three economic activities only, and now we are recalling the percentage of the last economic activity.

Then f_i may equal $I_A = 45.2\%$ to $V = 2.8\%$ and k_i equals

$k_i1 = 3.4\%$ to $k_i5 = 21.2\%$ and m_i may equal

$m_i1 = 4.5\%$ to $m_i7 = 30.1\%$ as indicated in Chapter IV.

Since the ratio between investment per year per each person in a family headed by an economically active member participating in one of the mentioned groups is 6.13 : 2.96 : 1.39 : 1 respectively and since the ratio does not represent actual trip trend* then it should be adjusted. It is logical to assume that the first class passengers are all or a fraction of the professional people, then if the actual trip ratio is $\alpha_f : \alpha_k : \alpha_m : \alpha_o$ then we will have the following constraints:

(1) assuming $\alpha_o = 1$ therefore $\alpha_m = 1.38$ and $\alpha_k = 2.96$

(2) $\alpha_f \leqslant 6.13$ and $\alpha_f > \alpha_k > \alpha_m > \alpha_o$

$$\frac{\alpha_f \sum P_i \times f_i}{P_i(f_i\alpha_f + k_i\alpha_k + m_i\alpha_m + 0_i\alpha_o)} = \frac{30}{100} \qquad (2)$$

where P_i = number of economically active members in the i-th subdivision. From Equation (2) it has been found that:

$$\alpha_f = 4.01$$

If

$$\beta_i = f_i\alpha_f + k_i\alpha_k + m_i\alpha_m + 0_i\alpha_o \qquad (3)$$

---

* Because we have two class fares for the same distance. First class revenue equal 30% of the total.

Let $$\lambda_{60} = \frac{680,000,000}{\sum P_i \beta_i} \qquad (4)$$

where 680,000,000 is the total number of trips per year in 1960 for the metropolitan area of Cairo.

Therefore $\lambda_{60} = 383$

If K_i is the trip potential for the economically active population in the i-th subdivision; i.e., the per capita number of trips per year for the economically active members.

Therefore $$K_i = \lambda_{60} \beta_i \qquad (5)$$

K_i actually represents the number of trips per year per each economically active member in the i-th subdivision.

At this stage, if the data on the place of each activity as well as its relative size had been available, then the study of the existing traffic flow would have been very simple, and in turn the traffic projection would be also simple and more accurate. But as I have mentioned in the first chapter, if we have to wait for all information to be available, then we have to wait forever.

6. The last group of available information is concerned with the city's transportation network, including its suburbs.

We have the path of each transport system from its origin to its destination. That path can be identified easily by some chosen points at their intersections or at joint path points. These points have their coordinates calculated using the same grid for the center of gravity points of the subareas of the city. The best points to be chosen should be at the bus stops or the stops of other systems. If they do not have common stops or if the stops in one direction are not facing

those of the other direction, then inbetween points should be taken, but in any case the numbers and location of the chosen points should be in some way related to these stops. This condition could not be satisfied in our case.

Other information is the volume of passengers per year for each line of each public transport system. The following are the symbols given to each line:

BL_S = the bus line number S

YL_S = the trolly bus number S

TL_S = the tramway number S

ML_S = the metro number S

RL_1 = Helwan railway line

RL_2 = El Mattaria railway line

Therefore $'VBL_2$, for example, will designate the number of passengers per year using bus line number 2. Knowing that all public transportation systems work for 16 hours a day, then VBL_2 designates the average number of passengers per working hour using bus line number 2, i.e.,

$$VBL_2 = {}'VBL_2/365 \times 16 \qquad (6)$$

Also any point or stop on a transportation line is designated by J, where J varies from 1 to N. Then $TL_{2,20}$ designates the point (or stop) number 20, through which the tramway line number 2 passes. We know from Chapter I that the peak hourly volume is 30% higher than the average, and lasts for three hours, the average hourly volume continues for seven hours and the low traffic volume is 30% less than the average and lasts for six hours.

The third group of available information, or that which could be approximately calculated, is the average daily round trip made by all units working on each line and is designated by $\acute{\psi}$. If $\acute{\psi}$ = average available capacity provided by a line (LS) per one working hour.

Therefore

$$\psi_{L_S} = \frac{L_S \text{ x average unit capacity of a line}}{16} \tag{7}$$

$$\psi_{BL_S} = \frac{\acute{\psi}_{BL_S} \text{ x } 60}{16} \tag{8}$$

$$\psi_{YL_S} = \frac{\acute{\psi}_{YL_S} \text{ x } 70}{16} \tag{9}$$

$$\psi_{TL_S} = \frac{\acute{\psi}_{TL_S} \text{ x } 50}{16} \tag{10}$$

$$\psi_{ML_S} = \frac{\acute{\psi}_{ML_S} \text{ x } 125}{16} \tag{11}$$

$$\psi_{RL_1} = \frac{\acute{\psi}_{RL_1} \text{ x } 750}{16} \tag{12}$$

$$\psi_{RL_2} = \frac{\psi_{RL_2} \text{ x } 530}{16} \tag{13}$$

where 60, 70, 50, 125, 750 and 530 are the average calculated actual capacity for each of the units of the respective transportation systems. It should be noted here, that the capacity of each unit in any of the public transport systems is not the actual number of seats plus the allowable number of standing persons, but it is the actual number of people who are actually accommodated in each unit, i.e., the actual capacity exceeds the theoretical capacity at least during the peak hours. In any case, the actual capacity should not be less than the theoretical capacity. It follows that we can calculate the average provided capacity at any point

on the network by simply adding the average actual capacities of all lines of all systems passing that point. The average provided capacity at any point J on the network per hour is designated by ψ_J.

The last piece of information is the number of tickets sold in each railway station on the suburban lines Helwan and El-Mattaria. The distribution of passengers ascending and descending all other lines along their path is not available, otherwise it would have been of excellent value.

C. The Solution for the Traffic Projection

It remains now, to find some available technology which could be directly applied to our case for the projection of traffic in the future years, or which could be partially used or modified to be acceptable in application.

Our aim is to estimate the traffic volume which will be carried by each line on the transportation network. Also, it will be better if our solution can lead to estimate the number of passengers leaving, passing through, or catching each line at any point. That is, if for example, we have the actual bus stops of a bus line BL_S, then what will be the actual number of passengers using that line at each of these stops?

If a scientific solution then could be reached and traffic projection could be achieved with a reasonable degree of confidence, then this solution or technique could be of a valuable potential for the design of public transport passenger movement in Cairo and probably in the Egyptian region.

Available data summarized and reduced to its simple usable form in Section B of this chapter, draws one's thinking towards an approach

by which a theoretical evaluation of the volume of traffic in 1960 could be accomplished for each transport line. Modification of this approach should be carried on until a correlation between the theoretical and actual volumes could be found, then we can conclude that we are on the right track.

The most promising technique which could be partially applied and modified is the "Gravity, Potential, and Spatial Interaction Models."(45-57

Suppose there is a metropolitan area with population P, as shown in Figure 40. If internal trips per year taken by the inhabitants of this area is T then $\lambda = T/P$ is the per capita number of trips per year.

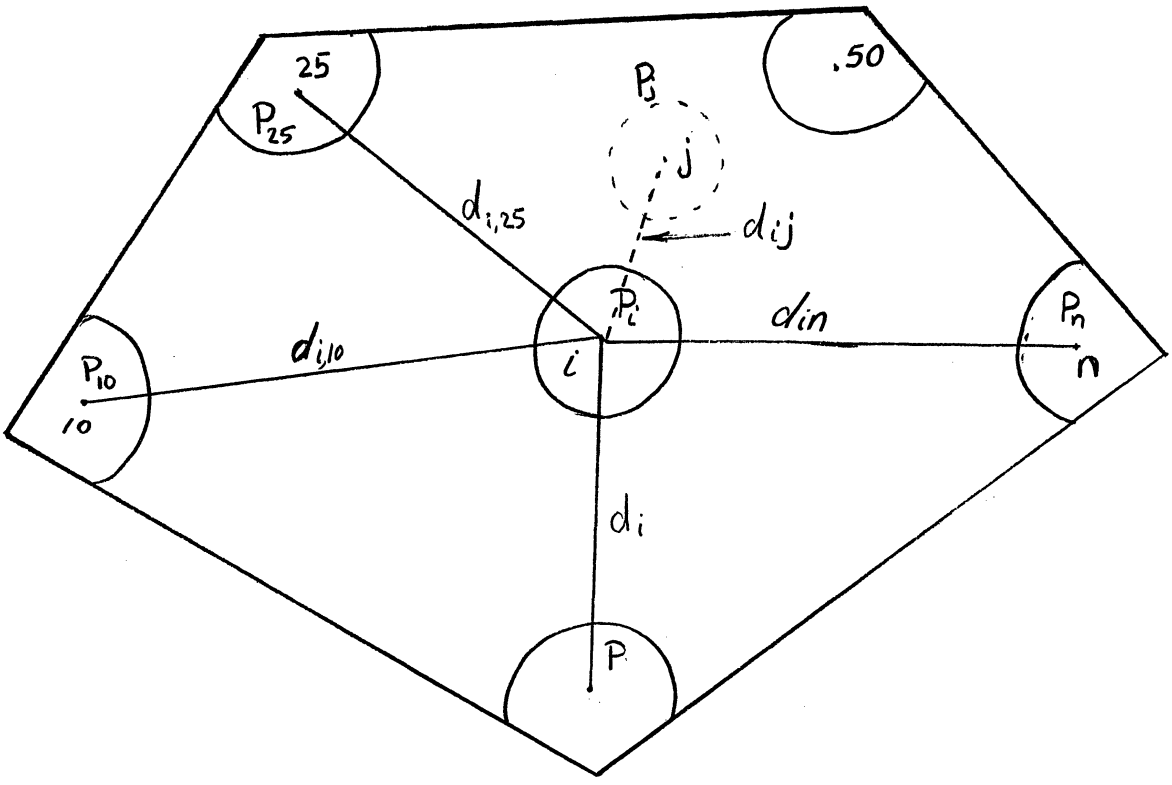

Figure 40. Hypothetical Interaction between Subareas in a Metropolitan Area.

Suppose the area is divided into n number of small divisions with known population of P_i where i ranges from 1 to n. Assume also, as a hypothetical case, that the movement is free of cost and time restraints. Assume also that all populations have social homogenity so as to assume an even utility function for transportation demand among them. Let us assume, further, that all activities are evenly distributed that there is no one subdivision that has more attractive powers than any other subarea, or in other words, there is no land use effect.

Now we expect that the percent of trips for a representative individual in subarea i to terminate in subarea j equals P_j/P. It follows that this absolute number of trips per year to subarea j $= \lambda \frac{P_j}{P}$. Then for the entire population of subarea i, the number of trips per year to subarea j equals:

$$T_{ij} = \lambda \frac{P_i P_j}{P} \qquad (14)$$

It should be noted here that T_{ij} is equal to T_{ji} and the total interaction $= 2T_{ij}$.

Distance and Cost Effect

Distance as a friction factor in travel comes with it, the cost, time, and effort effects to a reasonable extent. If I_{ij} represents the actual number of trips between the i-th and j-th subareas, then for a number of subareas having different distances inbetween a straight line relation could be found by plotting distances d_{ij} against actual over theoretical number of trips on a log-log scale as in Figure 41.

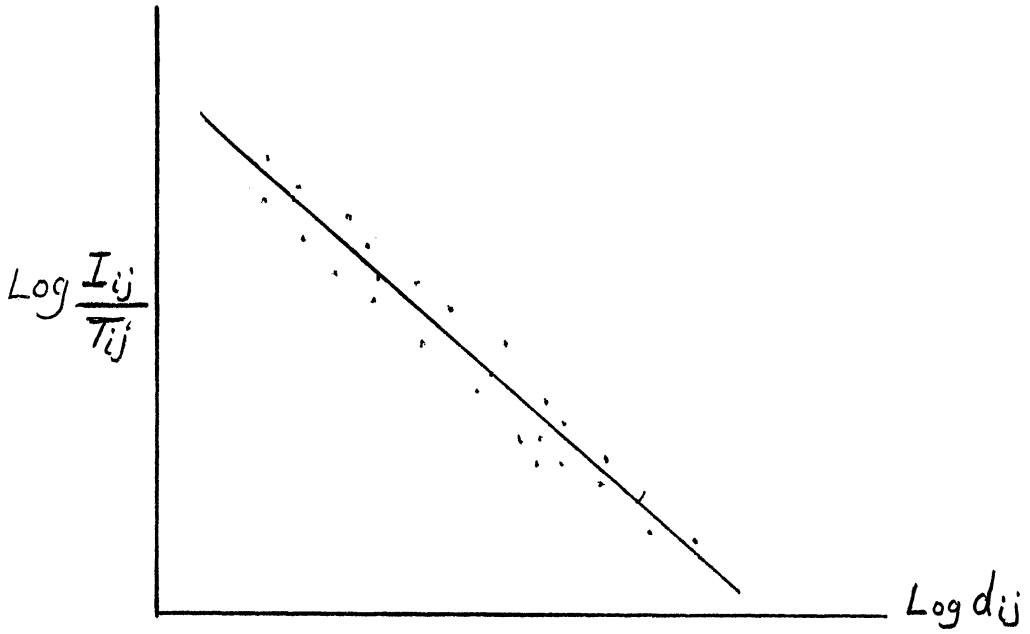

Figure 41. Distance Effect on Travel Pattern.

Therefore

$$\log \frac{I_{ij}}{T_{ij}} = a - b \log d_{ij} \tag{15}$$

where a is a constant which is the intercept of the straight line with Y axis, and b is a constant defined by the slope of the line. Let c equal the antilog of a, we have

$$\frac{I_{ij}}{T_{ij}} = \frac{c}{d_{ij}^{b}}$$

or

$$I_{ij} = \frac{cT_{ij}}{d_{ij}^{b}} \tag{16}$$

Substituting in Equation (16) the value of T_{ij} given in Equation (14) and letting $G' = c\lambda/P$ where c, λ and p are constants as defined earlier, we obtain

$$I_{ij} = \frac{G' P_i P_j}{d_{ij}^{b}} \tag{17}$$

The sum of interaction between subarea i and all other subdivisions could be evaluated then as

$$\sum_{j=1}^{n} I_{ij} = \acute{G} \sum_{j=1}^{n} \frac{P_i P_j}{d_{ij}^b} \qquad (18)$$

Dividing both sides by P_i to determine the per capita or per unit of mass total interaction with all the region including subarea i itself:

$$\frac{\sum_{j=1}^{n} I_{ij}}{P_i} = \acute{G} \sum_{j=1}^{n} \frac{P_j}{d_{ij}^b}$$

replacing the left hand side by the symbol $\acute{\rho}_i$ which usually designates a potential of interaction at the center of gravity of subarea i therefore:

$$\acute{\rho}_i = \acute{G} \sum_{j=1}^{n} \frac{P_j}{d_{ij}^b} \qquad (19)$$

Social Effect

We have seen from Table XXIX of Part B of this chapter how the consumption function of transportation varies according to so many social differences and how we developed β_i in Equation (3). β_i could be inserted in Equation (17) through Equation (19) and could be associated with either P_i or P_j depending on the situation as will be seen later.

Land Use Effect

It is evident that weight of land use cannot be evenly distributed in all subdivisions in a metropolis. Since this is the case then

each subarea should be weighed according to the type of activities it creates, which attract different sizes of traffic volume.

If w_i designates a potential power of attraction of the i-th subarea due to its land use, then this factor could be inserted in Equations (17) through (19) to give with the use of β_i a final form of travel interaction between an area and the rest of the regions.

Then Equation (17) after inserting K_i and w_i becomes

$$I_{ij} = \acute{G} \frac{K_i P_i \times w_j P_j}{d_{ij}^b} \tag{20}$$

Where $\acute{G} = c/P$ and $K_i = \lambda \beta_i$.

Similarly

$$I_{ji} = G \frac{K_j P_j \times w_i P_i}{d_{ji}^b} \tag{21}$$

That is at this point we no longer claim that $I_{ij} = I_{ji}$ since $K_i w_j$ is not always equal to $K_j w_i$. The total interaction then between subareas i and j equals $I_{ij} + I_{ji}$.

Equation (18) becomes

$$\sum_{j=1}^{n} I_{ij} = \acute{G} \sum_{j=1}^{n} \frac{K_i P_i \times w_j P_j}{d_{ij}^b} \tag{22}$$

Similarly

$$\sum_{i=1}^{n} I_{ji} = \acute{G} \sum_{j=1}^{n} \frac{K_j P_j \times w_i P_i}{d_{ij}^b} \tag{23}$$

Also Equation (19) becomes

$$\acute{\rho}_i = \acute{G} \sum_{j=1}^{n} \frac{K_i \times w_j P_j}{d_{ij}^b} \tag{25}$$

Where

$$\rho'_i = \frac{\sum_{j=1}^{n} I_{ij}}{P_i}$$

and represents the potential of each individual in subarea i to interact with the rest of the region.

Similarly

$$\rho'_i = G \sum_{j=1}^{n} \frac{P_i w_i \times K_j P_j}{d_{ji}^b} \qquad (26)$$

Where

$$\rho'_i = \frac{\sum_{j=1}^{n} I_{ji}}{P}$$

and represents the interaction of the rest of the region including subarea i on a per capita basis with the i-th subarea. We also, instead of using the per capita potential of the whole region in Equation (26) can limit it to P_i instead of P so that we can apply the potential equation at any point instead of at any subarea and the equation becomes

$$\rho_J = G' \sum_{j=1}^{n} \frac{w_J \times K_j P_j}{d_{ji}^b} \qquad (27)$$

Therefore the difference between ρ'_i as ρ_J is that ρ'_i in Equation (26) represents the interaction between each individual in the region with the total subarea i, while ρ_J, is the total interaction of all people of the rest of the region with a point J in any subarea i.

If an origin and destination studies as well as land use evaluation as related to its attractive power for passengers are available for a certain area then G and w_J in the last series of equations

could be solved. In our case this type of information is not available and instead we have the path of each line of the network and the volume of traffic carried by each line.

Evaluation of a Path of a Line

Assume a bus line BL_1 starts from an origin bus stop 1 to a final destination stop, as in Figure 42. Assume further that at each bus stop the population of the community which can use that line is known, i.e., from P_1 to P_n.

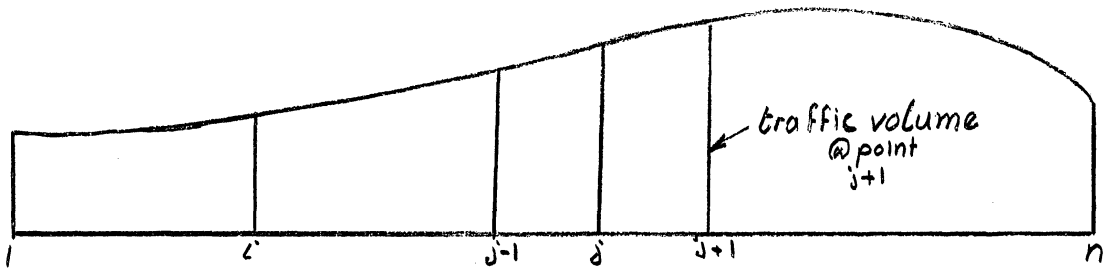

Figure 42. Traffic Volume Along a Line Path.

To describe the volume of passengers using the line at any stop from one direction to another, say from origin to destination, then at any bus stop, say i we have:

a) The sum of passengers living in communities from 1 to i and choose their origin at any stop from 1 to i but their destination varies from 1 to n. This value has a positive value.

b) The sum of passengers of the previous sections having their destination points at any point from 1 to i. This sum has a negative value.

c) The sum of passengers living in communities from i to n who are present at any stop from 1 to i and returning to their origin from i to n. This sum has a positive value.

For part a,

at stop 1 = $\sum_{j=2}^{n} I_{ij}$

at stop 2 = $\sum_{j=3}^{n} I_{2j}$

at stop 3 = $\sum_{j=4}^{n} I_{3j}$

at stop i = $\sum_{j=i+1}^{n} I_{ij}$

For part b,

at stop 1 = zero

at stop 2 = $-\left[I_{11} + I_{12}\right]$

at stop 3 = $-\left[I_{11} + I_{12} + I_{13} + I_{23}\right]$

at stop 4 = $-\left[\sum_{j=1}^{i} I_{ij} + I_{23} + I_{24} + I_{34}\right]$

at stop 5 = $-\left[\sum_{j=1}^{i} I_{1j} + \sum_{j=2}^{i} I_{2j} + \sum_{j=3}^{i} I_{3j} + \sum_{j=4}^{i} I_{4j}\right]$

$$\text{at stop } i = - \sum_{i=1}^{i} \sum_{j=i-1}^{i} I_{i-1,j}$$

For part c, at stop 1 $= \sum_{j=2}^{n} I_{ji}$

$$\text{at stop } 2 = \sum_{j=2}^{n} I_{j2} + \sum_{j=3}^{n} I_{j2}$$

$$\text{at stop } 3 = \sum_{j=2}^{n} I_{j1} + \sum_{j=3}^{n} I_{j2} + \sum_{j=4}^{n} I_{j3}$$

$$\text{at stop } i = \sum_{i=1}^{i} \sum_{j=i+1}^{i} I_{j4,i}$$

The line path equation then will be, at any stop i the volume of traffic (V) using that line L_S is equal

$$VL_S = \sum_{j=i+1}^{n} I_{ij} + \sum_{i=1}^{i} \sum_{j=i+1}^{n} I_{ij} - \sum_{i=1}^{i} \sum_{j=i-1}^{i} I_{i-1,j} \qquad (28)$$

I_{ij} and I_{ji} as shown in Equations (20) and (21).

Equation (28) is ideally applicable in the case of a railway line passing the centers of regions or Governorates in our case, especially the Upper Egypt line from Aswan to Cairo where there is no interferences from other lines. Also it is applicable in the case of a bus line working between two cities and passing by scattered villages.

In an urban area it is difficult to apply this equation except where we can define exactly the area accessible to that line at each stop, i.e., we have to replace our subdivisions which are limited by existing political boundaries with other divisions having boundaries measured by walking distance from the stop of a line. The second

restriction to use this equation is that this line should not be intercepted or overlapped by another line. This is rarely the case in an urban area using many mixed and flexible public transport systems. Still if we can overcome the above difficulties we cannot apply this equation to the case of Cairo since $\acute{G}$ and w_i are not known and cannot be replaced by other measures as they are used now in Equation (28).

Alternative Solution

Let us now restate the available data in some systematic and diagrammatic form, as in Figure 43.

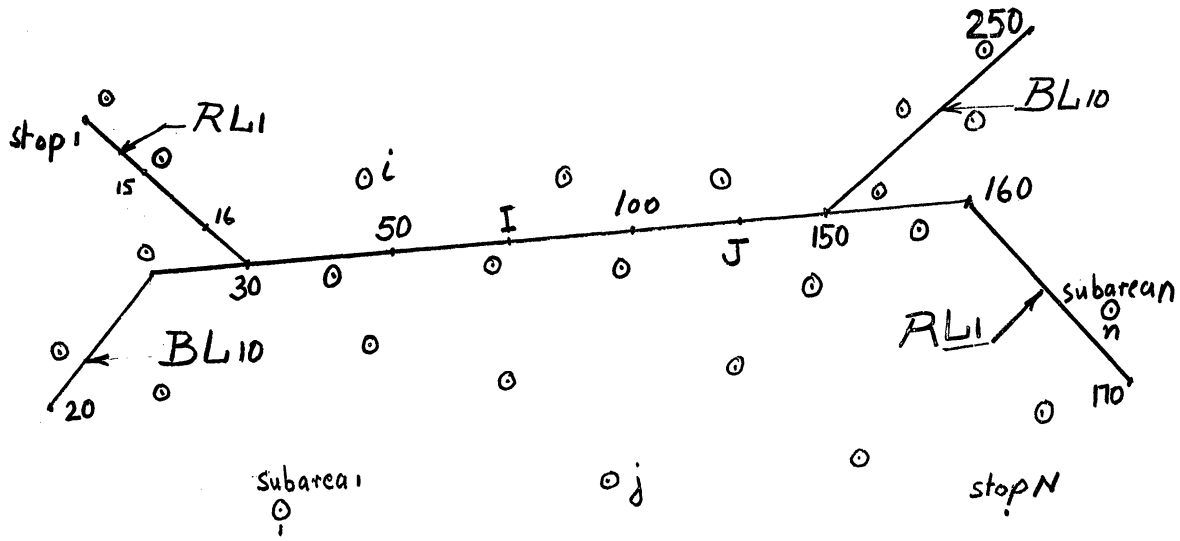

Figure 43. Representation of a Network in a Space

a) The center of gravity of subareas i from 1 to n designated by ⊙

b) Some lines passing points not necessarily the c.g. of the subareas. Assume only two overlapping lines BL_{10} and RL_1 as shown in Figure 43.

c) We have identified the path of each line as passing through some points of known coordinates. BL_{10} passes through points 20, 30, 50, 100, 150 and 250. RL_1 passes through points 1, 15, 30, 50, 100, 150, 160 and 170.

From the previous equations the only one which explains the interaction between any point in the space of a region with the rest of that region is equation

$$\rho_J = \acute{G} \sum_{j=1}^{n} \frac{w_j \times K_j P_j}{d_{ji}^b}$$

where J is a point or a stop on the network and varies from 1 to N. In this equation $\acute{G}$ is unknown, K_j is known for each subdivision, b is practically chosen equals 2 to be exactly describing a physical phenomena and finally we have w_i at a point and not at all subareas as needed in all other equations. So this is the equation that needs least information. If we somehow find a notion which explains w_J at any point where a line or more passes through, then this equation could be of a great help. The equation then in its final form is

$$\rho_J = G \sum_{j=1} \frac{w_J \times K_j P_j}{d_{jJ}^2} \qquad G = \acute{G} \text{ after its adjustment when b equals to } \underline{2}. \tag{29}$$

d) We have the volume of traffic through each line which theoretically should equal to the sum of the potentials ρ_J at the points where this line passes, if not overlapping, occurs. For RL_1

the volume of traffic from the original point (1) up to point 16, i.e., VRL_1 (1, 15, 16) should equal to $P_1 + P_{15} + P_{16}$, that is,

$$VL_S = \sum_{J=1}^{N} \rho_J = \sum_{J=1}^{N} \sum \frac{w_J \times K_j P_j}{d_{jJ}^2} \qquad (30)$$

When the line is overlapped, say at points 30, 50, 100, 150, then it is logical to assume that the share of RL_1 from the total traffic available at these points is proportional to the ratio

$$\frac{\text{capacity of } RL_1}{\text{total provided capacity at each point}} \quad \text{i.e.,} \quad \frac{\psi_{RL_1}}{\psi_I}$$

e) It remains then to find some way to measure w_J in Equation (30).

If our public transport network in the city of Cairo had been distributed properly to provide a capacity equal to/or in proportion to the demand at any point on that network, then it is also logical to assume that w_J (the degree of attractiveness to travel due to land use effect) at any point J is equal to travel demand at the same point. It follows that w_J is proportional to the provided capacity at a point J to the total provided capacity of the network.

That is,

$$w_J = \frac{\psi_J}{\Sigma \psi_{L_{SI}}} = \frac{\psi_J}{\psi} \qquad (31)$$

Where $\Sigma \psi_{L_S} = \psi$ equals the sum of the total provided capacity of all lines on the network.

Equation (29) then becomes:

$$VL_{SJ} = \sum \frac{\psi_{L_{SJ}}}{\psi_J} \rho_J$$

$$= G \sum \frac{\psi_{L_{SJ}}}{\psi_J} \cdot \frac{K_j P_j}{d_{jJ}^2} \cdot \frac{\psi_J}{\psi}$$

Therefore,

$$VL_{SJ} = G \sum \frac{\psi_{L_S}}{\psi} \cdot \frac{K_j P_j}{d_{jJ}^2} \qquad (32)$$

If ν_{L_S} represents

$$\sum \frac{\psi_{L_S}}{\psi} \cdot \frac{K_j P_j}{d_{jJ}^2}$$

Therefore,

$$VL_S = G \nu_{L_S} \qquad (33)$$

f) Since we have the values of all VL_{SJ} for 1960, and since the values of $\nu_{L_{SJ}}$ could be calculated for 1960 also, then we can plot both values with VL_{SJ} on the vertical axis and $\nu_{L_{SJ}}$ on the horizontal axis we can draw a fitted straight line passing through the origin and representing the public transport behavior in an urban area. The slope of that line is equal to G which takes care of the distance effect over the total population, as shown in Figure 44.

For both years 1975 and 1985 we can calculate the $\nu_{L_{SJ}}$ and from the straight line relation we can project the values of VL_{SJ}.

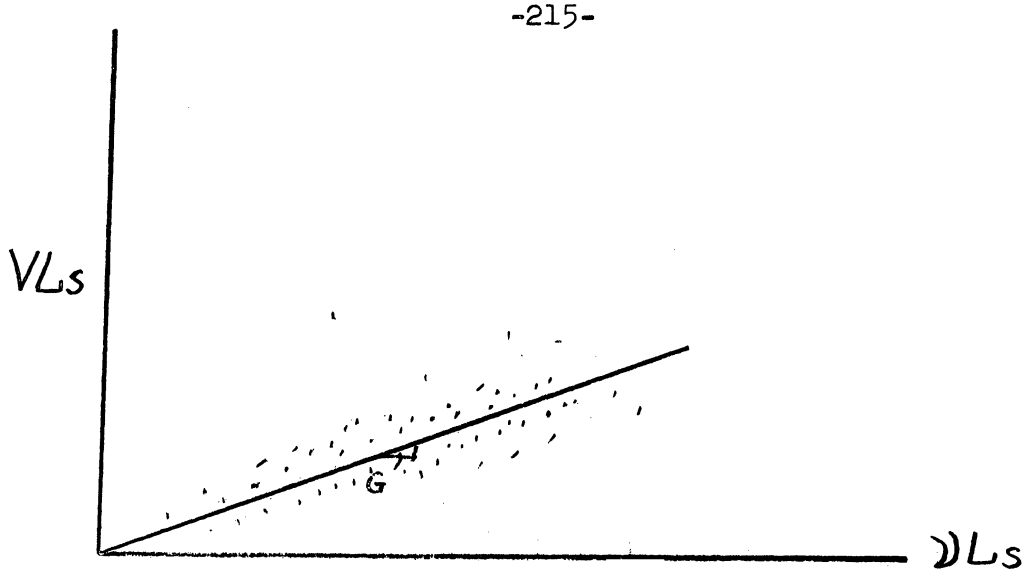

Figure 44. Public Transport Behavior in an Urban Area.

D. Results and Their Analysis

1. Calculated values of K_i are shown in Appendix C. K_i as defined before, is the average per capita number of trips per year for each economically active member in each subarea. The values of K_i vary from 442 trips for subarea d_{150}, to 1100 trips for subarea d_{198}. Each of these members work at least 260 days per year. That is, if he has to use the public transportation system for his way to work and vice versa, he has to make at least 520 trips per year. In other words, in the poorer community at least 13% of the trips to work have been consumed within that community on foot, while the richest community has consumed its normal trips to work outside that community and exceeded that by 111% for trips other than work purposes.

Projected values of K_i for 1975 and 1985 have been also shown in Appendix C.

2. Figure 45 shows some points obtained from the available data of 1960 for VL_S, and the calculated values of $)L_S$ for the same year.

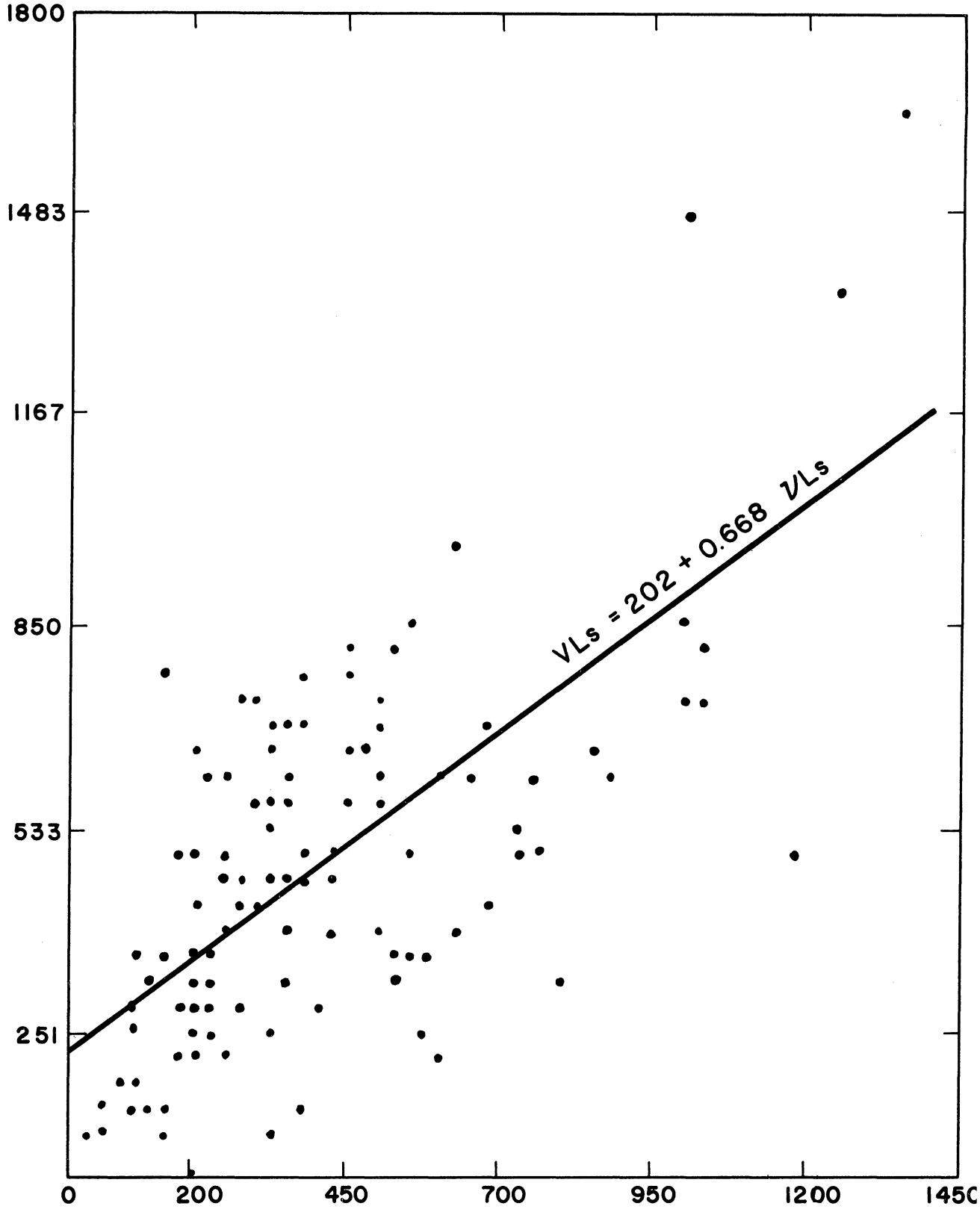

Figure 45. Public Transport Behavior in Cairo.

For all points (exclusive of BL_S', YL15, RL1 and RL2, for reasons explained later), the correlation coefficient between both values has been found to equal 0.65.

The equation of the best fitted straight line for these points has been found to be

$$VL_S = A + b\,\mathcal{V}L_S \qquad (34)$$

where

$$A = 202 \quad \text{and} \quad b = 0.668$$

Figure 45 indicates that the straight line cuts the vertical axis rather than the horizontal. Statistically speaking the actual line that describes the relation between VL_S and $\mathcal{V}L_S$ can cut either axis. Since the best fitting straight line is adoped, then the value A - when it is positive - has no meaning. On the other hand, when the straight line cuts the horizontal axis at a constant value A, its equation becomes

$$VL_S = G\,[\mathcal{V}L_S - A] \qquad (35)$$

The constant A then, indicates that, whenever the sum of the potentials at successive points - multiplied by $\psi L_S/\psi$ - , and when this value equals to or is less than A, then there is no need to operate any line to pass through these points. In other words, the experience of the responsible authority of any public transport shows that it is a burden to run some lines whereever $\mathcal{V}L_S \leq A$.

The maximum loss of passengers to any transport line can be -G.A., but how many times this maximum value has occurred within the network, we do not know. This would also be true for any line having $\mathcal{V}L_S < A$. Then the value $-\frac{1}{2}$ GA x A does not actually represent the total traffic lost by the network.

VL_S becomes zero when $\mathcal{V}L_S$ equals to A. That is,

$$\mathcal{V}L_S = \sum_{J=1}^{N} \sum_{j=1}^{N} \frac{K_j P_j}{d_{ij}^2} \cdot \frac{\psi L_S}{\psi}$$

where ψ_{L_S} is the total provided capacity of a line, and ψ is the total provided capacity of a network then $VL_S = 0$.

Therefore

$$A = \sum_{J=1}^{N} \sum_{j=1}^{n} \frac{K_j P_j}{d_{ij}^2} \cdot \frac{\psi_{L_S}}{\psi}$$

therefore

$$\sum_{J=1}^{N} \sum_{j=1}^{n} \frac{K_j P_j}{d_{ij}^2} = \frac{\psi}{\psi_{L_S}} \times A$$

Suppose that we have a new line, where only one unit is working on it. This unit has a high speed that can accommodate all the lost traffic volume. Suppose also that this unit has only one unit capacity, say a motorized bicycle for example. The ψ_{L_S} becomes 1:

Therefore

$$\sum_{J=1}^{N} \sum_{j=1}^{n} \frac{K_j P_j}{d_{ij}^2} = \psi \times A$$

But since the seat occupancy of the network equals V/ψ, on the average, where $V = \sum VL_S$ which is the actual number of passengers carried by the network per unit of time. The unit of time of V should be equal to the unit of time of ψ.

Therefore

$$\sum_{J=1}^{N} \sum_{j=1}^{n} \frac{K_j P_j}{d_{ij}^2} = A \times \psi \times \frac{V}{\psi} = A \times V$$

Multiplying both sides by G to take care of the distance effect, we then designate the left hand side by η

Then

$$\eta = G \times A \times V \qquad (36)$$

In other words the number of passengers that the public transport is losing, per unit of time when it does not operate its lines every where, equals η.

Unfortunately, due to some serious discrepancy in the available data - which is listed below - the straight line cuts the vertical instead of the horizontal axis. This discrepancy is due to:

i) the center of gravity (c.g.) of the areas has been used in this research, while it would be more accurate to use the c.g. of the population concentration especially on the edge of the city where the subdivisions are large and the population is concentrated in few spots, as in the case of d_{94}.

ii) the key map of the city - Figure 2 - showing the boundaries of its subdivisions, has some mistakes which are recorded in footnote of Page 193. These mistakes have resulted in assigning a low income level to some subdivisions - e.g., d_{232} - while it is known that a major part of them are of high income level. If followed that k_i has been changed from 1100 to about 450 resulting in low potential values for all lines passing these subdivisions, while their traffic volumes are too high, as in the case of YL15 and BL5.

iii) although I have calculated the unit capacity of each line according to some principles, but the personal judgment has played a part to reach the figures stated in Page 200. That resulted in assigning very high potentials for some lines relative to other lines, as in the case of RL1 and RL2. Provided unit capacities could be reached by sampling methods of minor and inexpensive work.

iv) the model used in this research was based on measuring the potential at each stop of each line. Since we had no idea about these actual stops, some random points have been choosen and the potential of each line has been calculated. These potentials have to be adjusted as explained in Table III, Appendix D. This method is just an approximation which may include some serious deviations from the accurate calculations.

3. From Equation (34), and from the calculated values of ν_{LS} for 1975 and 1985, the corresponding values of VL_S have been calculated and tabulated in Appendix D.

The values of VL_S could be easily converted to demanded capacities by dividing each value of VL_S for the projected years by the seat occupancy of 1960, where seat occupancy equals $\frac{VL_S}{\psi L_S}$.

Dividing these capacities by the unit capacity for each line gives the number of units needed for each line. The unit capacities given at the beginning of this chapter should be reduced for the projection years since those capacities have been calculated on the basis that it was permissible to overload each unit, a matter which should not be encouraged.

Anyhow the results in Table IV, Appendix D, should not be taken as granted. This work should be done again after the proper corrections are made and the data of the actual stops is inserted.

CONCLUSIONS

1. An effort has been made in part F of the first chapter, with help of Tables X and XI - Appendix A, to analyze and discover the relation between place of residence and place of work, with the absence of sufficient information. The conclusions abstracted from that part were general, but could not lead to quantitative values when land use effects were needed in the last chapter to project the traffic volumes.

The method could be carried further, especially when smaller subdivisions are analyzed by statistical techniques, to reach an average minimum requirement from each economic activity for each similar group of subareas.

In Chapter IV, w_i was introduced and was evaluated at some points on the transportation network. The results gave sufficient degree of confidence for this evaluation for the year 1960. Of course the values of w_i should be expected to change in 1975 and 1985 due to expected adjustment in the distribution of the network caused by the change in land use. Since there was no clear idea about the expected change in the land use effects in the future, then w_i was kept constant.

It is the future responsibility of Cairo's city planners to start building up sufficient information to calibrate the land use effect on transportation demand.

2. The public opinion in Egypt, even among the highly qualified bodies, is that a crucial part, to solve the congestion in the City of Cairo, is by the redistribution of all activities - especially industrial - evenly, but proportionally among all Egyptian clusters (urban cities, the Bandar, the Markaz and the village).

Discussions in the second chapter have proven that this is a serious trend which could lead to inefficient national economy and prosperity.

The dream to stop the increase of Cairo's population cannot be reached by any means. It should be realized that there is no time to be lost in dreams and hopes. The best that could be done is to lower gradually the rate of increase of the city by immediate establishment of large urban cities. The place for these large centers should not be at the Markaz or the Bandar, but they should be along the Mediterranean shores, the Red Sea shore, Sinai, the New Valley and Aswan. These centers should accommodate the population surplus of the old Nile Valley, leaving only a few of its population, sufficient enough to run activities in proportion to the Valley's economic potential. This is the only way to modernize the Old Valley. We conclude from this, that the redistribution of activities should be according to the economic potentials and not on the size of clusters, then demographic redistribution will follow.

3. The outcome of Chapter III, which has consumed a fair amount of time, is the evaluation of the social distribution and its effect on transportation. This evaluation has been translated successfully to trip pattern (β_i) for each subdivision. This method used to evaluate β_i in this research is simple but successful.

The choice of the economically active members instead of total population or number of families, as the independent parameter of trip generation especially in a society like that of Egypt - has also proved its validity.

4. Conclusions from the theoretical part has thrown some new lights on the application of the gravity model in transportation.

a) The land use effect w_i has been clearly defined in the new model, a matter which was vague in the literature.
Since no data were available for w_i from a direct sampling method at any point, it has been assumed that $w_i = \psi_i/\psi$ which is

$$\frac{\text{total provided capacity at a point}}{\text{total provided capacity of the network}} .$$

This value could also be extended to be applicable in a society where public transport has a neglible value. Instead, ψ_i/ψ will equal

$$\frac{\text{total traffic flow at a point in number of cars/unit of time}}{\text{total traffic flow in the whole urban area}} .$$

If w_i could be obtained by sampling methods, then the relation between w_i and ψ_i/ψ would give an excellent idea as to whether the public transportation network has been properly distributed or not.

b) In the literature before, it has been thought that I_{ij} equals I_{ji}, a matter which has been proven to be wrong. They are only equal when social and land use effects are equal in both subareas.

c) The application of the gravity model, to describe the path of a transportation line, is also a contribution to the literature.

d) The model used here could be extended to clarify the following points:

i) where new bridges have to allocated;

ii) redistribution of a network;

iii) redistribution of the community with its activities to minimize the unnecessary trips.

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APPENDIX A

DEMOGRAPHIC, ECONOMIC AND TRANSPORTATION ANALYSIS IN CAIRO

TABLE I

NATIONAL POPULATION GROWTH IN EGYPT

Census Year	Females	Males	Total	Arabs Not Included	% Increase Per Year
1852	3,362,500	3,343,325	6,705,825	98,196	--
1897	4,743,740	4,891,012	9,634,752	79,773	2.9
1907	5,573,338	5,616,640	11,189,978	97,381	1.6
1917	6,348,738	6,369,517	12,713,255	32,663	1.4
1927	7,119,791	7,058,073	14,177,864	40,000	1.1
1937	7,954,019	7,966,675	15,920,694	12,000	1.2
1947	9,575,039	9,391,728	18,966,767	55,073	1.9
1960	12,915,580	13,067,820	25,983,400	--	2.85

TABLE II

PERCENTAGE OF URBAN POPULATION TO TOTAL POPULATION

Census Year	% Urban to Total	% Urban Increase Per Year
1882	19	--
1897	20	3.52
1907	19	1.04
1917	21	2.49
1927	23	2.21
1937	25	2.18
1947	31	4.8
1960	38	3.12

TABLE III

POPULATION GROWTH IN CAIRO AND OTHER MAJOR CITIES IN (000)s*

LOWER EGYPT

Census Year	Egypt No.	%	Cairo(1) No.	%	Alex-andria No.	%	Port Said No.	%	Ismailia No.	%	Suez No.	%	Dimiatta(2) No.	%	Tanta No.
1882	6,706	--	399	--	233	--	17	--	--	--	11	--	--	--	34
1897	9,635	2.9	590	3.2	316	2.4	43	10.2	--	--	17	3.6	--	--	57
1907	11,190	1.6	678	1.5	356	1.2	51	1.9	--	--	18	0.6	--	--	54
1917	12,718	1.4	791	1.7	445	2.6	75	4.8	--	--	31	6.9	--	--	74
1927	14,178	1.1	1,065	3.5	573	2.9	104	3.8	--	--	41	3.1	--	--	90
1937	15,961	1.2	1.312	2.3	686	2.0	125	2.0	36	--	50	2.3	40	--	95
1947	18,967	1.9	2,091	5.9	914	3.4	178	4.0	68	6.8	107	4.5	54	2.7	140
1960	25,983	2.85	3,736	6.1	1,516	5.0	245	2.9	284	2.4	204	7.0	388	?	184

LOWER EGYPT

Census Year	Tanta %	Mansoura No.	%	Aswan No.	%
1882	--	32	--	--	--
1897	4.6	37	1.2	--	--
1907	0	42	1.2	--	--
1917	3.6	51	2.3	--	--
1927	2.1	64	2.4	--	--
1937	0.6	69	0.8	--	--
1947	4.7	102	4.8	--	--
1960	2.4	151	3.7	48	--

UPPER EGYPT

Asuit No.	%	Minia No.	%
37	--	19	--
47	1.8	27	2.8
52	1.1	31	1.5
60	1.5	39	2.6
66	1.1	48	2.2
71	0.7	55	1.5
90	2.7	70	2.8
128	3.3	95	2.7

(1) Political boundaries of Cairo have been changed before 1960 Census, the Governorate's population is 3,349,000 but 3,736,000 was put to adjust for the previous boundaries.

(2) Governorate of Dimiatta has extended its boundaries, so the sharp increase between 1947 and 1960 is partially due to that change. The city of Dimiatta itself was 72,000 in 1960.

*Materials are collected from "Master Plan of Cairo", 1956 and 1960 Census.

TABLE IV

CAIRO POPULATION DISTRIBUTION BY SEX, FAMILIES, AND PERSONS PER FAMILY

District	Males	Females	% Males Total	Total	No. of Families	Persons per Family
El Azbakia	52,313	29,719	53.6	64,032	14,082	4.3
El Gamalia	72,970	68,754	51.5	141,724	29,168	4.8
El Khalifa	83,304	78,654	51.4	161,958	33,146	4.8
El Darb El-Ahmar	76,065	72,541	51.2	148,606	28,795	5.1
El Zaytoun	50,993	49,381	50.8	100,374	20,796	4.8
El Sahil	155,282	148,320	51.1	303,602	62,415	4.9
El Saida Zeinab	128,405	125,243	50.6	253,648	50,468	5.0
El Daher	52,164	47,453	52.4	99,617	18,551	5.1
El Mattaria	82,307	78,513	51.2	160,820	33,663	4.9
El Maadi	45,054	37,946	54.3	83,000	16,080	4.7
El Mouski	20,062	18,407	52.2	38,469	7,788	4.8
El Wayli	155,951	151,222	50.8	307,173	62,117	4.8
Bab El-Sharia	77,897	75,234	50.9	153,131	30,993	4.9
Boulak	103,907	98,116	51.4	202,023	44,302	4.5
Helwan	49,323	45,062	52.3	94,385	19,059	4.9
Rod El-Farag	135,106	130,033	51.0	265,139	53,413	5.0
Shoubra	152,928	143,080	51.0	296,068	63,395	5.0
Abdin	48,398	46,571	51.0	94,960	20,335	5.0
Kasr El-Nile	21,889	21,205	50.8	43,094	11,209	3.7
Heliopolis	60,852	63,922	49.8	124,774	26,385	4.7
Masr El-Kedima	107,135	105,098	50.5	212,233	42,894	4.9
Kism Giza (1)	74,000	71,332	50.9	145,332	29,654	4.8
Kism Giza (2)	52,764	52,438	50.2	105,202	22,390	4.7
Bender Imbaba	69,196	67,233	50.7	136,429	27,683	4.9
Kism El-Ahram	5,974	5,710	51.1	11,684	1,956	5.6
Shoubra El-Khima	52,897	47,710	52.6	100,617	22,320	4.5

TABLE V

AGE DISTRIBUTION IN CAIRO

	Cairo, % of Total			Egypt, % of Total		
Age Group	Male	Female	Total	Male	Female	Total
Less than 1 year	3.35	3.4	3.35	2.9	2.8	2.85
1-4 years	12.40	12.3	12.35	13.2	12.8	13.0
5-9 years	14.50	14.1	14.60	15.1	14.1	14.6
10-14 years	12.10	12.9	12.40	12.6	11.8	12.2
15-19 years	8.55	9.1	8.85	8.5	8.0	8.25
20-29 years	15.10	16.7	15.90	13.6	15.0	14.30
30-39 years	14.10	13.1	13.50	12.7	13.4	13.0
40-49 years	9.40	8.1	8.70	9.4	9.2	9.3
50-59 years	5.80	5.5	5.65	6.3	6.4	6.3
More than 60 years	4.70	4.8	4.70	5.7	6.5	6.1
Total	100	100	100	100	100	100

TABLE VI

POPULATION AND DENSITY DISTRIBUTION IN CAIRO

District	Area in Km² 1947	Area in Km² 1960	Population % Increase	Population 1947	Population 1960	Population % Increase	Pop. Density Person Km² 1947	Pop. Density Person Km² 1960	% Increase	Persons Per Room
1 El-Azbakia	1.703	1.70	0.0	75,421	64,032	15.10	44,287	37,666	16.95	1.8
2 El-Gamalia	4.47	4.80	7.38	108,744	141,724	30.33	24,097	29,526	22.53	2.8
3 El-Khalifa	25.42	8.60	66.16	122,660	161,958	32.04	4,825	18,832	253.60	2.6
4 El-Darb El-Ahmar	2.71	2.80	3.33	123,195	148,606	20.63	45,047	53,074	17.82	2.7
5 El-Zaytoun	--	4.20	--	--	100,374	--	--	23,899	--	2.2
6 El-Sahil	--	6.20	--	--	303,602	--	--	48,969	--	2.3
7 El-Saida Zeinab	4.05	3.50	13.58	193,864	253,648	30.84	47,581	72,471	52.31	2.3
8 El-Daher	--	1.90	--	--	99,617	--	--	52,430	--	1.8
9 El-Mataria	--	67.90	--	--	160,820	--	--	2,369	--	2.4
10 El-Maadi	--	25.10	--	--	83,000	--	--	3,307	--	2.2
11 El-Mouski	0.59	0.60	0.0	35,963	38,469	6.97	61,165	64,115	4.83	2.2
12 El-Wayli	15.78	16.50	4.56	207,370	307,173	48.13	13,143	18,617	41.65	2.4
13 Bab El-Sharia	1.84	1.10	7.09	133,334	153,131	14.85	112,182	139,210	24.09	2.7
14 Boulak	13.71	2.70	80.31	232,602	202,023	13.15	14,826	74,823	404.67	3.1
15 Helwan	--	6.40	--	--	94,385	--	--	14,748	--	2.4
16 Rod El-Farag	4.79	2.70	43.64	195,890	265,139	35.35	40,501	98,200	142.46	2.3
17 Shoubra	25.72	7.30	71.54	229,696	296,008	28.87	8,826	40,549	359.46	2.0
18 Abdin	6.80	1.70	74.98	119,956	94,969	20.83	17,638	55,864	216.71	1.9
19 Kasr El-Nile	--	6.00	--	--	43,094	--	--	7,182	--	1.0
20 Heliopolis	55.07	32.30	41.35	165,131	124,774	24.44	2,817	3,863	37.13	1.3
21 Masr El-Kadima	16.65	10.20	38.74	117,552	212,233	80.54	6,227	20,807	234.10	2.4
22 Kism Giza (1)	1.6	5.2	--	66,157	145,332	--	41,348	27,949	--	2.1
23 Kism Giza (2)	1.6	8.0	--	66,157	105,202	--	41,348	13,150	--	1.6
24 Bander Imbaba	--	--	--	--	136,429	--	--	--	--	2.6
25 Kism El-Ahram	--	--	--	--	11,684	--	--	--	--	2.2
26 Shoubra El-Khima	--	29.6	--	--	100,617	--	--	--	--	2.8

TABLE VII

POPULATION AND DENSITY DISTRIBUTION IN CAIRO(1)

District	Area in Km² 1947	Area in Km² 1960	% Increase	Population 1947	Population 1960	% Increase
1 Azbakia	1.60	1.70	6.25	54,549	75,421	38.26
2 El-Gamalia	4.50	4.47	0.6	74,291	108,744	46.37
3 El-Khalifa	15.20	25.42	67.23	81,046	122,660	51.34
4 El-Darb El-Ahmar	2.80	2.71	3.2	81,112	123,195	51.88
5 El-Zaytoun	--	--	--	--	--	--
6 El-Sahil	--	--	--	--	--	--
7 El-Saida Zeinab	4.00	4.05	1.25	128,216	193,864	51.12
8 El-Daher	--	--	--	--	--	--
9 El-Mataria	--	--	--	--	--	--
10 El-Maadi	--	--	--	--	--	--
11 El-Mouski	0.50	0.59	18.0	25,919	35,963	38.37
12 El-Wayli	16.40	15.78	3.78	123,754	207,370	67.57
13 Bab El-Sharia	1.20	1.18	1.67	87,113	133,334	53.05
14 Boulak	14.10	13.70	2.79	156,639	232,602	48.50
15 Helwan	--	--	--	--	--	--
16 Rod El-Farag	5.80	4.79	17.40	115,756	195,890	69.23
17 Shoubra	13.00	25.72	97.80	117,871	228,696	94.02
18 Abdin	17.11	6.80	60.25	112,697	119,956	6.44
19 Kasr El-Nile	--	--	--	--	--	--
20 Heliopolis	54.90	55.01	0.20	87,771	165,131	88.13
21 Masr El-Kadima	13.8	16.648	20.64	66,792	117,552	75.99

District	Population Density(2) 1937	Population Density(2) 1947	% Increase
1 Azbakia	34,093	44,287	29.90
2 El-Gamalia	16,509	24,097	45.96
3 El-Khalifa	5,332	5,325	--
4 El-Darb El-Ahmar	28,971	45,047	55.48
5 El-Zaytoun	--	--	--
6 El-Sahil	--	--	--
7 El-Saida Zeinab	32,054	47,581	48.44
8 El-Daher	--	--	--
9 El-Mataria	--	--	--
10 El-Maadi	--	--	--
11 El-Mouski	51,838	61,161	17.98
12 El-Wayli	7,546	13,143	74.17
13 Bab El-Sharia	72,594	112,182	54.50
14 Boulak	11,109	14,826	33.46
15 Helwan	--	--	--
16 Rod El-Farag	19,958	40,501	102.93
17 Shoubra	9,067	8,827	2.65
18 Abdin	6,507	17,638	171.00
19 Kasr El-Nile	--	--	--
20 Heliopolis	1,599	2,817	76.17
21 Masr El-Kadima	4,840	6,227	28.65

(1) Calculated from the 1960 Census Populations (this and the following table).

(2) Gross Density in Persons per Km.²

TABLE VIII

RESIDENTIAL MOVEMENT IN CAIRO

1937 - 47

District	P7	$D_{7x}R_{1x}$	$A_7D_7XR_2A_1$	1-2	1-3	Reliability of Results
1 El-Azbakia	75,421	69,046	42,371	+	+	Reliable II
2 El-Gamalia	108,744	87,913	117,611	+	+	Reliable II
3 El-Khalifa	122,660	161,469	216,060	-	-	Reliable(not)I
4 El-Darb El-Ahmar	123,195	93,531	125,128	+	-	Reliable II
7 El-Saida Zeinab	193,864	154,654	206,899	+	-	Reliable II
11 El-Mouski	35,963	36,436	48,744	-	-	Reliable II
12 El-Wayli	207,370	141,856	184,777	+	+	Reliable III
13 Bab El-Sharia	133,334	102,049	136,522	+	-	Fair II
14 Boulak	232,602	181,309	242,558	+	-	Reliable II
16 Rod El-Farag	195,890	113,888	152,361	+	+	Reliable III
17 Shoubra	228,696	277,817	371,668	-	-	Reliable(not)I
18 Abdin	119,956	52,713	70,520	+	+	Reliable III
20 Heliopolis	165,131	104,789	140,188	+	+	Reliable III
21 Masr El-Kadima	117,552	95,991	128,419	+	-	Fair II
		1941 - 1960				
1 El-Azbakia	66,032	103,137	121,748	-	-	Reliable I
2 El-Gamalia	141,724	158,450	187,043	-	-	Reliable I
3 El-Khalifa	161,958	56,844	67,102	+	+	Fair III
4 El-Darb El-Ahmar	148,606	172,788	203,967	-	-	Reliable I
7 El-Saida Zeinab	253,648	228,134	269,301	+	-	Fair II
11 El-Mouski	38,469	50,271	59,342	-	-	Reliable I
12 El-Wayli	307,173	297,076	350,363	+	-	Fair II
13 Bab El-Sharia	153,131	169,046	199,550	-	-	Fair I
14 Boulak	202,023	54,837	64,733	+	+	Reliable(not)III
16 Rod El-Farag	265,139	149,802	176,834	+	+	Fair III
17 Shoubra	296,008	88,262	104,189	+	+	Fair III
18 Abdin	94,969	41,076	48,488	+	+	
20 Heliopolis	124,774	124,646	147,138	-	-	Reliable(not)I
21 Masr El-Kadima	212,233	87,010	102,711	+	+	Fair III

P_{47} and P_{60}: Population in the Censuses 1947 and 1960 Respectively
D_{37} and D_{47}: "Density in the Censuses 1937 and 1947"
A_{47} and A_{60}: District Areas in the Censuses 1947, 1960
R_2 and R_2 : Cairo's percent of population increase between 1937-47 and 1947-60 Respectively
R_1 and R_1 : Egypt's population increase between 1937-47 and 1947-60 Respectively
R_1 = 19.131%; R_2 = 59.375%; R_1 = 36.99%; R_2 = 61.71%

Negative sign in Column 4 indicates that population in a district is decreasing. Positive sign in Column 4 indicates that population in a district is increasing with a rate higher than the natural increase of the country. Negative sign in Column 5 indicates that population in a district is not receiving a relative share of migrants to inhabit in. The positive sign in Column 5 is the result of migration from outside the city and people moving between districts within Cairo.

We have three groups of districts; (1) the (-,-) group indicating an absolute reduction in population or a slight increase in population but less than the natural growth of population, the difference should indicate the number of people moving to another area; (2) the (+,-) group, where the population has increased at a rate higher than the natural growth rate but less than the urban growth of Cairo. Districts of this group have failed to receive their share of migrants; (3) the (+,+) group represents local advantages which attract migrants as well as people of other districts of Cairo seeking better locational or prestige advantages.

Not all the results of this table can be taken for granted, because of the sharp changes in political boundaries. Districts which have no slight change in area give reliable results. Others which have sharp changes in their areas and their results are unreasonable, e.g., I know for a fact that Heliopolis has seen a vast increase between 1947 and 1960 but the results indicate it in the (-,-) group which is 100 percent rejected, the sharp change in the area is responsible for that result.

TABLE IX

LITERACY

District	*Total Pop. (000)s	Literacy	Persons having University Degree	% of Graduates of District to Total of Cairo	
1	48	62.00	1,680	2.11	
2	97	41.43	526	0.66	
3	112	46.54	1,356	1.70	
4	103	50.15	1,482	1.86	
5	69	57.69	2,333	2.93	
6	203	55.95	4,943	6.21	
7	180	58.99	5,789	7.28	
8	74	70.27	3,578	4.50	
9	106	45.91	1,160	1.46	
10	59	45.23	1,764	2.22	
11	27	54.04	357	0.45	
12	212	54.33	6,484	8.15	
13	106	45.49	1,041	1.31	
14	139	40.54	744	0.93	
15	65	49.19	1,223	1.54	
16	185	57.25	5,017	6.30	
17	202	49.25	3,356	4.22	
18	71	64.80	3,023	3.80	
19	35	74.29	4,943	6.31	
20	95	74.59	9,455	11.88	
21	147	50.73	5,639	7.09	
22	104	58.33	5,277	6.63	
23	77	62.75	7,221	9.07	
24	91	50.44	940	1.18	
25	8	41.35	121	0.15	
26	67	35.65	110	0.14	
Total	2,682	54.25	79,562	100	(Cairo)
	18,052	30.26	145,499	--	(Egypt)
	14.83	30.26	54.68	--	(% Cairo to Egypt)

* Population 10 years and above.
* Source: from Census of 1960.

TABLE X

ECONOMIC ACTIVITY IN CAIRO
ITS DISTRIBUTION AMONG ACTIVE MEMBERS IN EACH DISTRICT

District	Agriculture %	Mining %	Industry %	Construc-tion %	Electric-ity %	Trade %	Transport Comm. %	Services %	Unspec-ified %	Non-active	Total
1	0.44	0.06	6.84	1.28	0.49	9.37	2.54	16.99	1.22	60.77	100
2	0.13	0.23	11.60	1.27	0.27	8.23	1.62	9.86	0.94	65.89	100
3	0.07	0.16	8.95	2.65	0.22	3.93	1.70	13.40	1.23	67.70	100
4	0.09	0.02	10.29	0.74	0.20	6.96	1.39	12.69	0.83	66.79	100
5	0.32	0.04	5.61	1.67	0.39	4.33	3.13	17.51	1.23	65.76	100
6	0.29	0.02	8.22	1.39	0.97	4.61	3.51	13.05	1.29	66.62	100
7	0.17	0.03	5.94	1.48	0.27	5.06	1.60	18.23	1.17	66.03	100
8	0.13	0.06	5.54	0.64	0.23	6.31	1.87	21.40	1.35	62.48	100
9	3.95	0.03	5.81	1.57	0.71	4.11	2.77	12.31	1.56	67.22	100
10	1.88	4.17	5.39	2.07	0.25	3.98	2.08	14.39	0.93	67.86	100
11	0.37	0.02	4.16	0.77	0.18	9.93	1.55	13.54	1.21	64.26	100
12	0.38	0.04	5.64	2.05	0.35	4.37	2.46	16.89	1.26	66.53	100
13	0.05	0.02	11.85	0.89	0.26	6.47	1.86	11.27	1.39	65.62	100
14	0.09	0.02	9.05	2.60	0.96	7.15	2.95	10.01	1.36	65.76	100
15	2.17	0.35	13.13	2.03	1.00	2.40	1.18	10.86	1.54	65.36	100
16	0.12	0.01	6.24	1.41	0.70	6.14	3.95	13.40	1.25	66.75	100
17	0.38	0.96	7.83	1.91	0.86	5.98	3.94	12.19	1.23	65.62	100
18	0.17	0.04	6.20	0.88	0.26	7.03	1.69	19.06	1.63	62.88	100
19	0.54	0.14	3.45	1.02	0.19	6.14	1.78	32.95	1.69	52.03	100
20	0.33	0.08	2.49	1.27	0.21	5.67	2.32	25.86	1.22	60.24	100
21	0.26	0.08	6.66	2.29	0.26	5.17	1.91	16.09	0.91	66.04	100
22	0.87	0.04	4.62	1.49	0.24	4.90	2.08	18.34	1.22	66.14	100
23	0.67	0.18	2.16	1.28	0.29	4.54	1.42	26.08	1.06	62.27	100
24	0.63	0.06	7.70	1.64	0.54	4.05	3.13	12.49	1.36	68.18	100
25	2.92	0.19	2.20	2.12	0.12	3.70	1.52	18.13	0.52	68.58	100
26	3.84	0.01	19.97	1.04	0.33	2.73	1.58	5.03	0.66	64.63	100
	0.61	0.09	7.50	1.61	0.48	5.41	2.45	15.06	1.22	65.55	2600

TABLE XI

ECONOMIC ACTIVITY
DISTRIBUTION OF PERSONS ENGAGED IN EACH ACTIVITY IN EACH DISTRICT

District	Agriculture %	Mining %	Manufac-turing %	Construc-tion %	Electric-ity %	Trade %	Transport %	Services %	Population %
1	1.25	1.21	1.59	1.39	1.78	3.02	1.80	1.97	1.66
2	0.76	9.84	5.67	2.90	1.66	5.58	2.42	2.40	3.68
3	0.46	7.97	5.04	6.96	9.95	3.36	2.93	3.75	4.21
4	0.60	0.70	4.33	1.69	1.60	5.00	2.19	3.27	3.86
5	1.34	1.06	1.93	2.67	2.09	2.06	3.29	3.00	2.61
6	3.71	2.13	8.42	6.65	15.65	6.54	11.00	6.65	7.89
7	1.91	2.34	5.30	6.17	3.73	6.26	4.36	8.69	6.59
8	0.57	1.10	2.00	1.08	1.33	3.16	2.07	3.86	2.59
9	25.98	1.28	3.12	3.92	5.95	2.05	4.54	3.29	4.18
10	6.64	28.96	1.56	2.79	1.12	1.59	1.83	2.07	2.16
11	0.61	0.22	1.10	0.49	0.38	1.86	0.64	0.91	1.00
12	4.94	3.52	5.96	10.09	5.75	6.40	7.95	8.87	7.98
13	0.32	0.81	6.31	2.21	2.17	4.78	3.03	3.07	3.98
14	0.77	0.92	6.29	8.42	10.45	6.89	6.27	3.48	5.25
15	8.53	9.80	4.21	3.04	5.03	1.07	1.16	1.74	2.45
16	1.38	1.25	5.73	6.06	10.08	7.82	11.10	6.13	6.89
17	4.71	3.78	7.90	9.02	13.57	8.36	12.14	6.12	7.69
18	0.71	1.32	2.13	1.42	1.36	3.35	1.78	3.27	2.47
19	1.18	2.02	0.56	0.78	0.49	1.40	0.88	2.69	1.12
20	1.86	3.05	1.26	2.71	1.48	3.60	3.25	5.89	3.24
21	2.36	5.47	5.02	8.05	3.00	5.26	4.27	5.87	5.51
22	5.45	1.83	2.35	3.55	1.90	3.46	3.23	4.65	3.78
23	3.07	5.87	0.81	2.23	1.72	2.36	1.63	4.86	2.73
24	3.56	2.57	3.54	3.53	3.87	2.58	4.40	2.86	3.54
25	1.44	0.66	0.09	0.40	0.07	0.21	0.19	0.36	0.33
26	15.87	0.29	6.74	1.63	1.78	1.28	1.62	0.87	2.61
Total	100	100	100	100	100	100	100	100	100
Total in Egypt	0.43	12.91	32.84	33.68	40.46	26.34	28.43	34.34	14.81

Constructed from Table in "Regional Census", issued January, 1963 for 1960 Census.

TABLE XII

LABOR FORCE DISTRIBUTION

District	*Labor Force	**Non-Active %	% Active Females to Total Active	% Active Females in Female L.F.	% Active Females in Total L.F.	Unemployment
1	54,448	39.2	13.1	10.8	5.0	2.0
2	114,482	34.1	5.5	3.8	1.8	1.5
3	131,782	32.3	8.2	5.3	2.6	2.0
4	121,322	33.2	8.5	5.7	2.8	1.4
5	80,480	34.2	13.5	9.2	4.5	1.7
6	239,838	33.4	9.2	6.2	3.0	1.6
7	208,751	34.0	15.1	14.4	5.0	1.8
8	84,737	37.5	17.7	13.7	6.5	1.5
9	125,579	32.8	6.6	4.2	2.1	2.0
10	67,605	32.1	9.1	6.3	2.9	1.1
11	31,621	35.7	9.7	7.1	3.4	1.7
12	247,068	33.5	12.9	8.6	4.2	1.6
13	124,721	34.4	8.8	6.0	2.9	1.9
14	162,638	34.3	5.8	4.0	1.9	1.9
15	75,234	34.6	7.6	5.4	2.6	1.6
16	215,213	33.3	11.2	7.4	3.6	1.7
17	236,181	34.3	8.0	5.5	2.7	1.7
18	80,585	34.1	16.1	11.9	5.8	0.8
19	38,423	48.0	27.9	26.9	13.27	0.9
20	107,183	39.8	28.2	21.5	11.1	1.4
21	171,654	34.0	14.6	9.8	4.9	1.6
22	119,287	33.9	15.6	10.5	5.2	1.3
23	87,690	37.7	24.2	18.0	9.0	0.8
24	107,618	31.8	6.31	4.0	2.0	1.6
25	9,401	31.4	7.4	4.7	2.3	0.4
26	79,042	35.4	2.3	1.7	0.8	1.2
Total	3,122,623	34.5	11.8	8.2	4.0	1.6
Egypt	21,061,321		7.7	5.6	2.8	

* Labor Force (L.F.); Those above 6 years of age.
** Active: Those who are actually working.
This table is constructed from "Regional Census", January, 1963, 1960 Census.

TABLE XIII

NUMBER OF PASSENGERS ARRIVING AND DEPARTING FROM CAIRO AIRPORT IN 1960

Africa	**33,316**
Ethiopia	5,745
Kenya	794
Uganda	57
Congo	510
Aretriya	3,753
Somalia	57
Madagascar	398
Tanganyika	712
Johanisburg	15
Khartoum	20,233
Port-Sudan	1,042
Asia	**24,691**
Aden	2,079
El-Bahrian	1,092
Burma	164
Ceylon	460
China	545
Singapore	887
India	8,271
Indonesia	161
Iran	281
Japan	669
Malaya	28
Pakistan	3,460
Philippines	77
Siam	1,988
Turkey	3,955
Vietnam	74
Europe	**131,224**
Albania	1,241
Austria	2,457
Belgium	1,581
Bulgaria	35
Czechoslovakia	4,712
Denmark	1,940
England	7,456
France	5,870
Germany	9,622
Greece	38,550
Hungary	903
Italy	25,386
Luxemburg	58
Holland	3,984
Portugal	14
Spain	153
Switzerland	17,904
Sweden	3
Yugoslavia	3,588
U.S.S.R.	5,767
Middle East	**165,012**
Iraq	1,995
Jordan	28,814
Kuwait	20,953
Lebanon	65,180
Saudi Arabia	47,985
Qatar	85
U.S.A.	**1,856**
Australia	**324**
Mediterranean	**9,240**
Libya	8,994
Cyprus	241
Tunisia	5

TABLE XIV

NUMBER OF MOTOR VEHICLES IN EGYPT BY YEAR

Year	Private Automobiles	Taxi	Private & Taxi	Bus	Lorries	Sub-Total	Motor-Cycle
1940	25,119	4,098	29,217	1,325	2,923	33,465	2,116
1941	24,881	4,171	29,052	1,393	3,539	33,922	2,110
1942	24,503	4,172	28,675	1,392	4,137	34,204	2,326
1943	23,591	4,289	27,880	1,326	4,073	33,279	2,597
1944	22,843	4,532	27,375	1,403	4,974	32,752	2,709
1945	22,451	4,944	27,395	1,629	5,209	34,233	2,931
1946	25,193	5,755	30,948	1,997	7,500	40,445	4,277
1947	29,710	6,301	36,011	2,273	8,859	47,143	4,277
1948	35,590	6,834	42,424	2,720	10,043	55,187	5,271
1949	42,747	8,880	51,627	3,124	11,757	66,508	6,230
1950	49,926	9,948	59,874	3,512	14,443	47,829	7,880
1951	54,933	10,976	65,909	4,129	15,559	85,597	9,235
1952	56,448	11,451	67,899	4,705	14,839	87,443	10,330
1953	57,517	11,915	69,432	4,894	14,566	88,892	10,808
1954	58,808	12,221	71,029	5,331	15,156	91,516	11,635
1955	60,661	12,535	73,196	5,597	16,064	94,857	12,573
1956	56,588	8,495	65,083	3,356	14,254	82,693	
1957	57,117	8,560	65,677	3,474	14,453	83,604	
1958	58,801	9,189	68,090	3,607	14,379	85,976	
1959	56,170	9,930	66,100	3,852	15,309	85,261	
1960							
1961							
1962							
1963	67,852	13,607	81,459	4,767	16,826		19,331

N.B. Government M.V. are not included.

Source: Traffic Department, Cairo, Table 2, p.20.

TABLE XV

VEHICLE TRAFFIC COUNT, SOLIMAN SQUARE
AUGUST 22, 1963, 6 TO 7 P.M.

Place and Direction	Passenger Vehicles											
	Private Automobile	Occupied	Empty	Bi-cycle	Motor Cycle	Bus	Trolly	Train	Truck	Motor Cycle with box	Man or Animal Driven	
From El-Tahrir (inbound)	378	150	120	30	6	6	--	--	--	--	--	
From Tawfick Square (inbound)	408	150	270	42	60	--	--	--	--	--	--	
From Basyony Street (inbound)	192	60	66	48	12	--	--	--	--	--	--	
To Basyony Street (out)	162	66	66	66	18	6	--	--	--	--	--	
To Mostafa Kamel Square (out)	438	198	138	42	12	6	--	--	--	--	--	
From Sabry Abu Alam (inbound)	150	42	72	42	12	6	--	--	--	--	--	
To Sabry Abu Alam (out)	222	72	66	36	24	--	--	--	12	--	--	
Total	1,950	738	798	306	144	26	--	--	12	--	--	

Place and Direction	Total	Number of Lanes
From El-Tahrir (inbound)	690	4
From Tawfick Square (inbound)	930	4
From Basyony Street (inbound)	378	4
To Basyony Street (out)	384	4
To Mostafa Kamel Square (out)	834	4
From Sabry Abu Alam (inbound)	324	2
To Sabry Abu Alam (out)	432	2
Total	3,951	24

TABLE XVI

VEHICLE TRAFFIC COUNT, RAMSIS SQUARE
AUGUST 2, 1963 2 TO 3 P.M.

Place and Direction	Passenger Vehicles								Freight Vehicles	
		Private Taxi				Public				
	Private Automobile	Occupied	Empty	Bi-Cycle	Motor Cycle	Bus	Metro	Tram	Truck	Motorcycle with a box
From Ramsis Street (inbound)	1,560	495	120	315	60	105	--	--	--	45
To Ramsis Street (out)	840	180	120	45	60	210	--	--	45	15
From Ibrahim Square (inbound)	266	120	9	34	9	25	--	--	9	--
To Ibrahim Square (out)	129	34	154	137	26	94	--	--	86	9
From El-Khalig El-Kasid (inbound)	260	310	100	150	60	100	--	--	90	60
From Ghamra (inbound)	800	110	270	80	70	280	--	--	70	20
To Ghamra (out)	1,370	290	300	100	50	110	50	--	100	30
From El-Galaa (inbound)	55	22	66	33	11	66	66	176	--	--
To El-Galaa (out)	44	22	33	55	--	44	44	209	--	--
Total	5,324	1,583	1,172	949	346	1,034	160	385	400	179

Place and Direction	Man or Animal Driven	Total	Number of Lanes
From Ramsis Street (inbound)	--	2,700	4
To Ramsis Street (out)	--	1,515	4
From Ibrahim Square (inbound)	--	472	3
To Ibrahim Square (out)	34	703	3
From El-Khalig El-Kadis (inbound)	330	1,560	2
From Ghamrah (inbound)	--	1,700	4
To Ghamrah (out)	--	2,400	4
From El-Galaa (inbound)	--	495	2
To El-Galaa (out)	44	495	2
Total	408	12,040	28

TABLE XVII

VEHICLE TRAFFIC COUNT, TAHRIRE SQUARE

AUGUST 22, 1963 2 TO 3 P.M.

Place and Direction	Passenger Vehicles								Freight Vehicles	
	Private Automobile	Private Taxi Occupied	Private Taxi Empty	Bi-Cycle	Motor Cycle	Bus	Trolly Bus	Trams	Trucks	Motorcycle with a box
From Kasr El-Einy (inbound)	635	374	361	140	60	174	87	--	87	40
To Kasr El-Einy (out)	394	307	114	53	33	200	73	--	40	14
From Kasr El-Nile Bridge (inbound)	595	306	187	60	43	94	--	--	42	20
To Kasr El-Nile Bridge (out)	230	119	128	153	34	85	--	--	9	9
From Ramsis Square (inbound)	375	143	60	23	30	203	--	68	98	23
To Ramsis Square (out)	518	218	75	165	38	248	--	173	120	8
To Shampilion (out)	105	90	60	90	--	--	--	--	15	15
To Kasr El-Nile (out)	735	330	210	60	30	15	--	--	45	15
From El-Boustan Street (inbound)	152	167	46	46	--	61	--	--	61	15
To El-Boustan Street (out)	106	46	61	15	30	76	--	--	76	--
From Bab El-Lauk (inbound)	460	340	160	200	60	200	--	240	80	40
To Bab El-Lauk (out)	380	180	380	40	60	160	--	220	40	80
Total	4,745	2,620	1,842	1,045	418	1,516	160	701	713	279

Place and Direction	Man or Animal Driven	Total	Number of Lanes
From Kasr El-Einy (inbound)	--	2,499	3
To Kasr El-Einy (out)	--	1,228	3
From Kasr El-Nile Bridge (inbound)	--	1,347	3
To Kasr El-Nile Bridge (out)	--	767	3
From Ramsis Square (inbound)	--	1,018	3
To Ramsis Square (out)	--	1,623	3
To Shampilion (out)	--	375	4
To Kasr El-Nile (out)	--	1,440	4
From El-Boustan Street (inbound)	--	548	3
To El-Boustan Street (out)	--	410	3
From Bab El-Lauk (inbound)	--	1,780	2
To Bab El-Lauk (out)	--	1,540	2

APPENDIX B

URBANIZATION AND URBAN DISTRIBUTION IN EGYPT

TABLE I

RANK SIZE DISTRIBUTION OF CITIES AND VILLAGES IN EGYPT

RANK	1	2	3	4	5	6	7	8	9	10	11	12
Cairo												3,348,779
Alexandria											1,516,234	
Port Said								245,318				
Ismailia									284,115			
Suez								203,610				
Subtotal:								449.029 2/	284,115 1/		1,516,234 1/	3,348,779 1/

(1) Cities of population from 0 to 1,000
(2) Cities of population from 1,000 to 2,500
(3) Cities of population from 2,500 to 5,000
(4) Cities of population from 5,000 to 10,000
(5) Cities of population from 10,000 to 20,000
(6) Cities of population from 20,000 to 50,000
(7) Cities of population from 50,000 to 100,000
(8) Cities of population from 100,000 to 250,000
(9) Cities of population from 250,000 to 500,000
(10) Cities of population from 500,000 to 1,000,000
(11) Cities of population from 1,000,000 to 2,500,000
(12) Cities of population from 2,500,000 and up.

LOWER EGYPT

RANK	1	2	3	4	5	6	7	8	9	10	11	12
Dimiatta	1,956 4/0.5	25,406 14/6.5	42,625 12/11.0	178,651 25/46.1	67,544 4/17.4		71,780 1/18.5					
Dakahlia	32,223 55/1.6	217,508 125/10.8	516,989 143/25.6	567,488 83/28.2	280,458 22/13.9	249,025 8/12.4		151,192 1/7.5				
Sharkia	36,665 62/2.0	254,890 148/14.0	514,430 142/28.3	575,787 85/31.6	196,571 15/10.8	118,038 4/6.5		124,417 1/6.8				
Kalyobia	8,422 11/0.9	101,119 59/10.2	211,648 59/21.4	269,648 43/30.0	296,184 11/15.3	150,991 4/10.9	102.679 2/11.3					
Kafr El-Sheikh	8,743 13/0.9	91,546 52/9.4	271,318 76/27.9	286,199 41/29.3	158,108 12/16.3	157,105 5/16.2						
El-Gharbia	21,953 32/1.3	186,542 102/10.9	418,627 114/24.4	469,688 70/27.3	167,773 13/9.8	89,042 3/5.2		362,587 2/21.1				
El-Menofia	22,476 29/1.7	171,376 91/12.7	378,195 105/28.0	437,594 65/32.5	147,342 12/10.9	136,060 5/10.1	54,910 1/4.1					
Bihera	38,505 77/2.3	249,576 143/14.8	451,419 126/26.8	453,419 67/26.9	226,047 17/13.4	138,638 4/8.3		126,600 1/7.5				
Subtotal:	170,943 283/	1,297,963 734/	2,805,251 777/	3,265,010 479/	1,394,834 106/	995,520 33/	238,769 4/	764,796 4/				

UPPER EGYPT

Giza	5,426 6/0.4	55,915 32/4.2	252,007 67/18.8	344,682 49/25.7	187,855 15/14.0	106,552 4/8.0		136,429 1/10.2	250,534 1/18.7			
Beni Sweif	12,839 17/1.5	155,315 86/18.0	296,009 84/34.4	190,252 29/22.1	79,854 6/9.3	46,743 2/5.5	78,829 1/9.2					
Fayom	6,753 9/0.8	83,413 47/9.9	186,514 53/22.3	303,474 43/36.3	122,104 10/14.7	31,831 1/3.8		102,064 1/12.2				
Mania	16,849 23/1.1	198,226 116/12.7	422,815 115/27.1	540,848 78/34.7	151,465 11/9.7	82,927 3/5.3	147,121 2/9.4					
Asyot	13,677 19/1.0	139,288 80/10.5	242,354 68/18.2	392,672 60/29.5	238,050 19/18.0	176,062 7/13.2		127,485 1/9.6				
Sohage	547	102,370 57/6.5	395,002 106/25.0	583,088 84/36.9	211,287 18/13.4	224,620 7/14.3						
Kena		37,139 19/21.9	255,403 68/19.6	573,843 85/44.1	248,291 19/19.1	129,265 5/9.9	57,417 1/4.4					
Aswan	11,636 20/3.1	37,488 23/9.7	70,032 20/18.2	96,851 15/25.1	76,052 6/19.2	95,281 3/24.7						
Subtotal:	67,727 95/	809,154 460/	2,120,206 581/	3,025,710 43/	1,312,958 104/	893,272 32/	283,367 4/	427,922 4/	250,534 1/			

THE COUNTRY

Total:	238,670 378/	2,107,117 1,194/	4,925,457 1,358/	6,290,720 922/	2,707,792 210/	1,888,792 65/	522,136 8/	1,641,645 10/	534,649 2/		1,516,234 1/	3,348,779 1/

TABLE II

ECONOMIC ACTIVITY IN EACH GOVERNORATE

Governorate	Total Population	Economic Activity				Literacy
		Agriculture	Mfg.	Services	Others	
Cairo	3,348,779	1.1	23.6	39.2	36.1	53.6
Alexandria	1,516,234	3.0	33.0	21.4	42.6	51.1
Port Said	245,318	6.9	11.5	36.1	45.5	49.7
Ismailia	284,115	46.1	4.9	26.0	23.0	33.6
El-Suez	203,610	11.0	17.4	28.7	42.9	44.5
Red Sea	25,452	2.9	6.6	13.6	76.9	44.4
New Valley	21,586	74.5	3.8	12.1	9.5	27.6
Matrouh	103,453	71.5	4.3	10.4	13.4	14.8
Sinai	49,769	12.1	5.1	27.1	55.7	46.3
Dimiatta	387,962	55.7	14.3	16.0	14.0	36.4
El-Dakahlia	2,014,883	70.0	5.3	14.3	10.4	32.3
El-Sharkia	1,819,798	74.0	4.3	11.8	9.9	25.1
El-Kaliahia	988,055	59.3	13.0	15.3	12.4	29.2
Kufr El-Shiekh	973,019	79.5	3.4	9.5	10.6	17.2
El-Gharbia	1,715,212	68.0	10.6	12.1	9.3	29.6
El-Menufia	1,347,953	72.0	4.8	14.1	9.1	29.3
El-Behera	1,685,679	76.2	6.3	9.5	18.0	23.3
El-Giza	1,336,418	47.8	11.1	23.6	17.5	31.4
El-Fayum	839,163	73.0	6.0	11.0	10	20.0
Beny Suife	256,120	75.2	3.5	11.3	10.0	22.6
El-Menia	1,560,311	77.0	3.6	6.1	13.3	21.5
Asute	1,329,588	76.4	3.7	10.5	9.4	21.0
Sohag	1,578,858	78.9	3.6	8.2	9.3	16.9
Kena	1,351,358	76.3	5.1	8.4	10.2	16.2
Aswan	385,350	60.7	6.8	13.1	19.4	24.84

TABLE III

ECONOMIC ACTIVITY IN EACH "BANDER"

The Bander	Population	Agriculture	Mfg.	Services	Others	Literacy	Labor Force
Bauder El-Mansora(1)	37,737	2.3	20.1	47.3	30.3	58.6	25,183
Bauder El-Mansora(2)	53,455	3.4	14.7	52.7	29.2	62.3	14,129
El-Giza(1)	145,332	2.7	14.2	56.3	26.8	58.3	38,886
El-Giza(2)	105,202	1.8	6.0	71.2	21.0	62.8	32,124
Imbaba	136,429	2.1	25.5	41.2	31.2	50.4	32,559
Kism El-Ahram	11,684	9.5	7.1	58.6	24.8	41.4	2,903
El-Zakazik	124,417	4.5	14.6	51.2	29.7	55.0	29,700
Kena	57,417	22.5	9.7	45.0	22.8	42.0	14,446
Asvet(1)	76,035	8.6	21.0	39.4	31.0	44.0	19,924
Asvet(2)	51,450	13.0	6.0	58.3	22.7	60.4	12,309
Sohag	61,944	10.0	10.2	46.6	33.2	52.1	15,401
Damanhor	126,600	6.4	18.0	41.8	33.8	48.1	32,758
Dimiatta	71,780	2.7	44.2	29.4	23.7	47.6	20,008
Tanta(1)	101,171	2.3	13.5	52.8	31.4	59.3	25,809
Tanta(2)	83,128	3.7	23.3	41.7	31.3	49.4	21,791
El-Mahalle ElKobra*	178,288	6.1	49.4	23.2	21.3	45.1	45,394
Bani Suef	78,829	10.4	12.7	48.1	28.8	50.0	19,886
Kufr El-Kheikh	38,592	18.0	10.2	43.2	28.6	43.2	10,167
Aswan	48,393	3.2	21.0	33.0	42.8	50.3	13,798
Benha	52,686	12.4	14.5	46.5	26.6	50.2	13,014
Shoubra El-Khima**	100,607	11.1	57.6	14.5	16.8	35.7	27,393
Shebrin El-Kam	54,910	11.6	16.3	50.0	22.1	51.3	14,398
El-Menia	94,507	6.7	14.6	46.6	32.1	55.3	24,652
Total:	1,950,593	6.3	22.0	44.0	27.7		506,632

* Included in Cairo M.P.A.
** Industrial Centers

TABLE IV

POPULATION DISTRIBUTION OF THE POTENTIAL METROPOLIS AREAS

	Existing Population (1960 Census)	%Increase from Last Census
Potential Metropolis Areas		
City of Cairo	3,348,779	61.3
Alexandria	1,516,234	59.7
Port Said	245,318	49.1
Suez	203,610	89.9
Ismailia	284,115	60.4
Dimiatta	96,714	
Sub-Total	5,694,770	About 60%
Rest of Cairo M.P. Area		
Shoubra El-Khima	100,607	
El-Giza	250,534	
Imbaba	136,429	
Kism El-Ahram	11,684	
Sub-Total	499,254	
Aswan	48,393	
Total	6,242,417	
Total Urban Population	9,651,097	
% of Potential Metropolitan Population to Urban Population	64.7%	

TABLE V

POPULATION DISTRIBUTION OF OTHER URBAN AREAS

Area	1960 Population	%Increase from Last Census	Number of Population of Banders	Class of Cities	Population
El-Dakahlia	364,223	46.6	151,192	6	213,031
El-Sharkia	295,365	47.6	124,417	6	118,038
El-Kaliobia	250,510	76.9	153,293	6 and 7	97,217
Kafr El-Sheikh	165,353	43.8	38.592	6 and 4	126,761
El-Gharbia	484,481	46.0	362,587	6 and 5	121,894
El-Menufia	183,660	30.9	54,910	6 and 4	128,750
El-Bihera	307,516	52.3	126.600	6 and 5	180,916
El-Giza	433,620	133.4	398,647	-	34,973
Beny Suife	183,587	31.5	78,829	6 and 5	104,758
El-Fayom	161,843	35.5	102,064	6 and 5	59,779
El-Minia	268,165	36.0	94,507	7 and 6	173,658
Asyot	289,569	38.9	127,485	6	162,084
Sohag	285,743	31.2	61,944	6	223,799
Kena	184,785	23.3	57,417	6 and 5	127,368
Aswan	97,902	60.8	48,393	6 and 2	49,509
Total	3,956,322	48%	1,980,877		1,975,445
		Substituting Cairo Suburbs and Aswan	547,647		
			1,433,230/40%		

APPENDIX C

POPULATION AND SOCIAL CHANGE PROJECTION IN CAIRO

TABLE I

PROJECTION OF POPULATION, ECONOMICALLY ACTIVE MEMBERS, INCOME LEVEL AND TRIP PATTERN, FOR EACH SUBAREA, IN PROJECTION YEARS

	1960				1975				1985			
di(1)	Population	% E.A.M.(2)	Income(3) Level	K_i(4)	Population	% E.A.M.(2)	Income(3) Level	K_i(4)	Population	% E.A.M.(2)	Income(3) Level	K_i(4)
1	7,480	43	$II_A 4,4$	848	11,000	45	$II_A 4,4$	848	11,000	45	$II_A 4,4$	848
2	3,650	37	$I_B 4,4$	927	6,500	40	$I_B 5,5$	965	6,000	38	$I_B 5,6$	969
3	10,667	27	IV 2,6	570	16,000	29	IV 3,6	608	15,000	28	IV 3,6	608
4	7,678	35	$II_B 5,3$	830	15,000	38	$III_A 7,4$	614	14,000	37	$III_B 6,5$	569
5	12,539	32	IV 2,4	556	18,500	33	V 2,3	496	18,000	33	IV 2,4	556
6	9,227	35	IV 4,5	640	13,000	39	IV 4,5	640	12,000	38	IV 3,5	604
7	3,079	41	$II_B 4,5$	817	6,000	44	$III_B 5,6$	733	5,000	43	$III_B 5,6$	733
8	9,720	35	IV 3,4	595	14,000	36	V 4,4	578	14,000	37	$III_B 4,5$	699
9	14,050	28	V 2,5	513	20,000	29	V 2,4	503	17,500	30	V 1,4	473
10	8,730	28	V 2,5	513	13,500	28	V 2,5	513	11,000	30	V 1,5	483
11	8,000	12	V 2,7	472	12,000	14	V 1,5	483	10,000	15	V 1,6	487
12	11,070	27	V 2,7	472	17,000	28	V 1,5	483	15,000	29	V 1,6	487
13	5,610	28	V 1,3	466	7,500	29	V 1,3	466	7,000	30	V 1,3	466
14	13,610	27	V 2,5	513	20,000	28	V 1,3	466	18,000	29	V 1,4	473
15	12,370	29	V 1,4	473	16,500	30	V 1,3	466	15,000	31	V 1,3	466
16	8,700	27	V 2,7	472	12,000	28	V 2,5	513	11,000	29	V 1,6	487
17	6,570	31	IV 3,6	608	10,000	32	V 2,5	513	8,500	33	V 1,6	487
18	13,850	26	IV 2,5	566	20,000	27	V 1,4	473	18,000	28	V 1,5	483
19	9,830	39	V 2,6	517	14,500	40	V 1,5	483	12,000	40	V 1,6	487
20	5,030	26	IV 2,6	570	8,000	26	V 1,4	473	6,000	26	V 1,5	483
21	4,050	27	$III_B 3,6$	667	6,500	28	$III_B 2,5$	625	5,000	29	$III_B 3,5$	663
22	10,340	29	V 1,4	473	14,500	29	V 1,2	458	11,000	29	V 1,3	466
23	11,040	28	IV 2,5	566	17,000	28	V 1,4	473	15,000	28	V 1,5	483
24	11,680	26	V 2,3	496	23,000	26	V 1,2	458	30,000	28	IV 2,3	549
25	8,910	26	IV 2,3	549	15,500	26	V 1,2	458	14,000	26	V 1,3	466
26	20,200	26	V 2,3	496	35,000	26	V 1,2	458	40,000	28	IV 2,3	549
27	8,030	28	V 2,3	464	15,000	28	V 1,2	458	16,000	28	V 1,2	458
28	21,040	28	$II_B 3,3$	764	30,000	28	$III_A 4,4$	744	40,000	30	$II_B 5,6$	850
29	8,670	26	V 2,4	503	16,000	26	V 1,3	466	13,000	26	V 1,4	473
30	10,980	26	IV 2,3	464	17,000	26	V 1,3	458	25,000	29	$III_B 3,4$	654
31	6,100	22	$III_B 3,3$	647	9,000	22	IV 2,3	549	8,000	22	V 2,4	503
32	16,150	28	V 1,3	466	30,000	28	V 1,2	458	40,000	29	IV 2,3	549
33	13,900	28	$III_B 3,3$	647	21,000	28	IV 1,2	511	20,000	28	V 1,3	466
34	12,200	27	IV 2,3	549	19,000	27	V 1,2	458	14,000	27	V 1,3	466
35	8,690	27	V 1,3	466	14,000	27	V 1,2	458	10,000	27	V 1,3	466
36	15,420	24	V 1,4	473	25,000	24	V 1,2	458	30,000	25	IV 2,4	564
37	2,980	28	$III_B 3,7$	622	5,000	28	IV 2,5	566	4,000	30	$III_B 2,6$	629
38	11,520	27	IV 2,5	566	19,000	27	V 1,4	473	15,000	27	V 1,5	483
39	2,350	33	$III_B 3,6$	667	5,000	32	V 2,4	503	3,500	32	V 1,5	483
40	10,260	30	$III_B 3,4$	654	16,000	30	IV 2,2	541	14,000	30	IV 1,3	519
41	5,500	28	IV 3,5	519	10,000	28	IV 1,3	519	8,000	28	IV 1,5	536
42	9,670	26	$II_A 3,3$	805	15,000	26	$II_B 2,2$	718	12,000	26	$II_B 3,3$	764
43	11,750	27	$II_B 4,3$	800	17,000	27	$III_A 3,2$	693	15,000	27	$III_A 2,4$	670
44	9,170	29	IV 2,7	525	16,000	29	V 1,5	483	11,000	29	V 2,6	517
45	9,630	27	IV 2,4	556	20,000	27	IV 1,3	519	17,000	27	IV 1,4	526
46	3,210	28	V 2,4	503	6,000	28	V 2,3	496	13,500	28	V 1,3	466
47	12,400	27	V 2,5	513	15,000	27	V 2,4	503	15,000	27	V 2,4	503
48	7,780	25	V 2,3	496	13,000	25	V 1,2	458	10,000	25	V 1,2	458
49	8,220	26	V 2,5	513	16,000	26	V 1,4	473	12,000	26	V 1,5	483
50	10,570	28	V 2,6	517	17,000	28	V 1,4	473	14,000	28	V 1,5	483

TABLE I (CONT'D)

	1960				1975				1985			
di	Popu-lation	% E.A.M.	Income Level	K_i	Popu-lation	% E.A.M.	Income Level	K_i	Popu-lation	% E.A.M.	Income Level	K_i
51	10,800	26	IV 2,7	525	20,000	26	V 1,5	483	17,000	26	V 1,5	483
52	3,540	26	V 1,4	473	5,000	26	V 1,2	458	4,000	26	V 1,2	458
53	11,840	26	$III_B3,3$	647	15,000	26	IV 2,2	541	15,000	26	IV 2,2	541
54	21,900	28	$III_B3,3$	647	45,000	28	$III_A5,5$	783	75,000	30	$II_B5,6$	850
55	22,080	27	$II_B4,3$	800	55,000	29	$II_B6,5$	687	85,000	30	$II_A6,5$	727
56	32,430	26	IV 3,3	588	60,000	28	$III_B4,3$	683	70,000	29	$III_A5,4$	773
57	33,970	28	$III_A3,2$	693	50,000	29	$III_A4,3$	737	70,000	31	$II_B5,4$	837
58	20,440	26	$II_B4,3$	800	25,000	28	$II_B4,3$	800	50,000	33	$I_B5,4$	956
59	4,180	25	IV 3,3	588	7,000	27	$III_B4,3$	683	20,000	31	$II_B6,4$	677
60	77,800	26	$III_B3,3$	647	120,000	27	$III_B5,4$	719	100,000	28	$III_B4,4$	690
61	46,760	26	IV 3,3	588	70,000	28	$III_B5,4$	719	60,000	29	$III_B4,4$	690
62	50,040	28	IV 2,4	556	75,000	30	III 4,4	690	111,000	34	$III_B5,4$	719
63	20,790	28	$II_A4,2$	833	25,000	30	$II_A4,3$	841	55,000	32	$II_A6,4$	718
64	56,640	28	$III_A4,4$	744	88,000	35	$II_B5,4$	837	85,000	30	$II_B5,5$	846
65	26,950	33	V 2,3	496	40,000	35	$III_B4,4$	690	50,000	36	$III_A5,5$	783
66	17,440	33	I 4,2	530	25,000	27	$II_A3,2$	796	23,000	34	$II_B3,2$	756
67	24,370	26	$III_B4,3$	683	35,000	28	IV 3,3	588	32,000	27	IV 2,3	549
68	17,870	28	$III_B4,3$	683	30,000	27	IV 3,3	588	25,000	28	IV 2,3	549
69	11,520	28	$III_B4,3$	683	20,000	30	IV 3,3	588	16,000	27	IV 2,3	549
70	16,960	29	$III_A4,3$	737	30,000	30	$III_B3,3$	647	25,000	29	$III_B2,3$	608
71	19,680	27	$III_B3,3$	647	32,000	30	$III_A4,4$	744	28,000	29	$III_B4,3$	683
72	14,710	27	$III_B4,3$	683	22,000	28	$III_A5,4$	773	17,000	29	$III_A4,4$	744
73	17,250	27	$III_A3,4$	708	33,000	33	$II_B4,5$	817	35,000	32	$II_B4,5$	817
74	17,090	27	IV 2,3	549	26,000	31	V 1,3	466	24,000	27	V 1,3	466
75	13,540	31	$I_B4,2$	911	20,000	28	$II_A5,3$	870	18,000	33	$II_A5,3$	870
76	19,870	28	$II_B4,3$	800	32,000	31	$III_A5,4$	773	29,000	30	$III_A5,4$	773
77	37,660	26	IV 2,4	556	55,000	28	$III_B4,5$	699	45,000	27	$III_B5,5$	729
78	13,140	29	IV 3,3	588	20,000	32	IV 3,3	588	17,000	31	V 2,3	496
79	12,570	28	V 2,3	496	20,000	31	V 1,2	458	16,000	30	V 1,3	466
80	6,000	28	$II_B4,3$	800	11,000	30	$III_A4,3$	737	8,000	29	$III_B3,4$	653
81	12,460	44	$III_B2,1$	590	21,000	46	$III_B1,1$	560	17,000	45	IV 1,1	502
82	22,490	29	$III_B4,4$	808	37,000	30	$III_A5,4$	773	35,000	30	$III_B5,4$	719
83	17,270	30	$III_A4,3$	737	28,000	33	$III_B5,4$	719	25,000	32	$III_B5,4$	719
84	21,040	30	$II_B5,4$	837	35,000	33	$III_A6,5$	623	30,000	31	$III_B5,5$	729
85	20,350	30	$II_B4,3$	800	35,000	33	$III_A5,5$	783	30,000	32	$III_B4,5$	699
86	10,840	27	$III_A3,2$	693	16,000	29	$II_B4,3$	800	30,000	32	$I_B5,4$	956
87	22,570	25	$III_B3,2$	638	37,000	28	$III_A4,3$	737	50,000	30	$II_A5,4$	877
88	7,000	22	V 3,2	526	12,000	25	IV 3,3	588	20,000	27	$III_A4,3$	737
89	7,740	25	IV 3,3	588	13,000	27	$III_B4,3$	683	30,000	30	$II_B5,4$	837
90	11,780	25	$III_B3,2$	638	20,000	27	$III_A4,3$	737	30,000	31	$II_A5,4$	877
91	4,010	26	$III_B2,3$	608	7,000	27	$III_A2,3$	662	20,000	30	$II_A4,4$	848
92	8,580	26	$III_A4,3$	729	15,000	29	$II_B5,3$	830	35,000	34	$I_B6,4$	796
93	8,320	28	V 1,2	458	13,000	30	IV 2,2	541	30,000	33	$III_A4,3$	737
94	23,860	26	V 2,4	503	38,000	28	IV 3,4	595	70,000	32	$III_A4,5$	753
95	52,500	26	V 1,3	466	70,000	28	IV 2,4	556	100,000	32	$II_A3,4$	812
96	3,630	24	V 1,2	458	6,000	25	IV 2,3	549	25,000	30	$III_A3,4$	708
97	6,600	24	IV 3,2	579	12,000	27	$III_A3,3$	701	30,000	32	$II_A3,4$	812
98	1,960	26	V 1,2	458	4,000	27	IV 2,3	549	15,000	32	$II_B3,4$	771
99	2,900	24	V 1,2	458	5,000	27	IV 2,3	549	15,000	32	$II_B3,4$	771
100	14,050	26	V 1,4	473	22,000	28	IV 2,4	556	65,000	32	$III_A2,5$	679
101	12,530	20	V 2,3	496	25,000	23	IV 3,5	604	35,000	27	$III_B3,5$	663
102	8,660	26	$III_B3,2$	638	15,000	29	$III_A4.3$	737	25,000	33	$I_B4,4$	927
103	4,960	26	V 1,1	448	8,000	28	$III_B2,2$	600	40,000	34	$I_B3,3$	883
104	2,260	26	V 1,2	458	5,000	28	IV 2,2	541	10,000	30	$III_B2,3$	608
105	6,370	27	V 1,2	458	10,000	28	IV 2,3	549	15,000	30	$III_B2,4$	615
106	3,680				5,000				5,000			
107	5,250				7,000				10,000			
108	3,060	30	IV 2,3	549	5,000	31	IV 2,3	549	5,000	33	$III_B3,3$	647
109	10,720	30	$I_A3,1$	1006	22,000	37	$I_A3,2$	1016	30,000	37	$I_A3,2$	1016
110	10,720	35	IV 3,4	595	6,000	32	V 3,3	534	4,500	32	V 2,4	503
111	13,120	29	IV 2,5	566	18,000	30	V 2,4	503	17,000	29	V 2,4	503
112	4,580	30	IV 4,6	644	6,000	30	V 3,5	551	6,000	30	V 3,5	551

TABLE I (CONT'D)

					1975				1958			
di	Popu-lation	E.A.M.	Income Level	K_1	Popu-lation	% E.A.M.	Income Level	K_1	Popu-lation	% E.A.M.	Income Level	K_1
113	4,220	32	IV 3,5	604	7,000	32	V 2,4	503	5,500	32	V 1,5	483
114	12,790	28	IV 3,6	608	19,000	28	V 2,5	513	17,000	27	V 1,6	487
115	43,270	30	$III_B3,3$	647	70,000	32	$III_A5,4$	773	80,000	33	$III_A5,5$	783
116	17,070	25	$III_B3,3$	647	27,000	27	$III_A5,4$	773	32,000	29	$III_A5,5$	783
117	19,720	27	IV 2,4	556	32,000	29	$III_B4,5$	699	40,000	31	$III_A5,6$	787
118	11,370	19	V 2,3	496	15,000	23	$III_B4,5$	690	25,000	26	$III_A4,5$	754
119	9,840	25	$I_B3,3$	883	15,000	28	$I_B4,4$	927	15,000	30	$I_B4,4$	927
120	13,290	27	$III_B3,3$	647	20,000	29	$III_A5,4$	773	20,000	29	$III_A5,4$	773
121	3,320	32	V 2,2	488	6,000	34	IV 4,2	615	15,000	37	$II_A6,4$	718
122	14,950	27	$II_B4,2$	792	22,000	29	$II_B4,3$	800	40,000	32	$II_B5,4$	837
123	26,100	26	$III_B3,3$	647	35,000	29	$III_A4,3$	737	45,000	32	$II_B5,4$	837
124												
125	22,810	26	V 2,3	496	31,000	28	IV 4,4	631	35,000	29	$III_A5,4$	773
126	3,850	28	V 2,4	503	6,000	29	V 1,3	466	8,000	30	IV 2,3	549
127	9,350	26	$II_B3,3$	764	15,000	28	$II_B3,3$	764	30,000	32	$II_A5,4$	877
128	24,910	28	$III_A3,3$	701	40,000	30	$III_A4,4$	744	45,000	32	$II_B5,4$	837
129	49,650	28	IV 2,3	549	70,000	31	$III_A4,3$	737	60,000	30	$III_A4,4$	744
130	10,110	29	$II_A4,2$	833	16,000	31	$I_B5,3$	949	20,000	32	$I_B6,4$	796
131	19,830	25	$III_B4,2$	674	30,000	28	$III_A5,3$	766	40,000	30	$II_B6,4$	677
132	6,460	29	V 2,4	503	7,500	29	V 1,4	473	6,000	29	V 1,4	473
133	6,090	31	V 2,5	513	7,500	31	V 2,4	503	6,000	31	V 1,4	473
134	3,230	29	$III_A4,5$	754	3,500	29	$III_B4,5$	699	3,000	29	IV 3,5	604
135	12,010	28	V 2,4	503	16,000	28	V 2,3	496	14,000	28	V 1,4	473
136	13,240	27	IV 2,4	556	16,000	27	IV 2,3	549	14,000	27	V 1,4	473
137	8,610	29	V 1,4	473	10,500	29	V 1,3	466	10,000	29	V 1,3	466
138	16,000	27	IV 3,4	595	22,000	27	IV 2,3	549	20,000	27	IV 2,4	556
139	9,040	28	$III_A3,4$	708	15,000	29	$III_B4,4$	696	14,000	29	$III_B3,4$	654
140	11,090	27	$III_A3,4$	708	18,000	29	$III_B2,3$	608	17,000	29	$III_B2,3$	608
141	17,670	29	V 2,4	503	21,000	29	V 2,3	496	20,000	29	V 1,4	473
142	11,900	27	V 2,5	512	14,000	27	V 2,4	503	14,000	27	V 2,4	503
143	9,930	29	$III_B4,4$	690	14,000	30	IV 3,4	595	13,000	29	IV 3,4	595
144	8,250	28	V 1,4	473	10,000	28	V 1,3	466	10,000	28	V 1,3	466
145	5,890	38	V 1,5	483	7,500	38	V 1,4	473	7,000	38	V 1,4	473
146	4,690	29	V 1,5	483	6,000	29	V 1,4	473	6,000	29	V 1,4	473
147	8,530	26	V 2,4	503	11,000	26	V 1,4	473	11,000	26	V 1,4	473
148	7,490	42	IV 2,3	549	11,000	42	IV 2,3	549	15,000	42	$III_A3,3$	701
149	8,030	27	IV 2,4	556	12,000	27	V 1,3	466	25,000	27	$III_A3,3$	701
150	12,160	30	V 1,7	442	16,000	31	V 1,6	487	40,000	34	$II_B4,4$	808
151	7,630	26	V 2,3	496	12,000	27	V 1,2	458	25,000	32	$III_B3,4$	654
152	10,500	26	V 1,4	473	13,000	26	V 1,4	473	10,000	26	V 1,3	466
153	3,210	27	IV 2,5	566	5,000	27	IV 1,4	526	25,000	30	$II_A4,5$	857
154	11,120	26	V 2,5	513	14,500	26	V 1,4	473	20,000	28	IV 3,5	604
155	7,720	26	V 2,4	503	10,000	26	V 1,3	466	10,000	26	V 1,3	466
156	21,430	30	V 2,4	503	28,000	30	V 1,3	466	40,000	33	$II_B4,5$	817
157	5,850	28	V 1,4	473	7,000	29	V 1,5	483	7,000	29	V 1,3	466
158	28,750	28	V 1,6	487	50,000	29	IV 2,3	549	40,000	28	V 1,5	483
159	9,140	27	$III_B3,4$	654	14,000	27	V 1,3	466	13,000	27	V 2,3	496
160	9,740	27	V 1,4	473	15,000	28	V 1,3	466	15,000	28	V 1,3	466
161	14,500	26	IV 2,4	556	20,000	27	V 1,3	466	23,000	27	V 1,3	466
162	9,390	26	V 2,4	503	12,000	26	V 1,3	466	12,000	26	V 1,3	466
163	6,900	30	V 2,4	503	10,000	30	V 1,3	466	25,000	33	$III_B4,5$	817
164	15,530	26	IV 3,4	595	20,000	27	V 2,3	496	45,000	30	$II_A4,5$	857
165	10,070	25	V 1,4	473	15,000	30	V 1,3	466	35,000	33	$II_A4,5$	857
166	2,890	25	IV 1,7	495	5,000	25	V 1,5	483	25,000	32	$I_B4,5$	936
167	6,510	25	V 1,2	458	15,000	26	V 1,2	458	30,000	30	$III_B3,4$	654
168	10,560	25	IV 2,2	541	20,000	26	IV 1,2	511	30,000	30	$III_A3,4$	708
169	20,520	27	V 1,1	448	30,000	28	V 1,1	448	70,000	32	$II_B3,3$	764
170	9,500	26	IV 2,2	541	15,000	27	IV 1,2	511	75,000	33	$II_B3,3$	764
171	12,970	28	V 1,3	466	25,000	28	IV 1,3	519	50,000	30	$II_A3,4$	812
172	6,610	28	V 1,1	448	15,000	28	V 1,1	448	30,000	33	$II_B3,3$	764
173	12,200	23	$II_B3,2$	756	25,000	26	$II_B3,2$	756	75,000	34	$I_B4,4$	926
174	15,530	26	$II_A4,2$	833	30,000	36	$II_A4,2$	833	75,000	41	$I_B4,4$	926
175	27,560	26	IV 2,5	566	40,000	29	V 1,3	466	40,000	28	V 1,3	466
176	31,380	28	$I_B4,3$	919	50,000	31	$II_A4,3$	841	50,000	32	$II_A4,3$	841
177	34,600	27	$III_A3,3$	701	55,000	30	$III_B4,4$	690	55,000	30	$III_B4,4$	690
178	70,940	26	V 2,5	513	100,000	29	$III_B5,5$	729	100,000	29	$III_B5,5$	729
179	58,900	27	$III_B3,4$	654	95,000	29	$III_B4,5$	699	95,000	29	$III_B4,5$	699
180	41,760	28	$III_A4,3$	737	60,000	31	$III_A5,4$	773	60,000	31	$III_A5,4$	773
181	36,070	27	$III_A4,3$	737	50,000	29	$III_B5,4$	719	45,000	29	$III_B5,4$	719
182	28,110	27	V 1,4	473	35,000	29	V 1,3	466	33,000	29	V 1,3	466
183	47,520	26	V 3,3	534	61,000	28	V 2,3	496	60,000	28	V 2,3	496

TABLE I (CONT'D)

	1960				1975				1985			
d_i	Population	% E.A.M.	Income Level	K_i	Population	% E.A.M.	Income Level	K_i	Population	% E.A.M.	Income Level	K_i
184	19,550	29	$III_A 4,4$	744	26,000	30	$III_B 5,5$	729	24,000	30	$III_B 5,5$	729
185	51,490	28	V 1,3	466	64,000	29	V 1,2	458	64,000	29	V 1,2	458
186	58,030	28	$III_B 3,4$	654	85,000	29	IV 3,5	604	80,000	29	IV 3,5	604
187	11,570	30	$I_B 5,3$	949	15,000	32	$I_B 5,3$	949	14,000	32	$I_B 5,3$	949
188	43,680	27	V 2,4	503	54,000	28	V 1,4	473	50,000	28	V 1,4	473
189	12,190	30	$III_B 3,3$	647	19,000	31	IV 4,4	631	20,000	31	IV 4,4	631
190	10,940	31	$III_B 5,3$	712	16,000	31	IV 5,4	660	15,000	31	V 4,4	578
191	3,140	39	$I_B 4,3$	919	6,000	40	$I_B 5,4$	956	25,000	40	$I_B 5,4$	956
192	14,400	36	$III_A 3,3$	701	23,000	37	$III_B 4,4$	690	45,000	38	$II_B 5,4$	837
193	15,350	28	IV 3,3	588	24,000	29	V 2,3	496	20,000	29	V 2,3	496
194	9,560	33	$III_A 4,3$	737	15,000	34	$III_B 5,4$	719	13,000	35	$III_B 5,4$	719
195	7,580	42	$II_A 4,3$	841	15,000	43	$II_B 5,4$	837	35,000	45	$I_B 5,4$	956
196	9,700	28	IV 3,3	588	14,000	29	V 3,3	534	12,000	29	V 3,3	534
197	12,120	29	$III_A 3,4$	708	18,000	30	$III_B 4,4$	690	15,000	30	IV 4,4	631
198	3,800	45	$I_B 4,3$	919	6,000	45	$II_A 5,4$	877	60,000	46	$I_A 5,4$	1100
199	11,640	44	$I_B 3,2$	875	15,000	45	$I_B 3,2$	875	15,000	46	$I_B 3,2$	875
200	5,500	47	$I_B 2,2$	837	8,000	45	$I_B 2,2$	837	8,000	49	$I_B 2,2$	837
201	9,860	43	$I_A 2,1$	968	15,000	44	$I_B 2,2$	968	15,000	45	$I_A 2,1$	968
202	1,900	52	$I_A 2,2$	978	3,000	53	$I_A 2,1$	978	3,000	54	$I_A 2,2$	978
203	10,400	37	$III_A 3,3$	737	13,000	38	$I_A 2,2$	988	13,000	38	$III_B 4,4$	690
204	37,210	32	$II_A 4,3$	841	80,000	35	$III_B 4,4$	690	120,000	37	$I_B 5,4$	956
205	32,140	34	$I_B 4,2$	911	90,000	36	$I_B 5,4$	949	130,000	38	$I_A 5,3$	1090
206	16,030	35	$I_B 3,2$	875	45,000	36	$I_B 5,3$	913	75,000	37	$I_A 4,3$	1060
207	19,910	35	$I_B 3,3$	883	45,000	36	$I_B 4,3$	956	75,000	37	$I_A 5,4$	1097
208	6,860	43	$II_A 4,1$	823	15,000	44	$I_B 5,4$	949	25,000	45	$I_B 5,3$	949
209	12,630	36	$I_B 3,2$	875	25,000	38	$I_B 5,3$	919	45,000	40	$I_A 4,3$	1060
210	58,510	25	V 2,4	503	75,000	28	IV 4,4	631	90,000	29	$III_B 5,4$	719
211	7,900	28	V 1,4	473	11,000	28	V 1,3	466	15,000	29	V 1,3	466
212	26,140	27	V 2,4	503	34,000	28	V 2,4	503	45,000	29	IV 3,4	595
213	14,060	26	IV 2,4	556	22,000	28	$III_B 3,4$	654	30,000	29	$III_A 4,4$	744
214	1,440	30	V 2,5	513	20,000	31	V 2,3	496	30,000	31	V 1,3	466
215	12,530	33	$I_A 3,2$	1016	22,000	34	$I_A 4,3$	1060	35,000	35	$I_A 4,3$	1060
216	14,290	26	$III_B 3,3$	647	23,000	28	$III_B 4,4$	690	35,000	31	$II_B 5,4$	837
217	18,210	29	$III_A 3,4$	708	29,000	29	$III_B 4,5$	699	45,000	31	$II_A 5,5$	887
218	15,640	27	V 2,4	503	23,000	28	IV 3,4	595	35,000	30	$III_B 4,4$	690
219	22,190	33	$I_A 3,2$	1016	34,000	34	$I_A 3,2$	1016	45,000	35	$I_A 3,2$	1016
220	21,340	29	$II_A 3,3$	805	37,000	30	$II_B 4,3$	800	45,000	32	$I_A 4,3$	1060
221	59,080	30	$II_A 3,2$	796	110,000	33	$I_B 4,3$	919	150,000	35	$I_A 4,3$	1060
222	19,970	26	IV 2,2	541	25,000	29	IV 2,2	541	40,000	30	$III_B 4,2$	674
223	17,130	25	$III_A 3,3$	701	25,000	27	$III_A 3,3$	701	40,000	30	$II_B 4,4$	806
224	49,150	26	IV 2,4	556	60,000	28	$III_B 4,4$	690	60,000	29	IV 4,4	631
225	11,800	33	$II_A 4,2$	832	30,000	35	$II_B 4,3$	800	45,000	36	$I_A 5,3$	1090
226	70,820	30	$II_B 3,3$	764	130,000	33	$II_A 5,4$	877	150,000	35	$I_B 5,4$	956
227	22,580	34	$I_B 2,3$	845	40,000	35	$I_A 3,4$	1031	55,000	36	$I_A 3,4$	1031
228	17,550	23	$II_B 5,2$	822	28,000	26	$II_B 5,3$	830	30,000	28	$II_A 5,3$	870
229	8,080	26	V 2,3	496	13,000	26	V 1,3	466	15,000	26	V 1,3	466
230	19,880	25	V 2,3	496	34,000	27	V 1,3	466	35,000	27	V 1,3	466
231	8,000	26	IV 3,3	588	15,000	28	$III_B 4,3$	683	15,000	29	$III_B 4,3$	683
232	13,520	28	V 2,3	496	70,000	32	$I_B 4,3$	919	75,000	34	$I_A 4,3$	1060
233	5,010	29	V 1,3	466	6,000	29	V 1,3	466	10,000	29	V 1,2	458
234	22,770	25	V 2,4	503	31,000	27	$III_B 4,4$	690	35,000	28	$III_A 4,4$	744
235	2,070	25	V 2,3	496	3,000	25	V 2,3	496	5,000	25	V 1,3	466
236	11,470	22	IV 2,4	556	20,000	25	$III_A 4,4$	744	20,000	27	$III_A 4,4$	848
237	28,420	25	$III_B 3,3$	647	60,000	28	$II_A 4,4$	848	70,000	30	$I_B 5,4$	956
238	1,010	28	$II_A 2,1$	749	2,500	30	$I_B 2,1$	827	4,000	31	$I_A 2,1$	968
239	10,670	25	V 2,3	496	14,500	27	$III_B 2,4$	615	16,000	27	$III_B 3,4$	654
240	59,390	28	V 1,3	466	86,000	30	$III_A 3,4$	708	100,000	31	$III_A 3,4$	708
241	4,810	28	V 1,2	458	8,000	30	$III_B 2,3$	608	15,000	31	$III_A 2,4$	670
242	20,500	31	V 1,2	425	32,000	31	V 1,2	458	35,000	31	V 1,2	458
243	11,200	28	V 2,2	488	17,000	28	V 1,2	458	20,000	28	V 1,2	458
244	4,700	30	V 1,1	448	7,000	30	V 1,1	448	10,000	30	V 1,1	448

(1) d_i is the subarea number

(2) % E.A.M.: percent economically active members to total population

(3) Income level as has been indicated in Chapters III and IV

(4) K_i: is the number of trips per year for each economically active member in the i-th subarea.

APPENDIX D

PROJECTED TRAFFIC VOLUME

TABLE I

COORDINATES OF THE CENTER OF GRAVITY OF EACH SUBDIVISION

Subdivision Number di	x	y
1	92	235
2	94	239
3	91	240
4	98	243
5	97	238
6	93	243
7	98	235
8	96	239
9	113	239
10	112	236
11	106	234
12	113	229
13	185	232
14	106	236
15	115	235
16	113	242
17	110	230
18	117	234
19	105	232
20	109	234
21	109	231
22	119	227
23	112	233
24	105	198
25	104	210
26	111	184
27	112	216
28	104	217
29	102	212
30	103	207
31	102	214
32	108	203
33	106	217
34	104	213
35	102	209
36	112	207
37	107	229
38	108	226
39	105	230
40	103	223
41	106	224
42	104	221
43	101	223
44	107	227
45	103	225
46	118	222
47	109	223
48	107	219
49	102	227
50	106	225
51	104	229
52	108	223
53	106	220
54	134	275
55	145	285
56	139	288
57	138	273
58	90	273
59	111	283
60	98	265
61	97	261
62	86	268
63	91	262
64	94	268
65	97	276
66	88	219
67	95	210
68	96	219
69	94	217
70	92	221
71	90	215
72	93	214
73	87	211
74	98	211
75	90	220
76	100	217
77	92	207
78	99	221
79	100	208
80	114	246
81	115	244
82	109	245
83	117	239
84	103	246
85	112	249
86	153	291
87	155	298
88	129	296
89	157	315
90	158	307
91	147	306
92	128	278
93	135	291
94	192	232
95	138	304
96	134	315
97	112	160
98	117	158
99	108	159
100	107	171
101	127	135
102	128	144
103	97	168
104	132	117
105	127	128
106	-	-
107	104	155
108	-	-
109	123	152
110	97	230
111	99	228
112	98	232
113	98	227
114	101	230
115	119	268
116	123	162
117	115	260
118	140	248
119	125	247
120	124	252
121	119	274
122	122	251
123	122	242
124	-	-
125	121	255
126	120	249
127	116	248
128	116	252
129	126	270
130	132	259
131	128	266
132	108	240
133	100	237
134	103	234
135	102	241
136	110	242
137	100	234
138	105	242
139	110	243
140	107	241
141	100	240
142	107	238
143	103	142
144	104	238
145	101	235
146	101	233
147	102	237
148	82	237
149	83	239
150	88	240

TABLE I (CONT'D)

151	82	250	189	95	226	227	70	232
152	84	244	190	93	223	228	64	222
153	81	241	191	89	224	229	69	272
154	81	250	192			230	66	268
155	83	238	193	98	223	231	72	252
156	84	235	194	92	225	232	56	246
157	85	242	195	94	230	233	64	252
158	86	239	196	90	230	234	69	251
159	85	238	197	98	226	235	73	257
160	87	237	198	85	228	236	66	246
161	86	245	199	74	245	237	69	253
162	84	242	200	78	232	238	8	167
163	85	243	201	85	219	239	11	152
164	80	245	202	87	224	240	103	295
165	85	234	203	87	232	241	85	301
166	82	239	204	157	280	242	92	307
167	134	105	205	174	278	243	114	319
168	139	96	206	164	273	244	130	318
169	145	55	207	150	276			
170	158	36	208	172	291			
171	172	42	209	158	262			
172	150	18	210	93	200			
173	159	54	211	95	179			
174	168	52	212	86	201			
175	86	251	213	87	182			
176	84	259	214	94	197			
177	91	247	215	80	197			
178	83	255	216	84	191			
179	90	255	217	84	202			
180	90	254	218	81	216			
181	97	256	219	96	186			
182	111	264	220	79	220			
183	101	248	221	53	190			
184	95	247	222	71	194			
185	108	272	223	71	191			
186	97	250	224	70	188			
187	109	256	225	66	236			
188	104	257	226	70	221			

TABLE II

COORDINATES; PROVIDED CAPACITY (1960); (1960, 1975, 1985) POPULATION TRAVEL POTENTIAL AT RANDOMLY CHOOSEN POINTS ON THE NETWORK

Point	x	y	ψ_i (1)	Potential (2) 1960	1975	1985
1	12	157	64	2,495	42,594	84,211
2	7	170	379	48,855	80,892	178,562
3	12	168	1,376	24,951	42,594	84,211
4	33	178	1,376	17,496	31,315	51,698
5	51	187	1,759	20,834	37,543	61,019
6	60	170	465	23,424	42,268	68,827
7	68	187	465	26,249	47,410	77,464
8	67	193	9,096	25,866	46,714	76,295
9	68	197	1,616	26,249	47,410	77,469
10	69	198	10,769	26,640	48,123	78,671
11	74	198	6,586	28,738	51,943	85,130
12	72	202	3,241	27,870	50,361	82,454
13	69	203	6,739	26,640	48,123	78,671
14	70	210	1,125	27,041	48,852	79,903
15	69	215	5,006	26,641	48,123	78,671
16	63	215	1,290	24,422	44,085	71,871
17	73	217	3,241	28,299	51,143	83,776
18	71	220	5,134	27,450	49,598	81,163
19	68	221	2,381	26,249	47,410	77,469
20	64	218	1,279	24,771	44,720	72,937
21	60	217	1,001	23,424	42,268	68,827
22	64	222	165	24,771	44,720	72,937
23	56	222	836	22,200	40,038	65,116
24	73	225	3,241	28,299	51,143	83,776
25	70	226	941	27,041	4,882	79,903
26	64	232	1,605	24,771	44,720	72,937
27	58	236	1,605	22,797	41,126	66,923
28	52	235	836	21,093	38,017	61,791
29	62	340	990	24,081	43,466	70,831
30	68	342	383	26,249	47,410	77,469
31	66	343	180	25,493	46,034	75,149
32	57	343	615	22,494	40,575	66,008
33	59	249		23,106	41,690	67,803
34	65	247	2,269	25,127	45,370	74,030
35	69	248	2,976	26,640	48,122	78,671
36	73	253	2,797	28,299	51,143	83,776
37	63	256		24,422	44,084	71,871
38	75	255	180	29,187	52,762	86,515
39	73	257	2,565	28,299	51,143	83,776
40	69	258	2,565	26,640	48,123	78,671
41	74	261	2,565	28,738	51,943	85,130
42	65	264	2,565	25,127	45,370	74,030
43	77	265	180	30,118	54,459	89,389
44	73	277	180	28,299	51,143	83,776
45	144	24	308	87,462	164,759	265,512
46	148	34	154	82,148	152,013	238,202
47	157	36	154	75,242	136,075	204,246
48	154	41	600	77,045	140,126	212,874
49	164	41	371	72,020	129,249	189,925
50	169	40	154	70,123	125,605	182,755
51	172	41	154	69,041	123,665	179,224
52	163	43		72,426	130,070	191,607
53	170	47		69,760	124,944	181,524
54	173	48	154	68,684	123,045	178,147
55	170	48	446	69,760	124,944	181,524
56	170	50	600	69,760	124,944	181,524
57	164	50	383	72,020	129,249	189,925
58	140	50	446	95,469	184,550	307,792
59	135	73	446	113,395	231,596	399,921
60	132	92	446	137,463	292,400	510,646
61	131	106	446	148,256	314,950	551,478
62	130	116	218	166,319	347,495	610,336
63	125	130	218	156,549	306,979	539,647
64	124	130	229	117,579	229,993	401,425
65	120	136	218	78,382	149,707	257,467
66					-	-
67					-	
68					-	-
69					-	-
70	114	140	446	62,595	116,612	197,813
71	107	147	525	52,401	96,236	161,222
72	113	147	446	60,853	113,057	191,396
73	118	147	326	71,516	135,202	231,357
74	120	152	326	78,382	149,707	257,467
75	119	153	296	74,613	141,743	243,138
76	114	155	296	62,595	116,612	197,813
77	110	149	1,069	56,277	103,864	174,847
78	114	150	326	62,595	116,612	197,813
79	104	154	544	49,029	89,707	149,691
80	98	166	-	43,377	78,966	131,032
81	90	161	525	37,412	67,845	112,056
82	88	179	543	36,125	65,471	108,030
83	113	184	368	60,853	113,057	191,397
84	82	192	-	32,647	59,082	97,213
85	86	193	2,078	34,906	63,226	104,228
86	85	199	1,331	34,320	62,149	102,405
87	84	204	6,299	33,748	61,100	100,629
88	87	202	1,624	35,508	64,333	106,103
89	90	200	2,608	37,412	67,845	112,056
90	96	201	1,200	41,744	75,902	125,776
91	107	198	1,968	52,401	96,236	161,222
92	108	201	368	53,630	98,639	165,499
93	105	205	2,817	50,105	91,780	153,338
94	102	203	1,166	47,002	85,829	142,908
95	99	207	-	44,236	80,583	133,817
96	96	208	323	41,744	75,902	125,776
97	92	205	1,174	38,772	70,364	116,333
98	89	206	1,754	36,760	66,641	110,013
99	86	205	409	34,906	63,226	104,228
100	80	196	-	31,599	57,164	93,967
101	80	200	5,040	31,599	57,164	93,967
102	81	199	5,228	32,117	58,111	95,570
103	80	206	5,040	31,599	57,164	93,967
104	81	211	6,165	32,117	58,111	95,570
105	83	211	5,756	33,191	60,078	98,899
106	86	210	1,477	34,906	63,226	104,228
107	88	211	383	36,125	65,471	108,030
108	87	213	754	35,508	64,333	106,103
109	89	212	1,279	36,760	66,641	110,013
110	87	215	-	35,508	64,333	106,103
111	92	215	2,678	38,772	70,364	116,333
112	91	216	-	38,082	69,086	114,161
113	92	218	6,373	38,772	70,364	116,333
114	90	217	1,774	37,412	67,845	112,056
115	89	217	7,218	36,760	66,641	110,013
116	87	217	5,440	35,508	64,333	106,103
117	93	214	12,586	39,481	71,682	118,575
118	96	217	-	41,744	75,902	125,776
119	105	212	3,904	50,105	91,780	153,338
120	108	210	143	53,630	98,639	165,499
121	114	214	143	62,595	116,612	197,813
122	118	212	143	71,516	135,202	231,357
123	133	198	143	128,049	269,708	469,526
124	108	219	428	53,630	98,639	165,499
125	103	220	4,077	47,995	87,726	146,219
126	107	225	428	52,401	96,236	161,222
127	102	226	428	47,002	85,829	142,908
128	100	224	4,981	45,125	82,263	136,718
129	96	226	1,766	41,744	75,902	125,776
130	94	225	5,113	40,213	73,043	120,893
131	93	227	7,323	39,481	71,682	118,575
132	92	227	-	38,772	70,364	116,333
133	88	226	13,129	36,125	65,471	108,030
134	92	226	-	38,772	70,364	116,333
135	92	223	11,502	38,772	70,364	116,333
136	87	218	11,167	35,508	64,333	106,103
137	88	223	6,488	35,508	64,333	106,103
138	86	228	12,667	34,906	63,226	103,228
139	85	230	1,624	34,320	62,149	102,405
140	86	231	4,403	34,906	63,226	103,228
141	82	235	-	32,647	59,082	97,213
142	85	232	11,681	34,320	62,149	102,405
143	69	353	1,885	26,640	48,122	78,671
144	86	236	7,250	34,906	63,226	104,228
145	84	238	795	33,748	61,100	100,629
146	82	241	-	32,117	58,111	95,570
147	81	242	-	31,599	57,164	93,967
148	80	242	3,605	31,093	56,241	92,404

(1) Provided capacity of all lines passing point i on the network seats/working hour

(2) Population travel potential to each point on the network assuming that $w_i = 1$

$$P_i = \sum \frac{w_i \cdot K_j P_j}{d^2_{ij}}$$

TABLE II (CONT'D)

Point	x	y	ψ_i	Potential 1960	Potential 1975	Potential 1985
149	75	240	7,228	29,187	52,762	86,515
150	81	246	-	32,117	58,111	95,570
151	84	246	-	33,748	61,100	100,629
152	88	244	3,481	36,125	65,471	108,030
153	89	246	405	36,760	66,641	110,013
154	87	250	791	35,508	64,333	106,103
155	86	253	1,631	34,906	63,226	104,228
156	83	251	3,596	33,191	60,078	98,899
157	79	250	349	31,093	56,241	92,404
158	90	253	840	37,412	67,845	112,056
159	91	253	743	38,082	69,086	114,161
160	82	259	-	32,647	59,082	97,213
161	83	262	2,084	33,191	60,078	98,899
162	87	261	3,716	35,508	64,333	106,103
163	89	267	3,079	36,760	66,641	110,013
164	93	268	9,447	38,772	70,364	116,333
165	86	273	349	34,906	63,226	104,228
166	92	276	10,419	38,772	70,364	116,333
167	93	280	9,508	39,481	71,682	118,575
168	94	282	431	40,213	73,043	120,893
169	92	284	1,335	38,772	70,364	116,333
170	94	291	1,335	40,213	73,043	120,893
171	-	-	1,335	-	-	-
172	88	299	12,134	36,125	65,471	108,030
173	97	229	-	42,548	77,407	128,354
174	97	235	-	42,548	77,406	128,354
175	96	236	-	41,744	75,902	125,776
176	93	235	-	39,481	71,682	118,575
177	92	236	15,536	38,772	70,364	116,333
178	91	239	14,434	38,082	69,086	114,161
179	93	239	-	39,481	71,682	118,575
180	94	239	-	40,213	73,043	120,893
181	92	242	14,243	38,772	70,364	116,333
182	94	245	2,040	40,213	73,043	120,893
183	96	249	638	41,744	75,902	125,776
184	93	250	-	39,481	71,682	118,575
185	95	255	2,554	40,967	74,449	123,291
186	93	259	11,801	38,772	70,364	116,333
187	101	262	416	46,046	84,010	139,745
188	98	263	1,935	43,377	78,966	131,032
189	101	254	416	46,046	84,010	139,745
190	100	271	2,186	45,125	82,263	136,718
191	100	274	2,186	44,236	80,583	133,817
192	100	284	788	45,125	82,263	136,718
193	109	228	1,631	54,920	101,176	170,031
194	105	230	3,236	50,105	91,780	153,338
195	103	234	686	47,995	87,726	146,219
196	108	240	-	53,630	98,639	165,499
197	109	242	6,490	54,920	101,176	170,031
198	106	241	1,418	51,228	93,953	157,175
199	109	245	1,065	54,920	101,176	170,031
200	104	245	2,606	49,029	89,707	149,691
201	105	247	5,670	50,105	91,780	153,338
202	105	248	-	50,105	91,780	153,338
203	103	250	1,455	47,995	87,726	146,219
204	107	250	1,069	52,401	96,236	161,222
205	110	257	251	56,277	103,864	174,847
206	110	286	788	56,277	103,864	174,847
207	117	229	960	68,875	129,646	221,340
208	114	233	645	62,595	116,612	197,813
209	119	238	960	74,613	141,743	243,138
210	115	240	304	64,484	120,494	204,832
211	119	242	341	74,613	141,743	243,138
212	116	246	10,031	66,559	124,804	212,603
213	111	246	2,603	57,711	106,721	179,981
214	116	248	2,813	66,559	124,804	212,603
215	115	253	859	64,484	120,499	204,832
216	112	253	-	59,231	109,775	185,478
217	117	259	431	68,875	129,646	221,340
218	113	266	251	60,853	113,057	191,397
219	116	272	750	66,559	124,804	212,603
220	118	284	251	71,516	135,202	231,357
221	120	284	750	78,382	149,707	257,467
222	123	286	1,358	99,883	194,325	337,486
223	122	289	608	89,828	173,669	300,471
224	118	289	788	71,516	135,202	231,357
225	123	294	431	99,883	194,325	337,486
226	127	306	431	736,456	1,426,762	2,554,812
227	128	270	532	458,423	897,844	1,601,997
228	123	266	2,280	99,883	194,325	337,486
229	128	266	-	458,423	897,844	1,601,997
230	130	265	2,952	166,319	347,495	610,336
231	127	262	1,984	736,456	1,426,762	2,554,812
232	121	261	2,891	83,205	159,860	275,704
233	128	260	3,049	458,423	897,844	1,601,997
234	121	255	3,053	83,205	159,860	275,704
235	123	253	9,764	99,883	194,325	337,486
236	127	253	600	736,456	1,426,762	2,554,812
237	124	251	-	117,579	229,993	401,425
238	121	251	9,086	83,205	159,860	275,704
239	125	248	263	156,549	306,979	539,647
240	121	248	1,088	83,205	159,860	275,704
241	131	250	600	148,256	314,950	551,478
242	133	254	229	128,049	269,708	469,526
243	135	269	2,258	113,395	231,596	399,921
244	136	269	1,984	108,338	218,120	374,740
245	133	274	945	128,049	269,708	469,526
246	133	283	1,024	128,049	269,708	469,526
247	137	282	-	104,315	207,435	354,234
248	136	286	1,133	108,338	218,120	374,740
249	131	286	941	148,256	314,950	551,478
250	138	292	1,159	100,965	198,641	336,823
251	138	295	431	100,965	198,641	336,823
252	140	298	795	95,469	184,550	307,792
253	142	303	795	91,048	173,529	284,351
254	147	308	356	83,289	154,724	243,993
255	149	204	-	81,108	149,556	232,960
256	148	298	964	82,148	152,013	283,202
257	150	301	431	80,156	147,320	228,196
258	150	297	431	80,156	147,320	228,196
259	149	291	788	81,108	149,556	232,960
260	146	289	739	84,544	157,723	256,411
261	144	288	476	87,462	164,759	265,512
262	140	289	-	95,469	184,540	307,792
263	147	285	476	83,289	154,724	243,993
264	143	283	1,526	89,161	168,895	274,408
265	149	282	611	81,108	149,556	232,960
266	140	277	1,170	95,469	184,550	307,792
267	141	275	476	93,143	178,720	295,446
268	145	275	784	85,929	161,052	257,549
269	144	272	1,984	87,462	164,759	265,512
270	141	268	2,051	93,143	178,720	295,446
271	147	262	476	83,289	154,724	243,993
272	145	260	483	85,929	161,052	257,549
273	140	242	263	95,469	184,550	307,792
274	153	266	338	77,735	141,702	216,231
275	150	270	1,484	80,156	147,320	228,196
276	153	271	1,751	77,735	141,702	216,231
277	158	271	765	74,713	134,911	201,771
278	151	275	1,046	79,283	145,280	223,853
279	151	277	931	79,283	145,280	223,853
280	154	276	2,220	77,045	140,126	212,874
281	155	282	931	76,404	138,672	209,775
282	160	286	500	73,736	132,801	197,307
283	157	290	780	75,242	136,075	204,246
284	157	299	533	75,242	136,075	204,246
285	159	299	847	74,212	133,822	199,464
286	160	297	533	73,736	132,801	197,307
287	163	297	679	72,426	130,070	191,607
288	166	292	578	71,239	127,712	186,831
289	167	287	1,078	70,862	126,986	185,403
290	169	285	1,484	70,123	125,605	182,755
291	166	282	-	71,239	127,712	182,831
292	169	283	2,290	70,123	125,605	182,755
293	168	281	1,694	70,490	126,285	184,047
294	169	279	578	70,123	125,605	182,755
295	167	279	2,614	70,862	126,986	185,403
296	163	278	2,688	72,426	130,070	191,607
297	160	277	1,983	73,736	132,801	197,307
298	162	277	-	72,846	130,932	193,391
299	164	274	1,238	72,020	129,249	189,925
300	163	273	427	72,426	130,070	191,607

TABLE II (CONT'D)

Point	x	y	ψ_i	Potential 1960	1975	1985
301	161	270	338	73,282	131,840	195,287
302	169	279	1,174	70,123	125,605	182,755
303	169	271	-	70,123	125,605	182,755
304	166	270	578	71,239	127,712	186,831
305	164	265	338	72,020	129,249	189,925
306	172	270	-	69,041	123,665	179,224
307	174	283	500	68,327	122,435	177,116
308	187	267	-	63,628	115,064	166,960
309	185	289	199	64,359	116,147	168,173
310	180	323	169	66,176	118,930	171,739
311	188	330	814	63,263	114,529	166,399
312	202	345	169	58,239	107,474	161,208
313	170	51	-	69,760	124,944	181,524
314	162	63	5,438	72,846	130,932	193,391
315	150	83	5,438	80,156	147,320	228,196
316	145	94	5,438	85,929	161,052	257,549
317	141	102	5,438	93,143	178,720	295,446
318	132	118	5,438	137,463	292,400	510,646
319	126	130	5,438	278,404	543,744	965,461
320	121	138	5,438	83,205	159,860	275,704
321	113	143	5,438	60,853	113,057	191,397
322	95	169	5,438	40,967	74,449	123,291
323	84	191	5,438	33,748	61,100	100,629
324	84	199	5,438	33,748	61,100	100,629
325	89	214	5,438	36,760	66,641	110,013
326	90	223	5,438	37,412	67,845	112,056
327	93	229	218	39,481	71,682	118,575
328	93	231	-	39,481	71,682	118,575
329	95	233	6,439	40,967	74,449	123,291
330	101	231	6,490	46,046	84,010	139,745
331	101	232	3,510	46,046	84,010	139,745
332	102	230	686	47,002	85,829	142,908
333	100	228	5,486	45,125	82,263	136,718
334	98	235	13,009	43,377	78,966	131,032
335	100	241	9,117	45,125	82,263	136,718
336	99	246	-	44,239	80,583	133,817
337	100	247	-	45,125	82,263	136,718
338	161	331	-	73,282	131,840	195,287
339	155	321	-	76,404	138,672	209,775
340	149	310	-	81,108	149,556	232,960
341	146	299	-	85,929	161,052	257,549
342	145	292	-	85,929	161,052	257,549
343	143	286	-	89,161	168,898	274,408
344	139	278	-	98,056	191,128	321,509
345	135	272	423	113,395	231,596	399,921
346	131	268	1,699	148,256	314,950	551,478
347	126	263	-	278,404	543,744	965,461
348	120	259	1,984	78,382	149,707	257,467
349	99	245	1,984	44,236	80,583	133,817
350	68	180	5,265	26,249	47,410	77,469

Point	x	y	ψ_i	Potential 1960	1975	1985
351	99	203	851	44,236	80,583	133,817
352	104	208		49,029	89,707	149,691
353	111	227	1,005	57,711	106,721	179,981
354	93	234	-	39,481	71,682	118,575
355	90	234	1,185	37,412	67,845	112,056
356	95	244	817	40,967	74,449	123,291
357	112	257	1,181	59,231	109,775	185,478
358	116	257	1,984	66,559	124,804	212,603
359	112	250	3,281	59,231	109,775	185,478
360	151	309	-	79,283	145,280	223,853
361	174	273	3,281	68,327	122,435	177,116
362	171	290	2,018	69,400	124,298	180,348
363			906			
364			-			
365			-			
366			-			
367			-			
368			-			
369			-			
370			1,193			
371			1,620			
372			4,988			
373			5,134			
374			-			
375	155	320	169	76,404	138,672	269,775
376	208	304	199	55,915	104,104	158,680
377	145	302	-	85,929	161,052	257,549
378	160	267	578	73,736	132,801	197,307
379	152	252	-	78,478	143,414	219,878
380	152	289	908	78,478	143,414	219,878
381	95	258	1,211	40,967	74,449	123,291
382	98	213	956	43,377	78,966	131,032
383	70	235	4,182	27,041	48,852	79,903
384	104	213	1,260	49,029	189,707	149,691
385	97	232	6,656	42,548	77,407	128,354
386	97	240	9,220	42,548	77,407	128,354
387			-			
388			593	85,929	161,052	257,549
389			593	93,143	178,720	295,446
390			-			
391			-			
392			2,528	137,463	292,400	510,646
393						
394						
395						
396						
397						
398						
399						
400						

TABLE III

POINTS IDENTIFYING EACH LINE ON THE NETWORK

Line	Passing Points No.	Length of Line (Km)	Assumed Distance Between Stops (Mi.)
BI2	85, 87, 86, 88, 98, 117, 128	10.00	400
3	2, 3, 4, 5, 9, 10	9.20	500
3'	1, 3, 4, 5, 9, 10	8.50	500
4	40, 39, 41, 42, 34, 149, 144, 329, 385	8.40	400
5	350, 8, 10, 13, 15, 19, 26, 27, 29, 30, 149, 144, 329, 385	14.70	400
5'	385, 329, 144, 149, 29, 27, 26, 22, 21, 16, 13, 10, 8, 350	14.70	400
6	350, 8, 10, 13, 15, 19, 25, 383, 149, 144, 329, 385	11.05	400
7	6, 7, 350, 8, 10, 11, 101, 103, 104, 105, 136, 137, 133, 131, 172	10.60	400
7'	385, 327, 131, 133, 137, 136, 105, 104, 103, 101, 11, 10, 8, 350	8.30	400
8	3, 4, 5, 9, 10, 11, 101, 103, 104, 105, 136, 137	13.70	400
8'	137, 136, 105, 104, 103, 101, 11, 109, 5	10.70	400
9	350, 8, 10, 13, 15, 18, 372, 373, 142, 178	9.00	400
10	350, 8, 10, 13, 15, 18, 372, 373, 133, 131, 172	8.50	400
11	90, 351, 97, 88, 86, 102, 11, 13, 16, 20, 19, 26, 27, 29, 35, 36, 42, 41, 39, 40	17.70	500
12	117, 111, 115, 116, 136, 105, 104, 103, 101, 11, 13, 15, 18, 372, 373, 133, 135, 113, 117	6.40	400
12'	117, 113, 135, 133, 373, 372, 18, 15, 13, 11, 101, 103, 104, 105, 136, 116, 115, 111, 117	6.40	400
16	3, 4, 5, 9, 10, 13, 15, 18, 372, 373	14.00	400
16'	5, 9, 10, 13, 15, 18, 372, 373	11.00	400
18	40, 39, 41, 42, 34, 149, 145, 152	9.00	400
19	350, 8, 10, 13, 15, 19, 25, 383, 149, 144, 178	19.00	400
21	167, 166, 163, 155, 154, 153, 181, 178, 142, 138, 133, 135, 114, 111, 117	9.80	400
22	167, 166, 164, 186, 181, 329, 385	8.20	400
22'	186, 181, 329, 385	4.50	400
23	171, 170, 169, 166, 164, 381, 185, 182, 178, 142, 138, 133, 135, 114, 111, 117	14.50	400
24	181, 190, 187, 189, 182, 386, 334	6.50	400
25	167, 166, 163, 162, 186, 181, 329, 385	8.20	400
26	171, 170, 169, 165, 157, 148, 139, 138	10.40	400
27	191, 190, 188, 185, 181, 329, 385	6.00	400
27'	188, 185, 181, 329, 385	4.20	400
29	191, 190, 188, 381, 186, 181, 178, 144, 149, 383, 24, 17, 12, 10	14.70	400
32	167, 166, 163, 155, 154, 145, 139, 138	8.20	400
34	350, 355, 388, 389, 242, 245, 227, 346, 230, 233, 235, 238, 214, 359, 201, 335	13.80	550
35	312, 311, 310, 375, 355, 257, 284, 286, 287, 283, 311, 370, 280, 278	14.20	450
36	249, 246, 245, 227, 228, 232, 201, 385, 117, 133	11.00	500
37	249, 222, 223, 220, 218, 205, 204, 203, 183, 182, 386, 334	9.60	400
38	249, 222, 221, 219, 357, 204, 203, 356, 386, 334	8.00	400
40	228, 232, 201, 335, 177, 140	8.00	400
41	254, 253, 252, 250, 261, 264, 266, 243, 230, 233, 234, 359, 201, 335, 177, 140	16.50	500
43	254, 253, 252, 250, 248, 245, 228, 232, 201, 335, 177, 140	14.50	500
44	350, 355, 256, 260, 264, 266, 243, 230, 233, 235, 238, 212, 199, 201, 335, 117, 140	15.00	500
46	361, 295, 296, 271, 311, 380, 263, 267, 243, 392, 233, 234, 359, 201, 335, 177, 140	16.8	500
48	361, 295, 371, 370, 280, 270, 392, 233, 234, 359, 201, 335, 177, 329, 385	15.00	500
50	292, 302, 295, 371, 280, 270, 392, 233, 234, 359, 201, 335, 177, 140	15.00	500
51	361, 295, 296, 297, 276, 270, 392, 235, 240, 212, 197, 330	13.00	500
53	278, 276, 270, 392, 233, 234, 359, 201, 335, 117, 140	11.60	500
54	361, 245, 296, 299, 300, 277, 276, 268, 345, 346, 228, 232, 215, 214, 212, 197, 330	15.50	550
57	278, 276, 277, 301, 305, 274, 272, 241, 236, 235, 240, 212, 197, 330	13.20	500
63	209, 207, 353, 194, 331, 172, 131, 133, 138, 139, 142, 329, 385, 331, 194, 353, 207, 209	6.40	400
68	124, 126, 127, 129, 172, 334, 386, 200, 213, 212, 238, 235	9.80	400
78	235, 238, 212, 199, 203, 183, 185, 381, 186, 159	9.30	400
81	158, 155, 156, 144, 329, 385, 333, 125, 119, 93, 91	10.20	400
82	158, 155, 156, 139, 138, 137, 136, 106, 99, 97, 351, 94, 93, 91	12.30	400
84	90, 94, 119, 384, 130, 172, 331, 194, 353, 208, 210, 212, 240, 235	12.30	400
85	384, 382, 113, 172, 331, 194, 353, 208, 211, 238, 235	10.50	400
87	90, 94, 119, 125, 333, 385, 329, 177, 200, 213, 212, 238, 235	10.50	400
88	96, 97, 98, 109, 108, 115, 117, 128, 332, 195, 198, 199, 212, 238, 235	10.90	400
89	96, 97, 98, 109, 108, 115, 113, 135, 172, 330, 197, 212, 238, 235	10.90	400
93	89, 88, 98, 109, 108, 115, 114, 135, 172, 374, 386, 356, 203, 204, 357, 217	12.00	400
95	85, 87, 102, 101, 103, 104, 105, 136, 137, 138, 142, 178	10.10	420
95'	102, 101, 103, 104, 105, 136, 137, 138, 142, 178	6.00	400
98	102, 101, 103, 104, 136, 115, 114, 135, 172, 385, 329, 177	8.50	400

TABLE III (CONT'D)

Line	Passing Points No.	Length of Line (Km)	Assumed Distance Between Stops (Mi.)
105	167, 166, 164, 186, 181, 177, 140, 137, 136, 105, 104, 103, 101, 102, 87, 85	15.20	400
111	44, 43, 38, 35, 31	4.50	400
124	167, 166, 164, 186, 181, 178, 142, 138, 137, 136, 105, 104, 14, 13, 10, 8, 350	14.05	400
124'	186, 181, 178, 142, 138, 137, 136, 105, 104, 14, 13, 10	9.70	400
128	167, 166, 164, 186, 181, 178, 335, 201, 359, 234	10.10	400
128'	236, 241, 273, 239, 235	2.50	400
132	171, 170, 169, 166, 164, 186, 181, 329, 385, 331, 194, 193	11.60	400
134	191, 190, 188, 185, 181, 177, 140, 137, 136, 107, 109, 98, 88, 89	10.70	400
134'	191, 190, 188, 185, 181, 177, 140	6.20	400
143	285, 286, 284, 256, 388, 389, 250, 248, 246, 222, 221, 219, 357, 198, 195, 332, 129, 131, 133	17.00	420
146	350, 355, 257, 258, 260, 264, 266, 243, 346, 228, 232, 215, 214, 197, 330	14.40	410
149	285, 287, 283, 265, 243, 346, 229, 232, 201, 335, 386, 334, 331, 194, 193	16.00	410
149'	193, 194, 331, 334, 386, 335, 201, 232, 299, 346, 243, 265, 283	14.00	400
152	292, 293, 296, 297, 280, 279, 281, 380, 259, 251, 226, 225, 224, 206, 192, 168, 167	17.3	600
153	292, 293, 371, 370, 280, 268, 264, 261, 248, 246, 222, 223, 224, 206, 192, 166, 164, 186, 159	18.00	400
167	193, 194, 331, 172, 131, 133, 373, 372, 18, 20, 21, 23, 28	10.90	400
167'	331, 172, 131, 133, 373, 372, 18, 20, 21, 23, 28	9.00	400
173	119, 125, 129, 131, 133, 138, 144, 149, 34, 42, 41, 39, 40	12.00	400
174	384, 382, 117, 115, 137, 353, 372, 18, 19, 26, 27, 32, 34, 35, 36, 42, 41, 39, 40	15.80	400
174'	384, 382, 117, 115, 137, 373, 272, 18, 19, 36, 37, 32, 34	9.30	400
175	167, 166, 164, 186, 182, 386, 334, 333, 125	10.40	400
176	191, 190, 188, 185, 182, 380, 334, 172, 129, 125	10.20	400
334	278, 276, 297, 299, 309, 376	14.60	400
401	333, 125, 119, 120, 121, 122, 123	12.40	550
405	119, 93, 92, 83	6.70	450
411	74, 73, 78, 77, 79, 82, 85, 87, 106, 137, 133, 131, 172	17.00	450
412	75, 76, 77, 71, 81, 87, 106, 136, 137, 138, 142, 178	15.90	450
431	56, 55, 49, 48, 58, 59, 60, 61, 62, 63, 65, 70, 72, 77, 79, 82, 85, 87, 106, 136, 137, 138, 142, 178	34.00	700
432	55, 56, 57, 48, 58, 59, 60, 61, 64, 70, 72, 77, 71, 81, 87, 106, 137, 138, 142, 178	35.00	700
441	45, 47, 49, 50, 51, 54, 56, 57, 48, 46, 45	7.80	500
YL15	8, 10, 12, 17, 24, 383, 149, 144, 334, 172, 135, 130, 115, 116, 136, 87, 102, 11, 10, 8	20.40	460
30	235, 238, 212, 197, 330, 172, 135, 130, 115, 116, 136, 87, 89	11.00	400
33	235, 238, 212, 197, 330, 334, 144, 149, 35, 36, 143	11.20	400
44	89, 86, 102, 11, 12, 17, 24, 383, 35, 36, 143	10.10	400
TL1	238, 212, 197, 330, 133, 135, 113, 117	6.50	400
2	238, 212, 197, 330, 333, 125, 119, 93, 91	7.30	400'
3	235, 238, 212, 213, 335, 177, 178, 142, 138, 133, 131, 172	8.80	400
3	235, 238, 212, 213, 335, 177, 178, 142, 138, 133, 131	7.00	400
5	167, 166, 164, 162, 156, 148	6.40	400
6	163, 156, 152, 178, 142, 138, 133, 130, 128, 117, 98	10.60	400
7	167, 166, 164, 162, 156, 152, 178, 142, 138, 133, 135, 113, 117	11.60	400
8	167, 166, 164, 186, 181, 178, 142, 138, 133, 131, 172, 334, 386, 177, 181, 186, 164, 166, 167	8.20	400
11	235, 238, 212, 197, 330, 334, 386, 177, 152, 156, 163	10.00	400
13	163, 156, 152, 177, 386, 334, 333, 125, 119, 93, 91	10.00	400
13'	163, 156, 152, 177, 386, 334, 333, 125, 119, 93	16.00	400
16	167, 166, 164, 186, 181, 178, 142, 138, 133, 135, 113, 117	9.00	400
16'	161, 162, 186, 181, 178, 142, 138, 133, 135, 113, 117	14.00	400
17	214, 200, 335, 177, 178, 142, 138, 135, 113, 117, 128, 130, 133, 138, 142, 178, 177, 335, 200, 214	7.70	400
20	167, 166, 164, 186, 181, 178, 142, 138, 133, 131, 172, 334, 386, 177, 181, 186, 164, 166, 167	8.20	400
21	235, 238, 212, 213, 335, 177, 181, 186, 164, 166, 167	10.00	400
21'	235, 238, 212, 213, 335, 177, 181, 186, 164	15.50	400
22	235, 238, 212, 197, 330, 333, 128, 117, 198	8.63	400
22'	235, 238, 212, 197, 330, 333, 128, 117	13.00	400
23	148, 152, 178, 142, 138, 133, 131, 172, 125, 119, 93, 91	10.00	400
4	148, 152, 177, 386, 334, 172, 128, 117	10.20	400
30	161, 162, 186, 181, 177, 386, 334, 172, 131, 135, 113, 117, 128, 333, 334, 386, 177, 181, 186, 162, 161	8.30	400
55	117, 128, 333, 334, 386, 177, 178, 142, 138, 133, 135, 113, 117	8.20	400
ML1 (Abdel Aziz)	307, 289, 282, 281, 279, 269, 244, 230, 231, 348, 358, 349, 181, 178, 148	-	-
2 (Nozha)	362, 290, 292, 293, 296, 297, 275, 269, 244, 230, 231, 348, 358, 349, 181, 178, 148	-	-
3 (Mirghany)	288, 289, 290, 294, 302, 304, 378, 275, 269, 244, 230, 231, 348, 358, 349, 181, 178, 148	-	-
4 (Estad)	379, 271, 275, 269, 244, 230, 231, 348, 358, 349, 181, 178, 148	-	-
RL1 (Helwan)	313, 314, 315, 316, 317, 318, 319, 320, 321, 323, 325, 326	-	-
2 (Matteria)	338, 339, 341, 342, 343, 344, 345, 346, 347, 348, 349	-	-

NOTE: (1) BL: Bus Line; YL: Trollybus Line; TL: Tramway Line; ML: Metro Line; RL: Railroad Line

(2) Since the actual stops on the network were not known, the choosen points were taken at random but to identify the path of all lines. Adjustments in the sum of the potential at these point to approximately equal that sum of the potential at the exact stops on the network, has been done through the assignment of distances between stops of each line as shown in the table above. The sum of potential then is divided by the number of random points on a line and multipling by the number of assumed actual stops calculated from the assumed distances between stops.

TABLE IV

PROJECTED TRAFFIC VOLUME* OF EACH LINE

Line No.	(1960) V_{LS}	(1960) V_{LS}	(1975) V_{LS}	(1985) V_{LS}
BL2	245	454	512	714
3	95	248	372	516
3'	23	42	225	242
4	308	587	592	843
5	250	512	565	798
5'	106	1563	356	455
6	267	742	635	912
7	199	511	550	775
7'	178	167	339	428
8	336	711	755	1124
8'	156	84	312	382
9	220	604	560	789
10	321	546	704	1026
11	192	652	457	620
12	148	758	399	527
12'	147	760	398	525
16	109	320	388	514
16'	120	107	317	390
18	193	423	446	602
19	260	387	642	923
21	266	421	538	758
22	232	334	496	689
22'	97	96	264	304
23	490	714	823	1229
24	218	289	479	662
25	336	592	628	906
26	199	246	454	618
27	240	367	507	708
27'	108	106	271	316
29	210	305	545	769
32	207	338	464	634
34	592	163	1033	1651
35	243	158	510	666
36	582	224	1016	1624
37	287	248	587	858
38	381	442	714	1076
40	600	614	989	1539
41	1181	694	1801	2932
43	679	405	1127	1764
44	725	488	1206	1920
46	996	731	1526	2398
48	1025	818	1620	2591
50	1018	730	1585	2515
51	556	505	1101	1643
53	525	316	905	1400
54	738	610	1185	1799
57	805	295	1282	2031
63	140	338	382	505
68	423	482	751	1130
78	358	368	668	990
81	309	719	595	855
82	351	607	647	940
84	378	474	694	1033
85	375	503	691	1030
87	467	669	808	1224
88	320	436	616	898
89	-	-	-	-
93	453	657	780	1163
95	379	692	681	991
95'	199	174	328	410
98	227	303	490	677
105	499	701	833	1243
111	43	68	256	290
124	544	869	922	1388
BL124'			528	740
128	502	618	847	1282
128'	325	69	648	990
132	370	790	673	984
134	283	471	560	794
134'	107	139	337	426
143	761	494	1211	1869
146	839	643	1330	2090
149	989	865	1509	2340
149'	176	126	436	590
152	870	618	1734	5757
153	735	549	1177	1810
167	322	668	611	878
167'	112	205	343	434
173	440	825	760	1122
174	357	710	653	943
174'	83	134	307	374
175	361	588	661	963
176	295	427	577	824
334	363	100	663	893
401	152	48	406	549
405	217	251	480	669
411	407	247	725	1079
412	329	227	623	906
431	531	291	885	1347
432	554	339	948	1441
441	61	100	280	319
YL15	786	2485	1707	2677
30	1243	1356	1813	2915
33	1342	1632	1948	3149
44	182	510	555	781
TL1	211	280	474	660
2	236	263	507	716
3	232	223	504	711
3'	348	446	655	966
5	203	269	459	626
6	178	266	427	573
7	440	592	759	1121
8	218	621	478	658
11	418	393	746	1120
13	416	469	731	1081
13'	568	353	937	1422
16	367	496	667	970
16'	342	287	635	917
17	257	600	529	747
20	212	480	470	645
21	490	586	840	1278
21'	620	374	1011	1572
22	658	597	1081	1691
22	508	359	867	1330
23	198	235	454	619
30	663	694		726
55	128	306	364	
4			590	845
ML1	518	813	1015	1582
2	1012	1500	1784	2858
3	618	969	1247	1948
4	451	781		
RL1			5598	9285
2				

* Traffic volume in number of passengers per each normal hour.