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# A Study on Formulation of Systems Model to Objectively Assess and Plan for the Essential Environmental Facilities of an Urban area of a Developing Country-Madras Case Study

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## Abstract

Urban management in the developing world has been snarled in the tangle of urban complexities. Phenomenal population growth, heightened urban poverty, insufficient Essential environmental stock, over utilization of the meager facilities and consequent deteriorating living environment, escalating public welfare and protection cost, persistent financial constraints due to inadequate revenue, non-objective orientation of urban development programs, in efficient urban management system and chaotic socio-political fabric are the common features faced by the urban areas of many developing countries. Utopian theories and analytical tools to assimilate and assess the urban complexities proved beyond scope. Conventional methods to ameliorate a sector or a group of population brought in a host of problems in other sectors. Consistent recurrence of the problems and repeated huge investments on the same kind of projects have not only been a drain on the public exchequer, but also did not bring in the desired results. It is not the lack of awareness of the mushroom growth of problems, it is the lack of appropriated analytical tool which could identify the trade-off between urban pressures and separate feasible improvements from Utopian failures to reduce the widening gap between planning and management. The urgent need therefore is formulation of an appropriate analytical tool relating the essential environmental facilities with the urban economic activity and different cross-section of the population to identify the deficiency levels and formulate cost effective programs within the frame work of the urban fabric. Towards this end, a small attempt is made to formulate an urban development model and application of the same to Madras city of India to assess the functional validity of the model.

**Key Words:** Economic Activity, EE Facilities, Urban Development Programs, Lower Income Group, Middle Income Group, Higher Income Group, Basic Services, Supplementary Services, Special Services, New Venture, Organized Business, Unorganized Business, Informal Sector, Slums, Functional Validity.

## 1.0 Introduction :

The Urban areas in the developing countries have exhibited a radically different character during the past few decades from those in the developed countries in

terms of Urban expansion and Urban renewal. The pace of socio-economic development being rather slow in the Third world countries, the urban magnet has been able to create and maintain an illusive image of higher employment potential and other socio-economic benefits. The one way migration resulting from this urban pull has only aggravated the complexities of urban living. Today we see the cities scarred by congestion and decay, speculation and ugliness. We see the science and invention of our remarkable age snarled in the tangle of the urban network. The physical form of the city emerges from the initiative and enterprise of many people, acting individually and in groups. They are guided not by some preconceived model of the future city, however brilliant or inspired, but by a set of standards. The real plans for the cities are the standards prescribed by law-the codes and ordinances that regulated the development of urban property.

It is the obligation of the people to determine the standards they deem appropriate for their community and to translate these standards into effective rules and regulations. This responsibility has not been discharged with intelligence and devotion demanded of citizenship in a democracy. Urban development implies a continuing responsibility, all forces associated in the process acting together and inter-dependently. The degree to which these forces are integrated reflects the aspiration, ambitions and convictions of a community and the initiative and responsibility of the citizenship as a whole and each of its parts. It will be a far sighted dream to accomplish this in a society having a large share of illiterate and poverty stricken people. This is the most common picture of any urban area of a developing country. Unchecked population growth, ineffective regional and rural development policies and programs, low income levels have caused the tidal flow of unidirectional migration from rural to urban areas.

The migration of rural folks to urban area has primarily been for a better job and living conditions. The unproductive low level of skills often land them in jobs which are informal in nature and can not be classified as gainful employment. Yet the surge of people into the cities continues as the income levels in the urban areas are better than what they otherwise would gain in rural areas. Nevertheless, the income level in the cities is not commensurate with urban living standards demand and they can ill afford all the services they are provided with. Thus the huge concentration of people in a city crushes all attempts to improve the Essential Environmental Facilities (EEF) in terms of quantity and quality. Facilities utilized beyond their designed capacity often warrant greater investments for regular maintenance and replacement resulting in very low level of investments on creation of new stock. While the non-affordable characteristics of a vast majority of population bring in less revenue to the coffers of the City Government, there has been increasing demand for social welfare and public protection. Diversion of huge segment of the city budget for such welfare schemes has not brought about any significant level of improvement neither in the quality of life nor in the general economy. It has been similar to filling up a bottomless pit. The principle of economic prosperity lies in the sustained economic growth of a city. Instead the

low level of literacy, affordability and consequent environmental degradation have been a deterrent for any economic improvement.

The housing situation is the worst of all. Unlike the situation in advanced countries, where in the housing plays a vital role in the overall urban economy and activity, housing has not been instrumental in attracting the people into the city compared to the illusive image of job opportunities. This is greatly exhibited in the mushroom growth of slums or squatter settlements. The growth of slums are essentially on public land and land around the water courses, which are neither subject to the trends of land market nor to the property taxing system. High concentration of population and lack of all EEf's make the area vulnerable to many kinds of diseases and natural hazards. Deteriorating living environment, aging housing stock in the central areas of the city and the skyrocketing land prices have been the major cause for the exodus of the better affordable group of the population to the periphery reducing the revenue to the city Government and warranting for new investments on services at the periphery too. The situation is not dissimilar to the experiences of many advanced countries, however in many cities of the advanced world unemployment has not been a serious problem and the people have always contributed for the services availed and the City Governments faced initial investment burden to a greater extent.

Besides the specific nature of economic activities that characterize an urban area, it is the infrastructure and services that are available to the dwellers that make it an urban organism. Atleast, that is how an urban dweller often conceptualises his life as different from rural living. Implicit in this concept is a better standard of living which includes other than higher economic opportunities, better housing standards and EE facilities. Several schemes intended to ameliorate the living environment of the less fortunate section of the population proved to be of no effect. Efforts made towards alleviating one problem aggravated another. Thus it is no longer advantageous to manage the cities according to a set of Utopian objectives and dealing with problems in isolation as they arise. In recent times, time and again, the short comings of the 'Crist's Management' mode of operation has become more evident inspite of the undesirable experiences gained in attempting such management measures. As a result, now, many cities of the developing world are found entangled with problems that seem to be totally out of control. Particularly in the case of the developing world it becomes important to understand the trade-off between urban pressures and strive to find analytical tools which could separate feasible improvements from Utopian failures to reduce the widening gap between planning and management. The pertinent question, therefore, is what should be the form and content of a comprehensive approach and what is the appropriate tool to analyze the existing system and formulate policies for future needs within the socio-economic constraints prevailing in the developing countries. It is within this context an attempt has been made to in this study to formulate an analytical tool which could address the problems of population, economic activity, EE facilities and the urban development programs needed to redress the situation

prevailing in the urban area of a developing country.

## 2.0 Why System Dynamics Approach:

Urban management is a system for allocating resources and regulating all the related activities to form an urban environment, wherein every individual is having equal opportunity and responsibility for the overall welfare of the urban community. As industrial societies emerged, systems began to dominate life as they manifested themselves in economic cycles, political turmoil, recurring financial panics, fluctuating employment and unstable prices. But these social systems suddenly became so complex and their behaviours so confusing that no general theory seemed possible. A search for orderly structure, for cause and effect relationships and for a theory to explain system behaviour gave way at times to a belief in random, irrational causes. Gradually over a period it has become clear that the barrier to understanding systems has been, not the absence of important general concepts, but only the difficulty in identifying and expressing the body of universal principles that explain the success and failure of the systems of which we are a part. Economics has identified many basic relationships within industrial and business systems. Psychology and religion have described some of the interaction between systems of people. Medicine has treated biological systems. Political science has explored government and international systems. But most such analyses have been verbal and qualitative. Mere description has not been sufficient to express the true nature of systems. The theory, however developed by Jay. W Forrester proved to be a reasonable tool to deal with complex variables and influences which were hitherto not accommodated by the conventional theories and mathematical models. However there have been wide spread contentions that the system dynamics approach, when applied to urban development context and simulated over a long period does not reflect the reality as the urban areas are always in a state of flux. Yet the only valuable tool that is available to deal with multivarious complex factors of developing country, the system dynamics approach is the most appropriate tool. Further, when the factors relating to the area of engineering and economics are combined with the Social factors the System Dynamics approach is the most valuable tool. Under the present context of a developing country and the socio-economic fabric, any attempt made towards formulating an urban development model needs a long range perspective. Drastic results are not expected to be realized in a short span of time. Since the attempt in this study is to formulate a system to enhance the affordability level of the less affordables, which has been the prime factor in not influencing the enhanced improvements to the living environment, the system dynamics approach has been considered most appropriate in this study. The experiences of Third world countries in identifying the fundamental systems particularly relating to the urban dynamics is minimal. Though several studies were conducted by local experts, international institutions and individual researchers on specific problems of urban areas, a comprehensive system which could describe the urban areas of a developing country has been a much needed

tool. It is within this context an attempt in this study is made to formulate a system to identify and assess the shortfalls in each component of the urban system and to understand the future efforts needed to be focused. The system thus formulated is tested for the city of Madras, the fourth largest city of India (Developing country).

### 3.0 Methodological Framework of the Study :

In consonance with the identified problems faced by an urban area of developing country the urban organism or the system has been conceived as illustrated in Figure 1. The conceptualized framework essentially address the developing country situation. Although similar problems are faced by developed countries also, the magnitude of the problem, the factors influencing each component of the system and the system of urban management and the economy are totally different from that of developing country. The comprehensive approach involves, inter-action among the parameters controlling each component of the system in a dynamic state. Each component and its related parameters state are identifiable at every desired stage so as to give leverage for applying the policy options deemed fit to orient the model in the desired direction. The system is also designed to function with suitable sectorial modulators so as to avoid greater oscillation within the model and also to be realistic with the practical situation.

The Figure 2 illustrates the complex factors influencing the urban system components and their interaction and also the interaction among the components parameters.

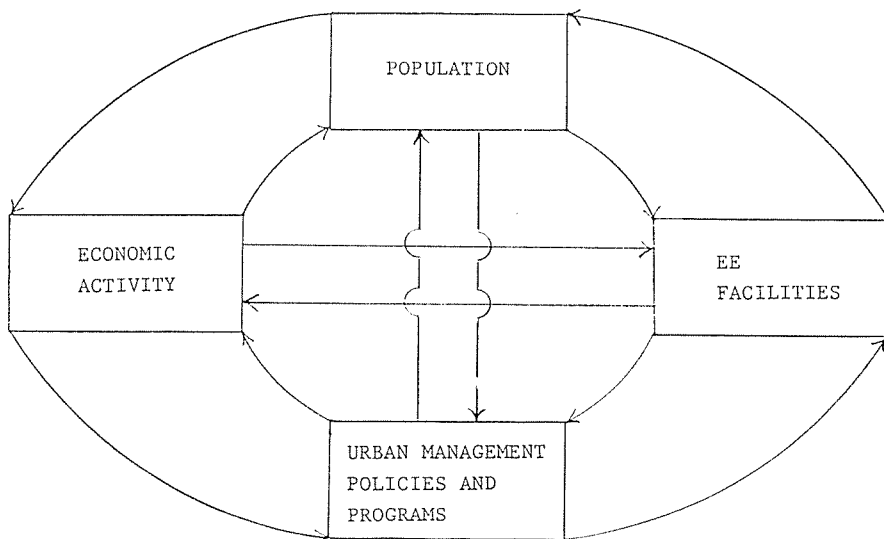


Figure 1. Study Concept.

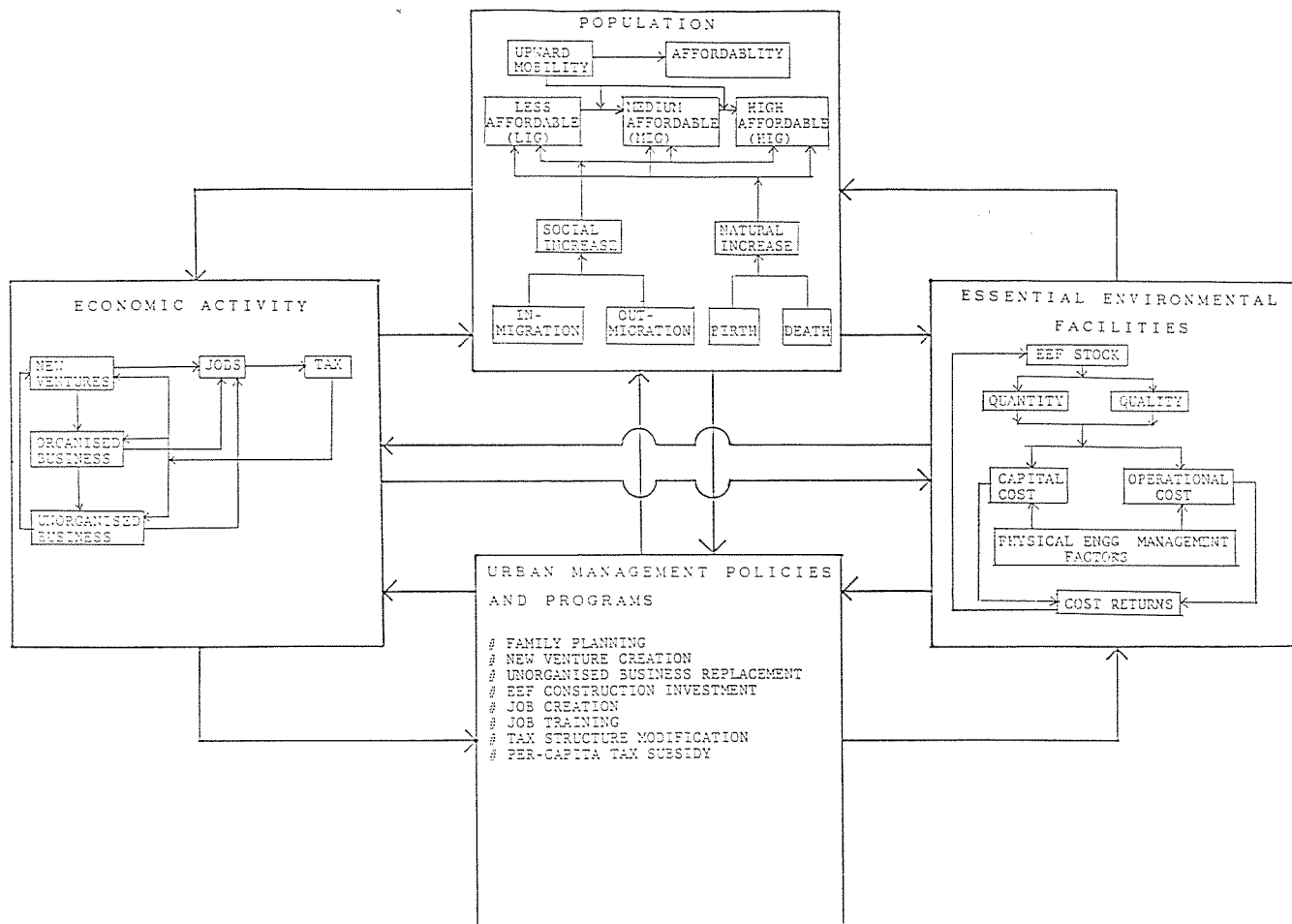


Figure 2. Urban Development Components Interaction.

### 3.1 Model Components Description :

#### (1) *Population Component :*

The population component includes the socio-economic factors or parameters. The total population is classified into three groups namely, LIG, MIG, and HIG based on the affordability characteristics. Each group is again stratified according to the typical age group as applicable to planning and development of different EE facilities. Each group is influenced by the demographic characteristics of Natural Increase and the Social Increase. The Natural Increase includes the birth rate and the death rate. The natural transfer of population that takes place as the population ages from one age group to another is also included. The Social Increase includes the In and Out-migration of the population relating to all age groups of the three population groups. The population sector also includes the transfer of people from one age group of a population group to the corresponding age group of another population group due to the upward mobility of population from lower affordability group to the higher affordability group. However all these demographic characteristics are inter-related to the improvement in the Economic activity the EE facilities and the Urban development Program components of the urban system.

#### (2) *EE facilities component :*

The EE facilities component of the system includes all the sectors considered under the 'Basic Services' and 'Supplementary Services' Figure 3. Every sector under consideration comprises of socio-economic, physical, engineering and administrative factors influencing the sector. The financial aspect relating to each sector is considered under two categories of investments, namely, Capital Investment and Operation Investment or the running cost. The cost returns from the individual population group is related to the affordability level of the population group and the level of the facilities availed by the individual groups. The private sector involvement, particularly in the supplementary sector is also incorporated to assess the extent of private involvement in delivering such facilities when the upward mobility and the consequent affordability level increases.

#### (3) *Economic Activity Component :*

The basic premises with which the model is conceived relates to the upward mobility of the population in terms of affordability, the Economic activity component deals with the key sectors of economic activity namely, the New venture Sector, Organized Business sector and the Unorganized or the Informal Business sector. New ventures during their growth phase provide for greater employment opportunity and over a period of time they attain a stage of maturity beyond which their employment potential is leveled off and they fall into the category of organized sector. As the general economic conditions improve and the application of technology increases, there begins a pronounced change in the market forces and the organized sector over a period of time declines in its vitality and falls into the category of Unorganized sector or the Informal sector. When the city faces



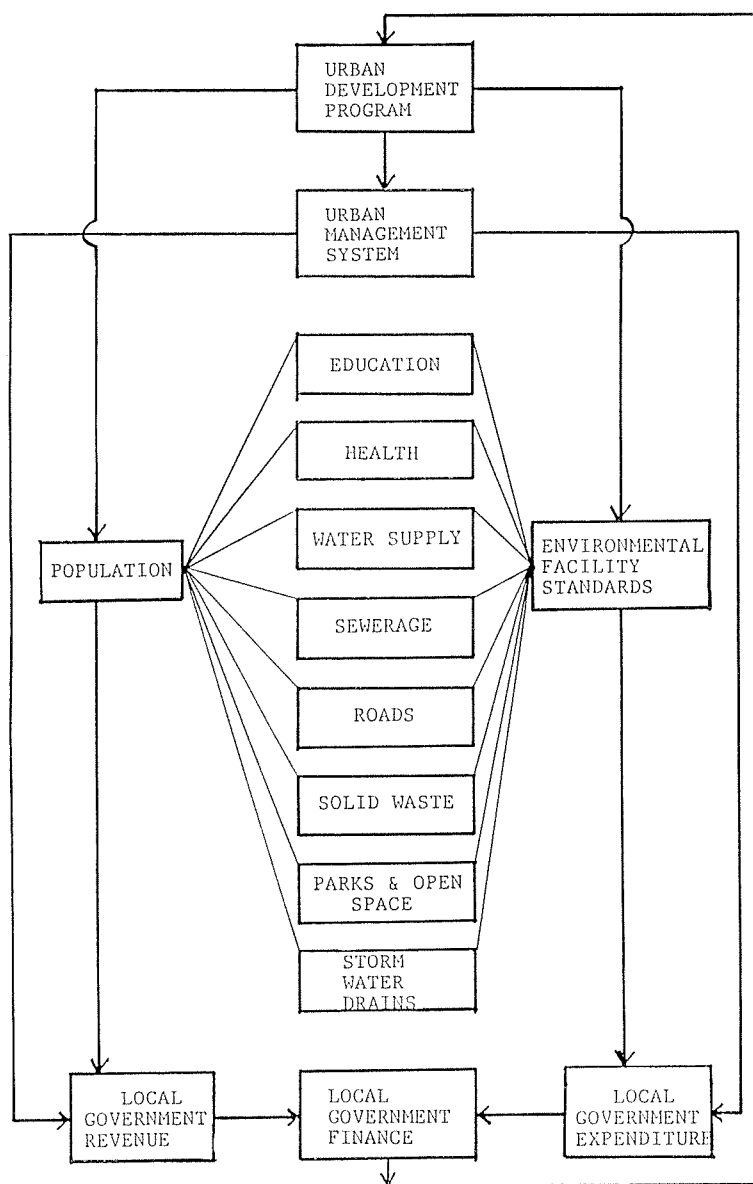


Figure 3. EE Facilities and Urban Development.

less construction of new ventures and sharp decline of organized sector culminating into Informal sector, the stage is diagnosed to be the economic stagnation stage. When the stagnation in the economic activity sets in, urban revival policies are of paramount importance to revitalize the economy and to foster sustained economic growth. To state the obvious it is not easy to bring in such a revitalization in a short period of time particularly in the case of developing country unless, measures pertaining to restructuring the taxing system and development of Man power resource need to be attempted on a massive scale. Specific urban development

programs like construction of Sites and services programs and job creation of new job opportunities should also be attempted simultaneously.

(4) *Urban Development Program :*

The basic premises with which this model is conceived relates to the improvement of the affordability level of the different cross-section of the population. Such an attempt needs a comprehensive urban development program. It is not an easy task to improve the affordability level over a short period of time given the socio-economic fabric of the cities. And therefore the model assumes that, when the general economic level improves there will be a simultaneous and gradual improvement in the affordability level of all groups of population and when there is a concerted effort to increase the upward mobility of the population, by virtue of reaching a better economic standard the affordability will also increase. Thus, the model is built to accommodate the improvement in the affordability level at two stages, one within the population group itself and the second, when the upward mobility increases.

(5) *Urban Development program :*

Specific urban development programs identified in accordance with the stated objectives to stimulate the economic activity are as listed below ;

- i. Family Planning Program
- ii. EE facilities Investment Program
- iii. New Venture Construction Program
- iv. Unorganized Business Replacement Program
- v. Job training Program
- vi. Job Creation Program
- vii. Tax Restructuring Program
- viii. Tax Per-Capita subsidy Program

It is obvious that these specific urban development programs are intended to stimulate all the component parts of the urban development program. The urban development programs are incorporated in the model in such a way that any one of the program or all of them can be instituted at any point of time within the plan period. Importance can be imparted to any program or multiple programs depending upon the severity and the priority needs of the problem.

#### **4.0 Madras City Demographic Profile :**

The very rapid growth of population has stretched urban administration in India and other countries of the less developed world to the limit. Urban populations have grown at rates of around 4.5 to 5% per annum. At this rate in cities touching 4 million, means catering for an additional 200,000 people (or 35,000 households) each year. The Tamil Nadu State of which Madras is the capital city, is the second most urbanized state in India (Table 1). Of the urban population of Tamil Nadu approximately a fifth live in the city of Madras and a fourth

**Table 1.** Population Growth and Urbanisation in Tamil Nadu 1901-1981

Item	Years								
	1901	1911	1921	1931	1941	1951	1961	1971	1981
Persons (in 100000)	193	209	216	235	263	301	337	412	484
Decadel Variation		+8.57	+3.47	+8.52	+11.91	+14.66	+11.85	+22.3	+17.5
Density (Persons/ Sq. km)	148	161	166	180	202	232	259	317	372
Percentage fo urban Population to Total	13.99	14.84	15.49	17.66	19.36	24.35	26.69	30.26	32.952
Population Index of Population (1901=100)	100	108.6	112.3	121.9	136.4	156.4	175	214	251.4

Source: Census of India 1981.

live in the Madras Urban agglomeration. Today Madras is the largest city in Southern India and the fourth largest city in India after Calcutta, Bombay and Delhi. In Tamil Nadu, the urban centers are equally distributed throughout the entire state.

(1) *Growth of Population in Madras:*

The first Census in India was undertaken in 1871. The growth of population in the city of Madras from that date is recorded as shown in Table 2. The rate of population growth has been high, particularly since 1931. This is due to three possible factors- a decline in the birth rate caused by social, educational and economic development, a decline in the death rate caused by the availability of modern medical and sanitary services and thirdly In-migration into Madras.

(2) *Density of Population:*

As the actual population of the city has increased so has the density of population. Table 3 records the increase in density in the city.

(3) *Migration:*

The study of migration gained considerable importance especially recently, on account of the influx of repatriates from Sri Lanka and Burma and the massive drift of rural population to urban areas in search mainly of employment and higher wages. Migration particularly is a subject for deeper analysis as changes in the rate of migration can occur quickly with far reaching effects on various sectors. However the generally established fact for rural to urban migration is because of the attractiveness (pull factors) of urban areas for better employment and higher wages. the push factors are normally related to unemployment, poverty and lack of opportunities in the rural and small town areas.

There is not much information available on, the number of migrants, characteristics of migrants etc. However from the available sources of Census Handbooks for Madras district recording migrants on the basis of survival ratio method, Birth tables held by the Directorate of Census operations and unpublished Census data on migrants, classified by place of last residence etc., minimum level

**Table 2.** Growth of Population in the City of Madras 1971-1981

Census Year	Population	Decadel Variation (%)	Index
1871	397000		100
		+2.2	
1881	406000		102
		+10.4	
1891	453000		114
		+18	
1901	553000		139
		+4	
1911	576000		145
		+2.7	
1921	592000		149
		+19.3	
1931	734000		184
		+17.2	
1941	886000		223
		+37.4	
1951	1416000		356
		+18	
1961	1729141		435
		+30	
1971	2469000		621
		+24.6	
1981	3276622		825

Source : Census of India 1961, 71 & 81 and Madras Corporation Annual Report for 1951 (Health Department).

**Table 3.** Increase in Density of Population in the City of Madras

Census Year	Area (in sq. km)	Density (Persons/sq. km)
1871	71	5600
1881	71	5700
1891	71	6400
1901	71	7800
1911	71	8100
1921	71	8300
1931	71	9800
1941	75	11800
1951	75	11100
1961	129	13600
1971	129	19300
1981	172	19274

Source : Census of India 1961, 71 & 81 and Madras Corporation Annual Report for 1951 (Health Department).

of information is available. According to the available information the net inward migration has been estimated in the order of 45-50,000 people a year since 1961 for the city of Madras Table 4.

**Table 4.** Net Inward Migration- City of Madras

Census Years	Males	Females	Total
1921-31	70000	54000	124000
1931-41	41000	37000	78000
1941-51	280000	260000	540000
1951-61	58000	42000	100000
1961-71	234000	206000	440000
1971-81	182000	180000	362000

Source: Structure Plan for Madras Volume 1. 1980.

Out of the total migrants in the city in 1971 55% were males and 45% were females and 96% of these had a previous residence in India and the rest outside India. A second set of information suggests that of the 550,000 people who migrated into Madras in the period 1961-71 from the other districts of Tamil Nadu, almost 60% were from rural areas and the rest from urban areas. The notable major reason for their migration to the city is expectation of employment and higher wages.

(4) *Birth rate, Death rate and rate of natural increase:*

The Table 5 indicates the birth rate, death rate and natural increase for the Madras city. The registered birth rate in 1971 was 38.6 per 1,000 population. It has declined since to 29.7 in 1979. The registered decline was 23% in 9 years, a 2.5 percent decrease per annum. The death rate has also shown a decline from

**Table 5.** Madras city Birth rates, Death rates and rates of Natural Increase (Per/1000 Population)

Year	Crude Birth rate	Crude Death rate	Natural Increase
1971	38.6	12.3	26.3
1972	37.8	12.7	25.1
1973	36.4	12.4	24.0
1974	34.4	11.5	22.9
1975	34.3	13.1	21.2
1976	32.1	12.0	20.3
1977	32.4	10.9	21.5
1978	31.7	9.5	22.2
1979	29.7	8.9	20.8

Source: MMDA-MMA Demography 1981.

12.3 in 1971 to 8.9 in 1979. It has declined by almost 28 percent over the period. Thus the decline in the rate of natural increase has declined by 21% over the same period. Many factors influence the birth rate. The primary factors are, the age structure of the population, the average age at marriage, incidence of Family Planning and the psychological feeling of socio-economic security. The earlier the marriage, the more the number of children. The average age of marriage in Madras, (Tamil Nadu) is 25.4 years for males and 18.2 years for females, which when compared to the all India figure is higher, that is, 22.2 years for male and 16.2 years for females. The observed reasons for the same is higher literacy rate and better socio-economic conditions in Tamil Nadu than in whole of India.

(5) *Infant Mortality:*

The quality of physical environment, nutrition level and proper medical attention are often reflected in the infant mortality. Again all the level of these factors depend on the affordability characteristics of the population concerned. The Table 6 indicates the infant mortality rate in Madras city.

**Table 6.** Infant Mortality rate in the City of Madras 197-79

Year	Infant Mortality rate expressed in death/1000 Births
1971	76.4
1972	85.2
1973	72.4
1974	73.8
1975	86.4
1976	84.4
1977	81.0
1978	67.2
1979	60.2

Source: MMDA-MMA Demography 1981.

When compared to 1971 and 1979 the infant mortality has shown a decline by 21%, the trend has not been in the declining order, rather it has been varying.

(6) *Age and Sex Structure:*

The age and the sex structure of the Madras population is as shown in the Table 7. Young population constitute a major share of the population. About 45% of the population are under 20 years of age. A further 20% are under the age of 30. The aged population group constitutes about 5% of the population. The average family size in the Madras city is 5.3.

(7) *Income Distribution:*

Information on incomes is notoriously difficult to obtain and to justify. Several studies conducted in Madras city to formulate urban development projects revealed

**Table 7.** Age and Sex Structure of population City of Madras 1981 Expressed in Percentage

Age Group	Males	Females	Total
0-14	33.7	36.5	35.0
15-19	9.7	10.3	10.0
20-24	11.2	10.8	11.0
25-29	9.3	9.2	9.3
30-39	14.9	13.2	14.1
40-49	10.5	8.7	9.6
50-59	6.0	5.9	6.0
60+	4.7	5.4	5.0

Source: Estimate Based on Census of India 1981.

that 46.5% of the total population fall in the category of Less affordable class, (LIG) whose income is below Rs. 600 per month. This level of income is assessed to be just enough to lead a hand to mouth existence and the ability to pay for all the service facilities is extremely low since their level of participation in the economic activity is low. Another 41% population belong to the category of middle income group (MIG) with an income range of 600-1500 Rs. per month. The contribution of this group towards the Local Government is considerably high, however not to the level demanded by the economics of the urban system. By virtue of its higher economic activity participation level, the affordability level is also higher, although this group of population also enjoys greater government subsidies. About 12.5% of the total population belong to the category of Higher income group or the group having higher affordability level. Unlike the other two groups, the economic activity participation level, contribution towards taxes etc. is very high and generally not eligible for any direct subsidy. This group has an income of more than Rs. 1500 per month. This group of population is distinctively indentifiable from the physical standards of living environment.

#### (8) *Family Planning:*

India holds the pride of being the first nation among the less developed to officially recognize the population problem and institute a family planning program. In a vast country like India, there have been several Family planning techniques adopted to suit to the choice of different strata of people. Hence the 'Cafeteria approach' which includes Vasectomy, Tubectomy, the IUD (Inter-uterine Devices), the Pills and as a last resort, Abortion. The Table 8 registers the number of persons who accepted the family planning program by the usage of different techniques in Madras city. Though the number of acceptors has shown an increase, acceptance of the program has mostly been observed among the MIG and HIG groups of the population, who have better economic affordability and awareness towards the problem. The success of this program among the LIG group of people is far below the desired level. This is the group of people whose affordability

**Table 8.** Acceptors for Family Planning Program in Madras City

Year	Vesctomy	Tubectomy	IUD	Total
1970-71	6000	4000	7000	17000
1971-72	7000	7000	7000	21000
1972-73	5000	8000	5000	18000
1973-74	7000	10000	6000	23000
1974-75	15000	14000	6000	35000
1975-76	12000	16000	6000	34000
1976-77	9000	21000	7000	27000
1977-78	2000	14000	6000	22000

Source: Structure Plan for Madras Volume 1. 1980.

level is low as well as their awareness towards such a program. The undocumented fact is that inspite of mass publicity about the program the people of LIG group do not come forward due to a psychological barrier towards the program. Prevalent thinking among this population group is that in the absence of economic upward mobility, the more the number of hands, the more the collective income. The effectiveness of the program also depends on the kind of technique, which would be of least hindrance to their employment and earnings coupled with after-care medical and social facilities. General economic progress and improvement in the literacy level will be of immense value in promoting this program.

(9) *Profile of the urban Poor in Madras:*

An estimated 46.5% of the total population falls under the category of urban poor or the LIG. A vast majority of this group of people live in the so called 'Slums' and the rest in the old quarters of the city which can also be classified as slum but for the structural conditions on the building and better level of service facilities available in these areas. As major thrust in this study has been on the improvement of the affordability level of the vast majority of the urban poor, it is essential to understand the problems of this group of people.

(10) *Population growth in Slum area:*

According to the basic definition of a Slum, considered by the Tamil Nadu Slum Clearance Board, the first of its kind in whole of India till recently, is 'hutting areas with huts erected in haphazard manner without proper access, protected water supply and drainage arrangement and so congested as to allow little free flow of air to get in' (TNSCB-1975). Accordingly the identified number of slums were 1202. One third of the city's population lived in slums. The growth of slums households in absolute number has been very high. It registered a growth rate of 67% between 1961-71 and there were .164 million households living in 1202 slums. The problems of slum population is also reflected by the fact that in 1971, slum population accounted for 30 percent of city's population and only 6% of land



area. About 68% percent of slum households were living on public lands and the rest on private lands. About 45% of the slums were more than 11 years old. Total number of households has grown from 163804 in 1971 to 212000 in 1979 registering a growth rate of 30 percent during the 8 year period. The annual addition of the number of households is about 6000. Table 9 registers the growth of slum households in Madras city.

**Table 9.** Growth of Slum Household in Madras City 1971-79

Year	Number of Slum Households
1971	163804
1979	21200
Growth rate	29.4%
Annual Growth rate of Households	6000

Source: ORG Report 1980.

Birth rates registered in slum areas was about 34 per thousand population which is higher when compared to the other two groups of MIG and HIG (29 and 27 respectively). Under registration (not registered at all) is also observed to prevail in slums. This is more so in the death and infant mortality. The general death rate for all the age groups excepting age group 1 of population is 12 per 1000 population, which is also higher when compared to similar age groups of other two groups of population. The infant mortality is the highest in slum areas as explained earlier. It registered at the level of 84 infants per 1000 births.

#### (11) *Migration Characteristics of Urban Poor:*

The migration characteristics of the slums is well documented in the report of ORG 1980, relating to the 'Economic profile of Urban Poor'. It is generally believed that the demographic profile of slum dwellers is characterized by age and selective migration, there is a preponderance of the males particularly in the age group of 20-50, in the slum population. This is based on the assumption that a large proportion of slum dwellers are migrants and since migration is mainly of adult males they bring about a demographic imbalance in the slum population. But the demographic imbalance in the slum population is not evident in the slum population of Madras city. From the Table 10 it is evident that in terms of sex ratio, there are about 990 females per thousand males, which is higher than corresponding figure for Madras city (905). Even in terms of age-sex distribution, there does not appear to be a preponderance of adults in the age group of 20-50 the percentage of males in this group to total slum population is about 21 percent and the corresponding figure for females is little over 19%. The percentage of children (0-14) to total population is higher in the slums (39%) than the city (35%). Demographic balance in the slum population perhaps indicates that there is no significant migrant movement of predominantly adult males to the slums. The migrant movement may be of the whole household.

**Table 10.** Some Demographic Indicators- Slums and Madras City

Items	Slums	Madras City
i. Females per 1000 Males	990	903
ii. % of Males in 20-50 Age Group to Total population	20.9	24.2
iii. % of Females in age group of 20-50 to Total Population	19.1	19.2
iv. % of Children (0-14) to Total Population	39.2	35.04

Source: ORG Report 1980.

**Table 11.** Estimated Population by Age Group -Slums of Madras

Age Group	Population	Percentage
0-14	434700	30.3
15-24	221480	20.0
25-34	157670	14.3
35-44	130990	11.8
45-59	112410	10.2
60+	49120	4.4
Total	1106370	100

Source: ORG Report 1980.

The average household size of the slum dwellers is about 5.2. Table 11 shows the age-wise distribution of population in slum areas.

#### (12) *Population Sector Model Formulation:*

Based on the demographic and affordability characteristics prevailing among the population of Madras, three distinct classification of the population is made for the purpose of this study LIG, MIG and HIG respectively. Each population group is again divided into 8 age groups (Tables 12, 13 and 14) essentially to relate the application of the EE facility sector to the population sector. Figure 4 illustrates the details of the model components for one group (LP1) of LIG population and the Figure 5 illustrates model components of all the age group of LIG population and their inter-relationships. Since the group-wise model components are almost similar to each age group detailed description of the model formulation is given in the preceeding paragraphs for LP1 age group.

### 4.1 Education sector:

#### (1) *Education System in Madras City:*

Effective implementation of any program aimed at alleviating the standard of living is dependent on the educational level of the society and a sound educational system. Enforcement of planning laws and the implications of different public welfare program become extremely difficult in the absence of clear understanding

**Table 12.** LIG Population- Some Demographic Characteristics

Classification	Age Group	Population	% to the Total	Birth rate (per/1000) LIG Population	Death rate (per/1000) group Population	Population Group Transfer Rate
LP 1	0- 1	45405	3.00	34	82	
LP 2	2- 5	231412	15.29	—	8	1.000
LP 3	6-10	181016	11.96	—	2	0.250
LP 4	11-14	132432	8.75	—	1	0.200
LP 5	15-19	136216	9.00	—	1	0.250
LP 6	20-24	166486	11.00	—	3	0.200
LP 7	25-59	552432	36.50	—	15	0.250
LP 8	60+	68108	4.50	—	56	0.067
TLP		1513512				

Source: Compiled from Census of India and ORG Reports 1980.

**Table 13.** MIG Population- Some Demographic Characteristics

Classification	Age Group	Population	% to the Total	Birth rate (per/1000) MIG Population	Death rate (per/1000) group Population	Population Group Transfer Rate
MP 1	0- 1	39260	2.80	29	60	
MP 2	2- 5	157038	11.20	—	6	1.000
MP 3	6-10	168255	12.00	—	1.5	0.250
MP 4	11-14	126192	9.00	—	1	0.200
MP 5	15-19	140213	10.00	—	1	0.250
MP 6	20-24	154234	11.00	—	2	0.200
MP 7	25-59	546830	39.00	—	12	0.250
MP 8	60+	70106	5.00	—	45	0.067
TMP		1402128				

Source: Compiled from Census of India and ORG Reports 1980.

**Table 14.** HIG Population- Some Demographic Characteristics

Classification	Age Group	Population	% to the Total	Birth rate (per/1000) HIG Population	Death rate (per/1000) group Population	Population Group Transfer Rate
HP 1	0- 1	9369	2.60	27	40	
HP 2	2- 5	39639	11.00	—	6	1.000
HP 3	6-10	36396	10.10	—	0.8	0.250
HP 4	11-14	33514	9.30	—	0.6	0.200
HP 5	15-19	36037	10.00	—	0.5	0.250
HP 6	20-24	39639	11.00	—	1.5	0.200
HP 7	25-59	147748	41.00	—	12	0.250
HP 8	60+	18018	5.00	—	40	0.067
THP		360360				

Source: Compiled from Census of India and ORG Reports 1980.

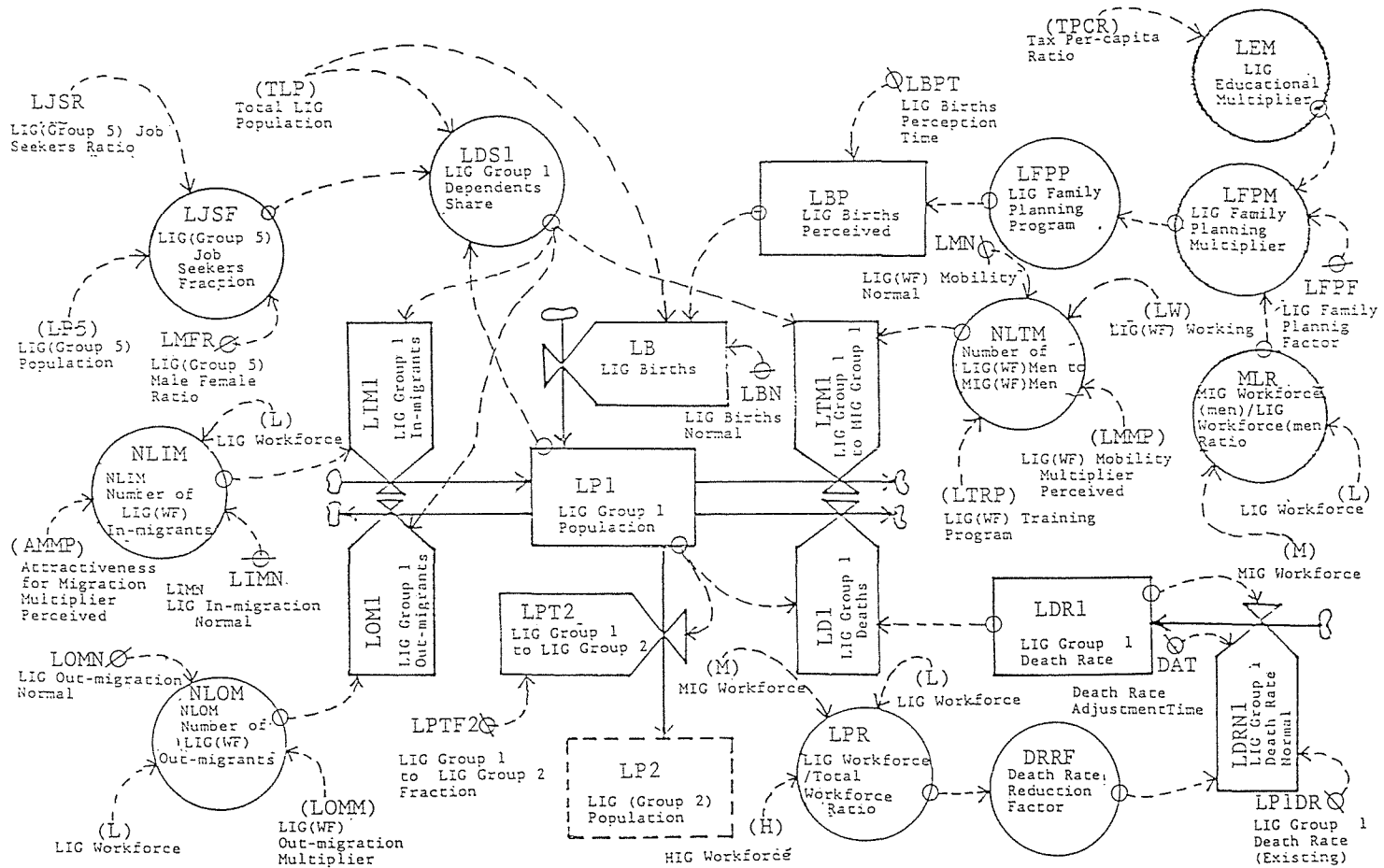


Figure 4. LIG-Group 1 Population Sector.



capacity of a vast majority of the population. The standard of developments and living environment is a measure of the level of education prevailing in the society. Tamil Nadu State has been enjoying the second highest recorded literacy rate of all the states in India. Literacy is defined as the 'ability to read and write in any single language'. Madras city has also been enjoying the highest literacy rate when compared to other major urban centers within Tamil Nadu State. Table 15 records the literacy rate in Madras city and Tamil Nadu State.

**Table 15.** Literacy rates in Madras city and Tamil Nadu  
1971 and 1981

	Madras City		Tamil Nadu State	
	1971	1981	1971	1981
Persons	62.01	66.28	39.4	45.78
Males	70.07	73.28	51.8	57.19
Females	52.54	58.80	26.8	34.19

Source: MMDA-MMA Demography 1981.

Education in the state of Tamil Nadu is free upto the Pre-University state (11 years of schooling and one year thereafter) and upto the primary school level (5 years of schooling) is compulsory. The different levels of Schools are Primary, Middle and Higher/Higher Secondary. Primary education is the responsibility of the Local Governments. The education sector being classified as one of the supplementary services and has a large share of private sector involvement. The Table 16 shows the general educational establishments in Madras city. The drop in the number of Middle Schools is due to upgradation of Middle Schools into High Schools. Besides the recognized schools more than 500 unrecognized schools are believed to be operating enrolling more than 100000 scholars. A major share among the unrecognized schools belong to the Preprimary or the Kindergartens schools. The prevailing share of scholars of different population groups in the total number of scholars enrolled are as shown in the Table 18. Although the primary education has been declared as compulsory, the share of scholars from different population group is dismal particularly from LIG population. In order to achieve a goal of 100 percent enrollment at primary school level, Government of Tamil Nadu has also instituted an incentive program in the name of 'Free Noon Meal

**Table 16.** General Educational Establishments in Madras city

Type of Establishments	Yeaas		
	1973-74	1977-78	1979-80
High/Higher	209	226	258
Secondary Middle School	258	247	250
Primary	336	344	354

Source: Directorate of School Education (Tamil Nadu).

Program' particularly applicable to the children belonging to the LIG. The intention behind this program is to provide food to the children so that they may not abstain from schools doing odd jobs to support family earnings. Though in terms of the number of scholars enrolled, the program seems to be a good attempt, its real impact in terms of imparting education is yet to be evaluated.

The private sector involvement in all levels of education is as shown in the Table 17. Almost all the private schools belonging to the Primary and Middle school level are aided by the Government in one way or the other. The private sector which is evaluated to be imparting better level of education compared to the Government run schools primarily serves the needs of the better affordable class of the society. Government schools serve predominantly LIG children. The scholars/teacher ratio in each category determines the quality of education and to a greater extent the level of congestion of scholars in class room.

The level of education is also determined by the facilities each school is equipped with. A vast majority of schools in all categories do not confirm to the minimum space standards and lack proper sanitary facilities, play grounds and equipments. The Table 18 records the space standards assessed to be the minimum requirement for the different category of schools. The space standards are set based on the assumption of 40 Scholars per class room and 500 scholars per school (The standards can vary depending upon the location and other constraints). The determination of building space standards is inclusive of Class room space, space for Laboratories, Libraries, Assembly hall, Head Master room, Staff room, the

**Table 17.** Education Sector Key Indicators

Type of Establishment	Number of Class rooms	Number of Scholars	Number of Teachers	Scholar Teacher Ratio	Share of Scholars from Population Groups (Estimated)			Private Sector Share (in %)
					LIG	MIG (in %)	HIG	
High/Higher Secondary Schools	3542	17000	2096	1 : 22	16	82	85	40
Middle Schools	3805	190252	4700	1 : 40	33	88	98	40
Primary Schools	2600	385667	3934	1 : 43	58	86	98	20

Source: Directorate of School Education (Tamil Nadu).

**Table 18.** Space Standards for Schools

Type of Establishment	Minimum Land Requirement (in Sq. mts)	Building space/ Class rooms (Inclusive of all Facilities in Sq. mts)	Floor Space/Land Ratio (inclusive of Play grounds (in Sq. mts)
High/Higher Secondary Schools	22000	104.3	1 : 9.8
Middle Schools	14000	75.3	1 : 8.44
Primary Schools	5000	66.25	1 : 6

Source: P. W. D (Tamil Nadu).

number of floors and the Circulation space. Current assessment of the space standards prevailing in all kinds of schools indicate, that about 70% of the Primary and Middle schools do not have any play ground facilities at all and only about 3% of Primary schools and 6% of the High schools meet the required standards. The blighted conditions of many schools can be gathered from the fact that more than 30% of the school buildings are very old (more than 50 years) and belong to the private parties. Added to that, more than 25% of the schools have semi-permanent structures. Lack of adequate finance for regular maintenance of the structures and other facilities deteriorate the conditions of the structure. In more than 50% of the Primary schools, shift system of education is followed because of lack of adequate class rooms. The replacement and reconstruction of class rooms will have greater financial implications besides creating new class room stock for the increasing population. The conditions of the privately run schools are equally bad calling for enhanced concentration of efforts.

The 'Supplementary Services' sector accounts for about 8% of the total investments made in the city during the period 1970-80, out of which, education sector accounted for 15%. More than 60% of the budget provision is accounted for establishment cost of the schools. Conventional methods of administration and lack of orientation of the policies towards upgradation of quantity and quality of the stock, have been the primary reasons for the present dismal situation of this sector.

The present model for education sector is built on the premises that, while the general improvement in the economy will influence more enrollment in the schools, programs oriented towards upgradation of the quantity and quality will enhance economic activities in terms of creation of more gainful employment opportunities. The model encompasses all the three important levels of school education (University education is not considered in the Model, instead Job training programs are considered later in this model). The model components are ; Scholars of different education levels based on the age group applicable to that particular level of education form the three population groups (LIG, MIG, and HIG), building space and construction cost. Equipment cost, establishment cost and Teachers number and cost. All these components are assessed in monetary terms to form Capital cost and Operating Cost depending upon the quantity and quality enhancement programs. Since the private sector involvement at all levels of education is very high, similar model is built for private sector also, to assess the quantum of financial aid needed and its policy implications to promote the role of private sector. The Figure 6 and 7 illustrates the model components and their interaction for the Government run Primary schools.

## 4.2 Medical Sector :

Medical sector is the most vital sector for the healthy living of the human resource. Although there has never been a case of reduction in the level of investment in this sector, the greatest concern has been that of optimum service at affordable cost. Madras being the hub of activities in the Southern part of India,



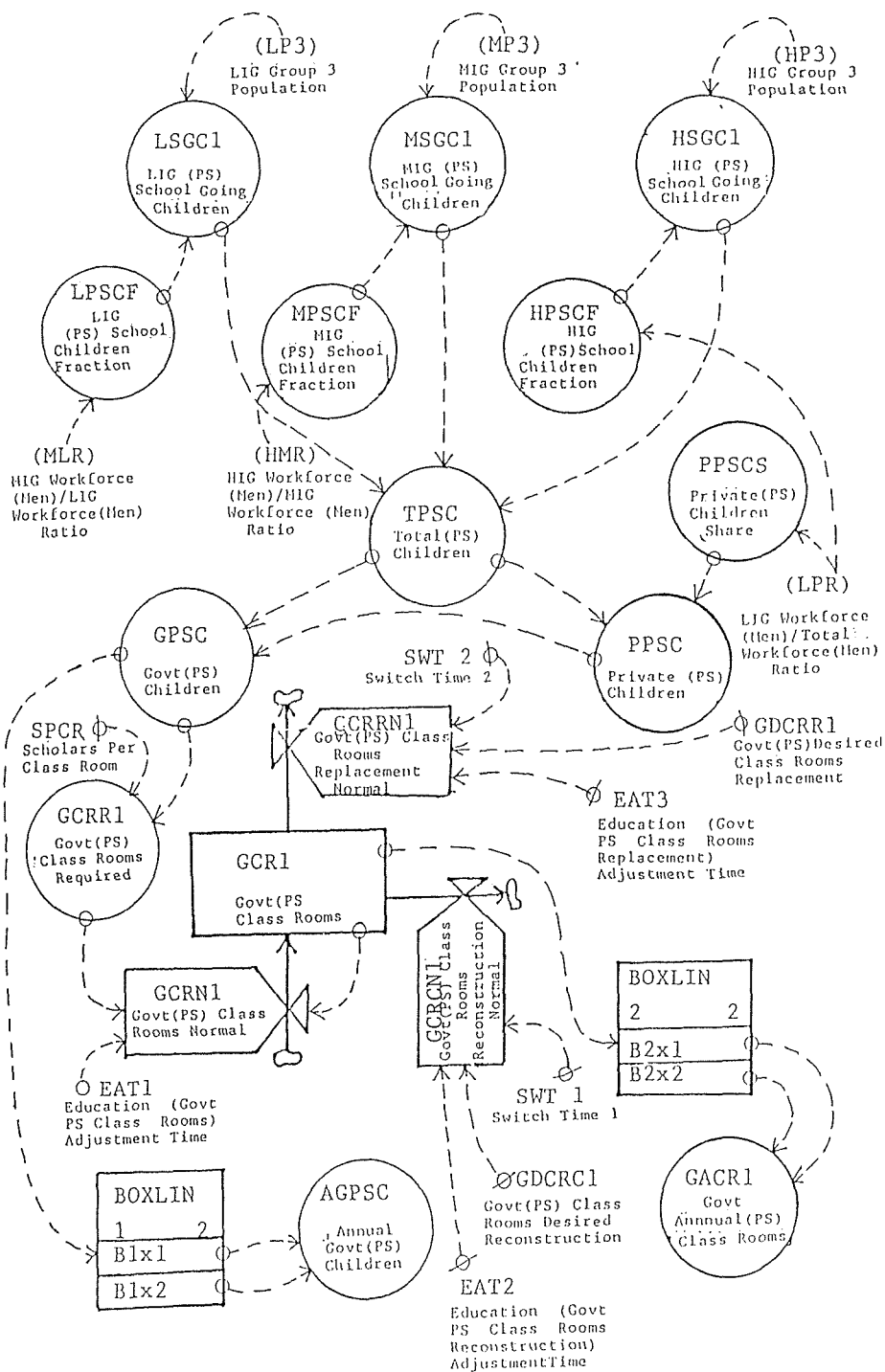
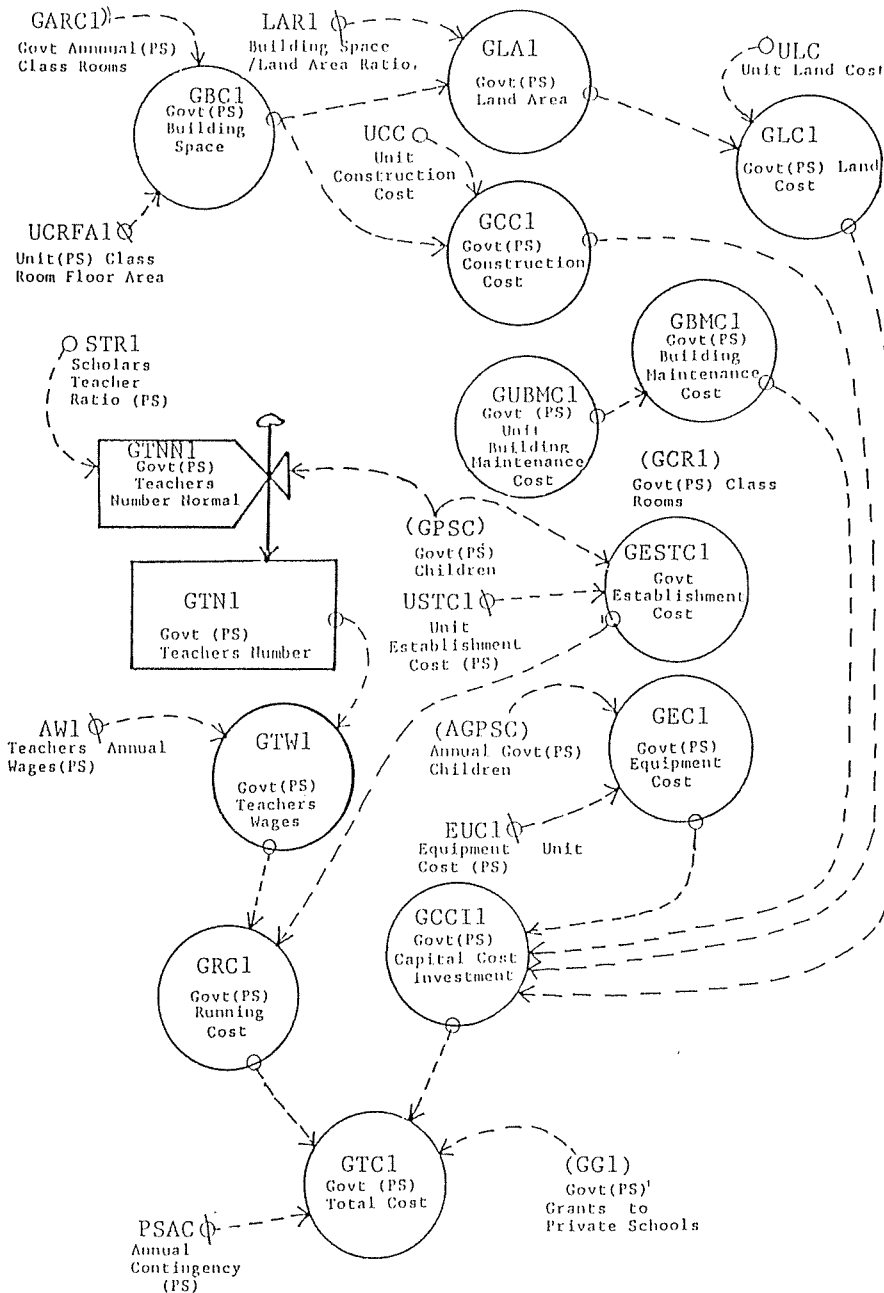


Figure 6. Government Primary School Sector.



**Figure 7.** Government Primary School Cost Sector.

it has many specialized hospitals and is the center of attraction from all over the state as well as from outside. Akin to the characteristics of a developing country, there is hardly any system of 'Medical Insurance' in Madras city. The prevalent thinking among the population in general and the most of the administrators in particular is that this sector has to be exclusively viewed as a public

service notwithstanding the fact that this sector consumes a major segment of the financial resources with very little returns. This situation is not dissimilar to even many advanced countries, however the magnitude and dimension of the problem is different.

The Table 19 records the important information about Hospitals (Government Only) in Madras city. There was a 30% increase in the number of Doctors, a 20% increase in Nurses, a 10% increase in hospital beds and 2% increase in the admission of In-patients between the period 1973-74 to 1977-78. In 1980 too the situation has not changed significantly. There was one doctor per 3500 people in the city, one Nurse per 2000 people and one hospital bed per 500 people. About 10 million Out-patients were treated in the major hospitals alone in 1980. Besides the 15 major Government hospitals, there were two Employees State Insurance hospitals and more than 30 dispensaries maintained by the Government. These hospitals serve mostly for the factory employees. Besides the Government run hospitals and dispensaries, the City Municipal Corporation maintains one hospital and 143 dispensaries in the city with a bed strength of 770, 134 Doctors and 100 Nurses. An estimated 60000 inpatients were treated by these facilities in 1980. The hospitals and dispensaries belonging to the City Municipal Corporation deals mostly with health programs relating to eradication of communicable diseases.

**Table 19.** Medical Sector Key Indicators during 1973-74 and 1977-78 (Govt sector Only)

Items	1973-74	1977-78
Hospitals	15	15
Doctors	745	930
Nurses	1340	1545
Beds	7190	8530
In-patients	272200	278600

Source: Structure Plan for Madras Volume 1. 1980.

The Medical service system if not large, has an equal share of private sector involvement primarily catering to the out-patients. More than 95% of the clinics are owned by individual Doctors working in the major hospitals of the Government (Detailed information is not readily available). These clinics provide marginal employment opportunities to the complementary staff other than the Doctors. Besides the large share of private clinics, there were more private Nursing Homes functioning in the city catering to the demands for specialized medical treatment particularly to the well-off section of the population. There were also 4 private aided hospitals with 390 beds, which treated some 13500 in-patients and 160000 out patients in 1980.

The Table 20 records the annual expenditure in Major State Government hospitals of Madras city. The per-capita expenditure by the Government has

increased from Rs. 22 in 1977 to Rs. 35 in 1980. The medical cost has been observed to be increasing at the rate of 4 percent per annum. It has been estimated that the medical cost will double (Rs. 70 percapita) if the medical service delivery system is improved to the optimum level. Although highly classified information on the medical cost and recovery relating to each group of population are not available. The available information suggest that the LIG population avail the service almost free and their contribution towards the medical charges is marginal (10% of the Total cost). The MIG group of population contribute about 30-35% of the total cost, where as the HIG population contributed almost the entire cost (95%).

**Table 20.** Annual Expenditure In Major Govt Hospitals of Madras city

	Expenditure in Million Rs
Cost of Personnel	29.93
Office Contingency	3.73
Dietary Charges	9.00
Medical & Hospital Neccessaries	34.76
Stipends	0.43
Other Charges	0.61
Motor Vehicles	0.40
Machinery Equipment (Capital) Maintenance	0.01
Linen	0.83
Total	87.51

Source: Structure Plan for Madras Volume 1. 1980.

**Table 21.** Population and the Medical System in Madras city

System parameters	Population Groups		
	LIG	MIG	HIG
1. Hospital Visits Frequency	14	12.8	9.5
2. In-patients share (percentage to the Total Patients)	3	2.6	2.4
3. Private In-patient share (%)	—	5	35
4. In-patient Medical Cost recovery Fraction (% to the Total cost)	10	30	90
5. Private Out-patient share (% to Total Out-patients)	5	30	95
6. Out-patient Medical cost recovery Fraction % to the Total cost)	10	50	95
7. Average number of Hospitalisation Days		30 Days	
8. Private Beds Share (% to the Total Beds)		5%	
9. In-patient Medical Cost (Cost/Patient)		Rs. 30	
10. Out-patient Medical Cost (Cost/Patient)		Rs. 22	
11. Annual Increase of Medical Cost		4%	

Source: Directorate of Medical Education (Tamil Nadu).

The Table 21 records some of the key parameters relating to the medical service delivery system.

Despite the fact that a wide network of health facilities have been established, there are several deficiencies prevailing in the system. The establishment of major hospitals were with the primary intention of functioning as referral hospitals for treatment of major inpatient diseases. However the general dissatisfaction with the services rendered at the dispensaries and lower tier medical facilities scattered in the city, the major hospitals have been burdened with vast number of out-patients. It is here the private nursing homes and clinics have been given importance by the affordable groups of population particularly for out-patient treatment.

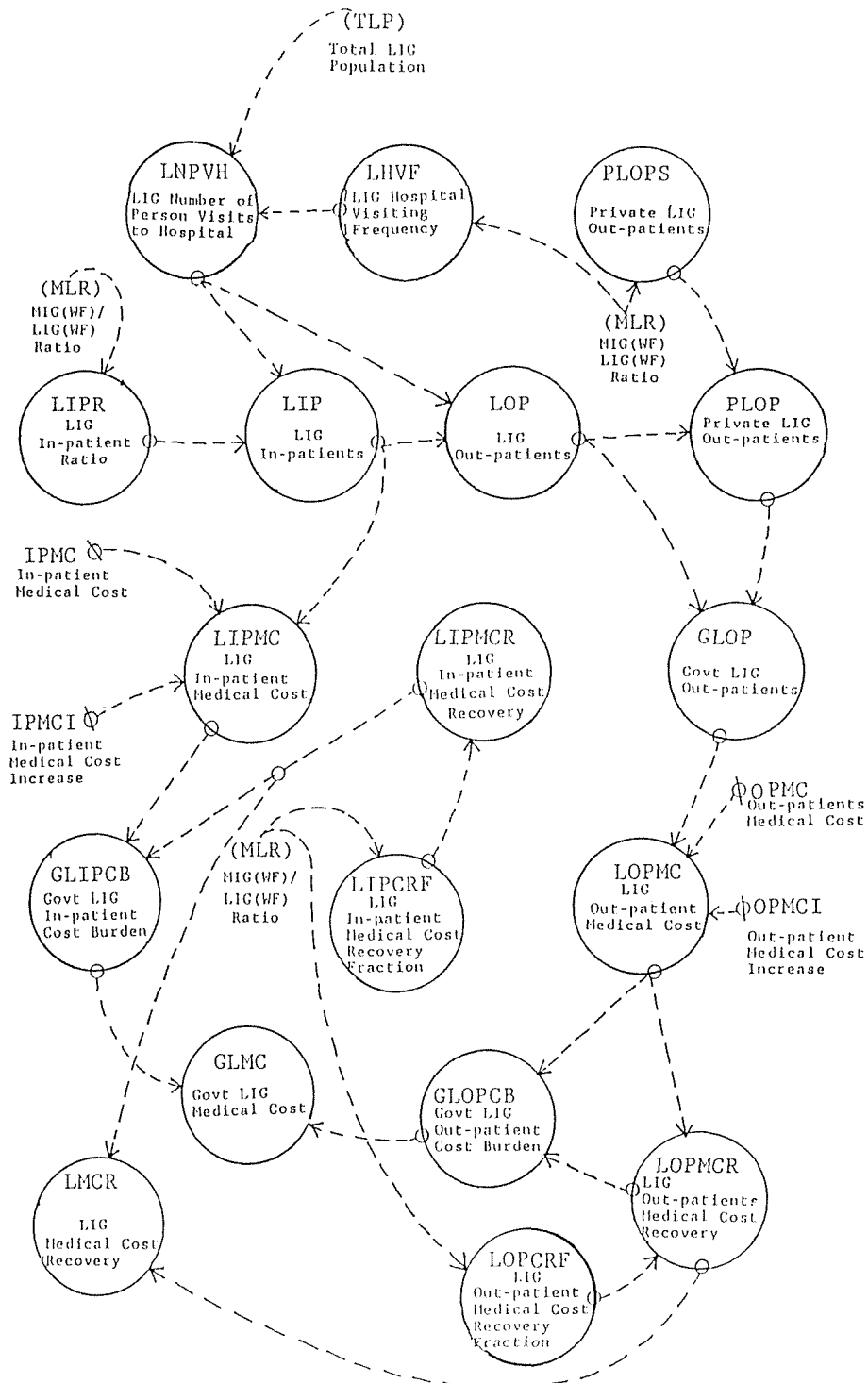
There are several reasons for the deteriorating medical environment. While there has not been lack of professional competence, lack of resource due to poor returns and ever increasing demand for services have been the major impediments for improvement in the system. The prevailing conditions of this sector needs drastic policy revisions to make the sector more cost effective with appropriate system of medical insurance. While efforts are needed to revamp this sector, appropriate measures for health care subsidy in consonance with the economic improvement and affordability level are needed to be instituted. The role of private sector should be enhanced to lessen the burden on the Government exchequer. Significant achievement in the better delivery of services can be achieved only on the overall improvement of the economy of the city. It is within this broad perspective, the medical sector model is built and the model structure of LIG population is as shown in Figure 8 and 9. The model structure for MIG and HIG are similar to LIG excepting the Private In-patients share, which does not exist in LIG.

#### 4.3 Water Supply Sector :

##### (1) *Water supply System in Madras City:*

Protected water supply is of prime importance in a high population density agglomeration to ensure desirable living environment. Lack of protected water supply will act as a root cause for increased medical budget, high death rates and less incentive for promotion of economic activities and deterioration of urban environment. Thus water supply is enlisted as one of the 'Basic Services'.

Persistent short supply of protected water supply in Madras has created not only greater health hazards but also deflects the establishment of New ventures. Madras is yet to have a perennial source of water supply. The present source of water supply is a lake called 'Red Hills' which is monsoon dependent. Underground source is also tapped to serve the population. Madras city often faces droughts with minimum protected water supply for drinking purposes alone. The water drawn through 'Wells' located at individual houses, though not of good quality supplement the public supply. The core of the present water distribution system was designed in the year 1911 for an anticipated population of 0.66 million. This population was outstripped in the year 1941 and difficulties began to be ex-



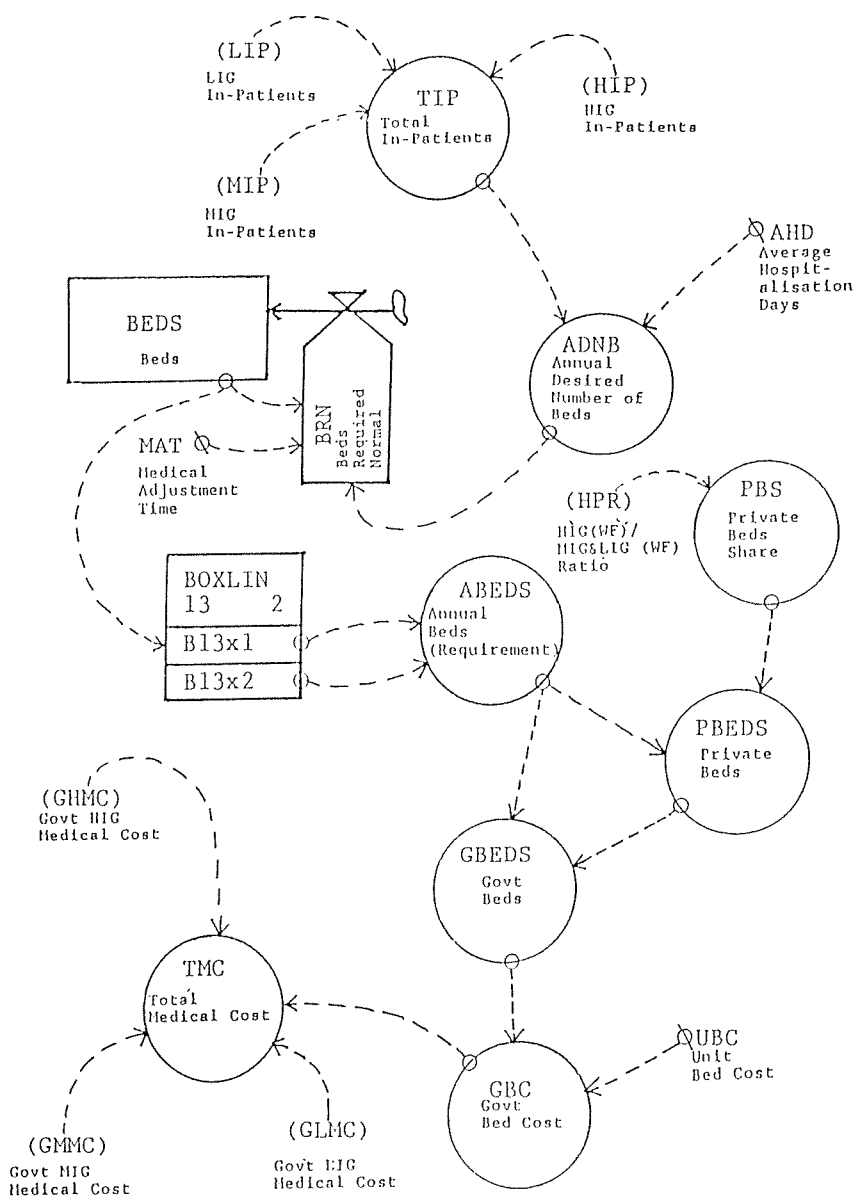


Figure 9. Medical Facilities Sector.

perience over the years in the supply of water such as, inadequacy in pressure, uncertainty of continuous supply, meager quantity of supply etc. To meet the above problems a zonal (13 Zones) distribution system for the city was conceived and gradually implemented. Table 22, indicates the key elements of the water supply system of Madras city.

The conventional approach of water supply system formulation based on demand and supply has never been applied in the case of Madras city because of lack

**Table 22.** Key Indicators of Madras Water Supply System

Key Indicators	Years								
	1970-71	1971-72	1972-73	1973-74	1974-75	1976-77	1977-78	1978-79	1979-80
1. Length of Mains/sub-mains (Kms)	127	132.29	145.83	152.96	154.81	155.438	168	183	185
2. Length of Distributor pipes (Kms)	1027.62	1070.07	1094.79	1108.7	1112.06	1122.26	1210	1218	1230
3. Amount of Water Supplied (Mld)	183.89	207.32	222.63	217.32	141.4	134.6	217.92	237.71	240.57
4. Number of House connections	87285	89780	92177	94216	95478	96371	98200	116000	116900

Source: MMWSSB Madras.

of perennial source of water supply. The average quantity of water supplied per person is about 70 liters in 1980. This quantity of water is far below the desirable standards. Even, when compared to other major cities of India, the water situation in Madras city is pathetic. All the major industries either have their own source of supply or buy the water from the water supply authorities through separate pipelines and are not included in the public distribution system. The city system essentially serves for domestic and commercial uses.

In Madras city each house connection serves more than one household. Recent survey has revealed that the majority of individual properties contain 3 families groups. On average each family having minimum of 5 members. In non-slum areas each connection thus serves 15 people and more.

The water supply system in slum areas where a vast majority (75%) of the LIG population lives, there is no individual house connection. They are served either by 'Stand pipes' or water tanks located in most of the areas periodically filled up by mobile water trucks. An estimated 5600 'Stand Pipes' were located in the slum areas serving a population of 1.2 million at the rate of 175 people per stand pipe.

Although 85% of the city population has been provided with protected water supply, the quantity and quality of supplied are far below desired standards. The quality of water is maintained till the water enters the distribution system, beyond which it is contaminated by the underground polluted water and leakage from sewers. The present system of 'intermittent water supply' adds to the worsening situation.

Pilot study reports on the quantity of water availed by different population groups indicated that the annual percapita consumption by HIG is 38 Cu. mts, MIG 25 Cu. mts and LIG 7.2 Cu. mts. Water consumption level is related to the affordability level. However the latent demand prevailing among the MIG and HIG population has not so far been exhibited as there has never been a surplus supply. However the demand is anticipated to rise sharply on increased availability of



water. In the case of areas (Slums and old quarters), where the concentration of the LIG population is the highest, there no opportunity for increased consumption of water in future even when the supply position improves, as long as these areas are served with Stand pipes.

The revenue front of the system shows a dismal picture as the contribution from the public for the water service availed is extremely low. This could very well be judged from the fact that a city of huge population concentration and developments has only 11000 metered water connections and hardly 3200 meters are found to be in working condition. So far a segment of Property tax collected has been treated as water tax. This amount (2% of the total property tax) does not even cover a fraction of the maintenance cost of the system. Further the contribution from the LIG population is totally out of question as the the slum areas are yet to be brought under the property taxation system.

Such a dismal situation could very well be understood through the existing practice of accounting system of the water supply department. More than 10% of the revenue expenditure is accounted towards maintaining the water supply system. However the total maintenance expenditure as well as all the different components which have been steadily increasing, seem to be independent of the amount of water supplied. The possible explanation for such a state of affairs is that all the cost components are of the fixed kinds and are not function of water drawn and supplied, and only the natural inflationary trends are responsible for the observed pattern of the change in maintenance cost over the years. In such a situation, the computation of yearly unit cost of water supply is not a meaningful or enlightening exercise unless the system is drastically changed. However, when the total cost of water supply and cost in 1980 indicates the unit cost to be at Rs. 0.20 per 1000 liters. The Table 23 records the recent investments made towards water supply system in the Madras city. The investment level has been steadily increasing, however compared to the magnitude of the problem, the annual apportionment towards water supply is observed to satisfy only 60% of the total requirement every year.

Realizing the gravity of the increasing short supply of water to the growing

**Table 23.** Recent Investments in Water Supply

Year	Investment in Rs. Million	
	Capital Works	Annual maintenance
1973-74	6.17	20.20
1974-75	5.23	18.30
1975-76	9.77	16.25
1976-77	9.77	18.15
1977-78	14.56	14.25
1978-79	17.35	25.75
1979-80	25.60	41.42

Source: MMWSSB Madras.

population, the Government has been implementing a long term water supply scheme 'Krishna Water Scheme' at a total cost of Rs. 4000 million. According to the scheme proposals, water would be drawn from a distance of more than 280 kms in adequate quantity to supply to the growing population of the Madras City. The scheme is scheduled to be completed by 1989. Simultaneously, work relating to the improvement needs in the existing system to cope with the future supply needs is being done.

However, policies aimed towards environmental improvement in Madras city should focus attention on water supply in adequate quantity and quality on priority basis. Unless the water supply position is improved, the impetus necessary to be provided for economic development will not be forthcoming. The water supply sector model formulation focuses attention on all the aspects stated above for a comprehensive framework. The water supply sector model flow diagram is as shown in Figure 10.

#### 4.4 Sewerage Sector :

Sewerage system which serves to remove the waste water and sullage to protect the public from health hazards falls in the category of 'Basic Services. The Madras city sewerage system was designed in 1910 for an estimated population of 0.66 million in the year 1961 at a rate of 114 lpcd. It was designed as partially separate system. The system allowed for admission of storm water from house courtyards and roofs through gullies. Since the topography of Madras city is generally flat with the contours ranging from 2.5 to 10 meters above MSL, increasing difficulties are faced in locating the sewers at suitable depths. Thus the network has more than 55 sewage pumping stations adding greatly to the maintenance cost.

The major problems confronting this system are, the capacity of the sewers is limited, during rainy days they become surcharged due to ingress of storm water. Any surplus of sewage in excess of pumping capacity is drained into the natural water courses of the city exposing the public to great dangers of health hazards. Since the present system is an extension of the core of the system established in 1910 major segment of the sewer lines are very old and have lost their utility value. Leakage from the sewer lines pollute the water supply as the pipelines run almost one above the other.

The collection system coverage in the city served about 75 percent of the population in 1980. Approximately 104000 service connections for an average of 15.6 people per connection (as each private property contains on average three households). The slum population within the city are served by 750 public conveniences with 4500 stalls (50% of them are not functioning presently). This provides one public convenience per 267 people, each public convenience having 6 stalls. In many cases they are not properly maintained- either water supply is inadequate or there is no lighting.

The sewage thus collected is treated in 5 major treatment plants and 10 oxidation ponds located around the city. The Table 24 indicates the investment levels

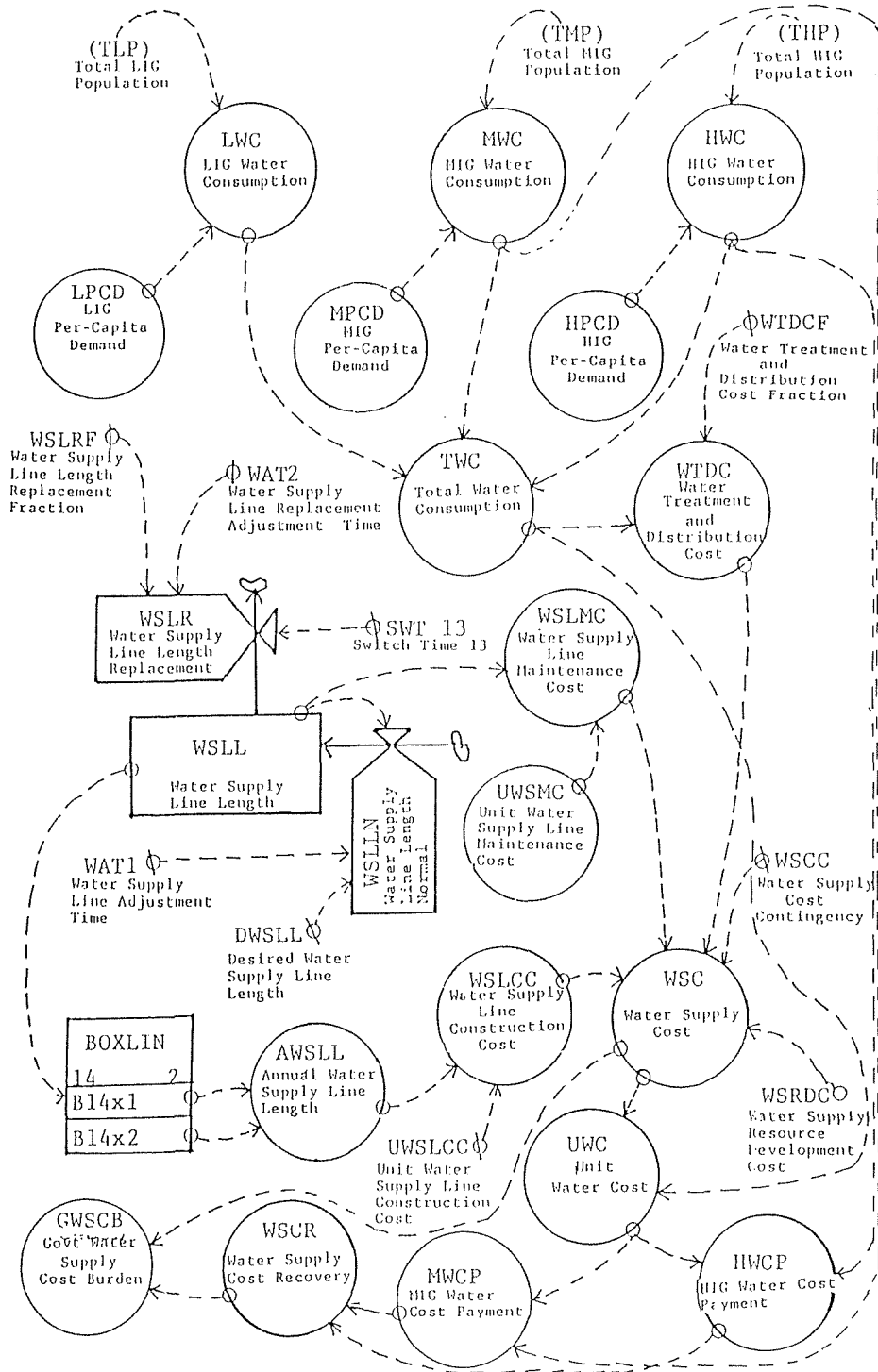


Figure 10. Water Supply Sector.

**Table 24.** Recent Investments in the Sewerage System

Year	Investment in Rs. millions	
	Capital Works	Maintenance
1973-74	0.67	19.23
1974-75	0.61	17.53
1975-76	1.90	15.33
1976-77	20.11	19.24
1977-78	24.12	15.27
1978-79	18.35	17.28
1979-80	14.46	13.80

Source : MMWSSB Madras.

of this sector over the past decade. The investments show greater fluctuation indicating lack of finance, and the MIG population although contributes to the service charges in terms of property tax, the returns for the service is meager. Majority of the LIG population neither enjoys the full compliment of the service nor contributes towards the service charges. While the public convenience in the slum areas are constructed out of the public funds contributed by the other two groups, lack of additional revenue contributes to the inadequate maintenance of the facility already created.

The scale and nature of the problem can be summarized as follows.

- (i). Only a part of the urban area (75%) is served by a sewerage system.
- (ii). Sewage from the city sewerage system enters the natural water courses of the city, thus causing foul smell and health hazards.
- (iii). The sewage out fall in to the sea is in the tidal zone.
- (iv). The city sewerage system is surcharged. This is partly due to the absence of separate facilities for disposing of storm water drainage.
- (v). The system tends to get clogged by dumping of cattle waste in to the sewers and the collection of silt.

The situation can be rectified only when individual connections are made available to the LIG population which again depends on their affordability level. While the economic mobility will lead gradually to the situation of availing individual connections, increase in the current education level will lead to the better utilization of the existing facilities.

The proposed model of this sector encompasses all the physical, engineering and economic aspects and relates them to the affordability level. Since the sewage system is closely involved with the water supply system, the sewerage cost recovery is related to the quantity of water consumed. The model flow diagram is shown in Figure. 11. The principles involved in building the model is similar to the water supply sector.



#### 4.5 Storm Water Drains Sector :

##### (1) *Topography of Madras:*

The site of Madras city and its environs is very flat, the contours ranging from 2.0 to 10.0 meters above M. S. L. There are three rivers running through the Madras Metropolitan Area from west to east. All the rivers run in a radial direction in the north, central and southern sector. All the three rivers are non perennial, but have a substantial flow during the monsoon. There is another artificial canal running in the North-South direction, originally used for navigational purposes. Figure. 6 shows the rivers, lakes and canals existing in the Metropolitan area. All these water courses basically serve as drainage courses during rainy seasons, and have obstruction at the mouths by sand bars.

##### (2) *Rainfall in Madras:*

The climate of Madras is a 'tropical maritime monsoon type'. The intensity of rainfall, particularly during the North-East Monsoon can result in serious inundation. The South-west Monsoon is between June and September and does not bring such precipitation. During the North East Monsoon period "Every year ... cyclonic storms of varying intensity, some very severe cross the coast". The cyclone which hit the coast in 1977 generated a tidal wave about 6 M high which traveled several kilometers inland. The storms and cyclones mainly originate in the Bay of Bengal and are experienced more severely during the period of October to December of an year. The mean annual rainfall is 120 cms. During the monsoon period the maximum rainfall experienced is 66 cm over a period of one month only.

##### (3) *Inundation in Madras:*

The periods of heavy rain cause local floods for several days even after the rain has ceased. Stagnation in certain low lying areas lasts for several months. Drainage of this storm water is made more difficult for a number of reasons :

- a. Large areas of open fields which used to absorb water have been progressively built up.
- b. The rivers and channels draining into the sea do not possess adequate capacity. They have become constricted over a time by silting and by having their margins encroached upon by development (mainly squatter settlements).
- c. A number of irrigation tanks which formerly also acted as flood moderators have been taken over for urban development.
- d. The upkeep of streams and the construction of proper drainage channels leading to the streams have not kept pace with the growth of urban area.

The floods particularly those in 1976 which were of unprecedented severity causing damage running into millions of rupees and inflicting great human suffering to the poorer section of the community. This has re-emphasized the seriousness of the flood hazard and the urgent need to implement a program to prevent physical damage and suffering resulting from floods. Detailed information regarding the flooding hazards in Madras is given in the Reference 38. The storm water drains

system has not been given adequate importance although millions of Rupees are spent on relief measures. Several studies relating to construction of storm water drains have been carried out, but the implementation of the same has been lagging behind due to inadequate financial resources. Recurring massive expenditure incurred towards flood relief operations can be saved by implementing the drainage schemes on a systematic basis. Overall improvements in the urban economy will play an important role in making available necessary finance to improve this sector. The structure of the model for this sector is as shown in Figure 12. The principles involved in the formulation of this model are similar to sewerage sector.

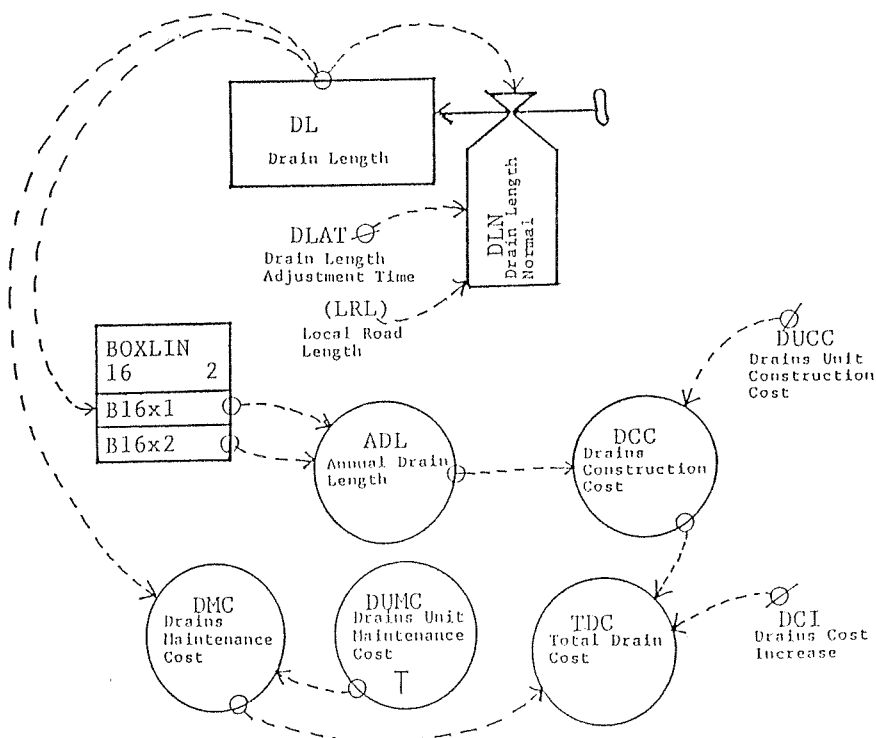


Figure 12. Storm Water Drainage Sector.

#### 4.6 Roads Sector :

Generally urban transport in developing countries is a combination of public, private and intermediate public transport. Madras city is not an exception to this generality. Urban transport is often greatly dependent on the intermediate public transport as the conventional mass transport system does not render services commensurate with the growing demand. On the one hand while the car ownership is seen growing, it is apparent that the use of public transport is also increasing. However the yawning gap between the demand and supply has resulted in the latent demand which is invariably catered to by the intermediate public transport. While the intermediate public transport offers service to the better affordable group of

population, it employs the people belonging to the LIG group as this sector is classified to be falling under the category of informal sector.

While the transport (Bus, Rail and or Water transport) fall within the purview of "Special Services", unique to the urban areas, roads form the most basic service to provide other basic services, facilities like water supply, sewer, power and drains etc. not only in terms of providing the accessibility, but also serve as the means. The special services either offered by public sector or private sector is operated on business principles, however in the case of developing countries and particularly in India, element of subsidy from Government is a common feature. Policies governing to the development and operation are mostly framed predominantly to serve the poorer section of the population.

For the purpose of this model, only the roads sector which falls under the category of basic services is considered, the system for the transport system is outside the scope of this study. The road network in Madras city is classified as National Highway, State Highway and city roads. The city roads are mostly the local roads primarily intended for access to buildings. The National Highway and a segment of city roads essentially serve as the arterial roads intended for motor vehicle traffic.

As on 1980, Madras city was having a total road network length of 1658 kms, of which 1440 kms constituted for local roads, collectors and distributors, and 218 kms as major arterial roads. The major problems confronting the road sector is inadequate width of roads, missing links, river and railway crossings and street furniture to ensure safety of the users. The road sector is entirely financed by the Government through the general taxes collected and the maintenance of the same depends on the availability of finance.

For the purpose of this model, two different classification of road networks has been identified so as to address the macro level deficiency in the system. One is the local roads of the city and the deficiency analysis combining the physical and economic aspects is carried out on the general standards applicable to this network. The second classification of the road network is the Arterial road network. The model framework of the Arterial road sector deals with the growth of road transport vehicles in consonance with the general economic improvement.

The principles involved in formulating the Arterial roads sector model is similar to the Local roads sector excepting the rate equation (ARLN) which determines the rate of construction of new roads. The construction rate is influenced by the vehicles growth and the consequent increase in traffic. Since there are different kinds fast and slow moving vehicles, all the vehicles are converted into passenger car units (Indian Roads Congress Standards) The vehicular growth rate is related to the economic improvement anticipated to prevail when major urban development programs are introduced as explained later in the Economic Activity component of this model. The Figure 13. Illustrates the model structure of the Roads sector.



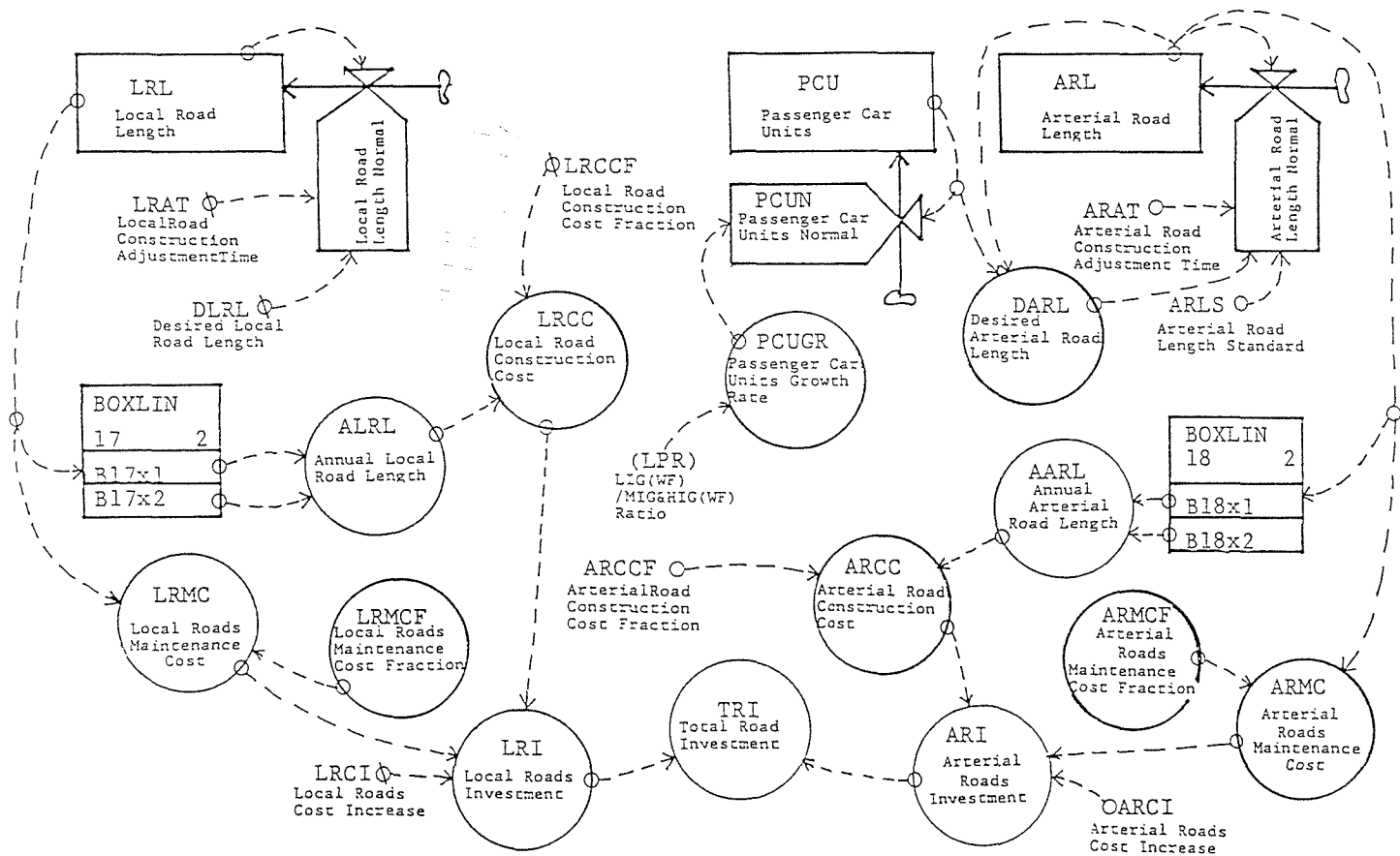


Figure 13. Roads Sector.

#### 4.7 Parks, Play Fields and Open Space Sector :

A fully urbanized area contains a considerable amount of open space either belonging to public or private serving for the physical, spiritual needs of the community and the economic and environmental needs of the whole urban area. The parks play fields and the open space can be classified into several categories depending upon the needs of different cross-section of the population, environmental standards and the ecological balance to be maintained.

Madras city continues to enjoy the privilege of having a forest in the heart of the city, however the parks and play fields sector is the least prioritized. The existing conditions call for drastic improvement in order to maintain certain minimum standards. While the Development control regulations stipulate stringent measures to maintain minimum level of environmentally acceptable open space at neighbourhood level, the larger open space needed for the community is grossly neglected. While there has been no conscious effort to create more open space, even the space already reserved are poorly maintained due to lack of finance. Most of the open space reserved as community park has either been encroached upon by the slums or utilized by the very authorities responsible for creation and maintenance for developmental purposes.

The amount of open space currently existing for a population of 3.27 million is in the order of 120 ha. In terms of per-capita availability, it is only 0.5 sq. mts per person. This standard is not any where near the desirable minimum standard to be maintained in an urban area. The play grounds and the stadia maintained by the local Government alone are maintained to a reasonable level as they fetch revenue. All other public open spaces are beyond utilization.

For the purpose of the model, this sector has been classified into two sub-sectors, namely, Active park sector and Passive park sector. The former relates to the play grounds and the open space needs of the younger generation and the latter relates to the general public and the aged. The model parameters relate to the physical, engineering and socio-economic aspects. The model flow diagram is as shown in Figure 14. The passive park sector which is intended to provide for passive recreation, namely, walking, cycling, resting etc. As explained earlier, the population of Madras city is currently young and unless, appropriate action is taken from now onwards, the condition may deteriorate beyond redemption when the present population attains age. There is a large scope for creation of such facilities along the river banks, coastal lines of the city. The model formulation is similar to the Active park sector. The model flow diagram is as shown in Figure 14.

#### 4.8 Solid Waste Management Sector :

Solid waste disposal has been a serious problem faced by many of the Third world countries. More often this sector attracts the last priority because of lack of awareness of the seriousness of the dangers it poses on the society and financial constraints. Advanced techniques and methods are adopted in a very few cities of

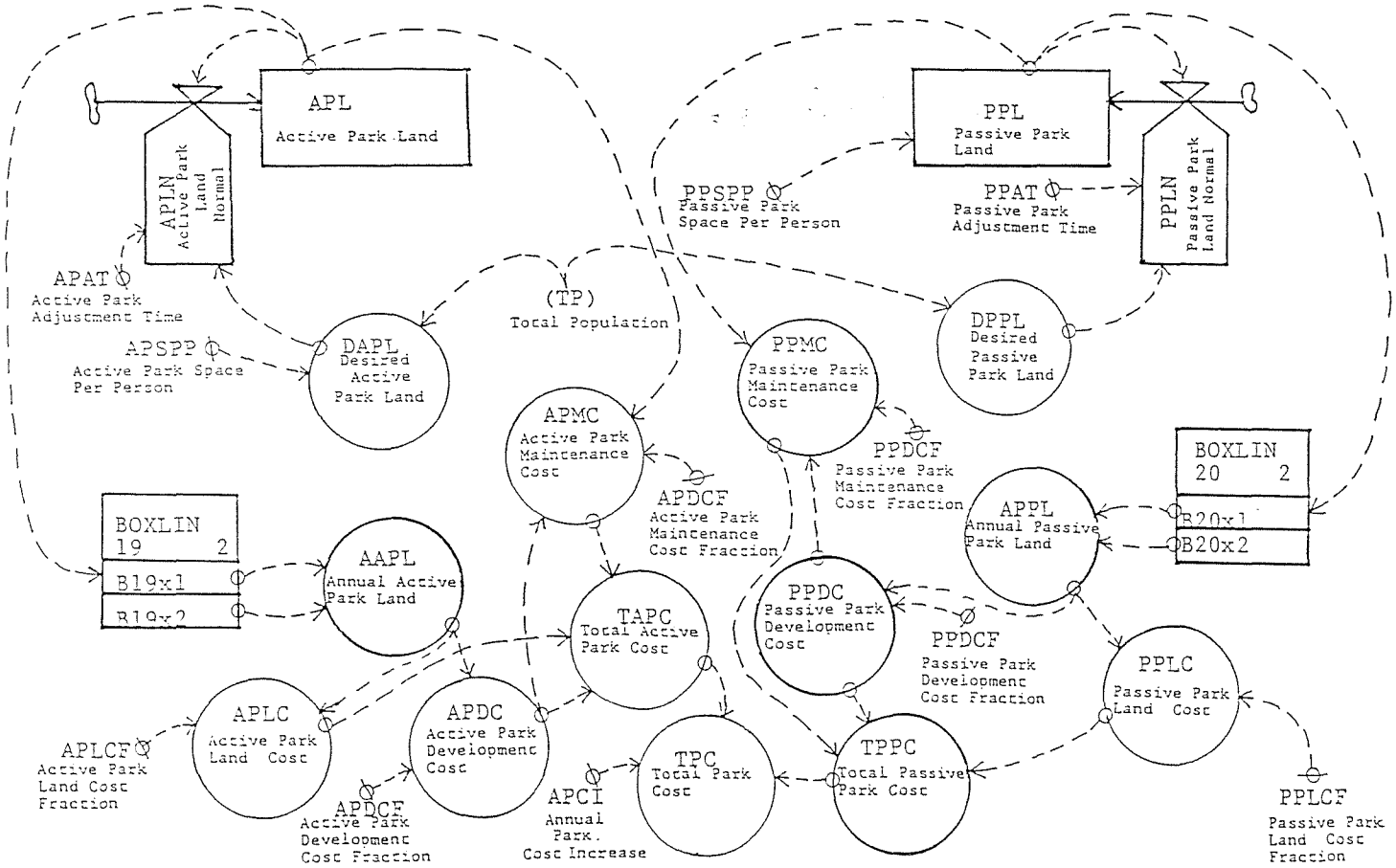


Figure 14. Parks and Open Space Sector.

the developing world that too only to a limited scale. Advancement in the area of disposal of the city garbages has been developed to such an extent, that almost 50% of the total garbage collected is recycled and reused. A major segment of the cost incurred in the collection and disposal is realized from the sale or reuse of the garbage. Methods hitherto adopted for disposal (incineration) is being reconsidered in many of the developed countries because of the pollution it causes to the atmosphere. The other conventional method of land filling also faces increasing difficulty because of lack of suitable land within economic distance, land and underground water pollution etc. The dimension of the problem in the developing world is not only the appropriate technology but also the necessary funds as this sector entirely depends on the public finance.

Madras city faces similar problems. Until recently, the garbage was collected and dumped on low lying areas of the city with no regard to the environmental effects. The magnitude and severity of the problem can be understood from the fact that, besides the human population more than 70000 cattle and buffaloes contribute to the solid waste. A total of 0.5 million tons of solid waste is collected annually, out of which 60000 tons is used for manufacturing 40000 tons of compost. The compost is sold as manure to the farms around the city.

While the household refuse is collected through garbage bins located on the roadside, the business refuse is accumulated at the road side for everyday collection. The chemical composition of the solid waste indicates that more than 70 percent of the garbage is organic in nature and the rest inorganic. Excepting the compost manufacturing, other methods of recycling have not so far been introduced. This sector employs both the conventional and modern methods of collection. Although on an average, 1000 tons of solid waste is collected everyday considerable quantity (200 to 300 tons) remain uncollected.

The annual expenditure on conservancy alone ranges from Rs. 33 million at the rate of Rs. 5 per household. The entire expenditure is borne from the general revenue. This sector currently engages more than 2000 workers and 90% of them fall in the category of LIG population. The urgent needs of this sector are (i) effective clearing of the solid waste from the collection points in an hygienic manner, (ii) reorganization of the entire system of collection and disposal system by applying appropriate technology to ensure environmental hygiene, (iii) creation of centralized treatment facility to convert the solid waste to stable form prior to being used as land fill, (iv) adaptation of advanced technique in land filling operation to avoid land and water pollution. Although improvements to the system are gradually being made they are not commensurate with the actual needs, and especially this sector calls for immediate attention.

The model for this sector comprises all the issues discussed above. The model flow diagram is as shown in Figure 15.

#### **4.9 EE Facilities Investment Sector :**

This sector deals with aggregate values, the Capital and the operating cost

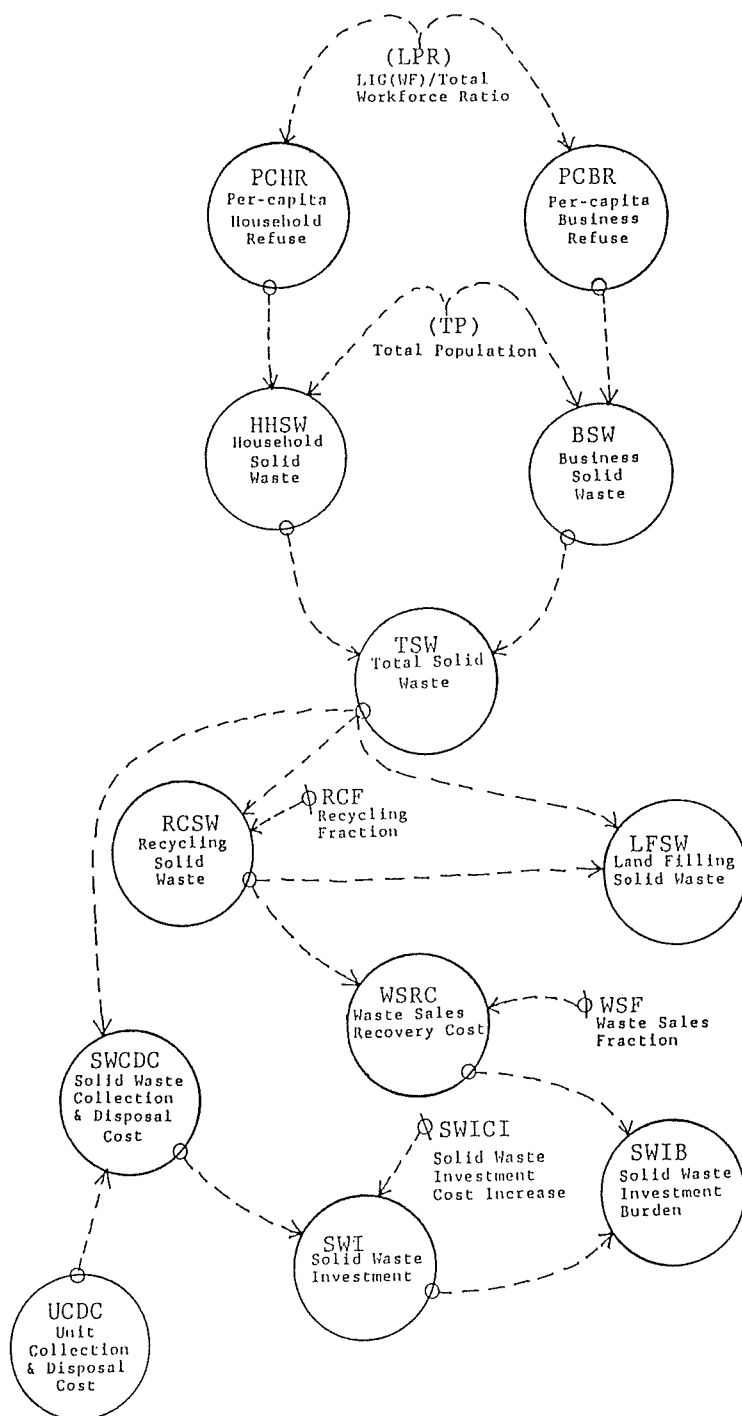


Figure 15. Solid Waste Management Sector.

involved in creating the specified EE facilities and the returns from the different population groups related to the cost of the service and the affordability level. Similarly the private investment levels relating to the Education sector is also evaluated to assess the quantum of subsidy to regulate the private sector. The Government sector investment level towards the EE facilities, the total tax collected and the service cost collected are related to determine the Government's financial burden. It is to be noted that the 'Income Tax' has not been included in this study as the Income tax assessment, collection and distribution rests with the National Government. The share of Income and its utilization will form part of the Government contribution or Government's financial burden. The system of financing is explained in the Economic Activity component of this model. The model flow diagram of this sector is as shown in the Figure 16.

### 5.0 Economic Activity Sector :

Economic activity is the Barometer of the living standard of an urban population. At the advent of industrialization and consequent urbanization, specialized and complimentary economic activities grew rapidly. Higher order concentration of population in urban centers, instead of inducing greater economic activity, depleted the gains attained initially. The illusive image created by the urban area continued to prevail upon and attracted many from outside. The skilled and the fittest could merge with the economic stream, the unskilled and less fortunate could not do so. The vast majority of such people were instrumental in creating the unorganized sector or the informal sector. As explained earlier, this sector neither contributes to the economic upliftment of the individuals nor to the general economy of the urban area. It is this sector which poses serious challenge to the urban managers, needs greater attention and importance. Any attempt made towards ameliorating the economy of an urban area needs a comprehensive policy framework to face the challenges posed by this sector.

To state the obvious, creation and maintenance of the EE facilities depends entirely on the affordability characteristics of the beneficiaries and the economic activity of the urban area. To break the vicious circle and to direct efforts, the prerequisite is objective assessment of the scale and nature of the problems involved and a system to redress the situation effective in the long run.

#### (1) *Economic Activity in Madras City:*

Madras is one of the fastest growing cities in India both in terms of population and employment growth. Madras city accounts for about 26% of the State total urban employment, its role in terms of organized manufacturing activity is still more important (Table 25). About 36% of total capital and about 42% of value added of all industries in the state covered by the Factory Act are located in the city and its environs. About 50% of Commercial Tax collection of the state is again accounted for by the city. The overwhelming importance of the city in industry and commerce is also reflected in private income and savings eg. about



45% of total deposits in the state is accounted for by the city population alone. This does not however imply that there is no lack of affordability or poverty in certain segments of the population.

During the period 1961 to 1971, population and employment growth rates per annum were recorded at 43% and 38% respectively. However during the period between 1971 and 1981 the growth rates showed downward trends 3.8% and 2.9% respectively. The growth in employment (Table 26) has mostly occurred in the tertiary sector with predominance of what may be called as marginal occupations. The organized sector (public and large scale private sector industrial and non-industrial activities) as a whole employs (Table 27) about 37% of the total working force. Available information reports indicate sharp decline in the growth pattern of new ventures belonging to organized sector (less than 1%). Another evidence suggests that the proportion of non-establishment employment is the (50%). All these have resulted in the observed high proportion of marginal employment which can otherwise be classified as under employment.

**Table 25.** Growth of Industries in Madras City 1939-81

Year	Number of Factories	Average Number of Workers Employed
1939	156	28981
1941	173	38839
1946	371	39862
1956	764	65339
1961	895	66132
1971	1431	97376
1981	1575	137376

Source: Census Report on Madras City 1981.

**Table 26.** Establishments in Madras City 1971-81

Year	All Units	Establishments Employment	Industrial Units	Establishments Employment	Trading Units	Establishments Employment	Other Units	Establishments Employment
1971	55650	293883	14342	95147	31872	121368	9436	77368
1981	173097	914114	39959	265093	103222	393069	31216	255952

Source: Census of India Reports 1981.

**Table 27.** Madras City Labour Force, 1981

Total Main Workers	Cultivators	Agriculture Laboures	Household Industry Manufacturing Processing and Servicing	Other Workers	Marginal Workers	Nonworkers	Total Population	% of Workers to Total Population
914114	1300	1166	16068	895580	13651	2348857	3276622	27.96

Source: Census of India Reports 1981.



The organized industrial sector has about 12% of total employment but accounts for 30% of total income. (Economic profile of MMA. ORG 1978). Within the organized industrial sector, machinery and metal products, particularly transport equipment account for 50% of capital and value added. This lack of diversification of the industrial base in the city is of particular concern in the context of stagnation of growth in recent years.

Establishments employing upto 9 people constitute 88% of the total number of establishments; those employing upto 4 people account for 80%. This sector accounts for between one third and two thirds of employment in each category. It is estimated that atleast 50% and at most 70% of the total employment in Madras city is accounted for by small unorganized sector.

The contribution of the informal sector to income is smaller than the contribution to total employment. Income per employed person in the organized sector may vary from 6.5 to 4 times the income per employed person in the informal sector. The contribution to total income generation in Madras city is estimated to be about 26% or less than half its contribution in terms of the number of jobs. The informal sector units have a very low labour income which partially explains the continuance of urban poverty.

## (2) *Extent of Unemployment and Poverty:*

The State Five Year plans from 1978 for whole of Tamil Nadu have been framed with the following objectives;

- (i). to effect reduction of economic and social inequalities in opportunities and incomes.
- (ii). to increase state, sectorial per-capita income.
- (iii) to reduce unemployment.
- (iv) to eradicate severe poverty, and reduce the number below the poverty line.
- (v) to provide basic needs of the poor, particularly fresh water, education, health care, housing, roads, and minimum services in the urban slum.

Inspite of the stated objectives, in the city of Madras the unemployment is estimated to be between 3.1% and 4.4% of the population. Under employment is more difficult to estimate in view of the large scale involvement in the informal sector activities. About 46.6% of the total population has an income below Rs. 600 per month, which is the minimum level to support life. Another 41% of the population has an income range of Rs. 600-1500 per month placing them at medium affordability level. The rest 12.4% of the population belong to the income bracket of more than Rs. 1500 per month, having a high affordability level.

The lowest 40% of the people spend about 75% of their income (which for this class is the same as expenditure) on food, but this is hardly enough to provide adequate nutrition which is exhibited in the number of people afflicted with nutritional deficiency diseases, and infant mortality. The gravity of the situation suggests that unless efforts are made to upgrade incomes, no amount of external assistance or improved urban service will improve the quality of life in Madras. It is estimated that if the population is to be lifted above the poverty line in the next five years,

it will be necessary to create 30000 new jobs annually with adequate income per job. In addition 72000 marginally employed people will have to be assisted annually to upgrade their incomes to take care of the problem of under employment over the next 5 year period. This however does not include the creation of 40000 new jobs per year to cater for new entrants to the labour market. Past performance shows that new jobs have been created annually for only 80% of the new entrants.

(3) *Economic Base and Scope for Expansion:*

The growth of the organized sector (covering trade and services) has been stagnant since 1971. The growth rate is less than 1% Table 25 to 27. The stagnation in the growth of organized sector or the new ventures will possibly have a much wider impact on the economic base of the trade and service sector as a result of the backward linkages of manufacturing activity. The diagnosis of a stagnating economic base has led to the conclusion (Structure Plan Volume 1) that inadequate infrastructure facilities in terms of water, power, skilled man power ; lack of industrial promotion activities ; generally the non-enlargement of the base of the public service facilities are the cause for such a stagnation. In terms of the future economic base, there is wide scope from the fact that growth in the organized sector (not necessarily large industries) has to be boosted to reduce the level of poverty prevailing in Madras. For quick employment opportunities construction of public service facilities has to be enhanced.

(4) *Financial Resource Base and Scope in Madras:*

There are, in general, three levels of Governments involved in the mobilization of financial resources and the deployment of resources towards public services and infrastructure. These three levels of government are — Central, State and Local. In the case of Madras city, the Local Government is the City Corporation. Efforts towards mobilization of financial resources are more or less directly related to devolution of powers of taxation (including levies) among different levels of government. Though the devolution of tax powers is not absolutely rigid, the general pattern is set by constitutional provisions and overall federal authority in the passing of laws. The major source of tax revenues for Central, State and Local Government are :

- (i). Central Government- Income Tax, Union Excise Duties, Estate Duties.
- (ii). State Government- Sales Tax, State Excise Duties, Urban Land Tax, Land Revenue, Stamp Duties, Registration fee, Motor Vehicles Tax.
- (iii). Local Government- Property Tax, Professional Tax, Company Tax and Advertisement Tax.

All these taxes are paid by the people of Madras directly (eg. Income Tax, Property Tax) or indirectly (eg. Excise Duties, Sales Tax). State Government gets a substantial share of central taxes. In 1976-77, collections from the state taxes were about Rs. 3440 million as against Rs. 1280 million by way of share of central taxes. Comparatively the share of local government from state tax is very small (20%). The indirect contribution of State Government to local government is,

however, more than this. A sizable part of capital expenditure of the local government is financed by the grants and loans from the State government. State government also gives grants on current account (primarily on the education account). In general, however, grants (not loans) by the State government have been meager, particularly when compared with the large financial resources collected through different taxes which are ultimately borne by the local people. Per-capita grant for the local government in the last three years has varied between Rs. 8 and Rs. 15.5 while the per capital state tax collection would be several times more than this. In summary it can be said that out of the total tax revenue contributed by the people, the largest share goes to Central government, followed by the State Government and the Local Government gets the lowest share with a wide margin of difference from that of State Government. For a city like Madras the difference will be still more glaring, judged against the fact that more than one-third of the revenue from taxes (like Income Tax and Sales Tax) is contributed by 12% of the people in the city.

As a compensating factor for a relatively low share of financial resources by the Local Government, the responsibilities for maintaining and creating public services and infrastructure are shared by higher levels of government. Although in terms of maintenance of civic services (mainly through current expenditure), local bodies share the major responsibility, the contribution of Central and State Government is particularly high in terms of capital expenditure. For eg. the majority of current and capital expenditure on Transport and Communications (roads, railways, telephone etc.) is borne by the State and Central Government agencies. In the field of social services like housing, slum clearance and education, the major part of expenditure is borne by the State Government. Among the most important investing agencies, the City corporation accounted for less than 20% of the total capital expenditure in 1980. In addition there are certain types of expenditures incurred by the Central Government which are not directly linked with the development of particular city or region but benefit a larger population (eg. National Highways). It is almost impossible to arrive at precise statistics regarding relative share of expenditure in a particular city by different levels of government so as to compare it against the relative share of revenue generated from the particular city. Even if this had been possible, it would not have led to any precise and rational allocation of resources, because often the geographic identification of revenue generation and benefits of expenditure is misleading.

In this complex situation of sharing the different levels of government, both in resource mobilization and in rendering different functional services and creation of infrastructure, the study approach is that instead of rationalizing a large share of resources (taxes and levies collected) by higher level of government from the metropolis or alternatively a larger transfer of income to the local bodies in the form of grants or soft loans, the focus has been on what best can be done by the local bodies in terms of revenue augmentation within the ambit of their own resource generating powers (Primarily taxing powers). While compared with the

desirable level of expenditure, this will also reflect the need for bridging the gaps. As a corollary of this study, it has been also necessary to discover how much is being spent to maintain and create EE facilities as distinct from economic infrastructure and special urban services. While the intention has been to cover both the maintenance and capital expenditure, the emphasis in the present study has been more on understanding the pattern of capital expenditure because it is here that proper allocation of resources and need for resource augmentations are called for. The capital and maintenance cost requirements for the present and the future population of the city can be determined as shown under the respective EE facility sector.

(5) *Madras City Corporation Finance:*

In Madras city, while the current expenditure is mainly financed by current revenue, capital expenditure is mainly financed by external assistance, ie. grants and loans. This has hardly anything to do with autonomous financial resources of local bodies. Moreover, capital expenditure has been generally ad hoc in nature. The absolute magnitude of capital expenditure in recent years has been meager compared to current expenditure. Property tax is the main-stay of the city corporation accounting for 75% of the total revenue. This is in contrast with other major cities of India where a special kind of tax namely Octroi (tax levied on all the commodities brought into the city for sale or consumption) and the property tax accounts for a maximum of 50% of the total revenue. Although property tax liability has been revised on many occasions in recent times, the main issues with regard to Property Tax are:

- (i). Collection performance has been poor, only 65% of the current demand and 50% of arrears demands are realized.
- (ii). Tax rates are not really progressive.
- (iii). The quinquennial revision of property assessment is not very methodical and often erratic. While expectedly, properties in commercial areas register higher rates of increase in revision of values, about one third of properties in many areas do not show any appreciable increase (less than 25%) in annual rateable value. Increasing taxes for commercial activities will be a deterrent in promoting job opportunities.
- (iv). In the context of inflationary trends, rising values of land and building and increasing significance of commercial properties (including hotels/recreation) a restructuring of property tax liability assessment is required. Because of the relatively low growth of new properties, the revision of valuation of old properties is the surest method of bringing larger funds to the exchequer of the local government.
- (v). Despite the fact that there is need to use the land to optimum extent, large tracts of unused lands exist. This happens because the level of taxation on the vacant lands is so low that it encourages speculative activities. This is an aspect that requires consideration not only from the point of view of revenue but also to help achieve desirable land use controls.

Realization from the two other taxes namely Profession Tax and Company Tax has been consistently poor (only about 30% of current demand was being collected.) The profession and company taxes face several problems in terms of procedures and stagnant economy. However these two sectors have a very large scope for improvement and becoming a progressive source of income.

The non-tax revenues consists of service charges, fees rents etc. This is another major source of revenue. This is the revenue which is derived from the services rendered to the population through the EE facilities. However, the cost recovery factor depends on the affordability level of the different groups of population as explained earlier.

Assigned revenue and grants on current account are the other two sources of revenue. This revenue relates to the transfer of funds from the State revenue, which has neither been increasing nor been consistent. The observed phenomenon of dependence on Property tax as the only important and dynamic source of revenue and the absence of steady growth from all other sources of revenue have inevitably resulted in the low level of per-capita current expenditure which is primarily constrained by the autonomous financial resources of the local body except for a small grant from the State Government.

While during the period 1970-71 to 1980-81, the consumer price index increased by more than 60%, per-capita expenditure has been as low as 45% for the Madras city. In absolute terms the expenditure is distressingly low (Rs.65). Thus the major concern with regard to the financial situation is: either the per capita revenue and expenditure efforts are at very low level or the growth in expenditure is even lower than the rate of inflation, indicating a deterioration in real level of services on per-capita basis. The current estimates indicate that expenditure needs to be raised by as much as 48% of the actual expenditure to maintain the same per-capita level of expenditure in real terms as in 1970-71.

(6) *Some Major Issues of Madras Local Government Finance:*

- (i). Continued dependence on the source- the property tax, as the major revenue generator stands in the way of augmentation of revenue by a sizable magnitude, most of the metropolises in India have one more important source of revenue (oe. Octroi). Inspite of unutilised yield potential of Property Tax in Madras, it is believed that the increase in revenue from this tax cannot cope even with the increasing needs for expenditure on current account for the growing population.
- (ii). There are obvious pit-falls in the rate structure and collection efforts for Property Tax which not only have stood in the way of maximizing yield from this tax but also have generated a tendency for evasion and inequity.
- (iii). Inter-governmental transfer ie. transfer of income realized from collection of tax administered by the State Government to the local bodies has not been a very elastic source of revenue. Commensurate with the expected high rate of growth of urban activities and large size of tax collection made by the State Government from the city dwellers, a review of the financial relationship between State and the Local Government is necessary.

(iv). Management of revenue and expenditure has been less than satisfactory and this has not only been reflected in the financial system, which does not permit any scientific evaluation through performance, budgeting and other methods, but also in the erratic pattern of expenditure even for basic services like water supply, public health etc. The paramount need of the local bodies is however, augmentation of resources not only through rationalizing the existing sources of revenue but also by tapping new sources.

The deficiencies and the problems identified in the revenue system have also been comprehensively built in the model under the tax sector. The model structure of the economic activity component is as shown in Figures 17 to 25 indicating LIG, MIG and HIG work force sectors, New venture, Unorganized Business sectors, Tax sector, Job sector and Urban development programs sector.

## 5.0 Model Behaviour :

The sectorial models relating to the major components (Population, economic Activity, EE facilities and Urban Development Programs) of the urban system and their inter-relationship expressed in terms of Dynamo equations were fed in to the Computer (HITAC S-810 & 680 H) for simulation runs over a period of 25 years from 1981 to 2005.

### I. Simulation Run 1 :

Simulation establishes the sectorial conditions that would be prevailing over the plan period on continuation of the current policies and programs towards the development of Madras city. In this simulation run the urban development program component has not been activated, so as to observe the trends and assess the magnitude and dimension of the problems for framing realistic policy options.

### II. Simulation Run 2 :

In the second simulation run, the urban development component which includes LIG (WF) training and Job creation programs, MIG (WF) training program, Construction of New ventures program and Unorganized Business replacement program and Tax revision program, are activated from the year 1985. These programs have been introduced as a concurrent effort to similar programs which have been introduced from 1983 on a moderate scale. The comparative analysis of the simulation 1 and 2 are as follows ;

#### (1) *Population and work force:*

Figures 26 and 27 indicate the macro level changes in the total population and the work force population of LIG, MIG, and HIG. Figure 26 relates to simulation 1, wherein the simulation follows the trends and with the continuation of existing policies and programs. The total population (TP) has shown a 46% rise from the 1981 level (3.27 million) registering a total of 4.495 million. There has been a pronounced increase in the LIG population from 46.2% in 1981 to 50.4% in 2005 and a corresponding decline in the MIG population- from 42.8% in 1981 to 37.8%

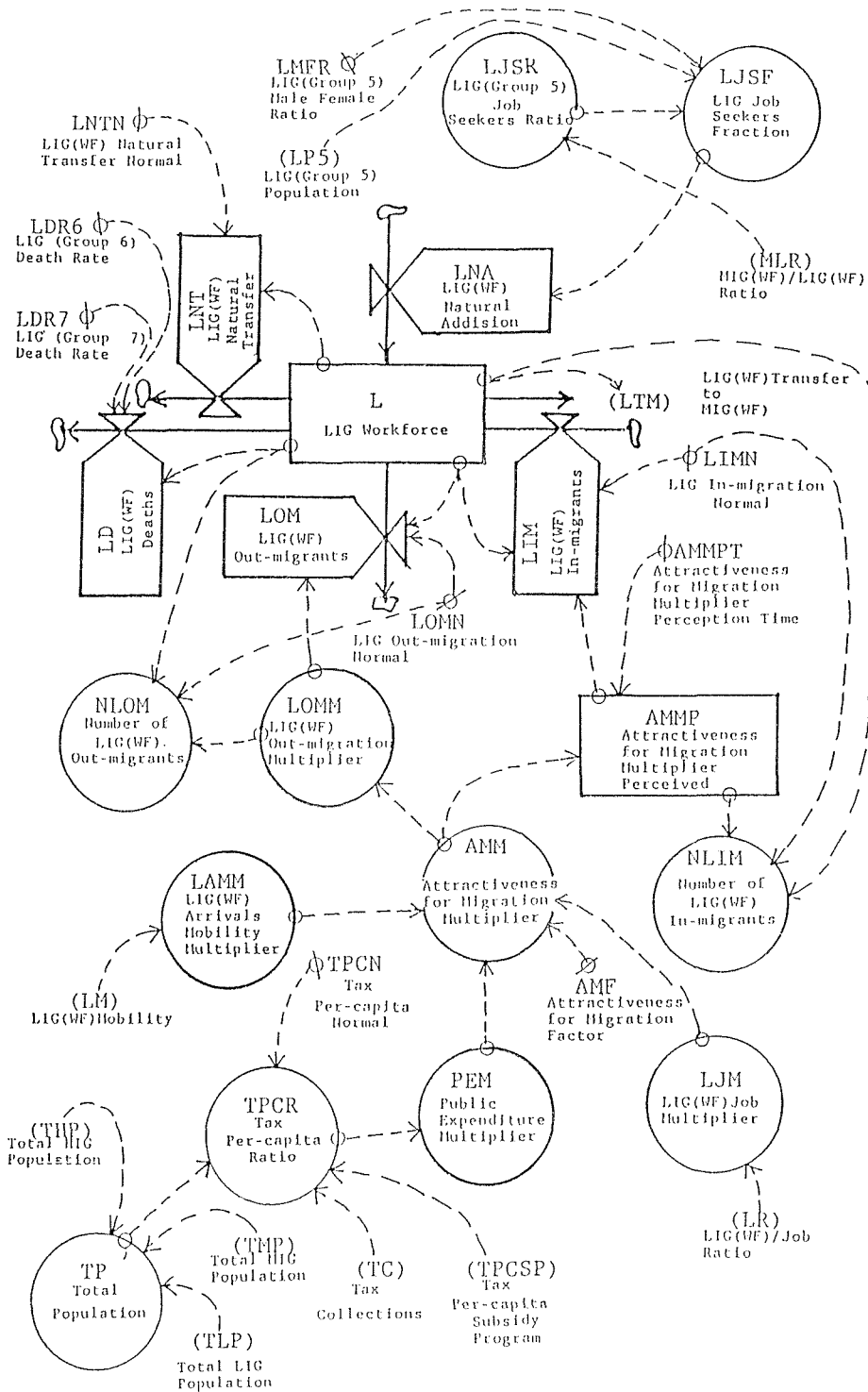
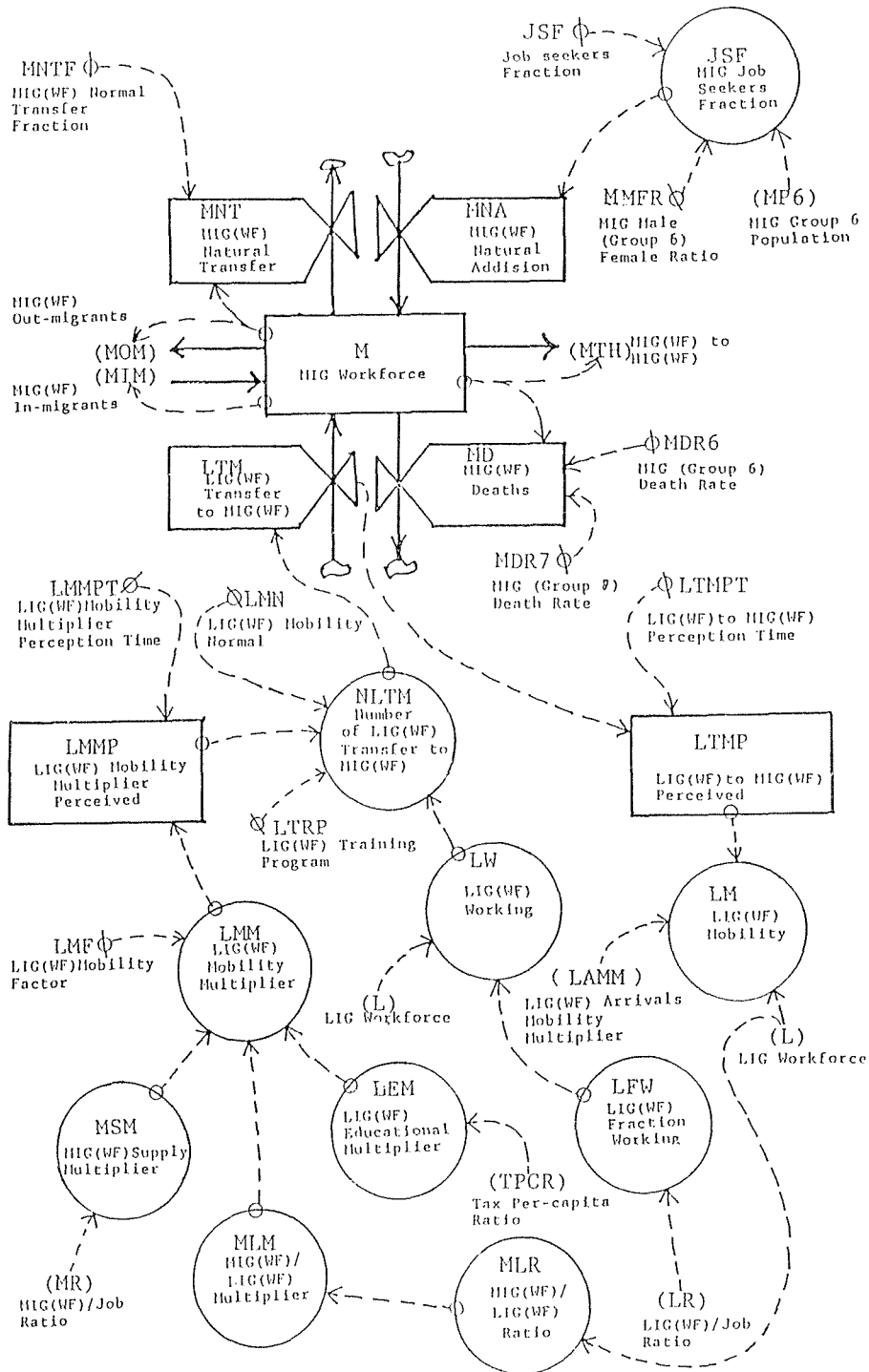


Figure 17. LIG Workforce- In-migration, Out-migration and Upward Mobility.





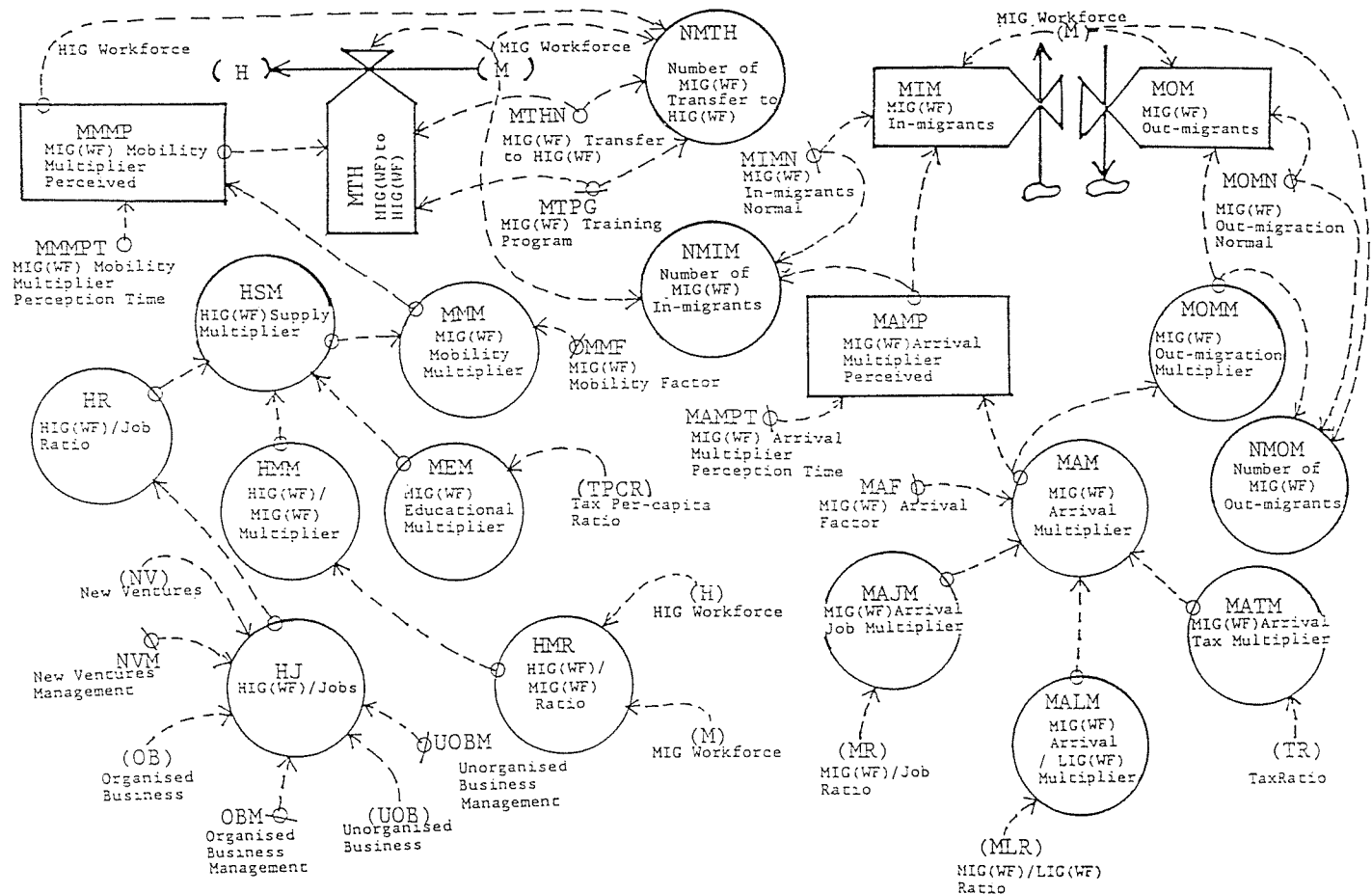
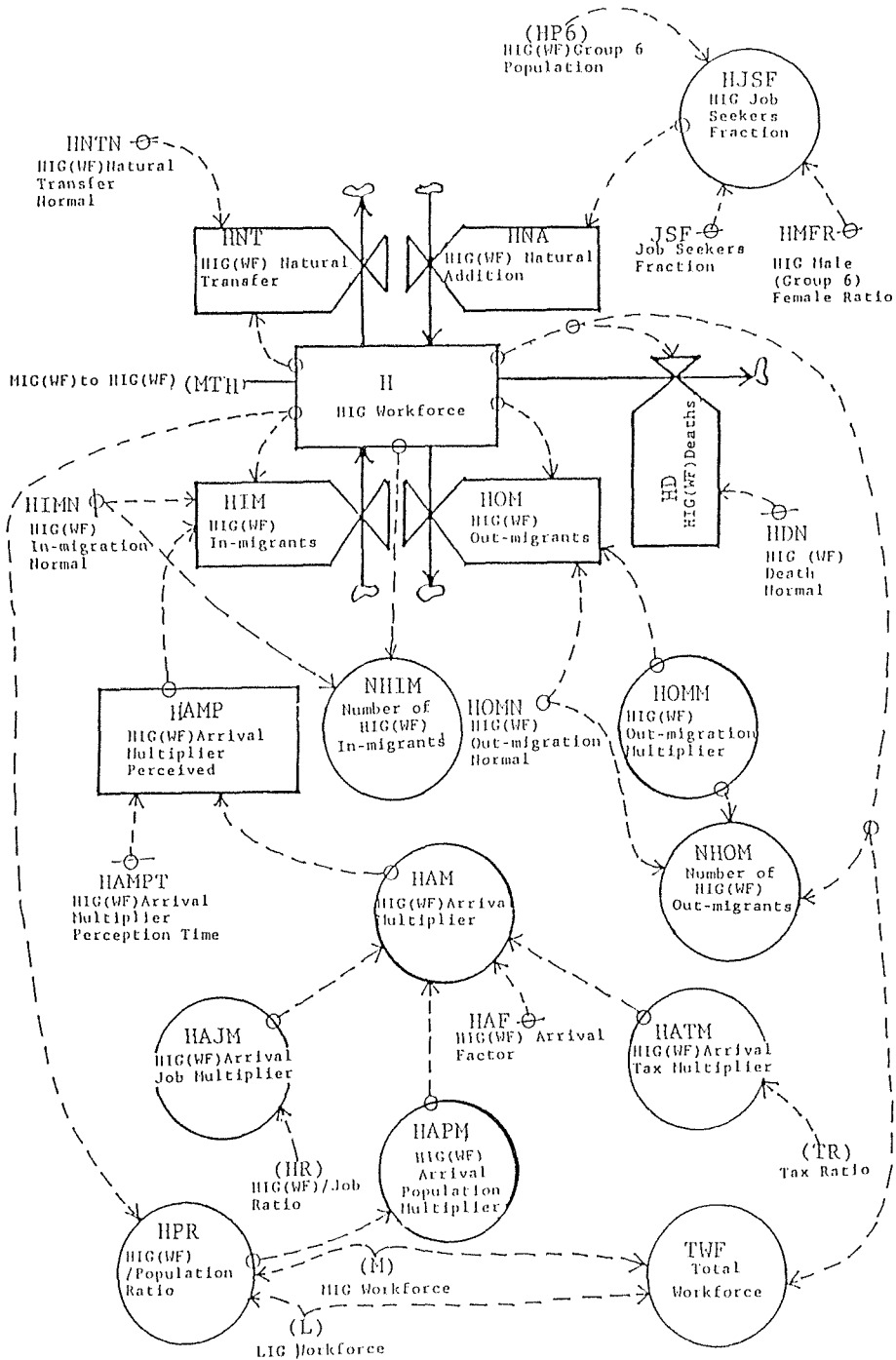


Figure 19. MIG Workforce- In-migration and Out-migration.



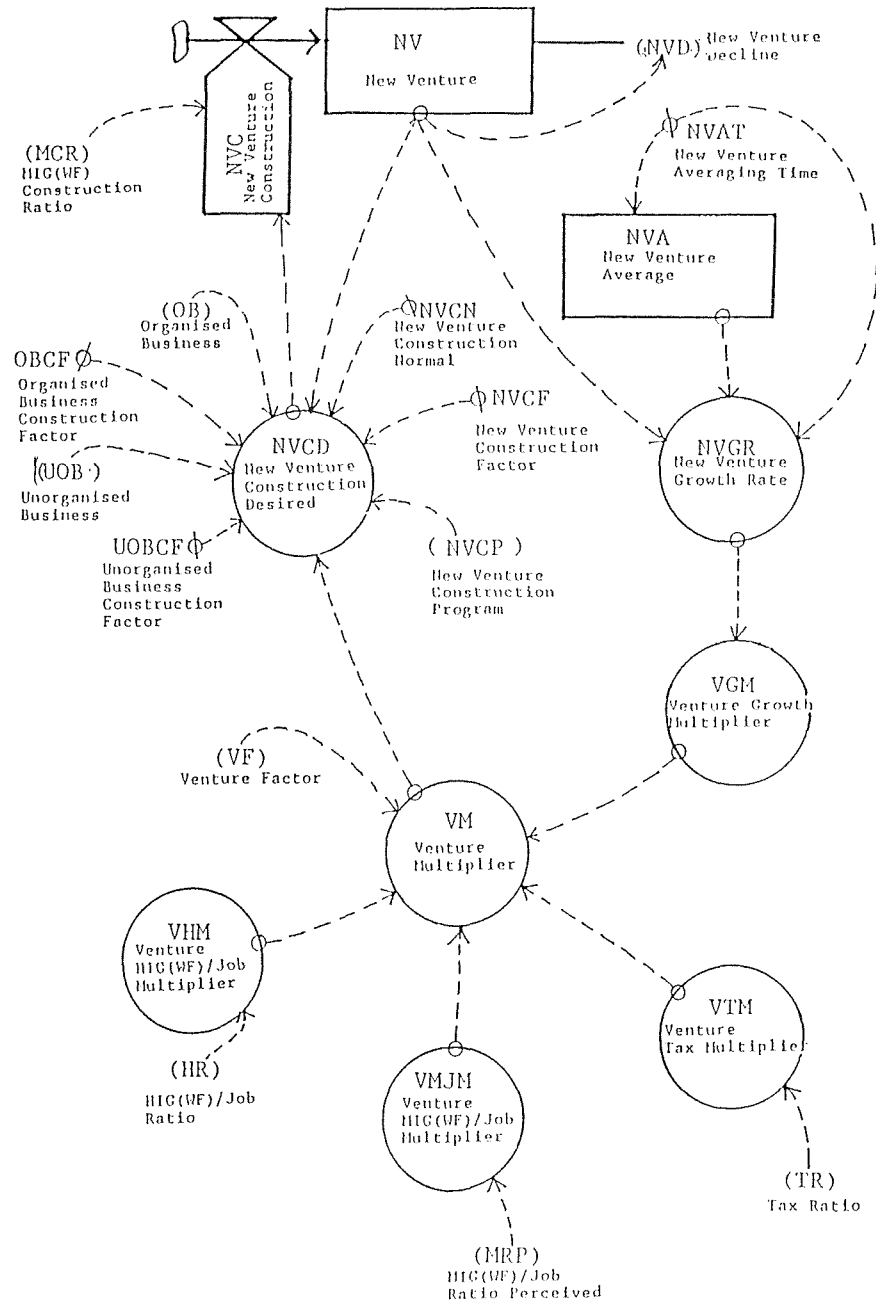


Figure 21. New Venture Sector.



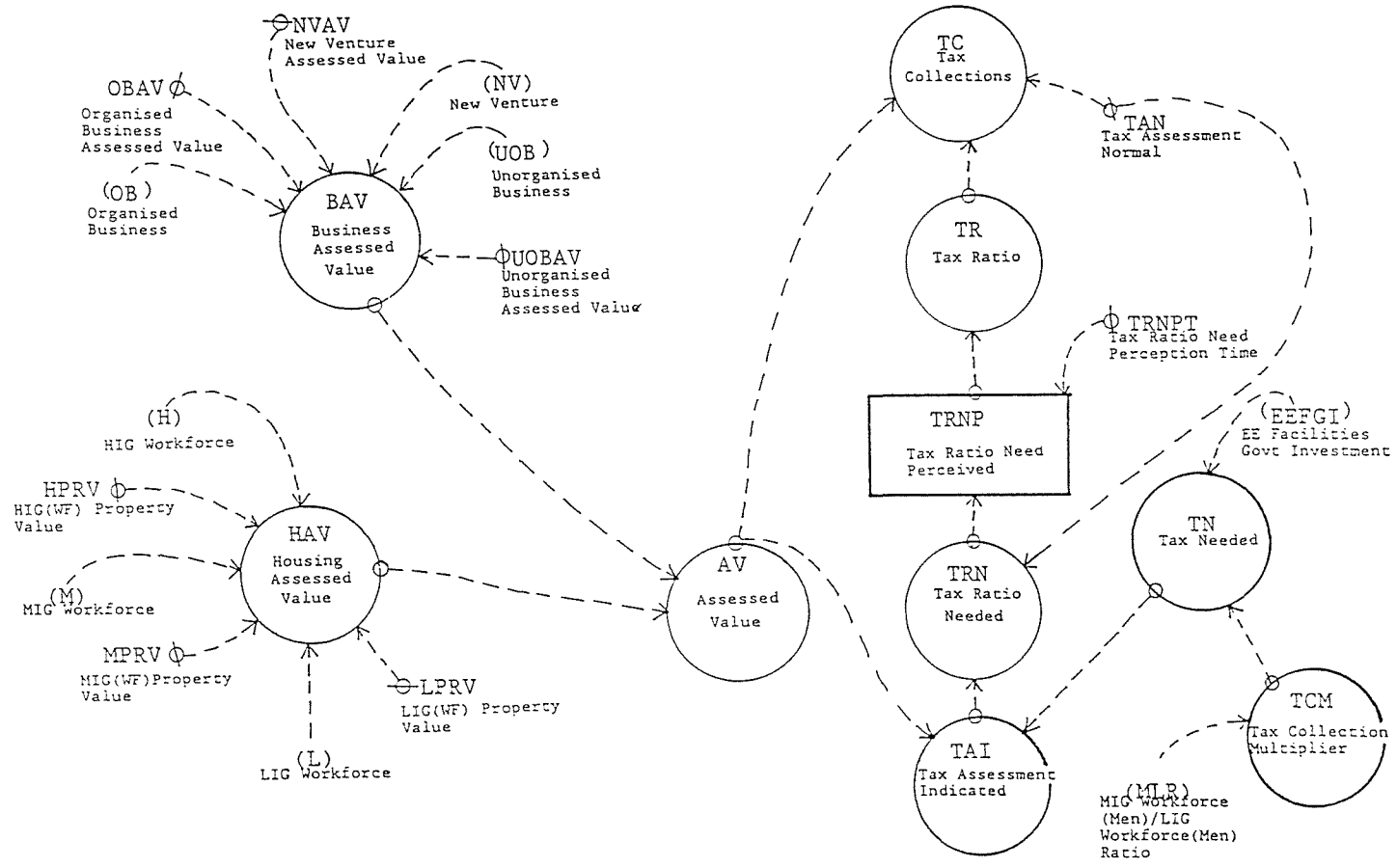


Figure 23. Tax Sector.

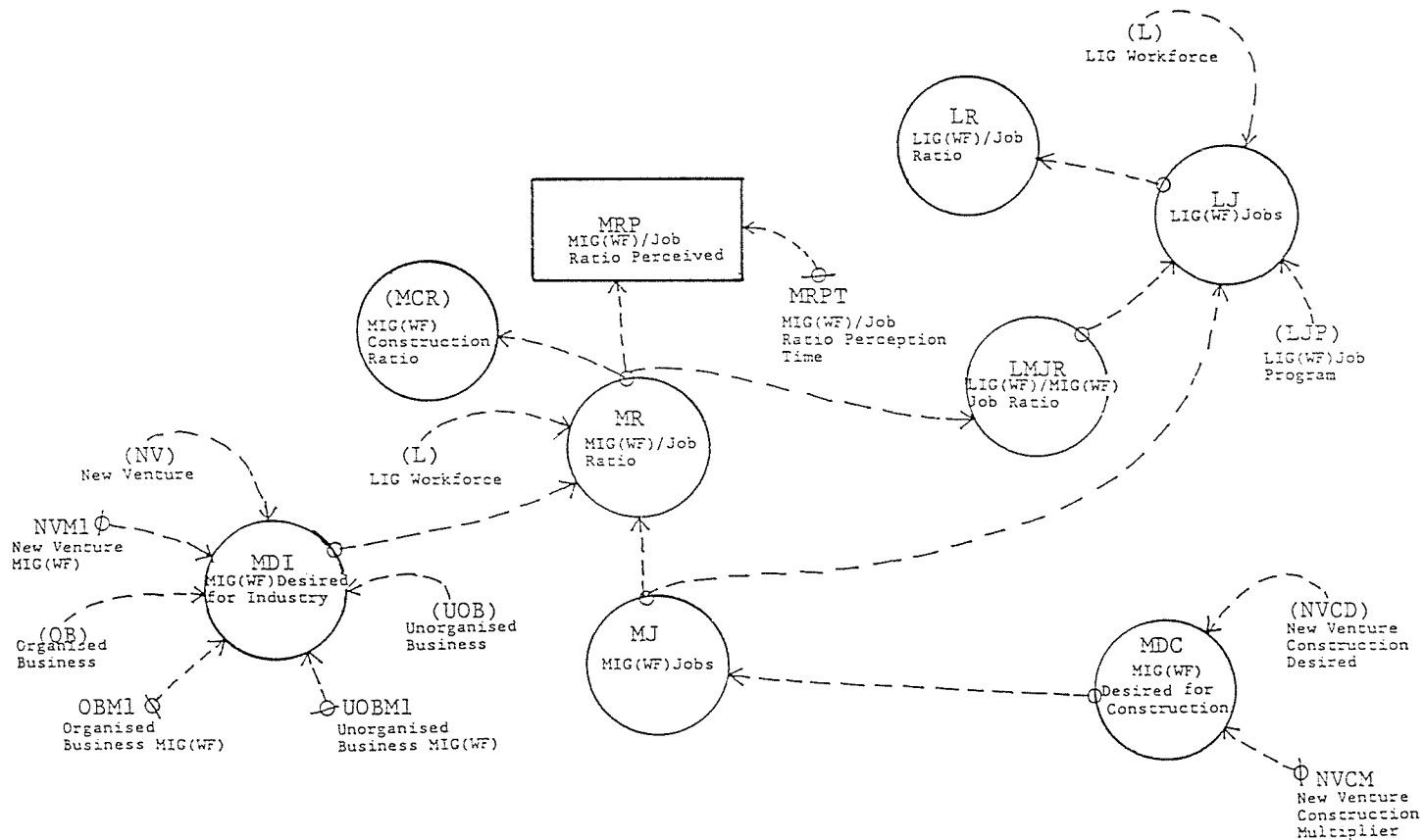


Figure 24. Job Sector.

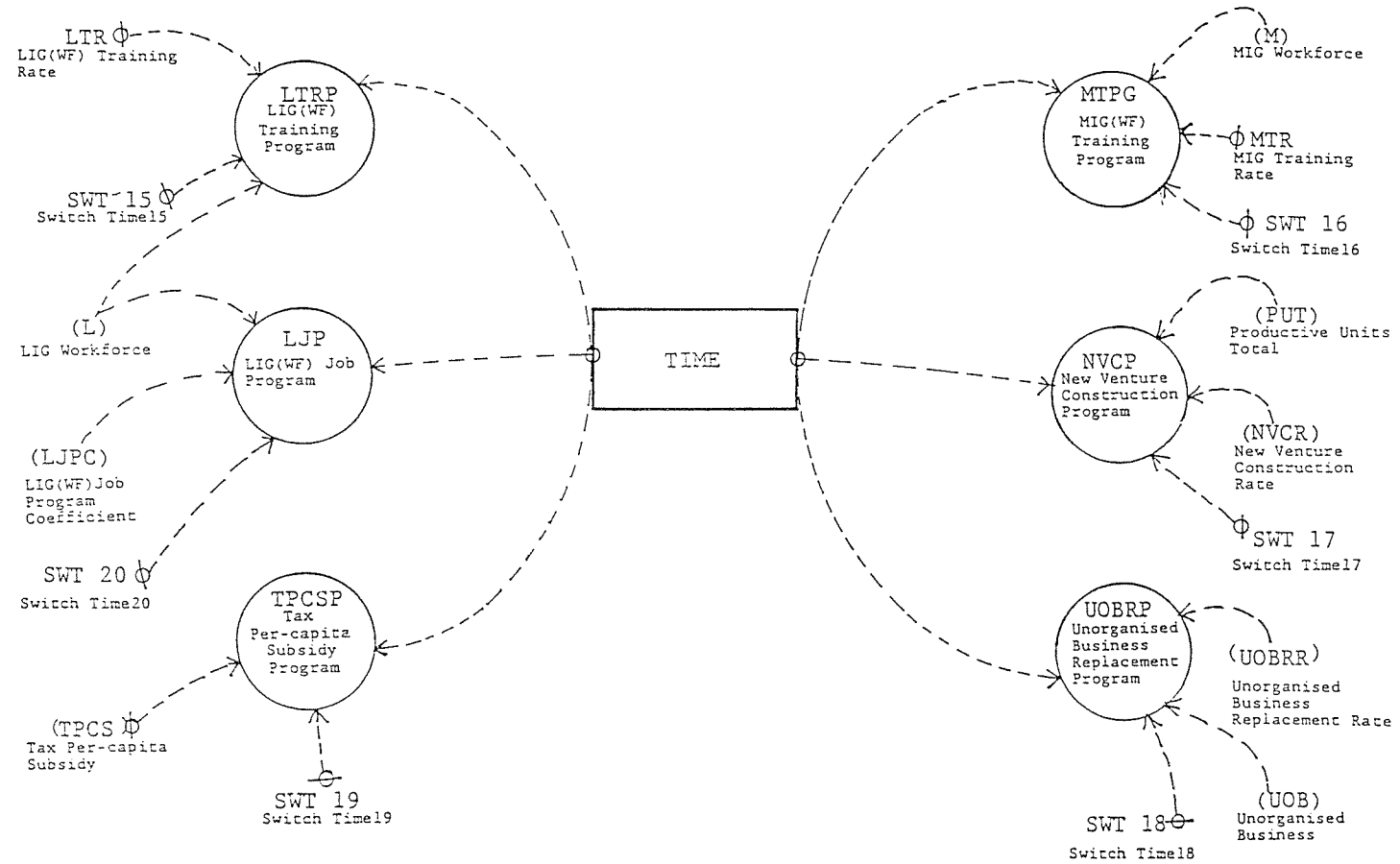
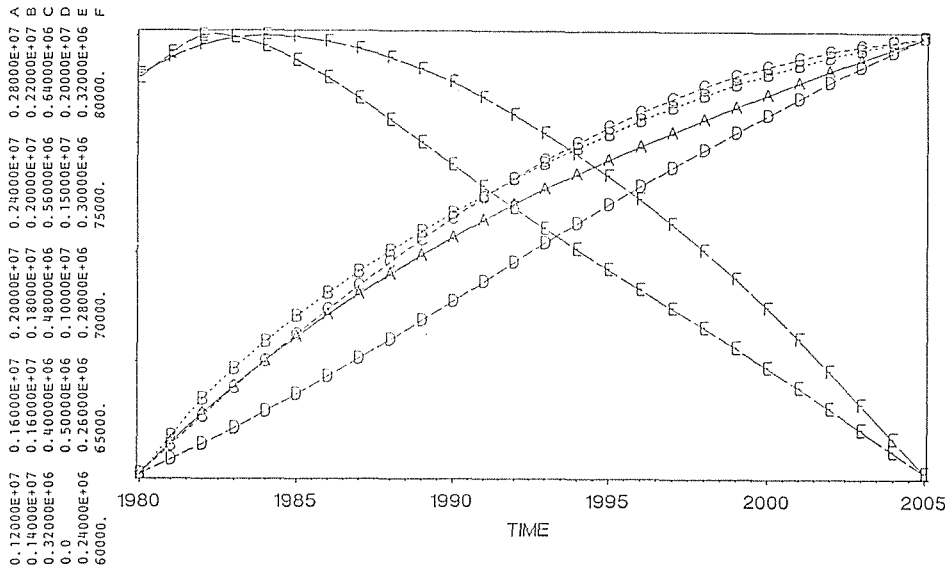
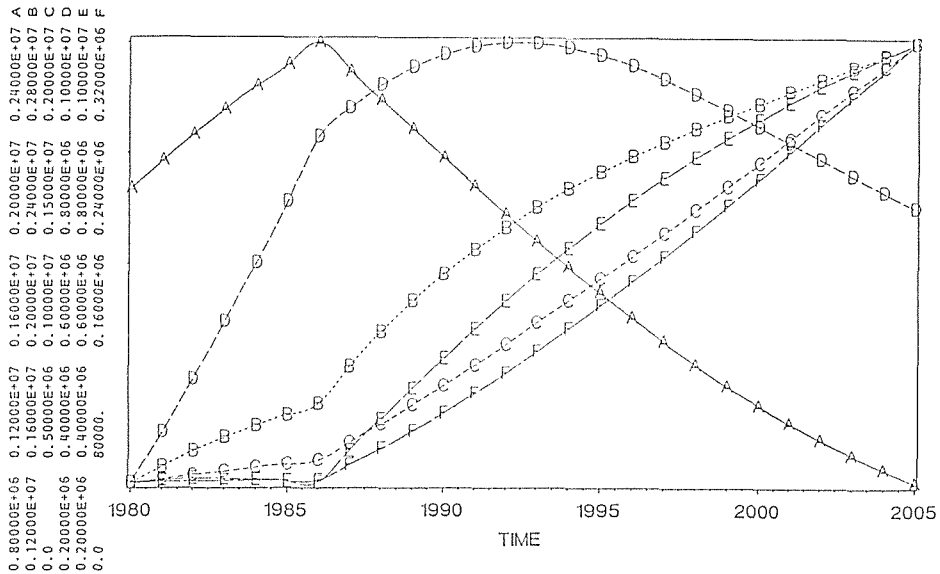


Figure 25. Urban Development Program Sector.



**Figure 26.** (TLP TMP THP LMH)=(ABCDEF)  
 TLP-Total LIG Population    TMP-Total MIG Population  
 THP-Total HIG Population    L-LIG Workforce  
 M-MIG Workforce    H-HIG Workforce



**Figure 27.** (TLP TMP THP LMH)=(ABCDEF)  
 TLP-Total LIG Population    TMP-Total MIG Population  
 THP-Total HIG Population    L-LIG Workforce  
 M-MIG Workforce    H-HIG Workforce

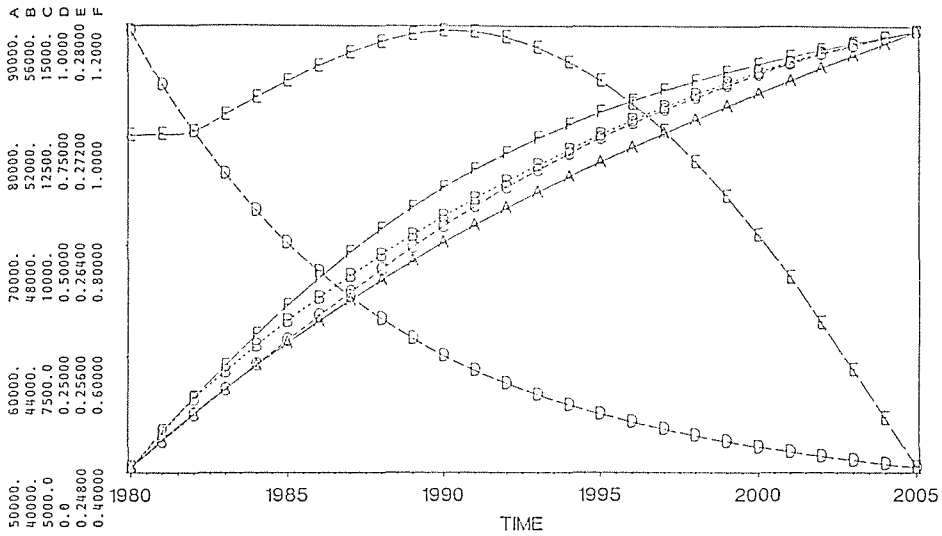


in 2005 is also observed. The HIG population has not shown any significant change indicating the fact that the MIG to HIG mobility has not been subject to any major change while the In and Out-migration remained at the same level. The sharp increase in the LIG population and decline in MIG population will inevitably be of great concern in terms of revenue and expenditure. This constraint will further worsen the EE facility sector, with greater demand for enhanced LIG welfare programs. The increase in the LIG (WF) is expected to increase five fold which will increase the informal sector activities, further declining the real income to the LIG population. This would be the most undersirable condition for any attempt to ameliorate the plight of the economically weaker section of the city.

On the contrary, on implementing the urban development programs as enunciated in the Simulation run 2, there is significant changes seen in the urban scene. Figure 27 illustrates the model behaviour under the influence of the urban development programs. Although the total population is seen increasing from 3.27 million to 5.032 million, (which is little higher than the First run — 4.79 million) the LIG population constitutes only 17.15% of the total population, which is a significant reduction achieved due to the urban development programs. At the same time, the MIG population has shown an increase from 42.8% to 46.42% of the total population and the HIG share has increased from 11% to 36.8%. These changes are accomplished in the model due to the effect of MIG (WF) training programs and the New venture creation programs. The increase in the MIG and HIG population indicates the more desirable situation in terms of revenue and cost effective investments on creation and maintenance of EE facilities. Since the urban development programs introduced, enhanced the upward mobility, reduced the birth rates the affordability level is naturally increased. This is further strengthened by a very few in-migrant LIG population (due to higher taxes) and increase in the immigration level of the other two groups of population. The economic climate necessary for the increased investments on creation of EE facilities is brought about.

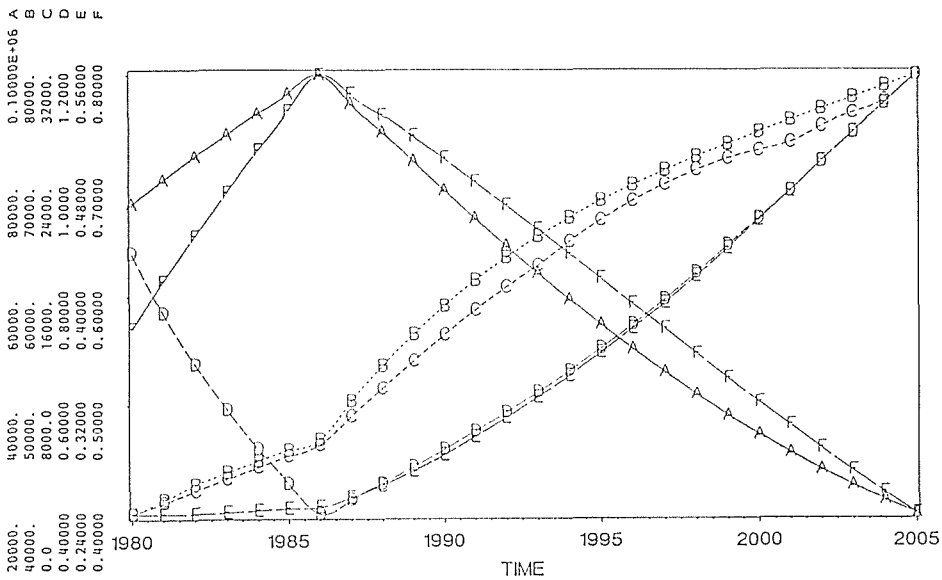
#### (2) *Birth Rates and Upward Mobility:*

The relationship between the upward mobility and the birth rates of the three population groups are recorded in the Figures 28 and 29 relating to the Simulation 1 and 2. The Figure 28 which is based on the continuance of the current policies and programs, urban development in general and the Family planning in particular, illustrates that there is no significant reduction in the birth rates achieved in all the three groups of population (a meager 2% reduction is achieved over the plan period). High birth rates have repeatedly been proved to be one of the major stumbling blocks for any economic improvement. As explained earlier, the major cause for non-reduction in the birth rates has been slow upward mobility which again is the root cause for low income level, education level, accessibility to improve the skill and low living environmental standards. The reduction in the MLR and HMR and the increase in LPR could well be understood in view of the increased out-migration of MIG and HIG population and the unchecked increase in the LIG population.



**Figure 28.** (LB MB HBMLR HMR LPR)=(ABCDEF)

LB-LIG Births      MLR-MIG Workforce/LIG Workforce Ratio  
 MB-IG Births      MHMR-HIG Workforce/MIG Workforce Ratio  
 HB-HIG Births      LPR-LIG Workforce/Total Workforce



**Figure 29.** (LB MB HB MLR HMR LPR)=(ABCDEF)

LB-LIB Births      MLR-MIG Workforce/LIG Workforce Ratio  
 MB-MIG Births      HMR-HIG Workforce/MIG Workforce Ratio  
 HB-HIG Births      LPR-LIG Workforce/Total Workforce

On the contrary in the Simulation run 2 (Figure 29) there is a considerable reduction effected in the birth rates; 5% percent in the case of LIG and 4% in the case of MIG and HIG population. The reduction in the birth rates were achieved through increased upward mobility and the consequent awareness of the Family Planning program.

(3) *In-migration and Work force Job ratio:*

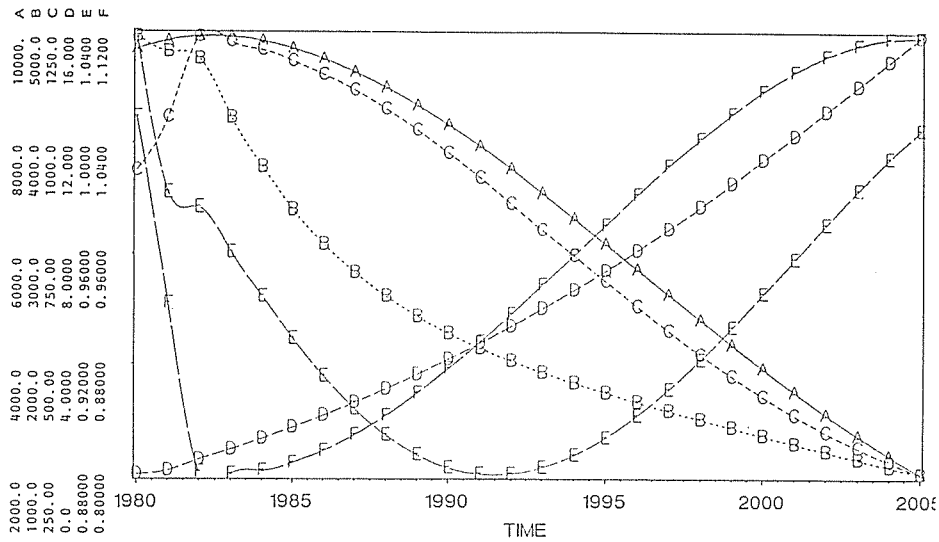
The relationship between the in-migration and the work force job ratio relating to the three population group work forces are as recorded in Figures 30 and 31 for the 1 and 2 simulation runs respectively. The first run (Figure 30) indicates furtherance of the present stagnant economy with more work force to the available jobs (LR, MR & HR) and the upward mobility is less significant. The in-migrating work force numbers of all the three groups are reduced to almost 50% of the current value.

On the contrary, on introduction of urban development programs (Figure 31) there is a significant change observed. While the LIG (WF) in-migrants are reduced from 8986 in 1980 to 4389 in 2005, the MIG (WF) in-migrants have increased from 4101 in 1980 to 7689 in 2005. The HIG (WF) in-migrants also have shown greater increase from 738 in 1981 to 3036 in 2005, which clearly establishes that increase in the availability of jobs pertaining to MIG and HIG could bring in better affordable group of people into the urban system. This is a more favourable condition for the furtherance of construction of new ventures. The improved job opportunities will greatly reduce the unemployment and underemployment.

(4) *Out-migration and Upward Mobility:*

The model behaviour in respect to out-migration and upward mobility for the two simulation runs are illustrated in Figures 32 and 33 respectively. In the first simulation run (Figure 32) the LIG (WF) out-migrants have shown considerable increase (2875 in 1981 to 14146 in 2005). This behaviour can be interpreted as, when the job opportunities become less and less and the informal sector is saturated, the LIG population which will be in search of better economic opportunities will move out of the city either back to their native place (rural area) or to smaller urban areas. This is however likely to create problems elsewhere and become a serious concern to the State Government. Similarly the out-migration of MIG and HIG work force also show greater increase. The stagnant economy is well represented by the declining upward mobility LTM and MTH. The LTM has declined from 354 in 1981 to 67 in 2005 and the MTH from 1367 in 1981 to 262 in 2005.

In the 2nd run (Figure 33) the LIG (WF) which increases gradually, registers a declining tendency on increasing availability of jobs after 1995. Similar tendency is predicted in the case of MIG (WF) also, however the HIG (WF) out-migration shows an increasing tendency as creation of new ventures and the employment opportunities are not commensurate with the availability of HIG (WF). This is further accentuated by the saturation caused by the higher mobility rate of MTH because of increased training. Correspondingly the LTM which rises initially is leveled off



**Figure 30.** (LIM MIM HIM LR MR HR)=(ABCDEF)

LIM-LIG In-migrants

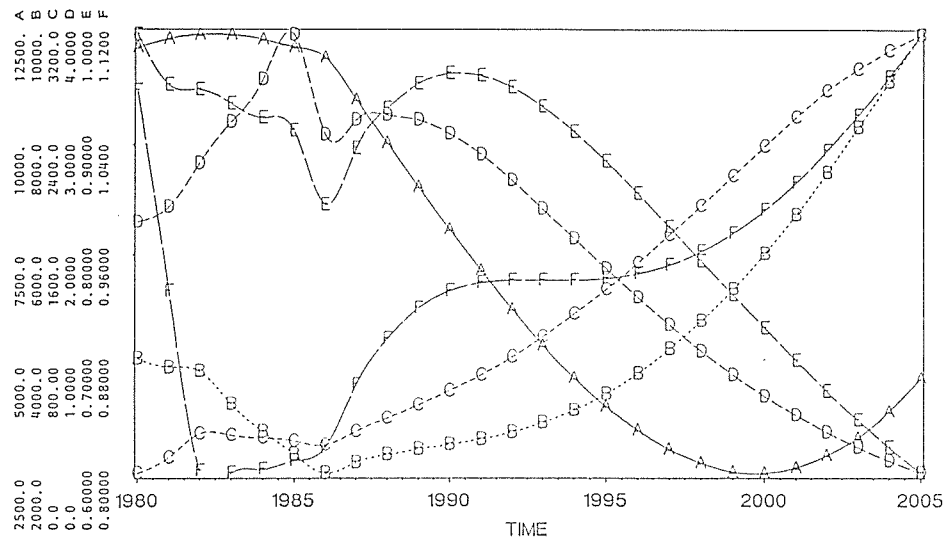
MIM-MIG In-migrants

HIM-HIG In-migrants

LR-LIG Workforce/Job Ratio

MR-MIG Workforce/Job Ratio

HR-HIG Workforce/Job Ratio



**Figure 31.** (LM MIM HIM LR MR HR)=(ABCDEF)

LIM-LIG In-migrants

MIM-MIG In-migrants

HIM-HIG In-migrants

LR-LIG Workforce/Job Ratio

MR-MIG Workforce/Job Ratio

HR-HIG Workforce/Job Ratio

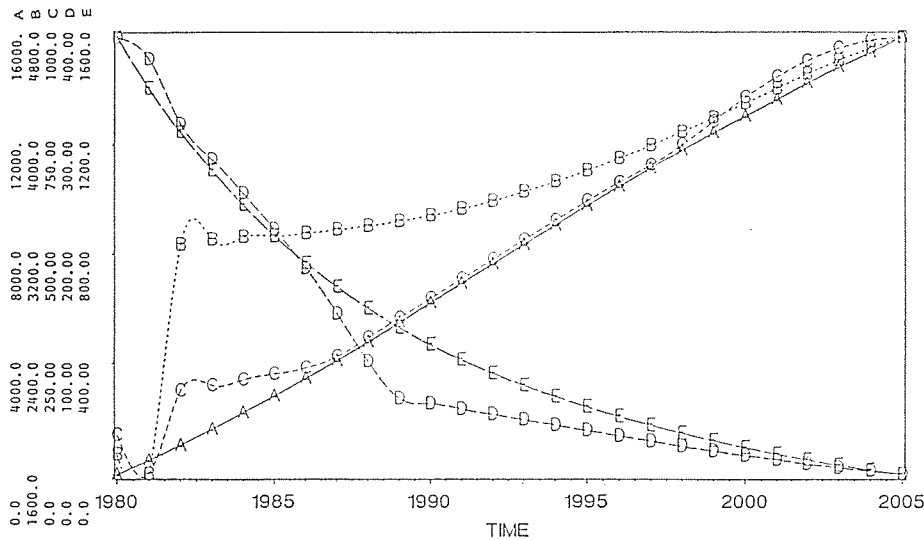


Figure 32. (LOM MOM HOM LTM MTH)=(ABCDEF)

LOM-LIG Out-migrants    LTM-LIG Workforce Transfer to MIG Workforce  
MON-MIG Out-migrants    MTH-MIG Workforce Transfer to HIG Workforce  
HOM-HIG Out-migrants

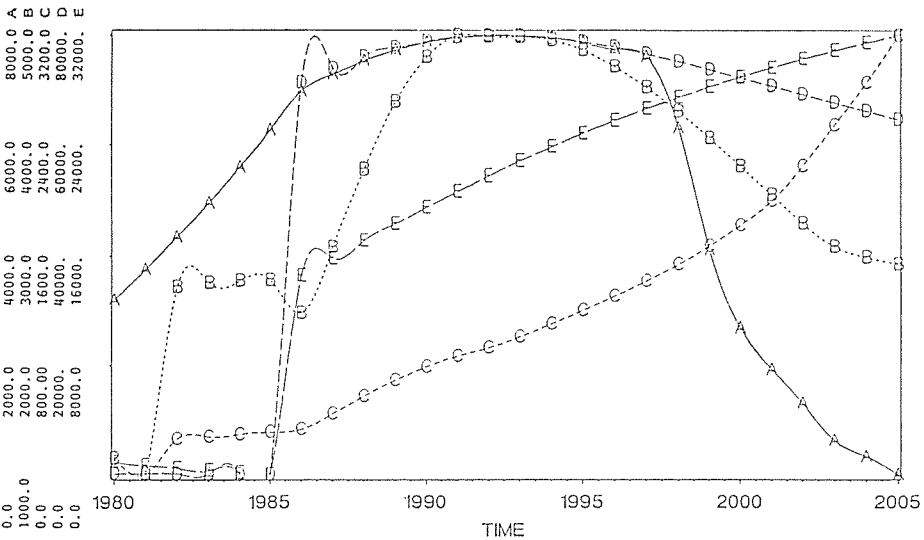
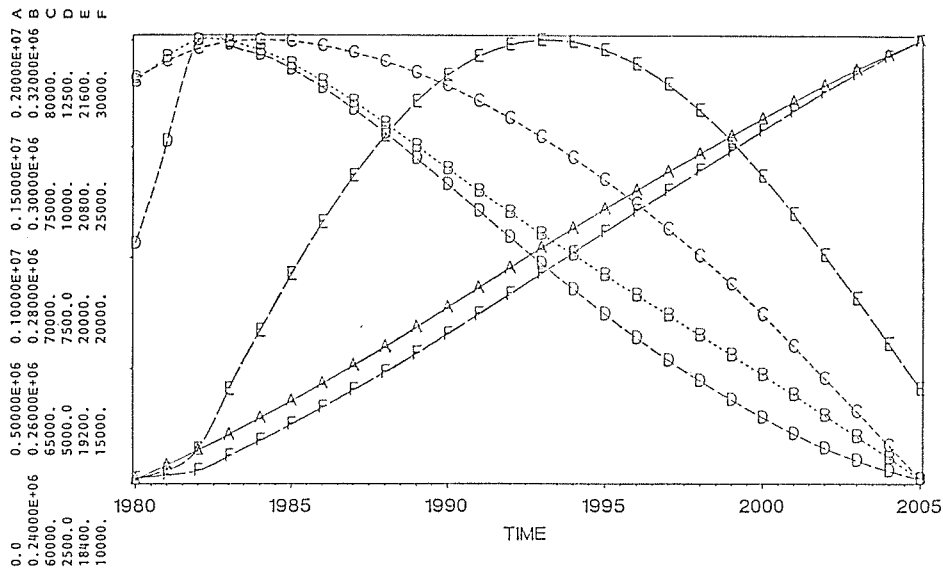
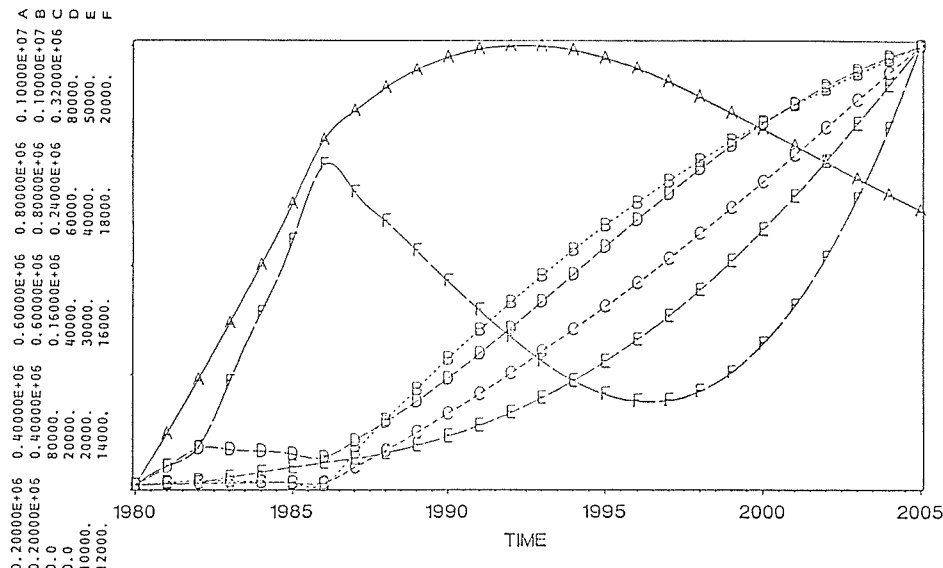


Figure 33. (LOM MOM HOM LTM MTH)=(ABCDEF)

LOM-LIG Out-migrants    LTM-LIG Workforce Transfer to MIG Workforce  
MOM-MIG Out-migrants    MTH-MIG Workforce Transfer to HIG Workforce  
HOM-HIG Out-migrants



**Figure 34.** (L M H NV OB UOB)=(ABCDEF)  
L-LIG Workforce NV-New Venture  
M-MIG Workforce OB-Organised Business  
H-HIG Workforce UOB-Unorganised Business



**Figure 35.** (L M H NV OB UOB)=(ABCDEF)  
L-LIG Workforce NV-New Venture  
M-MIG Workforce OB-Organised Bunsiness  
H-HIG Workforce UOB-Unorganised Business

soon and declines gradually. This is a situation which calls for more impetus to create new job avenues.

(5) *Establishments and the work force:*

On continuation of the present policies and programs as explained earlier, the LIG (WF) continues to increase and there is a significant decrease in the MIG and HIG work force. This is well explained by the fact that there is a sharp decline in the new ventures due to lack of impetus and enormous rise in the unorganized sector. The organized sector which shows a gradual increase during the early stages (1993) declines sharply in view of less creation of new ventures. When both new ventures and organized business sectors decline, there is a pronounced unemployment and the skilled man power tend to find new avenues outside the city resulting in large scale exodus as seen in the out-migration trend (Figure 34).

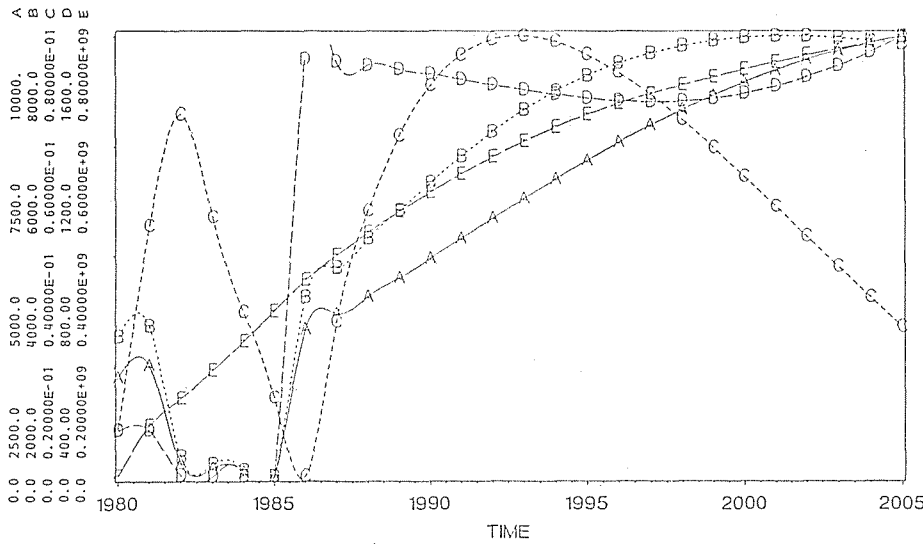
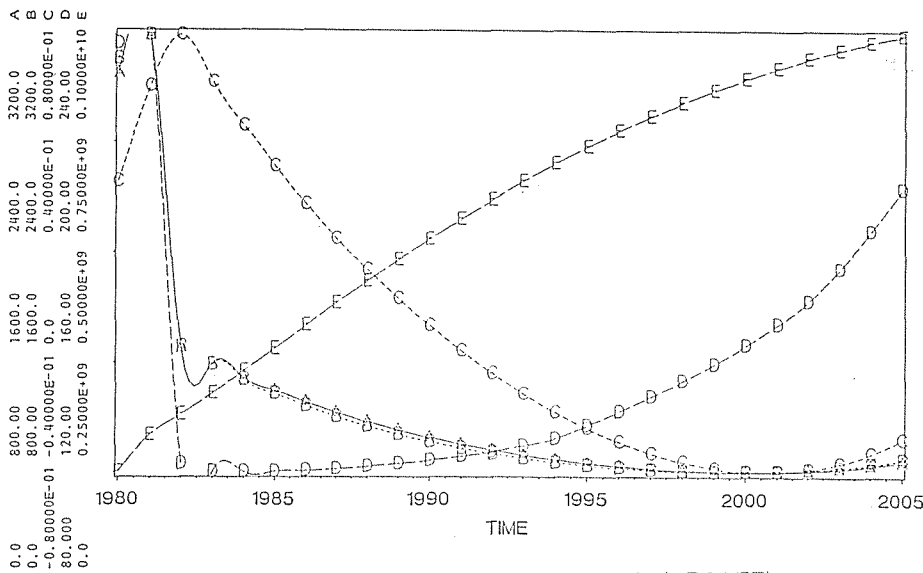
However in the Simulation 2, on implementing the suggested urban development programs, there is marked change in the employment opportunity and the work force as shown in Figure 35. The LIG (WF) after registering an initial increase, declines and the MIG and HIG (WF) increases with the increase in new ventures and Organized business and decline in Unorganized business. This shows that when the desirable atmosphere is provided, the growth is sustained. To achieve sustained growth it is imperative to initiate appropriate urban development programs at appropriate time. One such area of application is investing more on the EE facility creation which will achieve the dual objective of not only improving the living environmental quality but also will provide huge employment opportunities during and after the construction.

(6) *Construction of New Ventures and Replacement of Unorganized sector:*

The Figures 36 and 37 indicate the New ventures desired, constructed and the growth rate in tune with the Unorganized business replacement. The influence of the Tax structure is also expressed in terms of TN in both the simulation runs 1 and 2. Figure 36 indicates the state of stagnant economic activity, with declines in the New venture growth rate and increasing unorganized sector replacement (Desired). The tax needed inevitably shows an increasing tendency. On the contrary Figure 37 indicates that even with introduction of urban development programs the new venture sector does not show a sustained growth indicating public intervention in creating large scale economic activity. The tax needed indicates a constant rise in both the runs, as there has been a pronounced deficit in the revenue and expenditure towards creating and maintaining EE facilities.

(7) *Government investmental needs and Private Share in Education sector:*

In the first simulation run (Figure 38) quite obviously, the investmental needs for education sector show a sharp rise to cater to the increasing population. These investments are indicated only for the quantity of service which are to be provided to the future population at the current level. These investments however do not address the quality of service which gains significance only in an active economy.





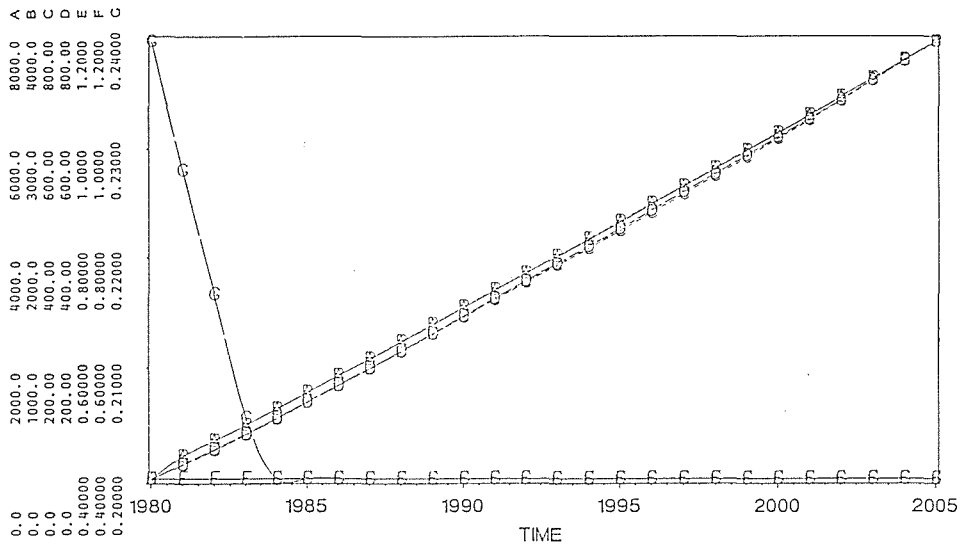


Figure 38. (RESI PESI GG 1 GG 2 PPSCS PMSCS PHSCS)=(ABCDEFGG)

GESI-Govt Education Sector Investment

GG 2-Govt Grants to Private Middle Schools

PESI-Private Education Sector investment

PPSCS-Private Primary School Childrens Share

GG 1-Govt Grants to Private Primary Schools

PMSCS-Private Middle School Childrens Share

PHSCS-Private High School Childrens Share

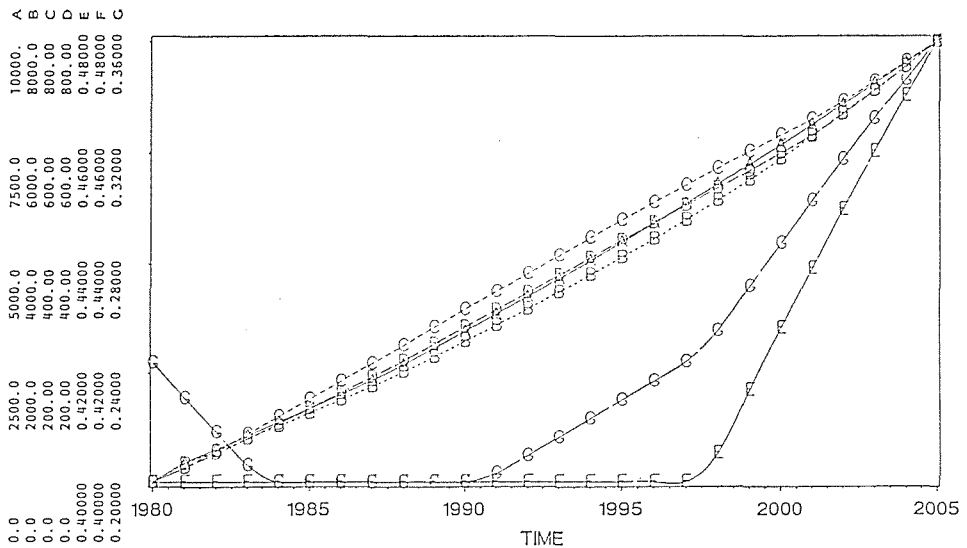


Figure 39. (GESI PESI GG 1 GG 2 PPSCS PMSCS PHSCS)=(ABCDEFGG)

GESI-Govt Education Sector Investment

PPSCS-Private Primary School Childrens Share

PESI-Private Education Sector Investment

PMSCS-Private Middle School Childrens Share

GG 1-Govt Grants to Private Primary Schools

PHSCS-Private High School Childrens Share

GG 2-Govt Grants to Private Middle Schools

The dimension of the problems could well be understood from the enormous capital investment needs. In the absence of adequate returns (in terms of overall revenue and since the Education is free) for the investments already made, the financial constraints affects greatly even the quantity of the EE facilities stock to be created. With the result the education environment will continue to deteriorate. With the stagnant economy and unchanged affordability levels the private sector can not be expected to participate to a greater extent. The same is reflected in the unchanged share of private sector.

In the second Simulation run (Figure 39) however, while it is obvious that the Government expenditure towards the education sector will constantly increase, the private sector does not become actively involved till 1998. This indicates that even with the programs directed towards economic upliftment, the necessary atmosphere for profitable running of the venture is not created immediately. In order to improve the private participation level, conscious efforts are needed by the Government to provide for necessary incentives to the private sector in terms of grants. This again will have to be analyzed visa-viz-a-viz the financial implications.

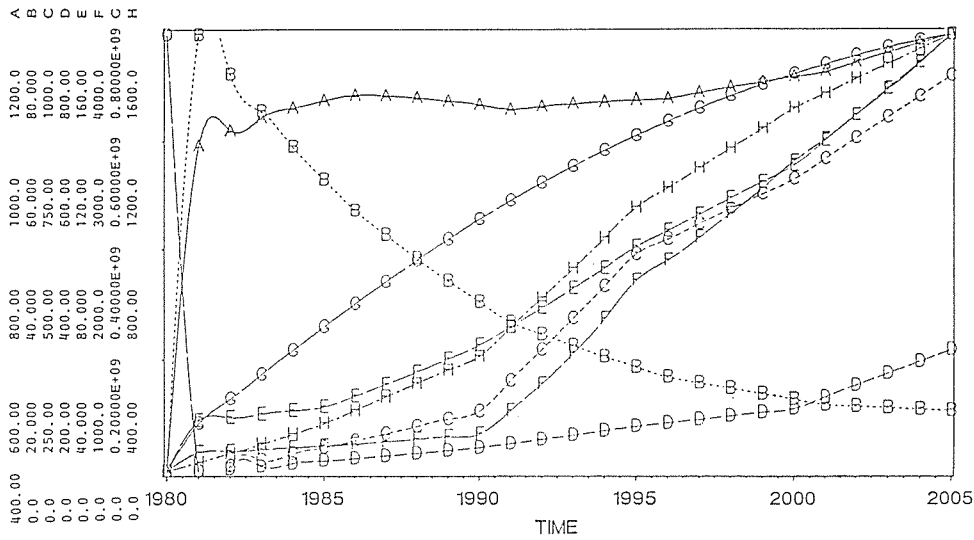
#### (8) *Medical Sector Investment:*

Figure 40 relating to the continuance of the existing policy framework indicates the investment levels (expressed in Rs. million) of the Medical sector. The investment requirement shows an increasing tendency in the absence of improvement in economy and consequent degradation of living environment. The PMSI, indicates the private sector investment in the construction of private hospitals and clinics alone and does not indicate the service cost involved as it is extremely difficult to quantify with the available information.

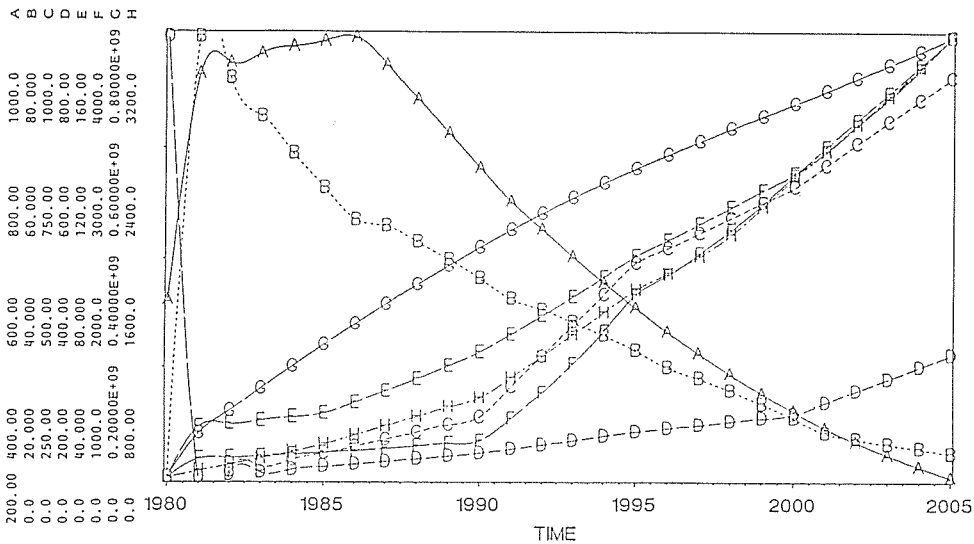
On the contrary Figure 41 indicates a declining tendency in the investment levels of both government and private sectors. Consequent to the improvement achieved in the EE facility sectors and the affordability levels of the population, there is a pronounced decrease in the investments levels towards Medical sector as the number of hospital visits are reduced gradually. The improvement in the overall economy will also be instrumental for introduction of advanced technology and reorganization of the current health care delivery system. This is reflected in the reduction in the number of hospital visits and the number of hospitalization days for the in-patients. The government investment level in creating medical facilities will decline as the private share increases due to overall economic improvement. However the governmental investment in real terms will always show an increase as the LIG population has to be served essentially by the government sector. This model will however show a different behaviour on introduction of a suitable Medical insurance system (currently absent) either to the entire population or only to MIG and HIG population.

#### (9) *Economic Mobility and the Tax Structure:*

The total government investment needed (EEFGI) and the revenue collected in the form of taxes (property tax, company tax and commercial tax) within the



**Figure 40.** (GMSI PMSI WSI SSI DSI RSI PSI SWSI)=(ABCDEFGH)  
GMSI-Govt Medical Sector Investment      DSI-Drainage Sector Investment  
PMSI-Private Medical Sector Investment      RSI-Roads Sector Investment  
WSI-Water Supply Sector Investment      PSI-Parks Sector Investment  
SSI-Sewerage Sector Investment      SWSI-Solid Waste Sector Investment



**Figure 41.** (GMSI PMSI WSI SSI DSI RSI PSI SWSI)=(ABCDEFGH)  
GMSI-Govt Medical Sector investment      DSI-Drainage Sector Investment  
PMSI-Private Medical Sector Investment      RSI-Roads Sector Investment  
WSI-Water Supply Sector Investment      PSI-Parks Sector Investment  
SSI-Sewerage Sector Investment      SWSI-Solid Waste Sector Investment

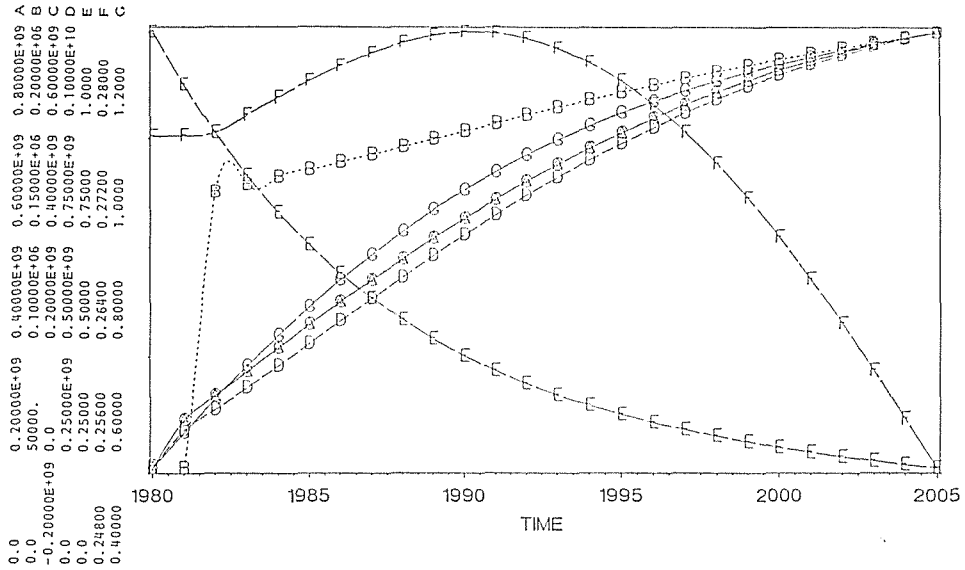


Figure 42. (EEFGI SCTR EEFS TN MLR HMR LPR)=(ABCDEFG)

EEFGI-EE Facilities Govt Investment      SCTR-Service Changes and Tax Revenue  
 EEFS-Essential Environmental Facilities External Finance  
 TN-Tax Needed      MLR-MIG Workforce/LIG Workforce Ratio  
 HMR-HIG Workforce/MIG Workforce Ratio      LPR-LIG Workforce/Total Workforce Ratio

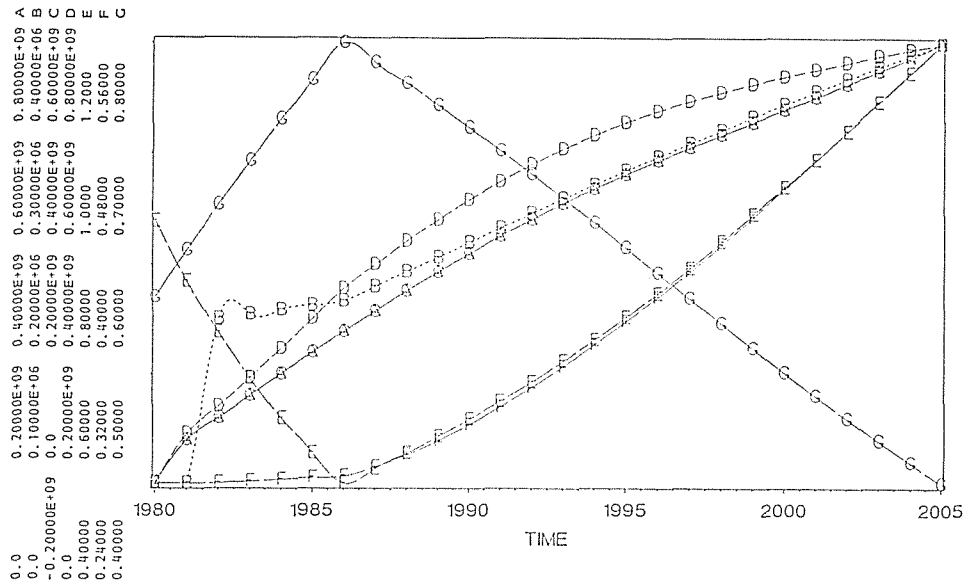


Figure 43. (EEFGI SCTR EEFS TN MLR HMR LPR)=(ABCDEFG)

EEFGI-EE Facilities Govt Investment      HMR-HIG Workforce/MIG Workforce Ratio  
 SCTR-Service Charges and Tax Revenue      LPR-LIG Workforce/Total Workforce Ratio  
 EEFS-Essential Environmental Facilities External Finance  
 TN-Tax Needed      MLR-MIG Workforce/LIG Workforce Ratio

city and the service charges collected (SCTR) are related to the overall improvement in the urban economy and the upward mobility. Figure 42 shows, in the absence of greater opportunity to improve the urban economy with the current policies and programs, the governmental investment level will be ever increasing while the revenue shows the opposite.

On the contrary due to the introduction of appropriate urban development programs and revision in the tax structure there will be considerable improvement achieved in the revenue level of the government proportional to the expenditure levels. The same is expressed in Figure 43.

### 5.1 Findings of Simulations 1 and 2:

The results of simulation 1 clearly establishes the deteriorating conditions in all sector of the Madras urban activities. The LIG population increases manifold, the MIG and HIG population exodus is pronounced, decrease in the revenue is increasingly felt, the EE facilities deteriorate further and the whole urban scene depicts a chaotic situation beyond any means of reversal.

On application of the suggested urban development programs, there is a pronounced improvement felt in all the sectors, with greater reduction in the birth rate improvement in the affordability levels and consequent availability of better stock of EE facilities. Enhanced revenue to the government coffers will drive the government to invest more on the EE facilities proportionate to the rise in demand, which again will induce greater employment opportunities. Continuance of such urban development program at the appropriate time and scale will set the urban economy rolling on the desired level so that the EE facility stock is maintained to the desired standard. In the second run, the model however shows an increase in the population. This increase is mostly attributed to the increase in the MIG and HIG population. The LIG population is considerably reduced due to reduced birth rates, less in-migration and higher mobility rate. This is the most favourable condition to launch any further urban development programs towards achieving better environmental standards. However, towards the end of the plan period, the new venture growth does show significant rise and the consequent effect is felt in the HIG work force out-migration. This however does not provide the favourable atmosphere to maintain adequate quality of services. The reduced mobility of MIG population to the HIG, at the end of the plan period does not also provide for conducive atmosphere for sustained economic growth. These imply that unless large scale investments are made in projects which are capable of providing large scale employment opportunities, the urban system will again drive back to the original conditions which prevailed in 1981. Further implications of such decline in the economic activity at the end of the plan period imply that, the tax structure should be revitalized commensurate with the demands for high order service facilities and the subsidy programs have to be restricted to the most vital sectors such as education and Medical sectors.

It is also imperative that, while the quantity of the EE facilities is enhanced,

the quality of the facilities must also be substantially enhanced since the Education sector, Water supply sector and the sewer sectors suffer from unacceptable quality. Current efforts towards Family Planning have to be enhanced for more desirable level of population growth. In Simulation 2 the maximum reduction that has been achieved in the birth rates in all groups of population is only 5%. Unless concurrent efforts are taken to reduce the population growth irrespective of religion and other influences, any amount of public investment will not bring in the desired results. By virtue of improved service facilities there will be a significant reduction in the death rate which again will increase the total population. The regional development and small and medium size city developments programs should be vigorously pursued to lessen the burden on the Madras city. These programs certainly will have greater influence on the growth of Madras city, however the growth of Madras city itself is not anticipated to have overwhelming influence on other areas of the State.

## 6. Conclusions of the Study :

The Simulation 1 and 2 results clearly established the functional validity of the model framed to represent the urban development in Madras. The application of this model to similar cities of developing countries needs modification in the structure of the sectorial systems rather than in the principles governing the model formulation. Validity of this model depends on the soundness of the information inputs. Thus formulation of appropriate 'Urban Information System' is a pre-requisite for the application of this model.

The present model envisages any number of simulation programs framed with different policy options based on the priorities and severity of a particular sector. Sectorial programs are framed in the model to facilitate activation of any particular program at any point of time within the plan period to suit to the needs. The scope of the present model can be extended by building additional sectors or by expanding the inputs of each sector.

## References

1. Alan Turner and Associates (June 1980): "Structure Plan For Madras Metropolitan Area-Volume. 1.
2. Alan Turner and Associates (June 1980): "Structure Plan For Madras Metropolitan Area-Volume. 2.
3. Alan Turner and Associates (June 1980): "Structure Plan For Madras Metropolitan Area-Volume. 3 Working Papers.
4. Civic Affairs (Dec. 1977): Volume 25 No. 5 pp. 158.
5. Corporation of Madras Budget Estimate 1978-79, 1979-80 & 1980-81.
6. Director of Statistics (1981): Statistical Hand Book for Madras District.
7. D. E. James, H. M. A. Jansen and J. B. Opschoor (1978): "Economic Approaches to Environmental Problems".
8. Govt. of India (1974): Report on Budgetary Reforms in Municipal Administration.
9. G. W. Barclay (July 1970): "Techniques of Population Analysis" John Wiley and Sons

New York, London, Sydney.

10. Jay W. Forrester (1961): *Industrial Dynamics*.
11. Jay W. Forrester (1968): *Principles of Systems*.
12. Jay W. Forrester (1968): *Urban Dynamics*.
13. Jay W. Forrester (1974): *World Dynamics*.
14. Jay W. Forrester (1975): *Collected Papers of Jay W. Forrester*.
15. Louis Alfeld (1976): *Introduction to Urban Dynamics*.
16. libd (Feb. 1978): *Master Plan for Water and Sewerage*.
17. Michael R. Goodman (1974): *Study Notes in System Dynamics*.
18. MMDA (1978): *Study on Slum and Low Income Settlements-Madras City*.
19. MMDA (Aug. 1974): *Madras Urban Development Project*.
20. MMDA (1981): *Madras Metropolitan Area Demography*.
21. Nathaniel J. Mass (1974): *Readings in Urban Dynamics: Volume 1*.
22. Operations Research Group (July 1979): *Housing and Land Development in Metropolitan Area —A Case Study*.
23. Operations Research Group (June 1980): *An Economic Profile of the Urban Poor —Slum Dwellers of Madras*.
24. Operations Research Group (Feb. 1980): *Informal Sector Enterprises —A Profile and Strategy*.
25. Operations Research Group (Sept. 1978): *Resource Mobilization and Investment Planning for Madras Metropolitan Area*.
26. Peter Nijkamp (1979): *Multidimensional Spatial Data and Decision Analysis*.
27. Peter Nijkamp (1981): *Multiple Criteria Analysis*.
28. Peter Nijkamp (1977): *Theory and Application of Environmental Economics*.
29. Papola TS (1978): "Informal Sector in an Urban Economy; Nagarlok, X No. 4 Oct. -Dec. 1978 pp. 50-62.
30. Peter Checkland (1981): *Systems Thinking, Systems Practice*.
31. Roger S. Smith (July 1974): "Financing Cities in Developing Countries" IMF Staff papers, Vol. XXI No. 2.
32. Sivalingam. P (Nov. 1976): *Floods in Madras*.
33. Sethuraman SV (1976): "Urban Informal Sector, Concept Management and Policy" —*International Labour Review* Vol. 114 No. 1 pp. 69-82.
34. Socio-economic Survey of Madras Slums TNSCB, 1975 p. 5.
35. Thirumurthy A. M. (1982): *Inland Water Transport for Madras Metropolitan Area*.
36. Thirumurthy A. M. (1983): *Land Pollution in Madras Metropolitan Area*.
37. Thirumurthy A. M., Etsuo Yamamura and Seiichi Kagaya (1987): *System Dynamics Approach for Objective Assessment of Essential Environmental Facilities and their Policy Needs —Sapporo Case Study*, *Environmental Science Hokkaido* No. 10(1) pp. 53-70.
38. Thirumurthy A. M., Etsuo Yamamura and Seiichi Kagaya (Dec. 1986): *Environmental Hazards of Flooding —An over view of Sapporo and Madras Experience*, *Environmental Science Hokkaido* No. 9(2) pp. 177-193.
39. Walter W. Schroeder III (1975): "Urban Dynamics and the City Boundary" —*Readings in urban Dynamics Volume. 2*, Edited by Walter W. Schroeder III, Robert E. Sweeney and Louis Edward Alfeld.
40. Walter W. Schroeder III (1975): "Urban Management Actions" —*Readings in urban Dynamics Volume. 2*, Edited by Walter W. Schroeder III, Robert E. Sweeney and Louis Edward Alfeld.
41. Walter W. Schroeder III (1975): "The Sensitivity of Migration to Housing Availability"

- Readings in urban Dynamics Volume. 2, Edited by Walter W. Schroeder III, Robert E. Sweeney and Louis Edward Alfeled.
42. Walter W. Schroeder III (1975): "Urban Dynamics and Housing Abandonment" —Readings in urban Dynamics Volume. 2, Edited by Walter W. Schroeder III, Robert E. Sweeney and Louis Edward Alfeled.
43. Walter W. Schroeder III (1975): "Urban Dynamics and the Suburbs" —Readings in urban Dynamics Volume. 2, Edited by Walter W. Schroeder III, Robert E. Sweeney and Louis Edward Alfeled.
44. Walter W. Schroeder III and John E. Strongman (1975): "Urban Dynamics and the suburbs" —Readings in urban Dynamics Volume. 2, Edited by Walter W. Schroeder III, Robert E. Sweeney and Louis Edward Alfeled.
45. WHO/UNDP (1976): Tamil Nadu Water Supply and Sewerage Pre-investment Studies, Madras Metropolitan Area; Briefing package.

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