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Systems Dynamics Approach for Objective Assessment of Essential Environmental Facilities and their Policy Needs —Sapporo Case Study—

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Abstract

In pursuit of planning and providing for Essential Environmental Facilities to an optimum quantity and desirable quality in tune with the ever changing socioeconomic characteristics of the people of an Urban area, the responsible Local Govts often confront conflicting ideals, complex physical and social environment and acute financial constraints. For sustained efforts to avoid and curtail furtherance of Social, Economic and Physical blight, many theories and models have been attempted. Since complex urban system involves interaction and interference of internal and external factors a comprehensive system model that could explain and examine the various factors needed to be understood to frame short and long term policy guidelines, particularly in the area of essential environmental facilities has been of paramount importance. In this direction a small attempt has been made in this study to search for a systems model which could possibly address the problem in accordance with the famous wordings of Abraham Lincoln" If we could first know where we are and whither we are tending, we could better judge what to do and how to do it".

Key Words: Conceptual approach, functional validity, systems approach, resource base, essential environmental facilities, beneficiaries, population diffusion, mass transportation corridors, frontier region. Essential Environmental Facilities —A Study Methodology for Objective Assessment and Policy Formulation— Systems Approach —Sapporo Case Study:
(Part 1. Conceptual Framework)

1. Introduction:

Ever since the establishment of Colonization Agency for Hokkaido in 1869, Sapporo city has been the hub of Administrative activities and central focus of development. The enormous developmental thrust induced by the National Govt to develop the Frontier region (Hokkaido Island), Sapporo experienced a phenomenal influx of population from various regions of Japan as well as from within Hokkaido. In recent years the in and out-migration also seemed to have evened out owing to lack of greater economic opportunities as the Sapporo city has not been developed as an industrial magnet, and significant growth of large and medium size cities surrounding the capital city, and consequent development of better and fast transport ation network facilities.

While there has not been greater impact of in and out-migration on the urban development process (with current policy of Urban development in force for Sapporo in particular and Hokkaido in general) the trend of Urbanization in Sapporo is one that of rapid peripheral expansion of the city with suburban centers. This phenomenon has been well collaborated elswhere also in Japan. Though various reasons could be attributed to this phenomenon like, high land cost, congestion in the core of the city, increasing awareness of the people for better living environment etc, the major cause seems to be delineation of a vast land for Urban promotion area without adequate plans for functional and economic development of the area. The growth of activities coupled with population is bound to be of greater interest to any Local Govt as they will eventually bring in large revenue to the coffers.

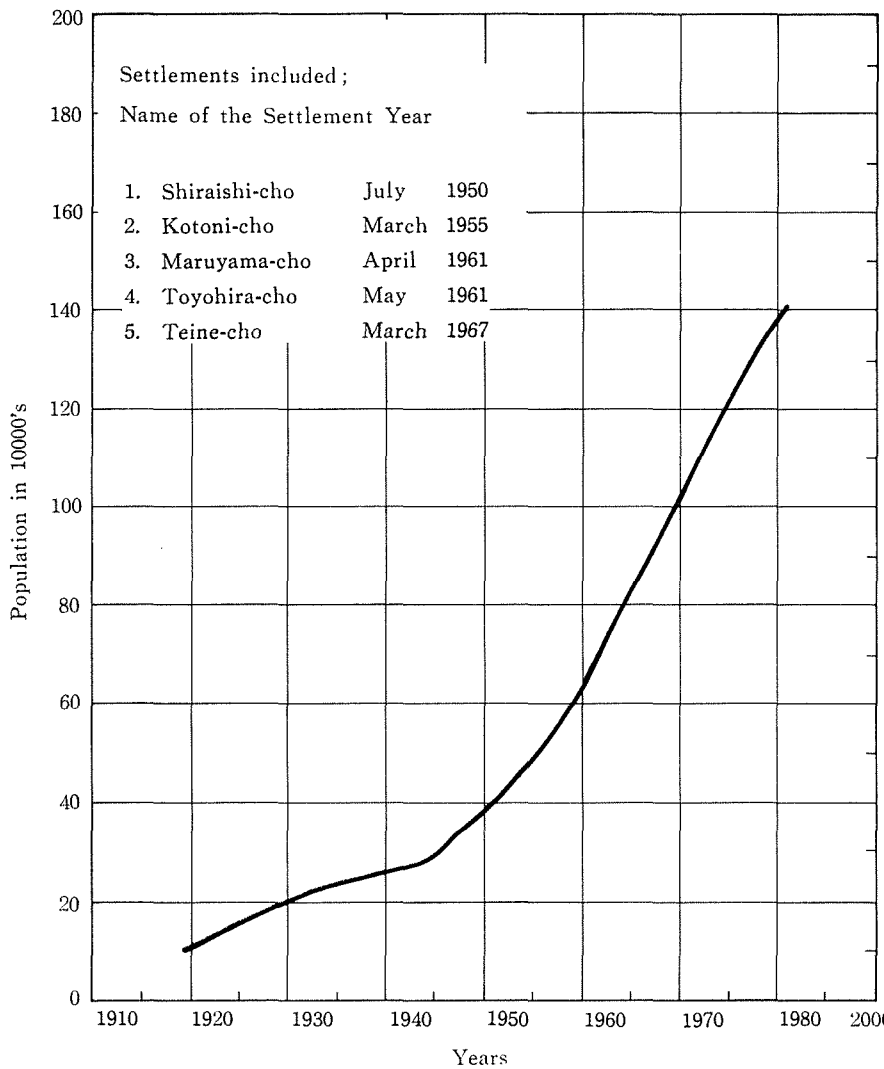

Figure 1. Population Growth Trend in Sapporo.

However, developments scattered over a larger space and having very low population density will warrant huge capital investment for the provision of basic environmental facilities and the returns will be negative when the cost of maintaining all the facilities created are taken in to consideration. Lack of adequate financial base for the city and the need for creation of more facilities to bridge the gap will eventually make the city non-functional. The major problem confronting the Sapporo Local Govt is to find adequate funds for its future development purposes. In the early stages of its development it enjoyed the benefit of National Govt pipe line, however the recent financial allocation trends of the National govt indicates that sustained flow of funds may not be forthcoming in future also. Therefore from the view point of decreasing National Govt financial support, absence of stable economic base for boosting self revenue, increasing gap between the desired and available facility standards, galloping demand for maintaining existing facilities and the special geographical character of the city, there seems to be an urgent and imperative need for deeper understanding and evaluation of the process of urbanisation, the provision of environmental facilities for the present and the future population to the desired standard and the physical and fiscal policies governing the developments. In light of the above trends and conflicting situations, a System's Dynamics model has been formulated in this study to frame rationale Urban development policies.

2. Study Backround:

1). *Population Growth in Sapporo :*

Sapporo city being the capital city of Hokkaido island was given an enormous impetus for development and settlement of the new migrants. Sustained efforts were made to promote its role to be a pivotal in the northern region. Con-

Table 1. Population Growth in Major Cities of Japan

Name of city	Population increase over 5 year periods				Population increase (%)			
	1960-65	1965-70	1970-75	1975-80	1960-65	1965-70	1970-75	1975-80
Sapporo	205589	188906	230490	161145	33.4	23.0	22.8	13.0
Tokyo	583067	△ 52152	△ 194422	△ 297311	7.0	△ 0.6	△ 2.2	△ 3.4
Kawasaki	221891	118620	41465	25747	35.1	13.9	1.3	2.5
Yokohama	413205	449338	383518	152051	30.0	25.1	17.1	5.8
Nagoya	238337	100623	43687	8144	14.0	5.2	2.1	0.4
Kyoto	80189	54158	41894	11934	6.2	4.0	3.0	0.8
Osaka	144659	△ 175735	△ 201500	△ 130829	4.8	△ 5.6	△ 6.8	△ 4.7
Kobe	102689	72271	71668	6787	9.2	5.9	5.6	0.5
Hiroshima	99378	88921	106324	46783	17.8	13.5	14.2	5.5
Kita Kyushu	55987	△ 70	15740	7026	5.7	△ 0.0	1.5	0.7
Fukuoka	86811	102541	130484	86416	12.7	13.3	15.0	8.6

Note: △ indicates decrease in population.

sequently the Sapporo city has seen greater influx of people. As the population and the physical extent of the city grew, many small and medium settlements were brought in to the folds of the Sapporo city Administration to form a viable Urban area. The Figure. 1 illustrates the names of the settlements that were brought in to the folds of Sapporo and the population of the city in chronological order. During the period from 1960 to 1965 the population increased by 205589 (Table 1) which marked the fifth largest growth in the Nation. The increase of Sapporo's population by 33.4 percent was the second highest followed by Kawasaki city which experienced a 35.1 percent increase. The situation, however during the period 1965 to 1970 was that Sapporo city experienced the second largest increase in population in the nation next to Yokohama city and so also interms of rate of increase. During the period 1970-79, while the same trend prevailed interms of population increase, Sapporo city experienced the highest rate (22.8 percent) of population increase. Sapporo city finally faced the population increase and the highest rate of increase over the period from 1975-80.

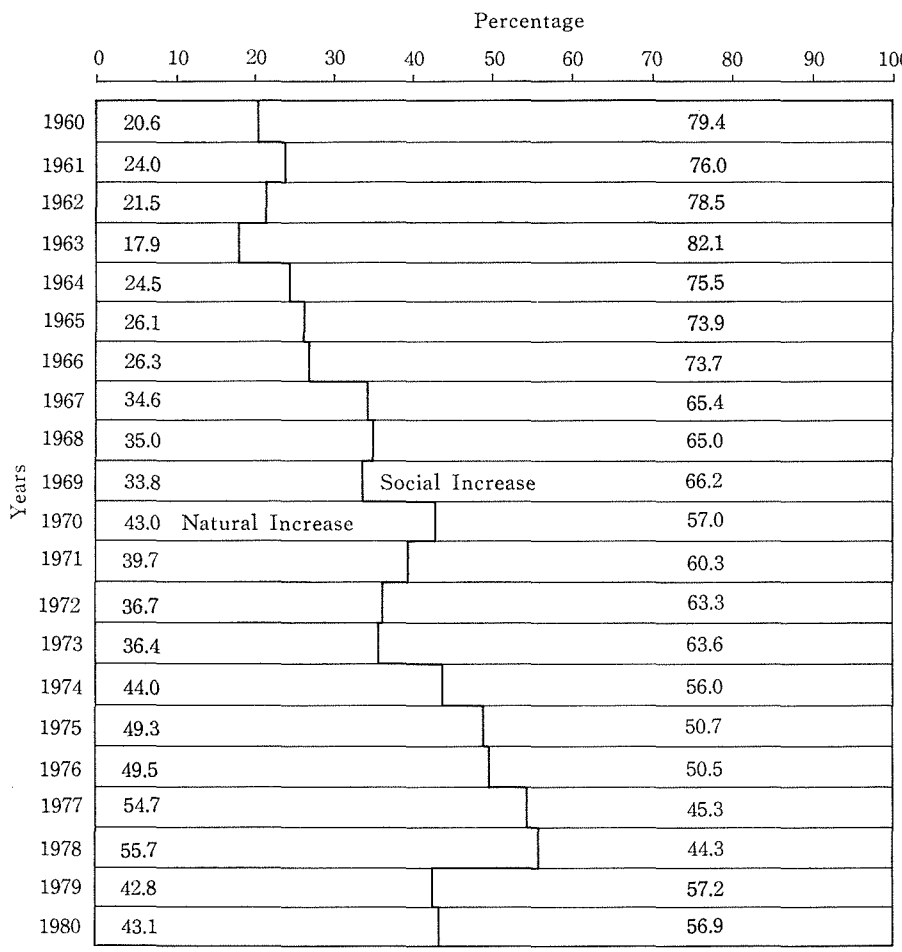

Figure 2. Social Increase Percentage Variation in Sapporo.

2). *Characteristics of Population Growth in Sapporo :*

Encouraged by the new settlement policy there had been a tremendous increase in population. The peak was in 1963 accounting for 82.1 percent due to large scale migraton of unemployed coal miners within Hokkaido. Nevertheless the proportion of population increase felt in Sapporo over a period of 21 years between 1960-80 (figure 2) has largely been due to Social increase, which could be averaged to 63 percent. On an average 24669 people per year moved in to Sapporo which was 1.7 times the natural increase of 14167. However the trend seemed to have been reversed in favour of natural increase accounting for slightly more than the proportion of Social increase and the Social increase constituted for slightly more than 50 percent ever since.

Table 2. Social Increase Changes in the Major Cities of Japan

Name of the city	1975	1976	1977	1978	1979
Sapporo	18470	18091	13691	13182	21167
Tokyo	△ 139018	△ 153191	△ 126211	△ 109862	△ 102056
Kawasaki	△ 10933	△ 4226	△ 7196	△ 4836	△ 9134
Yokohama	7943	3091	3418	4930	712
Nagoya	△ 23746	△ 22131	△ 18161	17205	△ 17285
Kyoto	△ 10303	△ 11959	△ 7919	△ 8884	△ 8871
Osaka	△ 54140	△ 50098	△ 45503	△ 36589	△ 31906
Kobe	△ 2879	△ 10112	△ 9247	△ 5947	△ 8686
Hiroshima	206	△ 3339	△ 1710	△ 3863	△ 66
Kitakyushu	△ 6220	△ 5240	△ 7210	△ 9881	△ 8732
Fukuoka	19001	5698	3338	3535	3652

Note: △ indicates decrease in population

The Table 2 shows a comprehensive statement of figures relating to population increase experienced by other major cities of Japan over the same period as experienced by Sapporo. Sapporo city stood out to be the foremost interms of Social increase constituting for more than 60 percent.

3) *Population Mobility Characteristics :*

Undoubtedly, the high order population growth in Sapporo is the manifestation of large scale influx of population in to the city from within and out side of Hokkaido. Table 3 & 4 indicate this phenomenon for a period of ten years from 1971. The information pertaining to in-migration clearly shows that 69 percent of the total of 93376 and 62 percent of out-migration out of the total indicate that the movement is predominantly from within Hokkaido. However the in-migration from outside of Hokkaido and out-migration from Hokkaido are found to be almost the same which explains the situation that the mobility may be purely an out come of business eventualities. A higher order mobility with in Sapporo among the migrated population, is evident from the 1980 data (Table 5) pertaining to the

Table 3. Migration Changes in Sapporo from within and out side of Hokkaido

Year	In-migration			Out-migration			Net-migration		
	Total	From Hokkaido	Out side Hokkaido	Total	From Hokkaido	Out side Hokkaido	Total	From Hokkaido	Out side Hokkaido
1971	100421	73600	26821	74140	40780	33360	26281	32820	6336
1972	100502	72487	23015	74023	41362	32661	26479	31125	4646
1973	108206	76747	31459	76826	44708	32118	31380	32039	659
1974	101344	69458	31886	76616	46147	30469	24728	23311	1417
1975	94096	63440	30655	75020	46499	28521	19076	16441	2135
1976	91763	61600	30163	74074	46345	27729	17689	15255	2434
1977	91379	61480	29899	77494	48551	28943	13885	12929	956
1978	89321	60217	29104	76237	47408	28879	13034	12809	225
1979	94857	64592	30255	73952	45785	28167	20905	18807	2098
1980	93375	64224	29152	74159	45719	28440	19217	18505	712

Table 4. Percentage Migration Changes in Sapporo from within and out side of Hokkaido

Year	In-migration			Out-migration			Net-migration		
	Total	From Hokkaido	Out side Hokkaido	Total	From Hokkaido	Out side Hokkaido	Total	From Hokkaido	Out side Hokkaido
1971	100.00	73.30	26.70	100.00	55.00	45.00	—	—	—
1972	100.00	72.10	27.90	100.00	55.90	44.10	—	—	—
1973	100.00	70.90	29.10	100.00	58.20	41.80	—	—	—
1974	100.00	68.50	31.50	100.00	60.20	39.80	—	—	—
1975	100.00	67.40	32.60	100.00	62.00	38.00	—	—	—
1976	100.00	67.10	32.90	100.00	62.60	37.40	—	—	—
1977	100.00	67.30	32.70	100.00	62.70	37.30	—	—	—
1978	100.00	67.40	32.60	100.00	62.10	37.90	—	—	—
1979	100.00	68.10	31.90	100.00	61.90	38.10	—	—	—
1980	100.00	68.80	31.20	100.00	61.60	38.40	—	—	—

Table 5. Population of Sapporo Classified According to In-migration Period

In-migration	Population			Percentage		
Period	Total	Male	Female	Total	Male	Female
Pop as on 1980	1401758	691189	710569	100.00	100.00	100.00
From Birth	123930	65186	58744	8.80	9.40	8.30
Before 1954	117129	52566	64563	8.40	7.60	9.10
Period 1965-69	111517	52210	59307	8.00	7.50	8.30
Period 1970-75	293585	140798	152787	21.00	20.40	21.50
Period 1975-79	502241	249288	252953	35.80	36.10	35.60
After 1979	251502	129937	121565	17.90	18.80	17.10

Note: The discrepancy while summing up the sub categories is due to inclusion of people whose period of in- migration was not known.

mobility characteristics. The people who never moved since birth from the then (1980) location constituted only for 8.8 percent or 123930 persons of the total population and about 92 percent or 1275974 either are in-migrants from outside Sapporo or the persons who moved within Sapporo city. Noticeably, 53.7 percent of the total population had settled in their present location only after 1975 Figure 3 and therefore it could be concluded that more than 50 percent of the population of Sapporo are new entrants to the city.

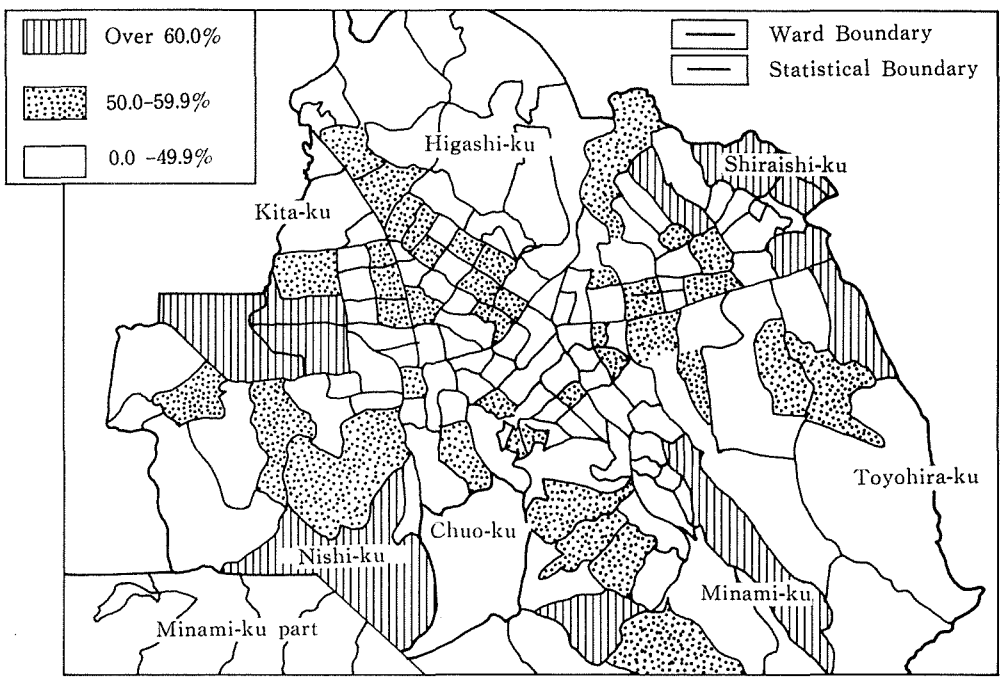

Figure 3. Percentage of Population (newcomers) Settled in Each District After 1975.

4) *Population Dispersion and Suburbanization :*

The most common experience of many cities of developed world in terms of gradual population dispersion tending to suburbanization with noticeable suburban centres is also felt in Sapporo, though Sapporo city has not been developed with large industrial base. The inter-zonal movements in general and population movements to the periphery of the urban area are highly pronounced in Sapporo. The statistics relating to the population mobility during the ten years from 1971 in Table 5 clearly exhibits the urban sprawl. Various factors may be attributed to be the cause of such exodus to the peripheral area like, Air, Noise, vibration pollution, better living conditions in terms of space and environment at the outskirts. As shown in Table 6, the Sapporo city is divided in to four zones according to the radial distance from the center of the city. From the Figure 4 and Table 5 it could be seen that zones 3 and 4 experienced a greater increase of population during the period 1975-80 and significant decrease of population could be seen in

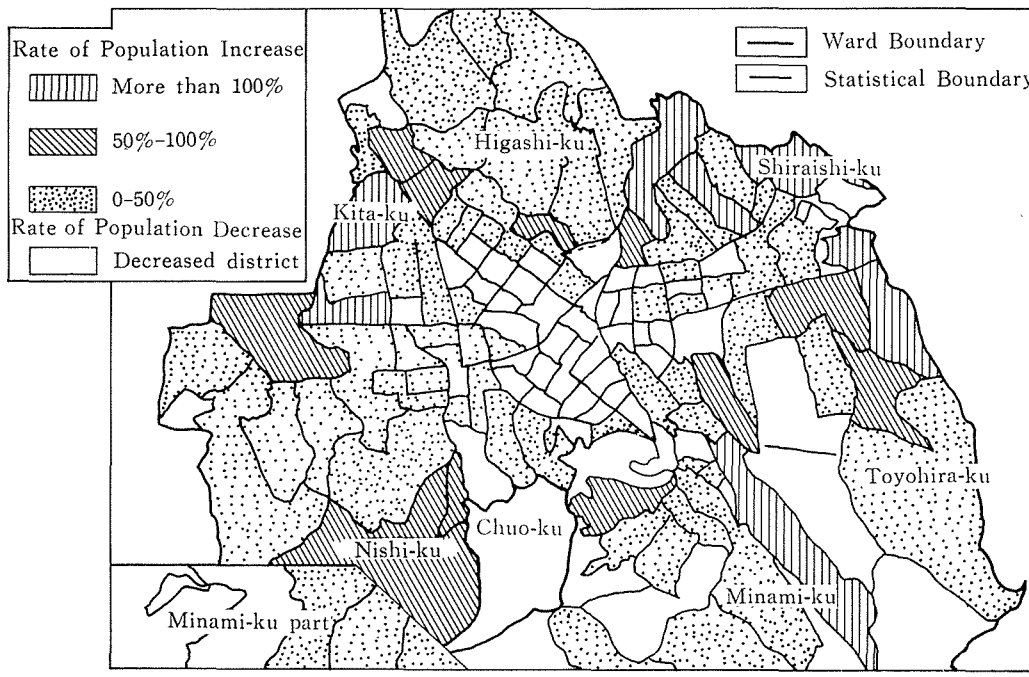

Figure 4. Population Increase Changes over a Period of Five Years (1975-1980) by Each Statistical Tract.

the zone 1. This could further be explained as 58.4 percent of the population had been living in the Zone 1 in the year ending 1960, however this percentage changed to 18 by the year 1980 indicating the fact that population was tremendously diffused from the Zone 1. Similarly, the Zone 2 experienced a greater population increase during the period 1960-70. However after 1975 the percentage of population living in this Zone which was at 42.7 gradually showed signs of diffusion or depletion. Population decrease has also been significant along mass transportation corridors in areas adjacent to subway or bus routes as these are the areas which experience greater non residential activity.

The third Zone which experienced a population share of only 6 percent in 1960, seemed to have been subject to an enormous pressure to accommodate more population. The third Zone which grew to 134 percent in terms of population increase during the periodd 1960-65 accommodated in 1980 almost nine times its population in 1960. The fourth Zone especially, experienced the highest population increase rate 41.1 percent and has seen six times growth of it's population in 1960.

3. Urban Development Policy and Long term Perspective Plan for Sapporo:

Urban development in Sapporo has been guided by a perspective plan drawn for a period of 20 years effective from 1976 till 1995. The broader guiding principles for development of Sapporo city have been ;

1) *As a core city in the Northern Hemisphere :*

To continue to maintain the role of Sapporo as the capital of Hokkaido and an important city in the northern regions which have similar natural features, through economic, cultural and sports exchanges.

2) *As a functional City :*

To create and ensure an unique pattern of living in harmony with the climate and modern advancement for a stable, healthy and comfortable life in Sapporo.

At the city level the guiding policies for development have been spelt out on the following lines.

I. A city where harmony exists with a rich natural environment :

In order to achieve this goal, necessary programs have been framed under the five year plans for the city with the following objectives ;

a. To develop a proper sized city, the projected population being a maximum of 1.85 million by 1995.
b. To create a living sphere of influence within a radius of 30 km which should include three cities and four towns sharing Urban functions on a regional basis.
c. To create a large scale urban park which would include surrounding mountainous areas.
d. To limit the urbanized area of the city to 25000 ha, taking into consideration open space.

II. A city where an atmosphere of vigor, richness and openess abounds ;

Objectives :

a. To develop unique local industries through sharing functions regionally with such areas as the Ishikari Port areas.
b. To extend the urban transit system and to establish as part of the road system, one bypass, one ring road and five main arteries.
c. To develop smooth control and transaction of cultural and economic activities for the benefit of the people of Hokkaido through use of the results of surveys and research.

III. A city where a safe and comfortable environment is provided ;

Objectives :

a. To ensure by 1995 one living room per household as well as one room per person per household.
b. To have 100% coverage of waterworks and sewage systems in the urbanized area of the city.
c. To provide a park area of 20 sq. mts per person.
d. To develop facilities for the protection of pedestrians and to control traffic movement through the establishment of residential zones.
e. To make a comprehensive disposal of waste and pollutant.
f. To protect citizens from natural disasters.

IV. A city where people can grow in warm-heartedness and create a highly-cultured life ;

Objectives :

a. To promote an education which enriches human nature and the city's unique culture.
b. To create culture-minded citizens through a lifelong education system.
c. To encourage citizens to join sports for pleasure and recreation activities.

V. A city where anybody can live at any time in peace and security ;

Objectives :

a. To support those who are unable to maintain a satisfactory living standard.
b. To promote citizen's health by further developing medical treatment and facilities.
c. To ensure and improve consumer livelihood.

VI. A city where a comfortable winter life can be created ;

Objectives :

a. To make winter life easier by controlling vehicles volume through utilization of the mass transit system and by improving snow clearance capabilities.
b. To establish unique living and cultural environs associated with northern climate through exchanges and consultation with other northern areas.

VII. A city where citizens bring themselves in heart to heart touch with each other ;

Objectives :

a. To encourage community units and establish respective community centres for the city's wards.
b. To create an efficient public relations- communication system which will serve as the pipeline between the administrative organization and citizens.
c. To activate citizen's participation in community development.
d. To improve the administrative organization through the effective employment and further improvement of the abilities of city employees.

To translate the policies in to realistic programmes five year development plans have been prepared and being implemented. The First Sapporo Five-Year Plan (1976-1980) gave priority to projects designed to improve living environs, welfare, education and culture and the transportation network. Most of these projects were completed earlier than originally expected. At the same time the needs and priority preferences of the citizens necessitated some changes in the projects. The Second Five Year plan (1980-1984) placed importance on the creation of proper sized city with due consideration of energy and natural resources and also on the improvement of living environs in accordance with each community's characteristics. The Third Five Year plan has been commenced in 1984 to achieve the objectives already spelt out and it is under implementation.

4. Urban Planning and Development in Sapporo :

Sapporo city has always been conceived, planned and developed as the capital city of Hokkaido island unlike many cities which have been developed spontaneously without adequate planning or development orientation. Nevertheless rapid increase

of population mainly due to Social increase created innumerable problems like, environmental facilities shortage, traffic congestion, public hazards, disorderly landuse developments and above all wide spread Urban sprawl. In accordance with The City Planning Act of 1968, Urbanization control area (UCA) extending over an extent of 33700 ha and Urbanization Promotion Area (UPA) extending over an area of 23200 ha were delineated in 1970 and the same being enforced even now. Land use plans and planning for service facilities are broadly done on stage by stage procedure with in the city planning area. UPA implies, that all developments within this area will be governed by the stipulation laid down in the perspective plan and UCA implies, that the developments are subject to strict control and can be permitted provided the developments conform to certain basic environmental standards and at the discretion of the Local Govt and the Prefectural Govt. While the land use developments are regulated based on the following objectives, there has been a host of problems encountered during the implementation of the programmes.

5. Summary of Urban Problems and the Need for the Study:

The rapid population growth till last decade has made the Sapporo city as the Fifth largest city in the nation, it has the lowest population density of 1345 persons per sq. km compared to other major cities in Japan. As described earlier the high population diffusion taken place from the central parts of the city to the outskirts, changing character of the land use developments in the inner core, particularly along the mass transportation corridors have been causing greater impact on provision of essential environmental facilities. The worst affected public service sectors are, transport, water supply and sewerage facilities. Extension of service facilities is always cost effective when the services are intended for a large population, however extending such facilities to low density population areas has not always been economical. That may be the reason for the inadequacy of many service facilities to the existing population inspite of heavy investments already made over a long period in Sapporo. Bridging the existing gap and to plan for the future population has been a challenge. The major impedence in carrying out full scale extension of the facilities to the growing population with the available resources is the proportion of budget expenditure on maintenance of the facilities already created. The facilities created need to be constantly serviced, maintained and replaced in tune with the development trends and population density characteristics of the different zones of the city, as population is the basic parameter which directs and decides the standards of such facility.

While the city has grown leaps and bounds, there has not been a significant change in the direction of travel rather than distance and mode. This places enormous pressure on the extension of mass transport facilities and creation of high capacity road network system. Here again, a huge share of public revenue is invested on road maintenance and snow clearance, coupled with adequate measures to reduce the dangers of spike tyre dust. The spike tyre dust problem is highly

pronounced in the heart of the city as the existing road network has to cater to the whole range of inter and intra urban travel trips. While there has been a steady increase in the number of private vehicles, the road structure and network have not increased simultaneously to cope up with the situation. Most of the specialized services and reputed institutions are concentrated in the core of the city which makes it vulnerable for congestion.

While Sapporo is claimed to have the highest per-capita open space, compared to the minimum standards and the standards prevailing in other similar cities of the advanced world, Sapporo stands far behind. Inspite of availability of large tracts of land, inadequate finance has been instrumental for the short fall. The huge investment required to create, maintain and replace the facilities may have to be borne by the beneficiaries, provided there is a simultaneous increase in the affordability levels of the beneficiaries. However the informations relating to the actual cost of the delivery of the facility and the cost recovered from the beneficiaries indicate that most of the service sectors are being subsidized, in otherwords provided for from the revenue which is to be available for the new developments. The affordability aspect of the beneficiaries directly relate to the level of employment and the increase in income levels. The prosperity of a city is reflected by the kind of employment the people are engaged in. In the case of Sapporo, almost 75 percent of the work force is engaged in the tertiary sector and considerably low percentage (24) is engaged in the secondary or the manufacturing sector. This has greater impact on the Tax revenue share that is alloted by the National Govt to the Local Govt. In recent times the National Govt trend of allocation of resources indicate that huge share is not likely to be forthcoming to the Local Govts in the future. In view of increasing demand for capital investment and decreasing per capita revenue, the Local Govt needs to harness it's efforts to seek new avenues to raise the resources needed. It is within this context the present study has been conceived to evaluate the present level of environmental facilities, anticipated needs and the replacement requirements in the sectors of Education, Health, Water supply, Sewerage, Roads, Sanitation and park and open spaces and the financial implications viz-a-viz altenative policy options to form a a basis for future Urban development policy formulation.

6. Objective of the Study:

1) To formulate a Systems Dynamics model which could explain the system relating to the Environmental facilities in terms of their existing level, desired level in terms of quantity and quality and the inadequacy level in tune with the population growth and needs.

2) To formulate support systems relating to each environmental facility sector which would address the sectoral characteristics and behaviour which are dynamic in nature.

3) To formulate a feed back system which could regulate the system to attain desired level of Environmental facility standards in consonance with the

Socio-economic, physical, fiscal, and administrative factors influencing the system and form basis for Urban development policy decisions.

4) To formulate policies relating to the environmental facility sectors as the out come of the system behaviour with alternative policy options to suit to the needs, nature and financial resource base of Sapporo.

7. Study Concept:

Figure 5 illustrates the conceptual approach to the problem. Environmental facilities stem out of broad urban development policy framed to suit to the National and local needs. However the environmental facility standards are related to the various factors governing a particular urban area. The broad classification of the governing factors are, Population, Socio-economic conditions, Physical environment, Technological viability and the urban management structure. The interaction between all these factors and the desired environmental facility standards again affect the Urban development policy. Again considerations towards Urban development and consequent policy changes influence the environmental facility standards. Since the whole system is a chain of process, provision of essential environmental facilities to the desired level for the changing population has to be carefully analysed within the frame work of the factors interacting with each other and the over all needs of the society for maximum advantage.

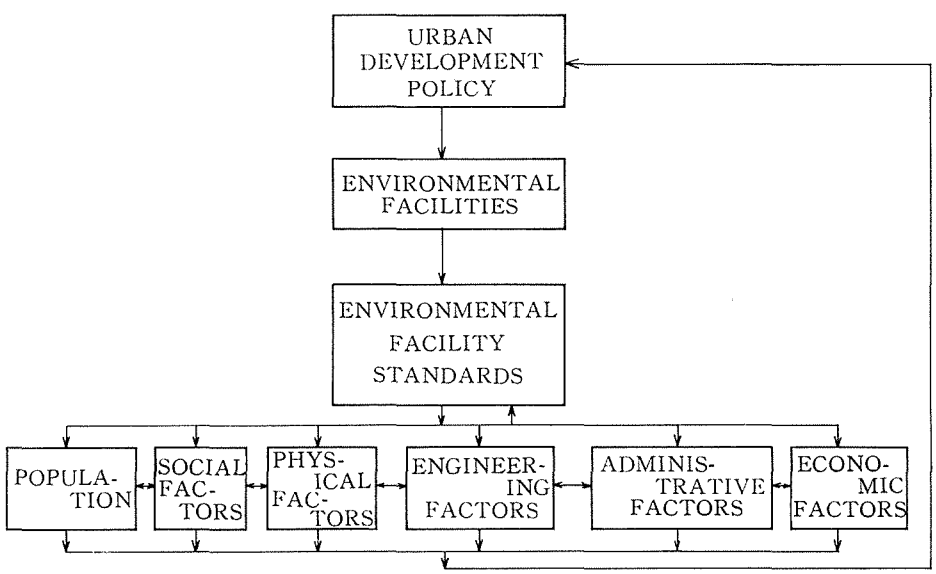

Figure 5. Study Concept.

The Figure 6 is an extension of the concept described above. The environmental facility standards with the interacting factors are comprised as the Urban management system. Urban development policy primarily relates to the population and environmental facilities and the facility standards desired. The changing popula-

tion needs several essential environmental facilities and the environmental facilities are provided based on standards governing a specific period as they change constantly. Urban management system and the environmental facility standards govern the expenditure pattern of the local govt while the same urban management system and population are responsible for the revenue of the local govt. Ultimately the local govt financial sector or the resource base determines the expenditure pattern based on priorities, as priorities also changes. Unrestricted financial flow certainly will not warrant such an exercise. The dynamic forces of urban area, while demanding more facilities and desirable environment increases severe financial constraints also. With limited possibilities for increased income of the Local govt and

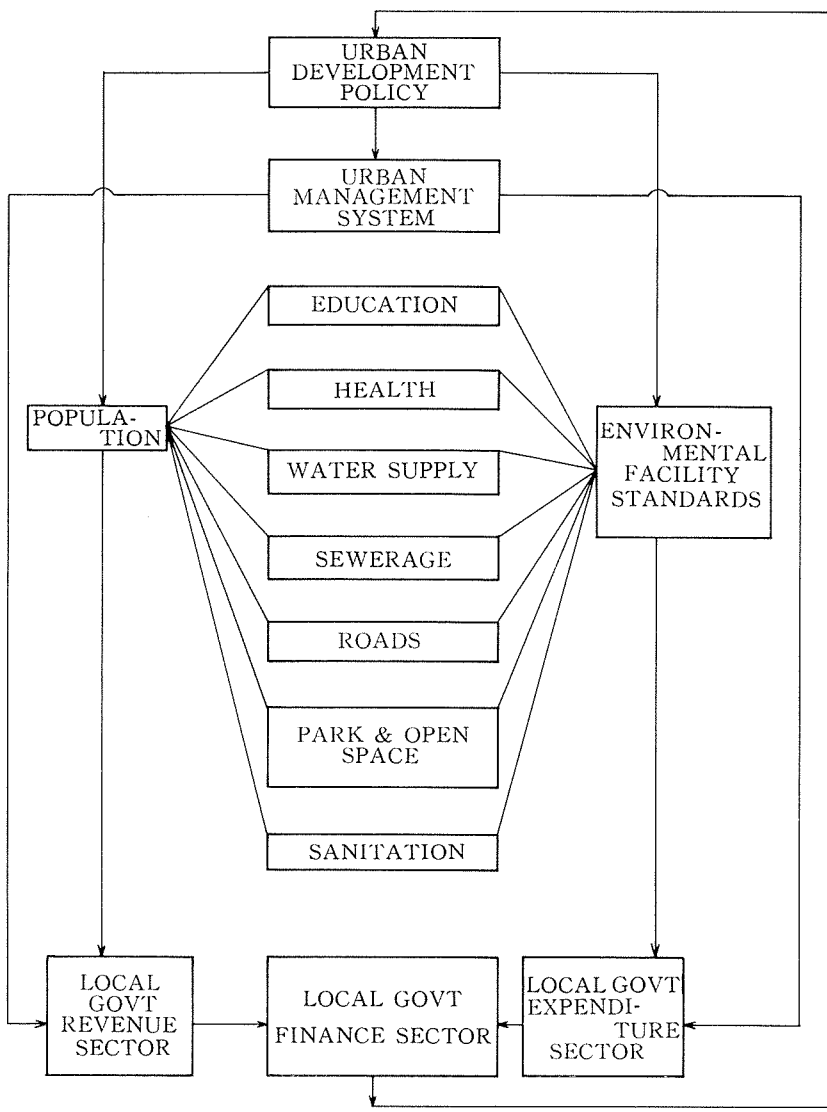

Figure 6. Environmental facilities and the sectoral relationship.

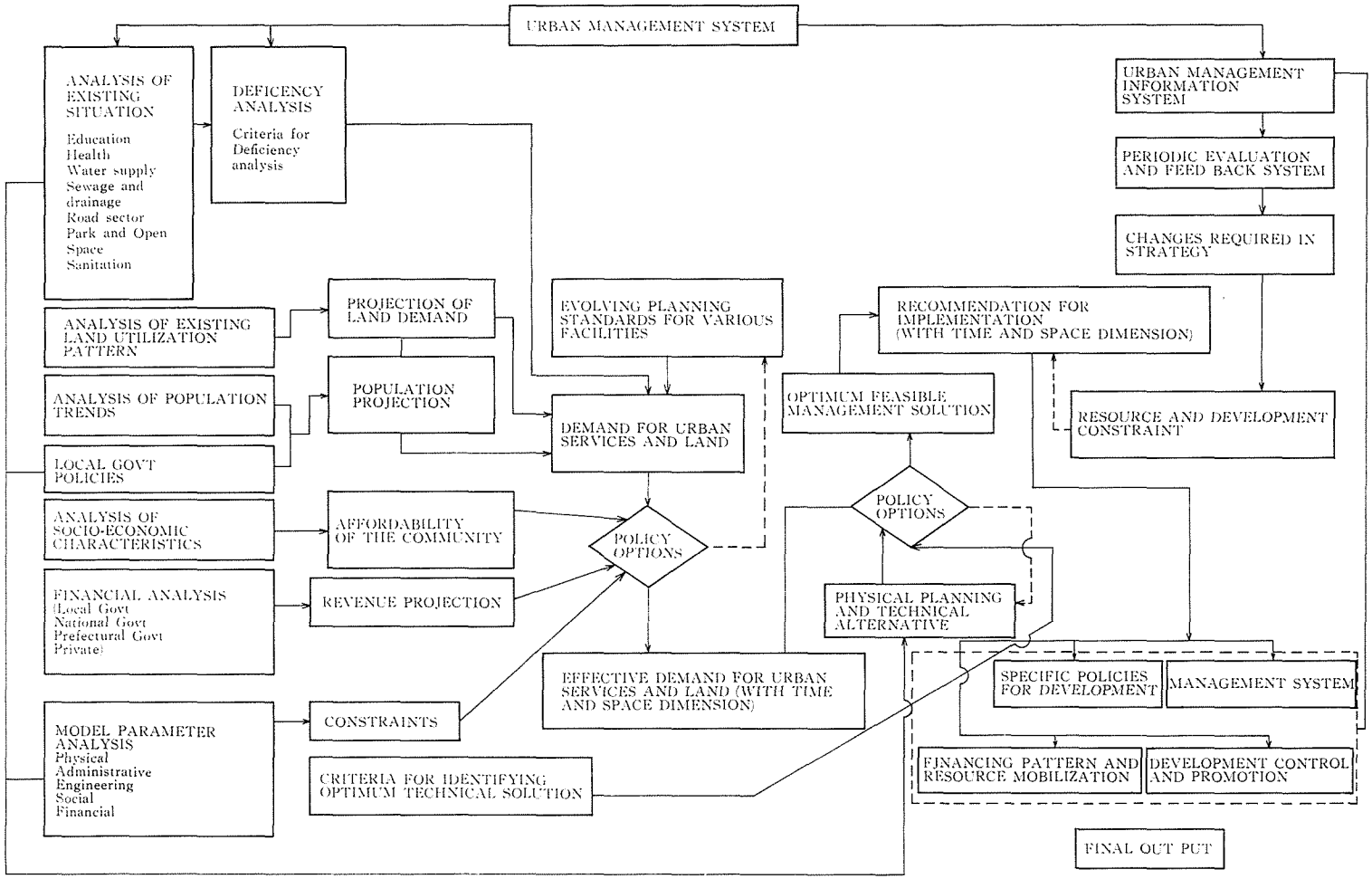

Figure 7. System's Approach to Environmental Facilities of Urban Area.

ever growing demand for better quality of facilities, there is also an imperative need for balancing the income and expenditure pattern of the Local govt. More often the financial constraints or the limitations force greater change in the Urban development policy, consequently the facility levels or standards also change. The imposed constraints more often warrant a system which could cover the whole range of parameters that could be easily understood and subject to changes for an optimum solution to ensure quantity and quality of the facilities to the ever growing problems. Such a system which could possibly be explained and evaluated is shown in Figure 6. The component parts of the system described are implicit in their function, while having a greater bearing on the others. Change in a component part and its governing factors could influence other component parts.

8. Systems Dynamics Approach:

The whole range of complex variables and their interaction with each other could better be studied by System Dynamics approach. In recent years the trend of planning has been one that of preparation of short term plans as they are mostly economic in character and encompass the prevailing and possible changes that are likely to occur in the immediate future. Though these plans have given short term relief to many of the problems, they do not address the long term effects on various related sectors and the financial implications. Therefore it is of vital importance to have a component based system which could be activated depending upon the needs and necessities of the society. Each component is governed by several factors which may change in their values but not in their character in order to assess and plan for short term needs and long term necessities. Figure 7 illustrates the various steps and procedures adopted to reach reasonable conclusion towards formulating Urban development policies relating to environmental facility needs. System analysis for the existing situation relating to the identified environmental facilitiesl, and utilization pattern, population trends, finance, socio-economic characteristics is carried out considering the physical, administrative, engineering, social and financial constraints and the system basis is formulated in the first phase. In the second phase population projection, Essential Environmental facilities projection with respect to quantity and quality, affordability of the community, constraints and planning standards of the facilities and the demand for urban environmental facilities are made. At this phase, policy options are also considered while determining the demand for the environmental facilities. In the third phase parameters relating to the resources and development constraints are introduced in to the system for interaction with the first two phases so as to arrive at recommendations for impli mentation with time and space dimension. All the three phases are inter connected in such a way to form many levels and rate functions with axillary equations to arrive at the desired results. Many control parameters are introduced in to the system which can be regulated to suit to the requirements.

9. Conclusion of the Study:

1) The conceptual approach and the analytical approach address the macro level planning process and could be applied to any urban area.

2) Each environmental facility sector and its controlling parameters are to be evaluated and incorporated in to the Systems Dynamics model for comprehensive explanation of the financial implications. While the controlling parameters may be similar for all urban areas, their application in terms of their efficacy need to be carefully analysed.

3) Functional validity of this model will be high only when the policy options and controlling parameters are defined properly.

4) Since policy options depend on sound information base it is vital to strengthen the urban information system before attempting this model.

5) Application of this system to a specific urban area taking in to consideration the existing policy needs will be examined and the results will be made available in subsequent issues.

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