CHAPTER - I

INTRODUCTION

1.0. Population

Population studies are concerned with size, composition, population density and the distribution of population and also variations in these aspects overtime. The population growth as well as city size expansion are most distinctive and universal features of 19th and 20th centuries. The world population since 1950 has increased at an annual rate of 17 percent. The population in developed countries is 20 percent of world population in 2000. The population of developing countries is four times higher than that of developed countries in 2000 (PRB, 2000). The rapid growth of population in developing countries creates problems such as unemployment, increased school-age population, population pressure on social status, housing and food supply. Certain preventive measures used by developing countries to reduce the population growth are integration of family planning with maternal and child health service, expanded training for programme personnel, improved status of women, population education, late marriage, motivating the couples on small family norms etc.

India is having 2.4 percent of land area of the world but its contribution to the world population is 16.5 percent in 2000 (PRB, 2000). The annual growth of population in India has been interpreted as the entire population of Australia being added every year. The world’s urban population is 45 percent while India's urban
population is 28 percent in 2000 (PRB, 2000). In the analysis of urbanization, total population is usually dichotomized into rural and urban classification. Urbanization in developing countries is weighted to big cities and it is a process of concentration of people in special area regarded as urban. According to 1981 census urban places are those settlements which satisfy the following criteria: i) all places with a municipal / corporation, town committee, notified area committee or cantonment board and ii) selected places with a) density of not less than 400 persons per Km$^2$. b) a population of 5,000, c) three-fourth of male working population should be working out-side agriculture. (Director of Census Operations, Tamil Nadu, 1981). In 2001 Census town panchayats and census towns are also added in addition to the above said urban components (2001 Census). Urban population as well as urban areas show upward trend since 1901 in Tamil Nadu (Director of Census Operations, Tamil Nadu, 2002). Thus the growth of urban population creates an imbalance between the population and the distribution of goods and services. Most of the developing countries experienced the massive urban growth. India is one of the countries having multiplicity of urban system. According to 2001 Census, twenty eight percent of India's total populations are living in urban areas. But forty-five percent of world populations are living in urban areas. Urbanization in the past two decades has increased the number of urban areas as well as population.
1.1 City Size

City is a permanent nucleated settlement of population within a circumscribed territory whose inhabitants are too numerous and closely spaced to grow. The main features of city are its permanence, its size, its density and its non-agricultural subsistence base. Nucleation is a basic aspect of city because urban communities are not spatially randomized. Any place with a population of 100,000 or more is called as a city (1981 Census).

The increase in number of cities and their size are the main sources of the growth of urban areas because city is one of the components of the urban system. The trend of city population and the number of cities are having upward growth in Tamil Nadu. Cities grow in population as well as through the annexation of new area every year. The study of city size growth, particularly its pattern of growth, will be interesting one for demographers, policy makers and programme implementers to gain knowledge as well as to take appropriate measures to tackle the problems related to the growth of city population.

City size indicates the total number of populations living in the city. The classification of cities into multiple size categories is called as City Size Distribution (CSD). CSD played a vital role in urban and regional analysis. The population characteristic such as size, density, residential status are important in the study of urbanization, particularly in the study of city system. City sizes are greatly influenced by demographic factors (birth, death, immigration, emigration),
socio-economic factors and government policies. The demographic factors associated with city size indicates certain kind of regularity in the CS D.

1.2 Model

Changes in the city sizes are due to the multiplicity of factors and it cannot be predicated with certainty. However, association between several determinants and city size can be explained with the help of stochastic models. A model is a set of assumptions about the relationship between variables explaining the city system. A model involving a random or chance factors is called as stochastic model or probabilistic model. Otherwise it is called as deterministic model. Model is a simplification of realities in a layman’s language. It clears what is relevant to a particular question at a particular time and neglects all other aspects. A model can be described by a list of endogenous variable, a list of exogenous variable and a list of specification as to which variables are present in each equation. It shows that model takes into account the essentials of a phenomenon. A model may be iconic, giving shape to an abstraction, symbols, involving mathematical relationship or statements underlying the various aspects of phenomenon under study. Model building enables us to study the phenomenon under ideal condition, which provides insight into its occurrence or evolution. If the deduction following the model agree with the actual observations, the model is satisfactory and use it for further study of phenomenon. Deterministic models are viewed as special case of Stochastic model by introducing random variable in the place of some
constants. Models can also be classified as Hierarchical model and Non-Hierarchical model. These models are used to describe the distribution pattern of city size with reference to central place concept. Mon-Hierarchical models are Rank Size Distribution, Pareto distribution etc, used to describe CSD.

Stochastic process is used to describe the complex phenomenon which includes more interdependent random variables. Many phenomenon occurring in urban system are having changing tendency with time or space. Families of random variables which are functions of time are known as Stochastic process or Random process and it is denoted by \( \{X(t), t \in T\} \) where \( T \) is a parametric space. The set of possible values taken by the random variables is called as state space \( S \). Stochastic process may be classified on the basis of parametric space and state space as i) Discrete time, discrete state space, ii) Discrete time, continuous state space, iii) Continuous time, discrete state space, and iv) continuous tune, continuous state space. Some authors classified the Stochastic process over discrete parameter space as “Stochastic sequence” and Stochastic process over continuous parametric space as “Stochastic process” (Methi, 1982).

If \( \{X(t), t \in T\} \) is a Stochastic process such that, given the value of \( X(s) \), the values of \( X(t), t > s \) do not depend on the value of \( X(u), u < s \), then the process is said to be a markov process (i.e.)

If, for, \( t_1 < t_2 < t_1 \ldots \ldots < t_n < t_s \)

\[
P\{a \leq X(t) \leq b | X(t_1) = x_1, \ldots, X(t_n) = x_n\}
\]
1.2.1 Model Building

The steps used in the model building process (Bhat 200) are as follows:

© Identify the essential characteristic of the phenomenon and their interrelationships based on experience, logical foundation and preliminary observation and then proposes a family of models. It involves the specification of the family of probability distribution of the random variable and the relation between them.

© Analysis of the models deducing various observable characteristics which would follow when the models are satisfactory.

© Fit a suitable model from the family of models by choosing one or more parameters of the model. Estimation of the parameters, obtaining confidence interval and testing the goodness of fit should be carried out by statisticians. If the fit is not satisfactory, try to modify the model. It may be done by including some factors in the model. It should be continued until the fit is satisfactory.
Use the model whose fit is satisfactory for the purpose of prediction and control.

1.3. Established Models for City Size.

As the current city size depends on the immediate past city size, city size variable follows the Markovian dependence relationship. Hence Markov model is proposed to study the variability of city size. Several models on city size were developed in the past such as growth model considering birth alone (Yule 1924, Zipf, 1949), income growth model (Champanown, 1973), City size model considering birth, death and provision for allowing new cities when its size is above the minimum threshold level (Simon, 1955), a modified Yule - Simon model allowing for inter city size distribution of cities (Haran and Vining, 1973), model allowing birth, death and immigration for accumulation of wealth (Shoirocks, 1974), Simon-type model (Okabe, 1977), nonlinear deterministic model using gravitational model (Okabe, 1979), population dependent migration model under a zero natural growth rate (Okabe, 1980), Yule-Simon model in its limiting case as a pure migration process under a zero natural growth (Vining, 1984), birth, death and emigration process ignoring the effect of immigration (Kapur, 1985), model based on Birth, Death migration process for describing the spread of insect populations (Matis, 1994), population process allowing emigration of families, i.e based on emigration of group of birds (Abebe Tersera, 1984) and model using stationary probabilities for a simple
immigration - birth - death process under the influence of total catastrophes ignoring the effect of emigration factor (Kyiakidis, 1994).

Okabe (1977) developed the theoretical relationship between rank size rule and CSD. He observed that Pareto CSD satisfies the Strong Expected Rank Size Rule (SERSR). He was unable to show that other than the Pareto CSD satisfies the SERSR.

As city sizes are changing Stochastically due to multiplicity of factors, these models considered the factors of birth, death, immigration, emigration, inter-city migration, intra-city migration in an isolated manner but not together in a model. Hence there is a need to develop a linear growth model incorporating all the appropriate variables like birth, death, immigration and emigration. An arbitrary city size model is proposed to examine its relation with SERSR. The present investigation is directed to achieve this objective.

1.4. Objectives

The general objective of the present study is to develop a stochastic model yielding steady-state Skew distribution taking into account the natural growth factors and migration factors and to establish the relationship between an arbitrary chosen CSD and the SERSR and to evaluate the same with empirical evidence. The specific objectives are as follows:

i) To develop a stochastic model with continuous time space and discrete state space, considering birth, death, immigration and emigration for studying the behaviour of city size.
ii) To apply a stochastic model using Markov process with continuous time and state spaces for studying the nature of CSD.

iii) To develop an arbitrary city size model and to establish their relationship with SERSR.

iv) To evaluate the stochastic models for city size mentioned in objectives (i) and (ii) and also tire relationship between City Size Model and SERSR with empirical evidence.

1.5.-Organisation of Thesis

Chapter I presents the population, definition for city size and model, established models and objectives. A review of literature regarding Stochastic model for city size, CSD, rank size rule and its relationship with CSD are given in chapter II. Methodology highlighting the important variables involved in the model, assumptions, techniques such as methods of estimation for estimating the parameters, statistical test: for goodness of fit, method of relating rank size rule to CSD are presented in chapter III. The proposed Stochastic model incorporating birth, death, immigration and emigration, explaining variables used in the model, assumptions, model constructions, obtaining steady state solutions, are presented in the section (4.0) of Chapter IV. A log normal approximation to the diffusion process used for studying the pattern of city size is presented in section (4.1) of Chapter IV. An arbitrary city size model and its relation with SERSR are also given in section (4.2) of Chapter IV. Empirical analysis for models developed is presented in Chapter V. Chapter VI contains the summary and conclusions of this thesis.