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OPERATIONS RESEARCH IN SERVICE DELIVERY

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The latest economic reforms aim at forming Close Global Economic Bonds to enhance the economic development of the country. For the last five years, the Central Govt. (UPA) presided by renowned economist Dr. Manmohan Singh alongwith Mr. P.Chidambaram has designed and implemented a number of schemes to bring rapid economic development in India. They used Govt. Machinery, Financial Institutions and NGOs for effective implementation of development plans. International Agencies like Lehman Brothers, Arthur Anderson, Macanzee, Moody, Price Water House Coopers etc., were given freedom to give magic pills to our economy. Now after five years we find – (i) As per survey conducted by Indian Statistical Institute, Kolkata, the number of people below poverty line in India in 2008 is 32.5 Crores which were 27.00 Crores in 2003. Thus the number of people below poverty line in India has increased by 5.5 Crores during the last 5 years. (ii) We have seen Lehman Brothers and Arthur Anderson sunk like anything. (iii) We find poor people standing at the end of the queue to get the benefit of the service by the Government to make them the better of citizens. (iv) The country suffers due to improper distribution of the services provided by the Government to the citizens of India. *The paper investigates whether there is any method to develop Service Delivery System which is both efficient and effective.*

Introduction

The key objective of economic reforms is to gain sustained high growth to alleviate poverty and raise the standard of living. We hear war story after war story that fails, one more unbelievable than the next. We do hear few success stories. We have seen plans that turned out to be years behind schedule. We have seen plans ended up over budget. In 1944 a plan for the economic development of India popularly known as Bombay Plan was framed by a group of 8 industrialists such as Purshottam Das, Thakurdas, J.R.D. Tata etc. But the scheme could not be put into operation. In order to solve the economic problems of India, The Planning Commission was set up in March 1950. Then it was decided that the development of India can be possible only by making plans. The first five year plan came into existence in 1951. India has gone through a long and painful period of adjustment before and after liberalization. In this era of recession it is the duty of the Government to protect the poor and the needs of the human development.

The great challenge for the Central and State Governments in India is to ensure that poor may get the benefit of the service provided. The time has come when Governments should use Operations Research Techniques to combat worldwide recession.

The term, Operations Research, was first coined in 1940 by Mc. Closky and Treftnen in a small town Bowdsay, of the United Kingdom. It is difficult to mark the 'beginning' of the Operations Research/Management Science operations research as it exits today, was born, during the Second World War when the British military management called upon a group of scientists to examine the strategies and tactics of various, military operations with the intention of efficient allocation of scare resources for the war effort.

The term 'Operations Research' was coined as a result of research on military operations during World War II. Since the war involved strategic and tactical problems which were greatly complicated, to expect adequate solutions from individuals or specialists in a single discipline was unrealistic. Therefore, groups of individuals who collectively were considered specialists in mathematics, economics, statistics and probability theory, engineering, behavioral, and physical science were formed as special units within the armed forces to deal with strategic and tactical problems of various military operations.

Such groups were first formed by the British Air Force and later, the American armed forces formed similar groups. One of the groups in Britain came to be known as Blackett's Circus. This group, under the leadership of Prof. P. M. S. Blackett was attached to the Radar Operational Research unit and was assigned the problem of analysing the coordination of radar equipment at gun sites. The efforts of such groups, especially in the area of radar detection are considered vital in Britain winning the air battle. Following the success of this group, such a mixed-team approach was also adopted in other allied nations.

After the war ended, scientists who had been active in the military OR groups made efforts to apply the operations research approach to civilian problems, related to business,

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industry, research and development, etc. There are three important factors behind the rapid development in the use of operations research approach.

The economic and industrial boom after World War II resulted in continuous mechanization, automation, decentralization of operations and division of management functions. This industrialization also resulted in complex managerial problems, and therefore application of operations research to managerial decision-making became popular.

Many operations researchers continued their research after war. Consequently, some important advancement was made in various operations research techniques. A key person in the post-war development of OR was George B. Dantzig. In 1947, he developed the concept of *linear programming* and its solution by a method known as *simplex method.* Besides linear programming, many other techniques of OR, such as statistical quality control, dynamic programming, queuing theory and inventory theory were well developed before the end of the 1950.

Analytic power was made available by high-speed computers. The use of computers made it possible to apply many OR techniques for practical decision analysis.

In India, operations research came into existence in 1949 when an OR unit was established at Regional Research Laboratory, Hyderabad for planning and organizing research. At the same time Prof. R. S. Verma also set up an OR team at Defence Science Laboratory to solve problems of store, purchase and planning. In 1953, Prof. P. C. Mahalanobis established an OR team in the Indian Statistical Institute, Kolkata to solve problems related to national planning and survey. The OR Society of India (ORSI) was founded in 1957 and started publishing its journal *OPSEARCH* from 1964. In the same year, India along with Japan became a member of the International Federation of Operational Research Societies (IFORS) with its headquarters in London. The other members of IFORS were UK, USA, France and West Germany.

REVIEW OF LITERATURE

Danish engineer, A. K. Erlang used for the very first time Queuing Model to eliminate bottlenecks created by telephone calls on switching circuits.

Few instances of queues are as follows:

(1) Computer programs are waiting to be processed at a computer center.

(2) Customers are waiting to be served at a bank teller's window.

(3) Parts are waiting to be processed at a manufacturing operation.

(4) Machines are waiting to be processed at a manufacturing shop.

(5) Trucks are waiting to unload their cargo at an unloading dock.

In general a queue is formed when ever units requiring services commonly referred to as customers, wait for service facilities, stand idle and wait for customers. Some customers wait when the total number of customers requiring service exceeds the number of service facilities. Some service facilities stand idle when the total number of service facilities exceeds the number of customers requiring service.

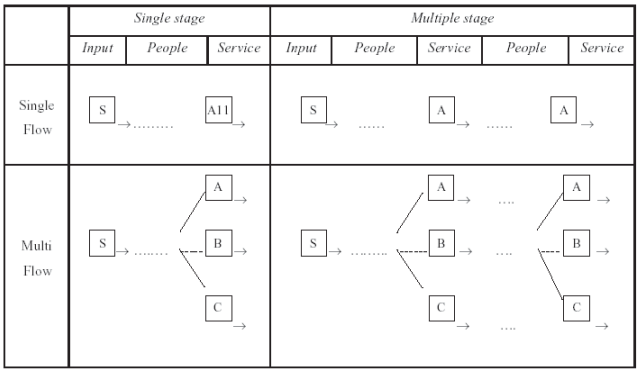
Craven B. D. and Islam [04,05] wrote two very important books Optimization in Economics and Finance-Some Advances in Non-Linear, Dynamic, Multi-Criteria and stochastic Models (2005); Operations Research Methods-Related Production, distribution and Inventory management Applications. They have discussed making good decisions among many alternatives. Craven B. D. and Islam [06] also published Logistics and Supply Chain Management – A Review of Some Operations Research Approaches.

Gass S. and Harris C. [07] published Encyclopedia of Operations Research and Management Science (2001). Molina [12] published Theory of Probability of Telephone Problems. Saatty [13, 14] wrote a important book Mathematical Methods of Operations Research in which he has resume of Queuing Theory. Maggu & Dass [10] induced covered Equivalent job & job block. Operations Research Society of India is Publishing Journal of the Operations Society [09] containing research papers on Operations Research and Managerial Decisions.

Mathematician or Pioneers, who dedicated in developing queuing theory such as Maggu Miller [11] (1960) obtained various queues parameters. There are various queues parameters: (a) parallel channels, (b) channels in series, (c) cyclic queues, (d) additional service channel, (e) service facility subject to breakdown the various results or joint efforts of Acnoff & Sasemi [01] (1963), Beekmann [02] (1968), Bellman [03] (1962), Gupta & Manndrand [08] (1975), the eminent mathematicians gave remarkable and useful works in this all walks of important daily public life. We feel necessary to give some examples where we see that queuing theory provide us solution to the problems.

TYPES OF QUEUING SYSTEM

The flow of people, their infinite population towards the service forms a queue on account of lack of service capabilities. In the absence of perfect plans between the service and people, waiting is required either for service facilities or for people's arrival. Queuing theory provides a large number of alternative mathematical models for describing a waiting line situation.



OBJECTIVES

The study has been pursued to achieve the following objectives:

(1) Set priorities in implementing Central and State Government policies.

(2) Developing effective operations research models for better implementation of government policies.

(3) Getting maximum people benefited by the government policies for them with minimum queuing delay.

Research Methodology

This study is based on secondary sources of information from published reports, annual statements and newspapers. The information so collected was supplemented by published information collected from libraries and websites, survey report of Indian Statistical Institute, Kolkata.

Service Delivery System

We discuss the proper allocation of services in different segments of the society. The volume demand in the system is first estimated. The estimated demand is divided into two components termed controllable and uncontrollable. The controllable component of demand is defined as the services need remain stable. The problem arises when unknown changes in the parameter values occur. The service allocation policy then becomes one as the model is sensitive to variations in the parameters. Thus in addition to applying the model initially considerations should be given to establishing methods for detecting parameter changes and each time there from computing a fresh.

One method for detecting significant variations in mean arrival and length of stay rates would be to collect enough data to establish confidence intervals for these parameters. The administrator could then observe rates collected on a weekly or monthly basis and as trends were observed towards or beyond the upper or lower confidence intervals, a decision could be made to revise the parameter values and compute again. Another technique, which is less desirable, would be to simply plot the parameter values overtime to observe any shifting trends in the values.

Mathematical analysis in service delivery systems can assist in designing the new system or revamping the old one. In the recent years, considerable progress has been reported in service systems and especially towards service allocation problems. Reported publications of papers reflect an application of operations research on service allocation problems. Some of the approaches to the problem have been:

(1) Analytic treatment of service allocation problems considering the relationship of people arrivals length of stay and additionally considering the minimum penalty for turning away peoples from society due to scarce facilities.

(2) Forecasting for groups of services based upon occupancy related variable such as people's length of stay and the daily census.

(3) Multiple regression techniques for predicting service requirements per classifications.

(4) Analyzing the effects of different service delivery policies with analysis of variance techniques.

(5) Prediction of total service requirements based upon the distributions of arrivals service times and occupancy.

Model to Analyze Priorities

We discuss mathematical modeling of SDS. First we consider a queue where people arrive and wait for service. All the people stand in a single queue where they will be served. We apply OR techniques to find (i) Queue length, (ii) Waiting time - (a) in service, (b) in queue.

In particular, distribution which is used to measure arrival of people at the service facilities is the Poisson distribution which is a discrete probability distribution, since it is used to count the number of people per unit time. The symbol used for mean people rate in queuing model is λ (lamda, a Greek letter). An important feature of Poisson distribution is that the mean is equal to the variance. The density function for the Poisson probability distribution is given by:

$$P(n) = \frac{e^{-\lambda}(\lambda)^n}{n!}; \quad n = 0, 1, 2, \ldots$$

where,

n = any number which the random number involved can assume,

$P(n)$ = probability of n-people arrivals

λ = mean people rate

e = constant, value is equal to 2.71828

! = the factorial value of the number

The distribution of service times could also be negative exponential, with a parameter μ instead of λ; so the service rate is μ. The traffic intensity is then, $\rho = \lambda/\mu$.

By some people's intuition, a queue with $\rho = 1$ is not stable; the queue length continues to built up as time increase. The reason is that, because of the randomness, there are always some idle times when the server has nothing to do, and this time is never made up. For a stable queue to be possible, the traffic intensity must be less than 1.

The situation considered herein is a kin to multi channel queuing problem the corresponding model was used to evaluate the number of services in each. In a multi channel queuing model, the laborious part involves solving for the $P_0(t)$ value, the probability of zero units in the system at time t,

$$P_0 = [\sum_{n=0}^{n=s-1} 1/n!\,(\lambda/\mu)^n\; 1/s!\,(\lambda/\mu)^s\,(s\mu/s\mu - \lambda)]^{-1}$$

The first term of this expression is:

$$1/0!\,(\lambda/\mu)^0 + 1/1!(\lambda/\mu)^1 + 1/2!(\lambda/\mu)^2 + \ldots + 1/(s-1)!(\lambda/\mu)^{s-1}$$

Which can be approximated as exponential series, subject to the condition that, large number of terms of the series as evaluated.

So,

$$P_0 = [e^x + 1/s!\,(\lambda/\mu)^s\,(s\mu/s\mu - \lambda)]^{-1}$$

where,

λ = Number of peoples arriving per day

μ = Number of peoples served on each service per day

n = Number of peoples in system

s = Total number of services

Number of peoples waiting for services or those turning away

$$E_w = \frac{\lambda\mu(\lambda/\mu)^s}{(s-1)!(s\mu-\lambda)^2} P_0(t),$$

Expected number of peoples being served, $Es = \lambda/\mu$

Expected number of peoples being served on services plus those waiting for service,

$$E_n = E_w + E_s = E_w + \lambda/\mu$$

The average time the people must wait before being served, Et

$$E_t = \frac{E_w}{\lambda} = \frac{\mu(\lambda/\mu)^s}{(s-1)!(s\mu-\lambda)^2} P_0(t)$$

Expected time in system i.e. the expected time spent in waiting for service plus spent on services $E\psi$

$$E\psi = E_t + 1/\mu$$

Mathematical Formulation of the Problem

Reactions (a) first come, first served discipline

(b) $P = \lambda/s\mu < 1$ or $\lambda/\mu < s$

For selecting a proper sized service facility, it is essential to have a facility for which E_w and E_t are low for optimum costs and maintaining the desired service to the peoples. To solve the problem, the values of E_w, E_t, E_n and E were calculated for different values of S leaving those values of S for which the condition $\lambda/s\mu < 1$ does not hold.

CONCLUSION

In this paper, we have proposed and studied service delivery system to give magic pills to support latest economic reforms. Our proposal scheme gives the techniques on which further technique having a quantitative basis can be built up which may be utilized to optimize performance and maximize the efficiency of Service Delivery System for economic development and poverty reduction.

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