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# CONTENTS

<b>Sr. No.</b>	<b>TITLE &amp; NAME OF THE AUTHOR (S)</b>	<b>Page No.</b>
1.	<b>MEDIATING ROLE OF EMPLOYEE RELATIONSHIP MANAGEMENT BETWEEN PERCEIVED TRAINING AND DEVELOPMENT AND EMPLOYEES PRODUCTIVITY</b> <i>Dr. D.S. CHAUBEY, NAVITA MISHRA &amp; Dr. RAJAT PRAVEEN DIMRI</i>	1
2.	<b>A STUDY ON THE CONSUMER AWARENESS TOWARDS GREEN PRODUCTS WITH SPECIAL REFERENCE TO BANGALORE CITY</b> <i>SUCHETHA HOSAMANE &amp; Dr. P. V. PADMAJA</i>	7
3.	<b>PERCEPTION OF TOURISTS TOWARDS ECOTOURISM - WITH REFERENCE TO SELECT DESTINATIONS IN TAMIL NADU</b> <i>Dr. A. ELANGO VAN &amp; K. SIVAPERUMAL</i>	12
4.	<b>IMPACT OF CELEBRITY ENDORSEMENT ON BUYING DECISION: A STUDY IN BHUBANESWAR</b> <i>SOMABHUSANA JANAKIBALLAV MISHRA, Dr. MUNMUN MOHANTY &amp; Dr. S. C. SAHOO</i>	16
5.	<b>FACTORS INFLUENCING CONSUMER SATISFACTION AND THEIR PREFERENCES TOWARDS ICE CREAMS</b> <i>ANUPAMA SUNDAR D &amp; Dr. D G KANTHARAJ</i>	23
6.	<b>GROWTH TRENDS, COMPOSITION AND CHANGING BEHAVIOR OF MPCE IN MADHYA PRADESH: WITH REFERENCE OF INDIA</b> <i>PRABHA BHATT &amp; TRISHA SINGH TOMAR</i>	27
7.	<b>IMPORTANCE OF CROSS CULTURE SKILLS IN MANAGEMENT</b> <i>Dr. SUBASH SINGH &amp; Dr. MANJU KHOSLA</i>	31
8.	<b>THE EFFECT OF DEMONETISATION ON THE INDIAN ECONOMY AT DIFFERENT TIME INTERVAL</b> <i>AMISH BHARATKUMAR SONI &amp; KOMAL BHAGWANDAS SIDHNANI</i>	34
9.	<b>DEMONETISATION IMPACT ON ELECTRONIC FUND TRANSFER</b> <i>JITIN SHARMA &amp; SANDEEP SEHGAL</i>	41
10.	<b>PERFORMANCE MEASUREMENT: A CASE STUDY FOR INDIAN MUNICIPALITIES</b> <i>DEBASIS BANDYOPADHYAY &amp; Dr. BISHWAMBHAR MANDAL</i>	44
11.	<b>AN INQUIRY INTO IMPACT OF TQM IMPLEMENTATION ON CUSTOMER ORIENTED PERFORMANCE AT WORKING IRON AND STEEL FIRMS OF HYDERABAD-KARNATAKA REGION</b> <i>K C PRASHANTH</i>	51
12.	<b>A STUDY ON SOCIO ECONOMIC CONDITION OF WOMEN WORKERS IN UNORGANISED SECTOR WITH REFERENCES TO CHENNAI CITY</b> <i>Dr. R. SURESH BABU</i>	56
13.	<b>A COMPARATIVE STUDY ON STOCHASTIC ANALYSIS OF MANPOWER LEVELS FOR BUSINESS USING FOUR AND SIX POINT STATE SPACE</b> <i>Dr. R. ARUMUGAM</i>	59
14.	<b>IFRS: A PATHWAY TO IMPROVE HUMAN RESOURCE ACCOUNTING PRACTICES</b> <i>Dr. P. SUCHITRA</i>	63
15.	<b>CUSTOMER SATISFACTION TOWARDS THE SERVICE QUALITY OF SOUTH INDIAN BANK</b> <i>CAMILLO JOSEPH</i>	66
16.	<b>TREND AND PATTERN OF FOREIGN DIRECT INVESTMENT INFLOW IN INDIA</b> <i>Dr. SANJAY NANDAL &amp; SEEMA RANI</i>	71
17.	<b>A STUDY ON BEHAVIOURAL BIASES</b> <i>HIMANSHI KALRA &amp; Dr. NEHA BANKOTI</i>	78
18.	<b>SPIN TRANSPORT IN BN DOPED CrO<sub>2</sub>-GRAPHENE-CrO<sub>2</sub> MAGNETIC TUNNEL JUNCTION</b> <i>DILPREET KAUR DHILLON &amp; RUCHIKA CHHABRA</i>	82
19.	<b>UNDERGRADUATE STUDENT'S PERCEPTION TOWARDS ENTREPRENEURSHIP - A STUDY WITH SPECIAL REFERENCE TO UNDERGRADUATE STUDENTS OF UDUPI DISTRICT</b> <i>MALLIKA A SHETTY</i>	86
20.	<b>FACTORS INFLUENCING COMPLETION RATE OF ROAD CONSTRUCTION PROJECTS IN KISII COUNTY KENYA</b> <i>NYABAGA MOUNDE PETER &amp; Dr. MOSES OTIENO</i>	92
	<b>REQUEST FOR FEEDBACK &amp; DISCLAIMER</b>	112

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# A COMPARATIVE STUDY ON STOCHASTIC ANALYSIS OF MANPOWER LEVELS FOR BUSINESS USING FOUR AND SIX POINT STATE SPACE

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## ABSTRACT

*The present study aim is to compare the steady rate of crisis and steady state of probabilities under varying conditions which are manpower, under irregular conditions of full availability and nil availability in the case of business and manpower. Four and six point state space has been compared under the different assumption that the transition from one state to another in both business and manpower occur in exponential time with different parameters.*

## KEYWORDS

markov chain, steady state, crisis rate.

## I. INTRODUCTION

Nowadays we start that labor has become a buyers' market as well as sellers' market. Any business which usually runs on commercial base wishes to keep only the optimum level of all resources needed to meet company's responsibility at any time during the course of the business and so manpower is not an exemption. This is spelt in the sense that a company may not want to keep manpower more than what is needed. Hence, retrenchment and recruitment are general and recurrent in most of the companies now. Recruitment is done when the business is busy and shed manpower when the business is lean. Equally true with the labor, has the choice to switch over to other jobs because of improved working condition, better emolument, nearness to their living place or other reasons. Under such conditions the company may face crisis because business may be there but skilled manpower may not be available. If skilled laborers and technically qualified persons leave the business the seriousness is most awfully felt and the company has to appoint paying deep price or pay overtime to employees. Approach to manpower problems have been dealt in very many different ways as early as 1947 by Vajda [11] and others. Manpower planning models have been dealt in depth in Barthlomew [1], Grinold & Marshal [3] and Vajda [11]. The methods to calculate wastages (Resignation, dismissal and death) and promotion intensities which produce the proportions corresponding to some preferred planning proposals has been dealt by Lesson [4]. Markov model are designed for promotion and wastages in manpower system by Vassilou [12]. Subramaniam [11] in his thesis has made an attempt to give optimal policy for recruitment training, promotion, and wastages in man power planning models with special provisions such as time bound promotions, cost of training and voluntary retirement scheme. For an application of Markov chains in a manpower system with seniority and efficiency and Stochastic structures of graded size in manpower planning systems one may refer to Setlhare [9]. A two unit stand by system has been examined by Chandrasekar and Natrajan [2] with confidence limits under steady state. For n unit standby system one may refer to Ramanarayanan and Usha [8]. Yadhavalli and Botha [13] have observed the same for two unit system with introduction of preparation time for the service facility and the confidence limits for stationary rate of disappointment of an erratically used system. For three characteristics system involving manpower, machine and money one may refer to C. Mohan and R. Ramanarayanan [6]. For the study of Semi Markov Models for Manpower planning one may refer to the paper by Sally Meclean [5]. Stochastic Analysis of a Business with Varying Levels in Manpower and Business has been discussed by C. Mohan and P.Selvaraju [7]. Applications of Stochastic Models in Manpower Levels for business by R. Arumugam [14].

## II. MARKOV CHAIN MODEL WITH FOUR AND SIX POINT STATE SPACE

In this paper we consider two characteristics namely business and manpower. We compare steady state rate of crisis and the steady state probabilities in both four and six point state space. The situations may be that the manpower may be fully available or hardly available and business may fluctuate between complete availability to nil availability. It goes off when the manpower becomes nil. This is so because the experts may take the business along with them or those who have brought good will to the concern may bring the client's off the concern. The business depends completely on the availability of manpower. The steady state probabilities of the continuous Markov chain relating the transitions in different states are identified for presenting the cost analysis. Numerical illustrations are also provided.

## III. ASSUMPTIONS

1. There are two levels of manpower namely manpower is full and manpower is nil.
2. There are two levels of business namely, (a) business is fully available (b) business is nil.
3. The time T- during which the manpower remains continuously filled and becomes nil has exponential distribution with parameter  $\alpha_{10}$  and the time R- required to stop full recruitment from zero stage is exponentially distributed with parameter  $\beta_{01}$ .
4. The fully available and zero periods of the business are exponentially distributed with parameters ' $\lambda$ ' and ' $\mu$ ' respectively.
5. While manpower becomes zero, the business is vanished and becomes nil.
6. T- and R- are independently distributed random variables.

## IV. SYSTEM ANALYSIS

### FOUR POINT STATE SPACE

The Stochastic Process X(t) describing the state of the system is Markov chain continuous time with four points state space as given below in the order of manpower and business

$$S = \{(0, 0), (0, 1), (1, 0), (1, 1)\} \quad \text{-----} \quad (1)$$

Where,

0 – Refers to shortage/non availability of manpower and business. The system is in state (1, j)

when the manpower is in state 1 and business is in state for (1, j) = (1, 1) or (1, 0) or

(0, 0) and there is not the state (0, 1) as the business is misplaced while the manpower goes off.

1 – Refers to busy time in the case of business and full availability of manpower.

The infinitesimal generator of manpower of order two is as follows

$$M = \begin{bmatrix} MP & 1 & 0 \\ 1 & -\lambda & \lambda \\ 0 & \mu & -\mu \end{bmatrix}$$

And the steady state probabilities are  $\pi_{M1} = \frac{\mu}{\mu + \lambda}$  and  $\pi_{M0} = \frac{\lambda}{\mu + \lambda}$

$$\pi_{00} = \frac{\lambda_{10}}{\lambda_{10} + \beta_{01}}, \pi_{01} = \frac{\alpha\beta_{10}}{(a+b+\lambda_{10})(\beta_{01} + \lambda_{10})}; \pi_{10} = \frac{(a+\lambda_{10})\beta_{01}}{(a+b+\lambda_{10})(\beta_{01} + \lambda_{10})};$$

$$\pi_{11} = \frac{b\beta_{01}}{(b+a+\lambda_{10})(\beta_{01} + \lambda_{10})} \text{-----} > (2)$$

Using the steady state probabilities, we get

$$C_{\infty} = b \frac{b\beta_{01}}{(b+a+\lambda_{10})(\beta_{01} + \lambda_{10})} \text{-----} > (3)$$

Six Point state space

#### ASSUMPTIONS

The time for which the manpower remains continuously full and enters a state of reduced strength follows exponential distribution with parameter  $\alpha_1$ . The other two phases have exponential distribution with means  $1/\beta_1$  and  $1/\gamma_1$ . The overall time for the process of recruitment time is then hypo-exponential. Since the sojourn time in the down state is two - stage hypo-exponentially distributed, the system being modeled in a semi Markov process. The busy and lean periods of the business are exponentially distributed with parameters  $a$  and  $b$ . The Stochastic Process  $X(t)$  describing the state of the system is Markov chain continuous time with six points state space as given below in the order of manpower and business

$$S = \{(0,0), (0,1), (0,2), (1,0), (1,1), (1,2)\} \text{-----} (4)$$

The steady state probabilities of Manpower are,

$$\pi_{0M} = \frac{1}{1 + \frac{\alpha_1}{\gamma_1} + \frac{\alpha_1}{\beta_1}}; \pi_{1M} = \frac{\alpha_1}{\beta_1 \left(1 + \frac{\alpha_1}{\gamma_1} + \frac{\alpha_1}{\beta_1}\right)}; \pi_{2M} = \frac{\alpha_1}{\gamma_1 \left(1 + \frac{\alpha_1}{\gamma_1} + \frac{\alpha_1}{\beta_1}\right)} \text{-----} (5)$$

Where

$$X = (b+a) \text{ and } Y = \left[ Y = \left(1 + \frac{\alpha_1}{\beta_1} + \frac{\alpha_1}{\gamma_1}\right) \right]$$

The rate of Crisis in steady state conditions is,

$$C_{\infty} = \alpha_1 \pi_{00} + a \pi_{11} = \frac{\alpha_1}{Y} \frac{b}{\beta} \frac{a}{X} \text{-----} (6)$$

$$C_{ij} = \pi_{ij} = C_B^j + C_M^j \text{.....}$$

The Steady state cost is

#### V. NUMERICAL ILLUSTRATION AND STEADY STATE COST CALCULATION

Four Point state space

The steady state probabilities and the rate of crises are measured by using the formulas (2) and (3) respectively. Taking,  $a = 20$ ,  $b = 10$ ,  $\lambda_{10} = 5$ ,  $\beta_{01} = 12$ , we get  $\pi_{00} = 0.2941$ ,  $\pi_{01} = 0.5042$ ,  $\pi_{10} = 0.4769$ ,  $\pi_{11} = 0.20168$ .

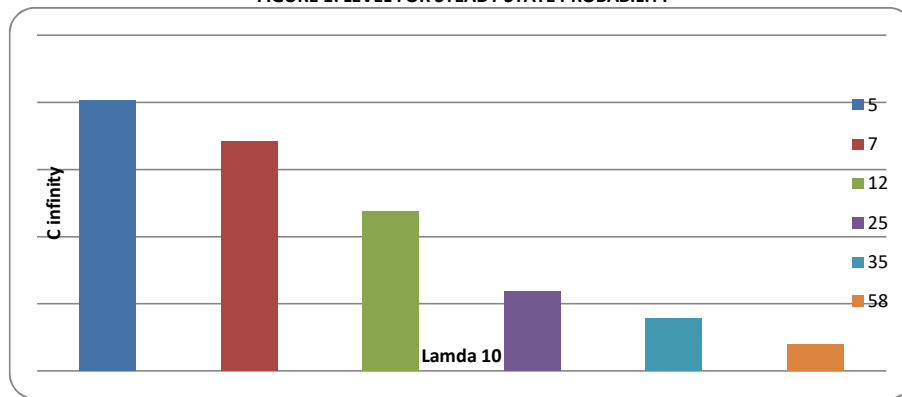
Now assigning the values  $\lambda_{10} = 5, 7, 12, 25, 35$  and  $58$ , we compute the corresponding rate of crises and they are given below in the table 1

Case (i)

TABLE 1: STEADY STATE PROBABILITY

$\lambda_{10}$	5	7	12	25	35	58
$C_{\infty}$	2.01680	1.70697	1.19047	0.58968	0.39279	0.19480

FIGURE 1: LEVEL FOR STEADY STATE PROBABILITY

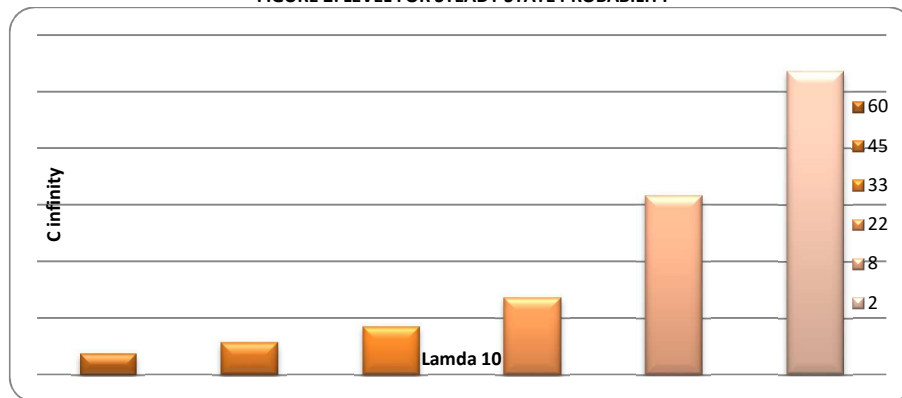


Case (ii)

TABLE 2: STEADY STATE PROBABILITY

$\lambda_{10}$	60	45	33	22	8	2
$C_{\infty}$	0.18518	0.28070	0.42328	0.67873	1.57894	2.67857

FIGURE 2: LEVEL FOR STEADY STATE PROBABILITY



The steady state costs in various situations are determined taking the values  $C_M^0 = 52$ ,  $C_M^1 = 45$ ,  $C_B^0 = 60$ ,  $C_B^1 = 38$  where  $C_M^0 = 52$  refers to cost of funds at state zero,  $C_M^1 = 45$  refers to cost of funds at state 1,  $C_B^0 = 60$  cost of business at state zero and  $C_B^1 = 38$  refers to cost of business at state 1.

Case (i)

TABLE 3: LEVEL OF COST AND STEADY STATE PROBABILITY

Steady state probability	$\pi_{00}$	$\pi_{01}$	$\pi_{10}$	$\pi_{11}$
Cost	32.94	40.53	52.94	16.74

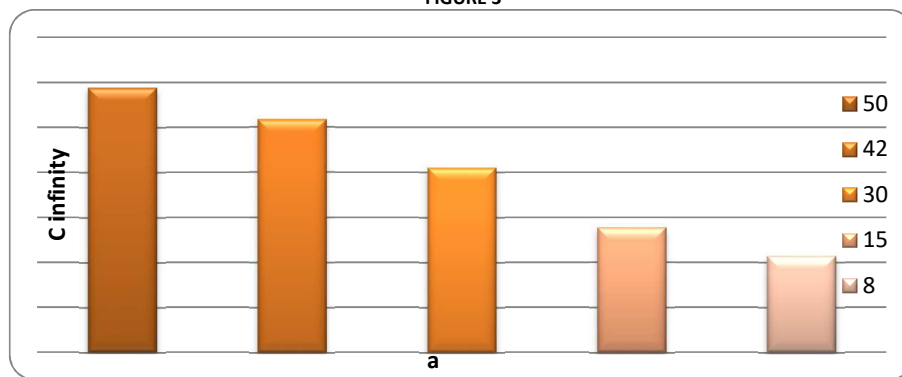
Six Point state space

The steady state probabilities and the rate of crises are measured by using the formulas (2) and (3) respectively. Taking,  $a = 20$ ,  $b = 10$ ,  $\alpha_1 = 5$ ,  $\beta_1 = 8$ ,  $\gamma_1 = 7$ , we get  $\pi_{00} = 0.2849$ ,  $\pi_{01} = 0.1781$ ,  $\pi_{02} = 0.2036$ ,  $\pi_{10} = 0.7608$ ,  $\pi_{11} = 0.0891$ ,  $\pi_{12} = 0.2036$ .

TABLE 4

a	50	42	30	15	8
$C_{\infty}$	5.8795	5.1667	4.0975	2.7610	2.1373

FIGURE 3



## V. CONCLUSION

It is found that as the value of  $\lambda$  increases and the corresponding crisis rate decreases in both four and six point state space. Also it is observed that the cost is high if there is full business but there is no manpower, under such situations labour has to be paid a lot. When the manpower is full, there is a chance of the business getting into crisis state if manpower leaves particularly experts and experienced people leave the concern. The same holds in the case of business are moderate while the manpower may be full or inadequate.

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