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Stochastic Model Assessing to Identifying the Shortage of Manpower in an Organization

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ABSTRACT: In every organization, manpower is the key factor in all levels. Whenever there is a shortage in manpower the organization gets immovable in some places. To identify the time at which these shortages occurs the authors have developed a stochastic model through Transmuted Lindely Distribution. The three parameters concluded the same results, as the time between the increases in parameter the threshold level decreases in all cases. Time and cost are the main challenging factors in an organization; this model will be an alternative for the stochastic model *developed.* The simulation method was carried through MathCAD and the graphs were figured using Minitab software.

Keywords: Factors, Manpower, Parameter, Organization.

I. INTRODUCTION

The importance of investments in human resources is vital to sustain any organization in a comfortable position and on the rising track. Manpower planning is very significant by which an organization can warrant optimal use of its manpower presently at their disposal as well as evidence for the prospect of the organization. It is stated that the progress, development and achievement of any nation can be evaluated by how its manpower is planned and used. Hence, manpower planning is considered as a significant element in technological and economic advancement. The critical role of manpower planning is to analyze the available resources in an organization and to fix how to get the various employees required to job vacancies with a range from assembly line workers to chief executive [1]. Besides, the need for manpower planning in an organization is to meet the manpower requirement, overcome the unproductive labor, shortage of labor, assess the labor shortages, and arrange for recruitment. Manpower planning is essential for organizations where there is the existence of a shortage of skilled manpower [2].

Moreover, a significant challenge facing the human resources department of organizations is the shortage of manpower. The labor shortage is defined as a constant market imbalance between supply and demand in which the number of workers needed surpasses the supply existing and willing to work with a certain pay, specific working environment as well as point in time. There will be a surplus when the number of labor offered surpasses the number that organizations desire to procure. There is a shortage when the number of labor preferred by organizations surpasses the number of labor agree with the existing pay [3]. Shortage of manpower is often considered as a major issue for the economies in various countries [5]. It has a high negative impact on the performance of any organization [4]. Altering environmental factors could affect the demand for manpower that might result in a shortage of manpower. The shortage of manpower results in a market economy when the demand for personnel for a specific job exceeds the supply of personnel who are competent, existing, and eager to work [6]. When organizations have such manpower, those organizations will have issues in finding their employees for developing generating human capital advantage. Positive organizations would aim to develop appropriate solutions to overcome the shortage of manpower. Research on the shortage of manpower showed more evidence towards the causes of manpower shortage and possible solutions to solve it [7].

There is a need to reveal the shortage of manpower in an organization since it is a significant issue encountered by organizations while attempting to improve their performance and productivity in a competitive market. To achieve this, this study applied a stochastic model to identify the shortage of manpower in an organization. Time and cost are the main challenging factors in an organization; this model will be an alternative for the stochastic model developed.

II. SHOCK MODEL DEVELOPMENT

Lindley introduced "Lindley distribution" in 1958. It is a one parameter lifetime distribution in the background of Bayesian statistics [8, 13]. The Lindley distribution was proposed to investigate failure time data, particularly in applications modeling stress-strength reliability (Lindley, 1958).

The motivation of this distribution ascends from its capability to model failure time data with rising, declining, unimodal, and bathtub shaped hazard rates.

This distribution comes under the exponential family, and it can be described as a combination of gamma and exponential distributions. It denotes an excellent substitute for the exponential failure time distributions that suffer from not exhibiting unimodal and bathtub shaped failure rates [9].

Previous studies have revealed the properties and inferential process for the Lindley distribution. It is stated that the Lindley distribution is found to be superiors compared to the exponential distribution, particularly in case of unimodal or bathtub shaped hazard rate [10, 11]. Also, [12] reported that the Lindley distribution is a potential substitute for Weibull and exponential distributions.

For $\alpha = 2$ and $\delta = 1$, the distribution function becomes

$$F(x) = (1+\lambda)\left[1 - \frac{\theta+1+\theta x}{\theta+1}e^{-\theta x}\right] - \lambda\left[1 - \frac{\theta+1+\theta x}{\theta+1}e^{-\theta x}\right]^2 ; x > 0$$

$$= 1 - \left[e^{-\theta x} + \left(\frac{\theta}{\theta+1}\right)xe^{-\theta x}\right] + \lambda e^{-\theta x} + \left(\frac{\lambda\theta}{\theta+1}\right)xe^{-\theta x} - \left[e^{-2\theta x} + \left(\frac{\theta}{\theta+1}\right)^2 x^2 e^{-2\theta x} + \left(\frac{2\theta}{1+\theta}\right)xe^{-2\theta x}\right]$$

$$\bar{H}(x) = 1 - F(x)$$

$$= e^{-\theta x} + \left(\frac{\theta}{\theta+1}\right)xe^{-\theta x} - \lambda e^{-\theta x} - \left(\frac{\lambda\theta}{\theta+1}\right)xe^{-\theta x} + e^{-2\theta x} + \left(\frac{\theta}{\theta+1}\right)^2 x^2 e^{-2\theta x} + \left(\frac{2\theta}{1+\theta}\right)xe^{-2\theta x}$$

$$P(x_i < y) = \int_0^\infty g_k(x)\,\bar{H}(x)dx$$

$$= [g^*(\theta)]^k + \left(\frac{\theta}{\theta+1}\right)\left[g^{*'}(\theta)\right]^k - \lambda[g^*(\theta)]^k - \left(\frac{\lambda\theta}{1+\theta}\right)[g^*(\theta)]^k + [g^*(2\theta)]^k + \left(\frac{\theta}{\theta+1}\right)^2\left[g^{*''}(2\theta)\right]^k + \left[\frac{2\theta}{1+\theta}\right]\left[g^{*'}(2\theta)\right]$$

$$P(T > t) = \sum_{k=0}^{\infty} V_k(t)\; P(x_i < y)$$

$$= \sum_{k=0}^{\infty}[F_k(t) - F_{k+1}(t)]\,P(x_i < y)$$

$$= 1 - [1 - g^*(\theta)]\sum_{k=1}^{\infty}F_k(t)\,[g^*(\theta)]^{k-1} - \left(\frac{\theta}{\theta+1}\right)\left[1 - g^{*'}(\theta)\right]\sum_{k=1}^{\infty}F_k(t)\left[g^{*'}(\theta)\right]^{k-1}$$
$$+\lambda[1 - g^*(\theta)]\sum_{k=1}^{\infty}F_k(t)\,[g^*(\theta)]^{k-1} + \left(\frac{\lambda\theta}{1+\theta}\right)\left[1 - g^{*'}(\theta)\right]\sum_{k=1}^{\infty}F_k(t)\left[g^{*'}(\theta)\right]^{k-1}$$
$$-[1 - g^*(2\theta)]\sum_{k=1}^{\infty}F_k(t)\,[g^*(2\theta)]^{k-1} - \left(\frac{\theta}{1+\theta}\right)^2\left[1 - g^{*''}(2\theta)\right]\sum_{k=1}^{\infty}F_k(t)\left[g^{*''}(2\theta)\right]^{k-1} - \left(\frac{2\theta}{1+\theta}\right)\left[1 - g^{*'}(2\theta)\right]\sum_{k=1}^{\infty}F_k(t)\left[g^{*'}(2\theta)\right]^{k-1}$$

$$L(T) = 1 - S(t)$$

$$l^*(s) = \frac{[1 - g^*(\theta)]f^*(s)}{[1 - g^*(\theta)f^*(s)]} - \frac{\theta\left[1 - g^{*'}(\theta)\right]f^*(s)}{\theta+1\left[1 - g^{*'}(\theta)f^*(s)\right]} + \frac{\lambda[1 - g^*(\theta)]f^*(s)}{[1 - g^*(\theta)f^*(s)]} + \frac{\lambda\theta\left[1 - g^{*'}(\theta)\right]f^*(s)}{\theta+1\left[1 - g^{*'}(\theta)f^*(s)\right]} - \frac{[1 - g^*(2\theta)]f^*(s)}{[1 - g^*(2\theta)f^*(s)]} + \left(\frac{\theta}{1+\theta}\right)^2\frac{\left[1 - g^{*''}(2\theta)\right]f^*(s)}{\left[1 - g^{*''}(2\theta)f^*(s)\right]} - \frac{2\theta\left[1 - g^{*'}(2\theta)\right]f^*(s)}{(1+\theta)\left[1 - g^{*'}(2\theta)f^*(s)\right]}$$

$$= \frac{[1 - g^*(\theta)]c}{[c + s - g^*(\theta)c]} - \frac{\theta\left[1 - g^{*'}(\theta)\right]c}{1+\theta\left[c + s - g^{*'}(\theta)c\right]} + \frac{\lambda[1 - g^*(\theta)]c}{[c + s - g^*(\theta)c]} + \frac{\lambda\theta\left[1 - g^{*'}(\theta)\right]c}{1+\theta\left[c + s - g^{*'}(\theta)c\right]} - \frac{[1 - g^*(2\theta)]c}{[c + s - g^*(2\theta)c]} + \frac{\theta^2\left[1 - g^{*''}(2\theta)\right]c}{(1+\theta)^2\left[c + s - g^{*''}(2\theta)c\right]} - \frac{2\theta\left[1 - g^{*'}(2\theta)\right]c}{(1+\theta)\left[c + s - g^{*'}(2\theta)c\right]}$$

$$E(T) = -\frac{d}{ds}\; given\, s = 0$$

$$= \frac{1}{c[1 - g^*(\theta)]} - \frac{\theta}{(1+\theta)c\left[1 - g^{*'}(\theta)\right]} + \frac{\lambda}{c[1 - g^*(\theta)]} + \frac{\lambda\theta}{(1+\theta)c\left[1 - g^{*'}(\theta)\right]} - \frac{1}{c[1 - g^*(2\theta)]} + \frac{\theta^2}{(1+\theta)^2 c\left[1 - g^{*''}(2\theta)\right]} - \frac{2\theta}{(1+\theta)\left[1 - g^{*'}(2\theta)\right]c}$$

$$= g^*(\theta) \sim \frac{\mu}{\mu+\theta};\; g^{*'}(\theta) \sim \frac{\mu}{(\mu+\theta)^2};\; g^{*''}(\theta) \sim \frac{\mu}{(\mu+\theta)^3};\; g^*(2\theta)$$
$$= \frac{\mu}{\mu+2\theta};\; g^{*'}(2\theta) \sim \frac{\mu}{(\mu+2\theta)^3}$$

$$E(T) = \frac{\mu+\theta}{c\theta} - \frac{\theta(\mu+\theta)^2}{(1+\theta)c[(\mu+\theta)^2+\mu]} + \frac{\lambda(\mu+\theta)}{c\theta} + \frac{\lambda\theta(\mu+\theta)^2}{(1+\theta)c[(\mu+\theta)^2+\mu]} - \frac{\mu+2\theta}{2\,c\theta} + \frac{\theta^2(\mu+2\theta)^3}{c(1+\theta)^2[(\mu+2\theta)^3-\mu]} - \frac{2\theta(\mu+2\theta)^2}{c(1+\theta)[(\mu+2\theta)+\mu]}$$

III. RESULTS AND CONCLUSION

When the parameter μ and θ are fixed; with λ increasing in a fixed time along with c the time interval, there found an overall decrease in all the sequences. i.e., when λ is small; 0.5 the expected manpower threshold in an organization decrease, when λ increases from 0.5 to 1 then we find the manpower threshold increasing compared to λ=0.5, same case observed when λ increases from 1 to 1.5.

When the parameter λ and μ are fixed; with θ increasing in a fixed time along with c the time interval, there found an overall decrease in all the sequences. i.e., when θ is small; 0.3 the expected manpower threshold in an organization decrease, when θ increases from 0.3 to 0.4 then we find the manpower threshold decreasing compared to θ = 0.3, same case observed when θ increases from 0.4 to 0.5.

When the parameter θ and λ are fixed; with μ increasing in a fixed time along with c the time interval, there found an overall decrease in all the sequences. i.e., when μ is small; 1.2 the expected manpower threshold in an organization decrease, when μ increases from 1.2 to 1.4 then we find the manpower threshold increasing compared to λ=1.2, same case observed when μ increases from 1.4 to 1.6.

The results showed a better fit with the stochastic model developed by Kannadasan *et al.*, (2012) [14]; Al Kuwaiti *et al.*, (2016) [15]; Goparaju *et al.*, (2019) [16].

Table 1.

μ=0.9; θ=0.2			
c	**λ=0.5**	**λ=1**	**λ=1.5**
1	4.743	7.541	10.339
2	2.372	3.77	5.169
3	1.581	2.514	3.446
4	1.186	1.885	2.585
5	0.949	1.508	2.068
6	0.791	1.257	1.723
7	0.678	1.077	1.477
8	0.593	0.943	1.292
9	0.527	0.838	1.149
10	0.474	0.754	1.034

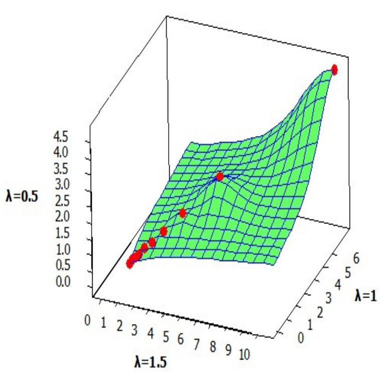

Fig. 1.

Table 2.

λ=0.5; μ=0.9			
c	**θ=0.3**	**θ=0.4**	**θ=0.5**
1	3.069	2.122	1.454
2	1.534	1.061	0.727
3	1.023	0.707	0.485
4	0.767	0.53	0.364
5	0.614	0.424	0.291
6	0.511	0.354	0.242
7	0.438	0.303	0.208
8	0.384	0.265	0.182
9	0.341	0.236	0.162
10	0.307	0.212	0.145

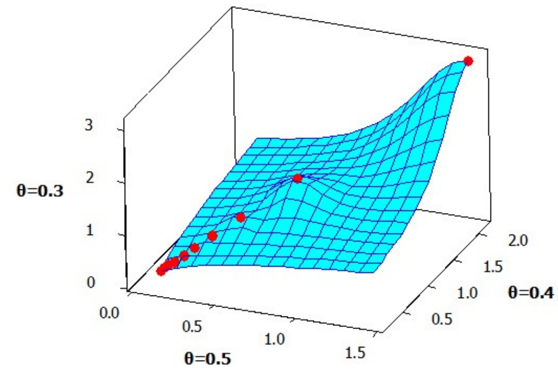

Fig. 2.

Table 3.

θ=0.2; λ=0.5			
c	**μ=1.2**	**μ=1.4**	**μ=1.6**
1	6.183	7.145	8.109
2	3.091	3.573	4.054
3	2.061	2.382	2.703
4	1.546	1.786	2.027
5	1.237	1.429	1.622
6	1.03	1.191	1.351
7	0.883	1.021	1.158
8	0.773	0.893	1.014
9	0.687	0.794	0.901
10	0.618	0.715	0.811

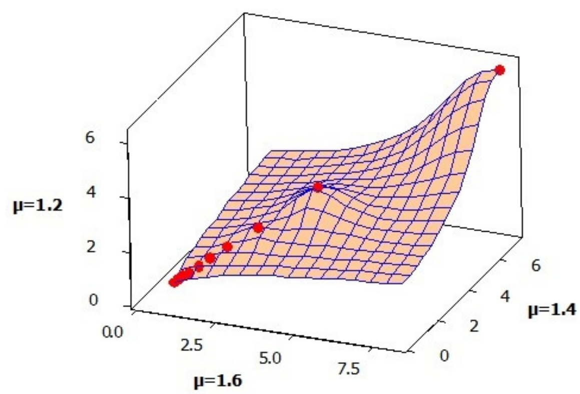

Fig. 3.

IV. FUTURE SCOPE

The limitation of the proposed model is used in theoretically simulation method only, not yet tested in real time data. So in future will going to test in real time Data.

Conflict of Interest. No.

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