Simulation Model for Manpower Planning

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Abstract
Purpose: *The main aim of the research is to develop a simulation model for manpower planning in organizations having pyramidal organizational structures.*
Methodology: *Simulation modeling technique has been used to develop a manpower planning model. A conceptual stock and flow diagram was developed to formulate the transition probabilities and relationship between different grades. Furthermore, seven different equations of the model were developed for all grades of the workforce. In order to implement the model a software application based on the equations of the model was developed to assist HR managers to alter the factors (like accession, promotion and retirement rates) and to analyze the effects on the force growth over long term planning horizon. To test the model a hypothetical assumption was made regarding the desired structure and different scenario based simulations were generated and picked those that yielded the best results.*
Findings: *The test results of the model were quite close to the assumed values of the desired structure that validated the effectiveness of the model.*
Practical Implications: *The model will assist the HR managers of the public sector organizations to attain/maintain the desired strength of the workforce.*

1. Introduction

Max Weber (German sociologist) was the first one to argue about the authority structure of the industrial organizations, since traditionally authority was embedded in inherited status, he stressed upon rational legal authority of the leadership in organizations. Basically, Weber proposed hierarchal bureaucratic organizational structure because he found out analogy between technological rationalization and economic order of the business organization. Similarly, he was also convinced that the same logic will enhance the efficiency of governmental organizations Hatch & Cunliffe (2013). Likewise, till today mostly the organizational structures of public organizations and corporates are pyramidal and the authority flow form the top to bottom.

Public sector organizations structures are generally Pyramidal, new entrant can only be accessed into the system through initial Grade only, lateral entries are not allowed. It has been learnt that most of the public intuitions develop shortages over period of time in different grades due different reasons like inadequate HR planning initiative, lack of contemporary skills in HR planning, and not considering the long-term perspective while inducting new entrants. Which intern acts as a barrier for them in achieving organizational objectives vas well as reduction in organizational performance. The shortage basically reflects the gap between the sanctioned and the existing strength of manpower.

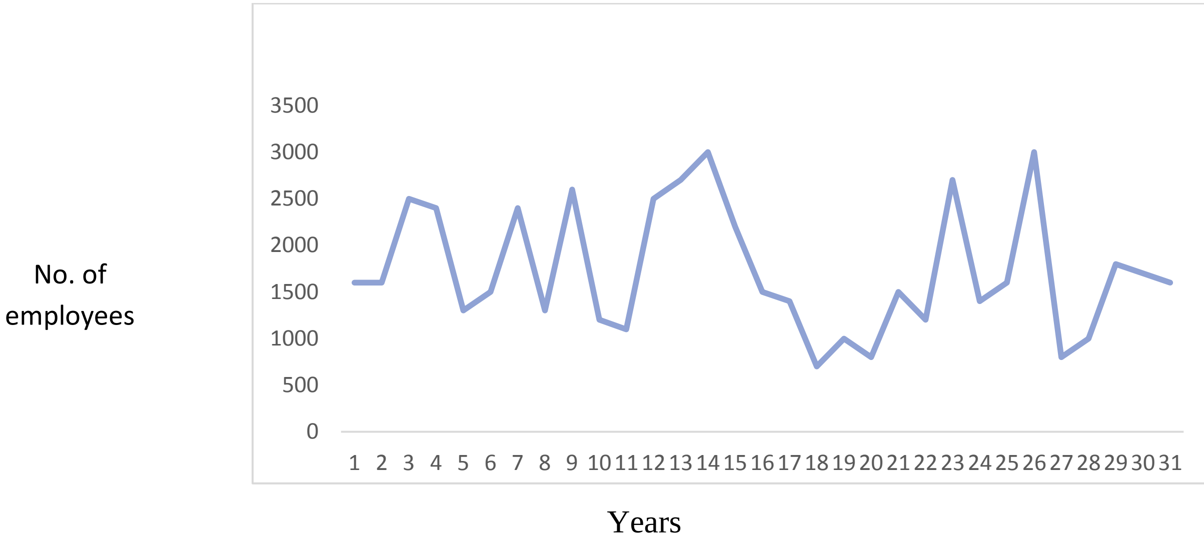
Hypothetical data in the Table 1 below describe the position of a manpower system in 2017, which have been developed over the time span of over thirty years.

Grades	Authorization	Present Stock	Shortage	% Shortage
Grade -1	12500	9137	3363	27
Grade -2	11209	9323	1886	17
Grade - 3	9054	7090	1964	22
Grade - 4	7063	5461	1602	23
Grade - 5	2565	1635	930	36
Grade -6	1510	708	802	53
Grade- 7	1565	1060	505	32
Total	**45466**	**34414**	**11052**	**30**

Table, 1: Hypothetical Data of Manpower System in 2017

The above data shows that appropriate accession to the system has not been maintained over the period of three decades. Though the attrition continued across the system, which resulted in shortages between different grades, it can be assumed that long term view must have been ignored.

Fluctuations reflected in the Graph 1 below could be seen as a result of unplanned accession to the system, this type of approach to manpower planning in the past has served short term purpose only and has generated more gaps between different grades.



Graph, 1: Induction rate of past 30 years (Based on hypothetical data)

Planning for future is the endeavor of every organization and manpower planning is integral part of this process. According to Bayliss, C. Maere, De. G. Jason, A. D. Atkin, A.D.J. & Paelinck, M. (2017) scenario based approach for planning is quite helpful in achieving robust optimisation. Therefore, by generating different scenario for future structure entail the best result to achieve the desired structure. Modern manpower planning approaches entails that simulation models are good for running different scenarios.

1.2 Purpose of Research

The main purpose of the research is to develop a simulation based manpower planning model for public sector organizations, which will help HR managers to address the long term effects of the yearly induction of new employees on the desired organizational structure. Could should shall

1.3 Research Questions

Specifically, the mathematical model has been designed to address the following research questions:

- Can a mathematical model become an effective tool to help the subject public sector organization to estimate the constant yearly induction of new employees?
- If so, then what manpower variables, such as accessions, promotions, attrition and retirement (using inventory grades one-up through one-down of requirement grade) can be leveraged to accomplish that task?

2. Literature Review

Endeavor of every manpower system is to ensure employees with desired skill set and right number are available all the time. The main functions of every manpower system includes recruitment, selection, training, conducting appraisals and planning for future manpower requirements, in order to reduce uncertainty. According to Dellacca and Justice (2007) and Malone (2004) generally manpower issues are dealt through qualitative techniques. In UK in 1937 station's superintendent A. P. Rowe used modern Operational research

(OR) techniques to analyze early warning radar system data for performance improvement and also to map behavior of operating personnel. Generally, OR techniques are referred as various Markov models, linear programming techniques (Goal programming, Integer Programming and Dynamic Programming), System dynamics models and Simulation models. Moreover, in the succeeding paragraphs these approaches have been discussed in detail.

2.1 Markov Models

Russian mathematician Andrei Markov in 1906 published a paper regarding stochastic processes and later on it was termed as Markov chain. Freedman (1983) described Markov process as stochastic, which depends on present state of the system, means the desired future state of manpower system will depend on the present state. Nilakantan and Raghavendra (2005& 2008) model was based on Markov process and used proportional recruitment to address the structural issues of manpower. Likewise, Cai, Li and Fengsheng (2004) solved the issue of two different jobs through stochastic process by using Markov process approach. Georgiou and Tsantas (2002) provided solution to manpower demand by developing Markov chain model based on internal mobility and recruitment.

Dimitriou ,A.V., Georgiou ,C.A., and Tsantas, N. (2013) have used Markov process to model manpower planning, while doing that they used transition probabilities to cater for intra/inter departmental transitions very effectively. They also utilized the model to control recruitment and transfer of employees to other departments in order to achieve desired manpower structure.

Valevaa, S., Hewittb, M., Thomasc, W.B., and Brownd, G.K. (2017) developed deterministic model to manage workforce capacity, flexibility and inventory. They have observed that cross training could be used to address the workforce demand uncertainty, which results improved task assignments for workers. They have also proposed that to deal the stochasticity in demand for longer future forecasts Markov process could be used.

These models are stochastic in nature and Markov process takes existing state of the system as a reference matrix and considers the existing relationship (referred as transition probabilities) between different manpower planning variables. Thus Markov models generates output for desired manpower structure from the existing state of the system.

2.2 Linear programming Models

In the umbrella of linear programming models an objective function is considered as a desired outcome, which is based on the different constraints. Objective function of ***integer programming*** models use different variables as integers and generates binary decisions to manpower problems at hand. Integer programming technique has been utilized by Sawik (2010) to address issue of scheduling different jobs, all the decisions variables used in the model were binary in nature.

Conflicting deviations from the goal are objective function in ***goal programming*** techniques and objective functions is generally to minimize the deviations from goals, in this regard weights are given to deviations. Cashbaugh et al. (2007) used goal programming to achieve desired manpower structure for Army enlist manpower system and used promotion and separation as constraints in the model. The issue of crew scheduling and gaps among shifts was addressed by Chu (2007) through goal programming model.

Dynamic programming technique is quite interesting in a sense that basically problem is divided into small portions to develop simple solutions. Sun, J., Li, Y. and Tu, F (2005) developed a manpower planning model for employee leasing company in their study transformed stochastic constraints into deterministic constraints and developed optimal control model to deal with the manpower planning problem in an employee leasing center.

Li, Chen, Cai and Tu (2009) solved employee cost related problem through dynamic programming and recommended that every employee should serve for certain minimum period before he retires in order to justify the cost related to recruitment, dismissal and salary. Nirmala and Jeeva (2010) also developed model similar to

Li, Chen, Cai and Tu (2009), they took total cost as objective function and the main aim was to minimize cost incurred to the organization while recruiting and promoting employees. Caia, Laib and Lib. (2010) used jobs ranking technique and addressed the problems of recruitment/attrition, cost and employee replacement through dynamic programming model by dividing main issue into four small issues.

Yang, T.I., and Chou, J.S. (2011) presented multi-objective staff to job assignment optimization model for employees of the consulting engineering firms to maximize profit/minimize workload and to minimize overtime/maximize utilization percentage.

Mohsen, A., Majd, K., Mahootchi, M., & Zakery, A. (2015) in their paper studied the human resource planning issue together with the production inventory control to calculate the right number of workers with right skill level for production and training through objective function to maximize profit levels.

The under-manning/over-manning problem of manpower planning was excellently dealt by Francesco, D.M., Llorente, D.M.N., Zanda, S., & Zuddas, P. (2016) for transhipment container terminals workforce. Basically they used integer linear programming to model the issue and adjusted the shift pattern of employees in such a way that it didn’t conflicted with the serving of the vessels, results were compared with the decisions of actual transhipment container terminals organization.

2.5 System Dynamics Models

Models based on system dynamics approach are popular in developing policy framework for manpower systems. These models are not preferred for estimating future manpower numbers. However, they are generally used to get feedback regarding certain policy.

Narahari and Murthy (2009) developed a model by considering system dynamics theory for estimating talent requirements for IT companies. Ng and T.S.A (2011) noted that models based on system dynamics could be used to understand the behavior of manpower planning systems. Likewise, it has been observed by Mutingi (2012) that recruitment and training strategies for manpower could be modeled through system dynamic approach in changing environment. Jiang (2013) used use system dynamics approach to understand the manpower cost attached to the implementation of new technology.

2.6 Computer Simulation Models

According to the Oxford dictionary meaning of simulation is ‘imitation of a situation or process’, it has been noted that to understand complex systems simulation are used as a tool, furthermore are also used for validation of decision already taken. Many academics for example Banks, Carson, Nelson, and Nicol (2000), Law and Kelton (2000) and Schriber (1991) stress on the usefulness of simulation in their writings. They identify in their work that simulations are good for problem identification, for answering what-if questions and to conduct bottleneck analysis.

Armed forces fancy simulation models a lot and use these models for simulating different battle field scenarios in military exercises, to understand result of policy changes on officers and training. Law and Kelton (1991) Banks (1998) Mooz (1970) and McGinnis et al. (1994).

Bazargan, L.M, Gupta, P. and Young (2003) highlighted the significance of computer simulation model used at Continental Airline for maintaining shift schedules for technicians. Miller & Haire (2006) modelled hieratical reporting process of employees to a single supervisor through computer simulations. Bazargan & Jiang (2010) have prepared simulation model for Air Tran’s aircraft maintenance process, the model simulates the routine maintenance activities performed by its maintainers at International Airport Atlanta USA by maintenance department of Air Tran’s.

Yu , M., Ding ,Y., Lindsey,R., and Shi,C. (2016) examined the workforce scheduling problem at Peace Arch (one of the major U.S.- Canada border crossings) with an aim to reduce time delay at the border crossing and used simulations to improve the time delay without increasing work hours of the employees.

Every organization has different organizational design and objectives, but public organizations around the world have generally pyramidal designs and have large number of grades in hierarchy. Furthermore, the policy frame work also varies, which depicts the relationship of different grades and the specific complications.
The models based on Markov chain approach and other mathematical techniques have certain protocols, which are necessary to be inculcated in the model for validation purpose. Moreover, their mathematics is not system specific, which is not the case for simulation models. They are very system and problem specific, therefore simulation modelling techniques have been used to develop a manpower planning model for the public sector organizations. This model will be generic, which could be used by any organization having pyramidal organizational structure.

3. Methodology

The issue of present shortages in the manpower of a public sector organizations results from the cyclical induction pattern in the past, which demands an estimate of constant yearly induction of new employees to finish the shortages. To peruse this particular inquiry quantitative techniques have been used and simulation model has been developed to help the HR planners to forecast the constant yearly induction over long term planning horizons. The organizational structure is hierarchal and composed of seven different grades, accession to the system can only be made as a new entry in grade I only. Transition probabilities have been calculated from past data of manpower variables. These variables have been used to create the model equations. And on the bases of that different scenarios were run by fiddling with the manpower variables such as accession, promotion and retirement, keeping in the policy ranges of these variables. This resulted in constant yearly induction rate for new entry employees in grade I.

3.1 Research design

The design is descriptive because according to Creswell (1994) descriptive method of research is about collection of information regarding the existing condition of the system. As in the case of the subject organization first of all the nature and amount of the manpower has been described and the Table 1 above clearly depicts the shortages in different grades. In the same light the nature of the situation further entails that the new induction since three decades has been cyclical as shown in the Graph 1 above. Which clearly indicate that shortages were caused by the ad hoc new entries in the past without conceiving the long term perspective of desired structure?

The causation is deterministic as explained earlier that the cyclical nature of new induction caused shortages in the different grades, since the organizational structure is such that new employees can enter the system from grade I only and the system is push flow till grade III and then on wards it is pull flow.

3.2 Research method

The method for the research is quantitative in nature and primarily based on mathematical techniques. Simulation modeling was considered quite pertinent in the subject inquiry and to addressed the particular issue deterministic simulation model was developed, since the parameters of the manpower system were already identified clearly.

Basically there were two issues, the first one was the identification of transition probabilities between different grades by considering existing policy framework of the system. The second one was to achieve and maintain the desired structure.

The stock and flow diagram was prepared to describe the structure of the system and to identify the relationship among different grades and the respective transition probabilities, which turned out to be quite help for development of the model. Seven different equations were developed for all the grades and to test scenarios user application was developed to pick the best results, in order to address the attainability of the desired structure.
In order to test different scenarios, live the application has been made very user friendly and easy through a user interface. The users have been provided front end forms to input data and test different scenarios, in order to

addressed attainability/maintainability of the desired structure. The users are testing in the live environment and get the results of testing instantaneously.

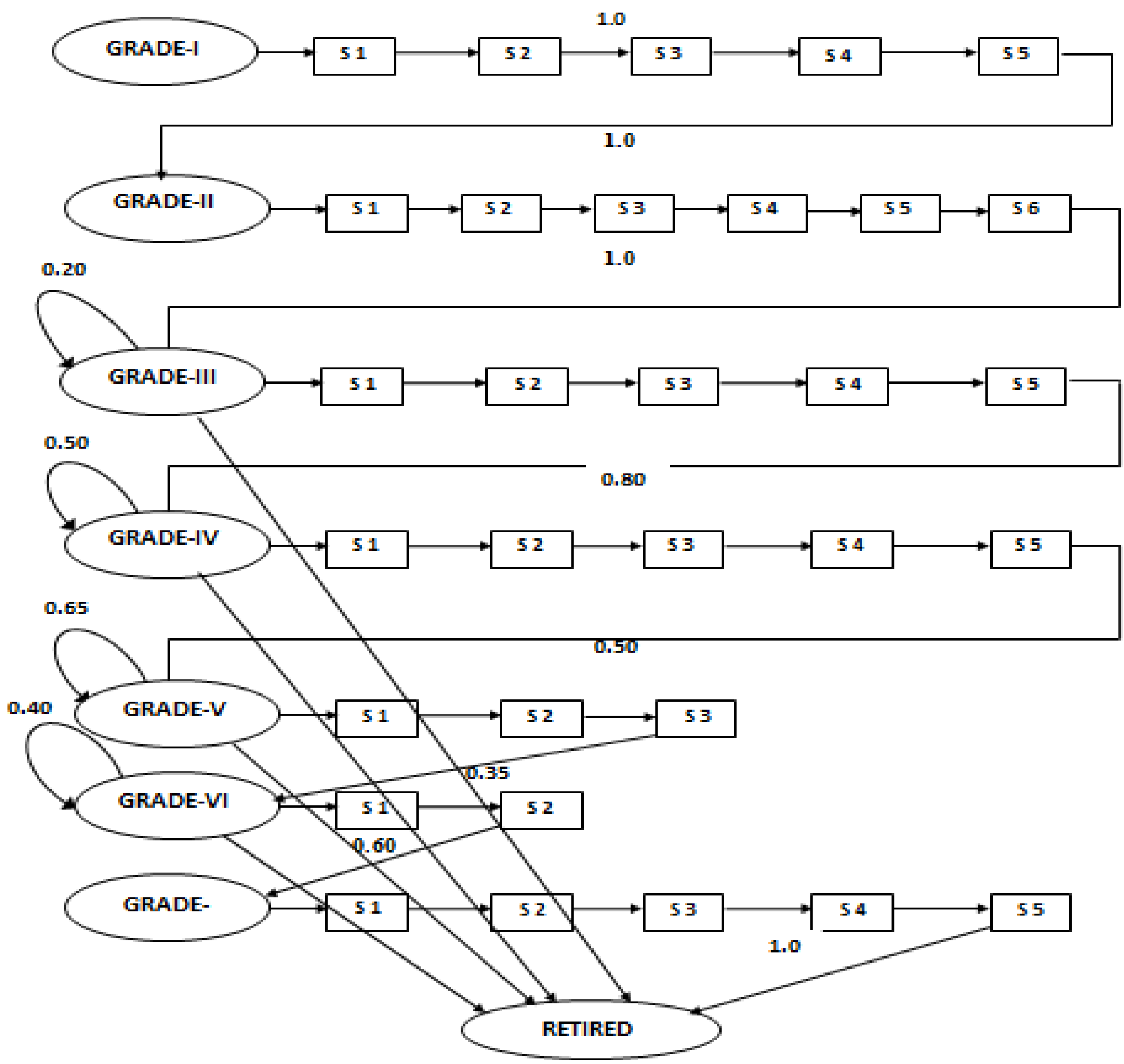
The model was validated by assuming hypothetical scenario that if organization wanted to double its manpower strength over next 25 years, then how many new entrants be inducted every year? Simulations were generated by using existing manpower data and different scenarios were tested, best results were picked to achieve the desired structure.

3.3 Data collection

Historic data (hypothetical data) regarding accession, attrition, promotion and retirement was used to calculate transition probabilities among different grades. Future projections for manpower were estimated from the data and substantial gaps were found between authorize positions and estimated numbers.

4. Model Formulation

The structure of the manpower was described through the under mentioned stock and flow diagram. Basically it explains the relationship and transition probabilities between different grades of the system, which provides conceptual foundation for the development of the model.



Figure, 1: Stock and flow diagram of the workforce

As par flow diagram the new entrants enters the system through Grade -1 and transition between Grade -1 and 2 are 100% after subtracting yearly attritions from the system but for Grade -3 and above the transition probabilities are shown in Figure 1 above. Furthermore, for Grade -3 and above the deductions are made on the basis of attritions and retirement variables.

4.2 Description of Model

Manpower system comprised of seven different grades, starting from the Grade-I and finishes at Grade-VII; complete detail is in Table 2 below:

GRADE	STAGES/YEARS
I	5
II	6
III	5
IV	5
V	3
VI	2
VII	5

Table, 2: No. of years in a grade

There are seven grades, ‘g’, starts from lower level grade i.e. garde -1 to uppermost grade- 7. numbered in sequence with the base level grade as 1 and the uppermost grade as 7. The ‘t’ represents time vector, for t = 0, 1, . . . , T , with t = 0 representing the initial point of time.

The model starts with a personnel stock vector **‘X’** describing the number of employees in the organization. This personnel vector, **‘X’**, is indexed by:

g	Grades ∈ {1 . . . 7}
s	stages (s=no. of years in a particular grade)
t	time ∈ {0 . . . T}

with t = 0 providing the initial starting conditions for the strength of the workforce .Thus the stock vector **X g,s,t** describes the number of employees in grade **‘g’** at stage **‘s’** in time (or period) **‘t’** .

The data or endogenous variables are:

X g,s,t	Accessions
L g,s	Attrition
D g,s	Discharge
P g,s	Promotions
R g,s	Retirement

4.3 Model Equations

Following are the equations for calculating number of employees in each grade, the personnel stock vector depends upon the other variable such as attrition, promotion, discharge and retirement.

Grade - I

$X_{g,t+1} = \sum_{s=1}^{5}(X_{g,s,t-1} - L_s - D_s - P_s + P_{s-1})$ P_o : new induction

Grade- II

$X_{g,t+1} = \sum_{s=1}^{6}(X_{g,s,t-1} - L_s - D_s - P_s + P_{s-1})$

Grade- III

$X_{g,t+1} = \sum_{s=1}^{5}(X_{g,s,t-1} - L_s - D_s - P_s + P_{s-1}) - Rg,s$

Grade- IV

$X_{g,t+1} = \sum_{s=1}^{5}(X_{g,s,t-1} - L_s - D_s - P_s + P_{s-1}) - Rg,s$

Grade- V

$X_{g,t+1} = \sum_{s=1}^{3}(X_{g,s,t-1} - L_s - D_s - P_s + P_{s-1}) - Rg,s$

Grade- VI

$X_{g,t+1} = \sum_{s=1}^{2}(X_{g,s,t-1} - L_s - D_s - P_s + P_{s-1}) - Rg,s$

Grade- VII

$X_{g,t+1} = \sum_{s=1}^{5}(X_{g,s,t-1} - L_s - D_s - P_s + P_{s-1}) - Rg,s$

5. Data Analysis and Results

The baseline data for all the grades is shown in the Table 2 below, it has been used for calculating all future estimates of the manpower. Past data regarding attrition, promotion and retirement rates have been used to establish transition probabilities between different grades mentioned in the table below:

	PRESENT STOCK	RATE OF LOSSES	RATE OF DISCHARGE	RATE OF PROMOTION	RATE OF RETIREMENT
GRADE - I	9137	10%	5%	100%	-----
GRADE - II	9323	10%	6%	100%	-----
GRADE-III	7090	-----	5%	80%	20% (AFTER COMPLETING 16 YEARS OF SERVICE)
GRADE-IV	5461	-----	2%	50%	50% (AFTER COMPLETING 31 YEARS)
GRADE-V	1635	-----	-----	65%	35% (AFTER COMPLETING 21 YEARS)
GRADE-VI	708	-----	-----	60%	40% (AFTER COMPLETING 26 YEARS)
GRADE-VII	1060	-----	-----	-----	100% (AFTER COMPLETING 31 YEARS)
TOTAL	34414	-----	-----	-----	-----

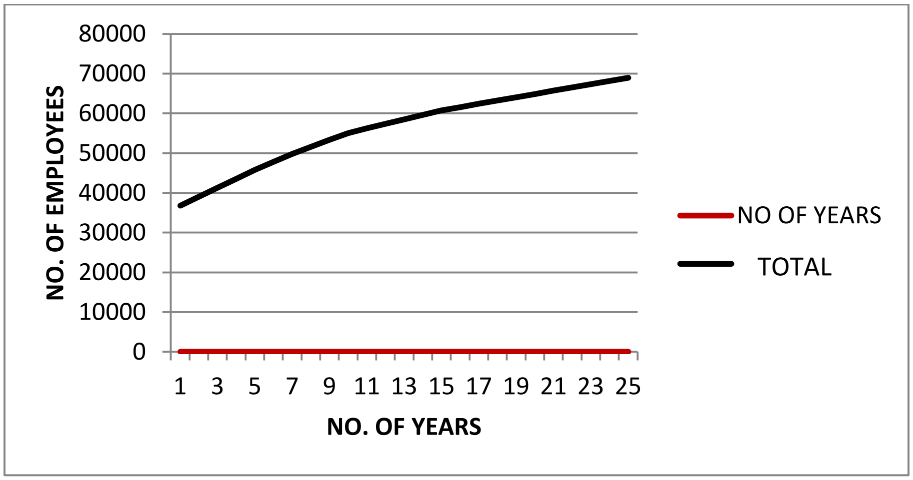
Table, 3: Statistics of previous average losses/discharge/promotion and retirement rates (Hypothetical data)

5.1 Testing the Model

To test the model hypothetical assumption has been made that if the organization wanted to double its lower level workforce strength over next 25 years then how many new employees would be inducted every year.

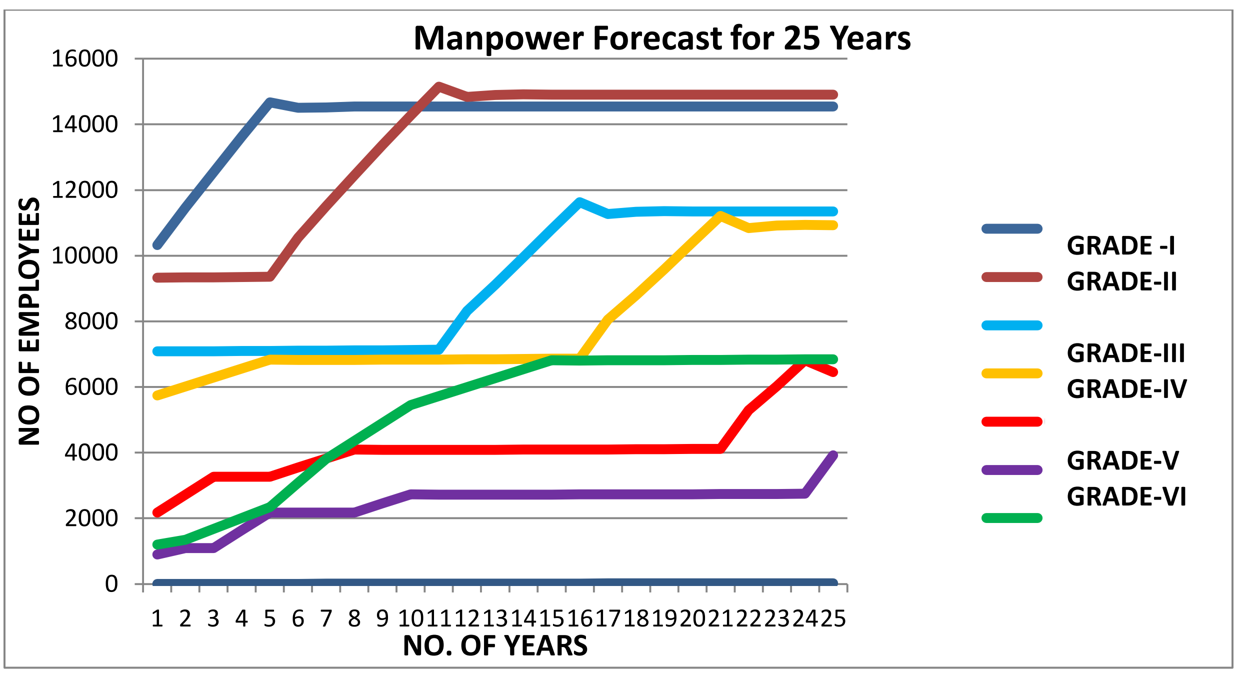
5.2 Results

Hypothetical data presented in Table 1 above was utilized as a base data to run different scenarios simulation. The results are presented in the following graph.



Graph, 2: Double the workforce over next 25 years

The Graph 2 above entails the results generated from the simulation software, which is based on the mathematical equations of the model. The results entails that if 3175 new employees are inducted every year for next 25 years then the manpower can be doubled as assumed. The Graph 3 below depicts the grade wise forecast pattern for all the grade, it shows that how in different grade linearly the manpower numbers stabilize.



Graph, 3: Manpower forecast for 25 years

Table 4 depicts yearly results of the scenarios based simulations spanned over 25 years. In the lower grades the increase is approximately 40%, whereas in the senior grades there is two to three folds increase.

NO OF YEARS	GRADE-I	GRADE-II	GRADE-III	GRADE-IV	GRADE-V	GRADE-VI	GRADE-VII	TOTAL
1	10319	9329	7090	5739	2180	899	1202	36759
2	11465	9336	7091	6014	2725	1090	1344	39067
3	12550	9344	7093	6286	3270	1090	1677	41310
4	13626	9351	7097	6558	3270	1635	2010	43547
5	14668	9360	7101	6830	3270	2180	2343	45752
6	14504	10544	7105	6824	3548	2180	3079	47783
7	14521	11514	7110	6825	3820	2180	3815	49785
8	14546	12446	7115	6827	4092	2180	4360	51565
9	14542	13375	7120	6831	4086	2458	4905	53317
10	14542	14272	7126	6835	4086	2730	5450	55041
11	14542	15150	7134	6839	4086	2724	5728	56204
12	14542	14836	8316	6844	4087	2724	6000	57348
13	14542	14894	9120	6849	4089	2724	6272	58489
14	14542	14914	9950	6854	4093	2724	6544	59620
15	14542	14906	10798	6860	4096	2725	6816	60743
16	14542	14907	11626	6868	4098	2727	6810	61578
17	14542	14907	11270	8050	4100	2730	6811	62411
18	14542	14907	11343	8794	4103	2732	6813	63235
19	14542	14907	11359	9586	4108	2732	6817	64051
20	14542	14907	11351	10405	4112	2734	6821	64871
21	14542	14907	11353	11211	4117	2737	6825	65691
22	14542	14907	11353	10843	5296	2740	6830	66510
23	14542	14907	11353	10923	6026	2743	6835	67328
24	14542	14907	11353	10938	6819	2746	6840	68144
25	14542	14907	11353	10930	6459	3924	6846	68960

Table, 4: Yearly forecast spanned over 25 years generated through the simulation software

5.3 Attainability/Maintainability of desired structure

The scenario based simulation were generated by proving different policy frameworks regarding accession and promotion. Table 5 below shows the results to attain the desired structure in 2024 by taking 2017 as base year.

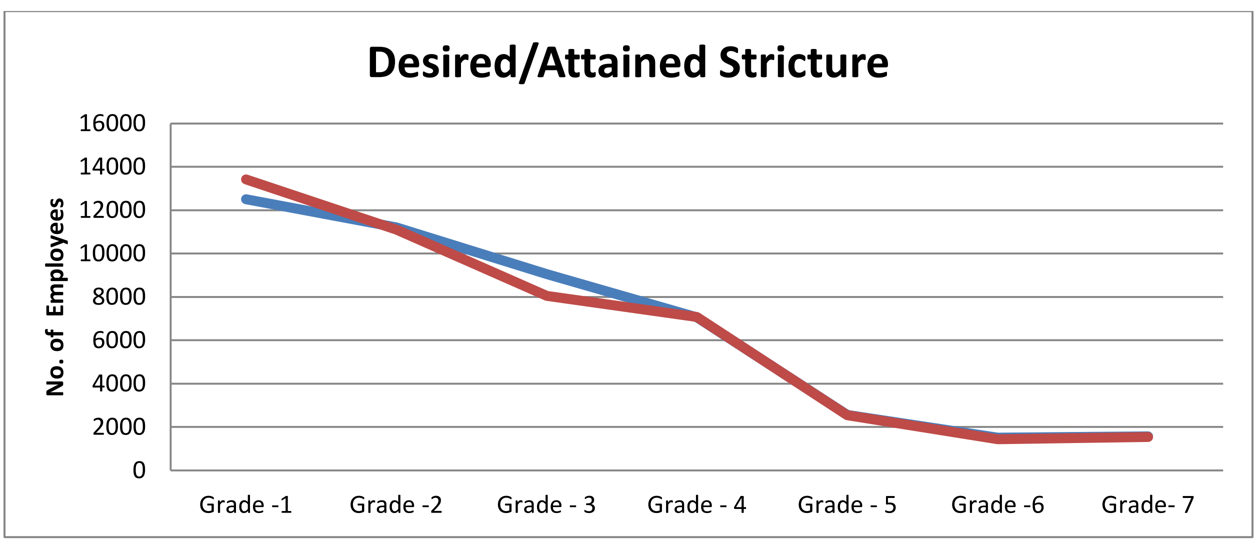
Year	New Entry	GRD-I	GRD-II	GRD-III	GRD-IV	GRD-V	GRD-VI	GRD-VII	TOTAL
2017	2000	9137	9323	7090	5461	1635	708	1060	34414
2018	3500	9894	9597	7225	5743	1893	899	990	36241
2019	3500	10789	9780	7360	6014	2014	1090	990	38037
2020	3500	11688	9857	7495	6286	2208	1090	1111	39735
2021	3500	12653	9764	7630	6557	2106	1348	1111	41169
2022	3500	13712	9527	7765	6828	2161	1469	1232	42694
2023	3500	13348	10657	7770	6952	2414	1405	1560	44106
2024	3500	13422	11098	8044	7082	2551	1439	1544	45180

Table, 5: Attainability of desired structure

The output of the forecast regarding attainability of desired structure in 2024 together with the % difference in each grade is clearly indicated in Table 6 below. It has been noted that the maximum difference is in Grade 3.

Grades	Desired Structure (2017)	Attained Structure (2024)	% Difference
Grade -I	12500	13422	7
Grade -II	11209	11098	1
Grade - III	9054	8044	11
Grade - IV	7063	7082	0
Grade - V	2565	2551	1
Grade -VI	1510	1439	5
Grade- VII	1565	1544	1
Total	**45466**	45180	-

Table, 6: Difference between the desired/attained structures 2017/2024



Graph, 4: Desired/Attained structure

6. Discussion

In the paper a case of organizations having pyramidal organizational structures (*public sector organizations)* has been considered in the notion of manpower planning is treated in the framework of operational methods. To achieve this simulations modeling technique was considered quite practical and manpower system was modeled through mathematical notations. Then these equations were utilized to forecast the future desired structure. The existing manpower numbers in different grades were taken as a base line and the desired structure was calculated by running different scenarios based simulations.

Firstly, the policy regarding accession, promotion and retirement was studied, historic data was used to find out the relationship and different transition probabilities between the grades. The concept of transition was modeled form Dimitriou, A.V. Georgiou, C.A. and Tsantas, N. (2013) as they used transition probabilities in their study to cater for intra/inter departmental transitions very effectively. Than on the bases of constant yearly induction future desired structure was forecasted, lot of gaps were found between the desired and actual results. To understand the system, a stock and flow diagram was prepared, which provided foundation for the model.

Mathematical equation for each grade was developed encompassing the variables accession, attrition, discharge, promotion and retirement. The equations were the practical depiction of the real manpower system, moreover these equations were converted into computer software and was used to run the scenario based simulations. The problem of attainability/ maintainability was also addressed through the scenario based simulations. According to Nilakantan and Raghavendra (2005) the induction in the lowest grade is important, since it is very critical for expansion of system and to adjust promotion and retirement policies. For practical application of the model the HR managers of the public sector organizations could adjust the new induction by running different scenarios for future structure accordingly. The software could be a very handy tool to check the various polices regarding promotion and retirement etc. from time to time.

Generally, in public organizations the induction is from the lowest grade, after completing certain time in a grade, qualify different courses and the average of yearly appraisal scores acts as a yardstick for promotion to the next grade. Thus the desired future structure depends upon the yearly induction of new employees. Research of Yu, M., Ding, Y., Lindsey, R., and Shi, C. (2016) provided impetus to use simulation model to solve the issue of finding exact new induction numbers. The results exhibited that exact structure can't be maintain, since the transitions probabilities were set on the previous data regarding attrition, discharge, promotion and retirement rates. Likewise, to maintain the attained structure running scenario base simulations was a viable option, which allowed adjusting the polices of promotion and retirement accordingly to keep the manpower numbers close to the ideal.

7. Conclusion

The subject paper has been developed to address the manpower planning issues in the organizations having pyramidal organizational structures *(public sector organization)*, simulation modeling approach has been used to address the issue. Hypothetical data has been utilized for calculations, validity of the model has been check through hypothesis that if organization wants to double its manpower over next 25 years. Then what would be the new induction numbers every year.

Scenario based simulations were used to achieve the desired structure by calculating the constant yearly induction. Likewise, the maintainability of the structure was also achieved through the simulation. The simulation application will be very good tool for the HR planners for future policy making.

7.1 Recommendations

Following recommendations have been made:

- For development of future policy regarding new induction, promotion and retirement different future scenarios could be test in planning phase.

- Issues related to the attainability/maintainability of desired structure could be solved through scenario bases approach.
- The over manning/ under manning issues could be addressed through simulations.
- The effectiveness and implication of the existing polices could also be check by building different scenarios and calculating the results through software.

7.2 Limitations

The basic limitation was the access to the past data regarding accession, attrition, promotion and retirement. Similarly, it was difficult to establish transition probabilities for different grades exactly according to the Markov process, which was dealt through stock and flow diagram.

7.3 Ideas for Further Research

The model could be used for induction of diverse groups in different public sector organizations.

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