Organizational Demographic Management: A System Dynamics Model

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ABSTRACT

Nowadays, organizations need to pay much attention to the subject of human capital management in order to progress and succeed in competitive and variable business environment. One of the topics discussed in human capital management, which has an important role in processes of organizational growth and development and resources allocation, is the issue of organizational demographic composition and the study of its characteristics e.g. size, aging chain structure, and staff education. This issue becomes more important especially for service-based organization such as banks that manpower is their main capital. In order to increase effectiveness and efficiency in these organizations, this issue should be analyzed with a holistic approach. In a systemic view, Staff educational demographic should be distributed in form of a chain of consecutive educational levels in which the number of people is determined in balance with jobs and grows based on organization needs. Due to the influence of each component of this dynamic chain on the next one, policies and decisions which could guarantee their appropriate and balanced growth are of great importance. This research has been carried out in a commercial bank in Iran as a case study to analyze the dynamics within its Staff educational demographic, and for this purpose a dynamic model is developed based on system dynamics. In this respect, various scenarios regarding different policies are simulated by VENSIM software, and the results of adopting these policies are analyzed both qualitatively and quantitatively.

Keywords: *Organizational Demographic, System Dynamics, Human Resource Management, Staff Educational Demographic*

I. INTRODUCTION

Today, due to the existent variable business environment, the future of organizations is somehow unpredictable, and managers are confronted with a lot of challenges. System dynamics approach could help managers to pay attention to cause and effect relations, analyze various decision scenarios, observe trends of system components in different time frames, find out improvement policies, and finally achieve a better understanding of the system.

No one is unaware of the role of studying the structure of educational demographic in economic and social planning in long term. Regarding the variable trends in monetary and banking businesses, senior managers need to expand their knowledge about the quality and quantity of human capital structure and its dynamics. By a systemic view, they would be able to adopt right policies in connection with the development of organization human capital in long term.

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The most important action to do in the present situation is adopting a comprehensive policy and holistic view in which more than just staff recruitment and promotion issues are noticed. Here not only we should consider the rate of employment and its fluctuation during service processes related to Staff educational demographic, but also we should regard the efforts to improve the condition of human capital in terms of enhancing skills through education and adopting reasonable policies to prevent disruptions in educational demographic.

In order to deal with current instabilities in the business environment, human resource managers need to pay much attention to suitable approaches and staff's educational dynamics to cause any growth. Lacking a systematic view about educational demographic might even lead to many challenges.

Structure of staff's composition in an organization can be studied via statistical information within the organization; however, given the widespread growth of organizations and their sophisticated architecture and dynamic conditions, it is necessary to do analysis and increase awareness about staff's composition.

By adopting policies based on system dynamics, senior managers of human resource can organize the educational demographic of their organization by dynamically evaluating and analyzing different phenomena such as recruitment, training, education, and promotion in such a way that they would be able to provide prerequisites for future development planning. In the meantime, due to banks' variable working conditions, it is important for their managers of human resource to have a different perspective about their Staff educational demographic. Regarding the significance of responses to changes, environment prediction, and making effective decisions about the future, human resource management should have a holistic and systematic view towards this issue.

This research offers a dynamic model for analyzing the organizations educational demographic based on a structured approach. For this purpose, after reviewing the literature and identifying status quo and processes related to current staff's structure, effective factor in designing of a bank's educational demographic model are identified. Then, the system dynamics model is prepared according to real system structure, and the effect of using different policies on the body of educational demographic are examined in accordance with decision scenarios.

In fact, it can said the most important purpose of this research is to identify the feedback loops and leverage points in Staff educational demographic and also, to analyze the dynamic and nonlinear outcomes of implementing different decision policies in form of scenarios which would finally result in a decision support system for banking organizations' human capital management.

II. LITERATURE REVIEW

Extensive researches have been carried out regarding the studies of demographic structure on human-centered and service organizations and also, human resource management and its subdomains. Generally, the studies related to human resource management and personnel training can be divided into two categories. The first group includes the researches in which the main approach they apply in employees planning is based on mathematical and statistical models. The most important feature of these types of models are their static behavior. In this type of planning, training programs are designed and implemented commensurately with the predicted number of jobs in the future.

The use of statistical prediction tools and the study of various trends leads to a behavioral analysis of past historical data which would be consistent and appropriate as long as none of the paradigms of business environment are changed, and also, no discontinuous mutation

during the planning time window has occurred. In fact, it can be said that plans which are designed based on this approach will be much event-oriented.

In another approach for planning in organizations, dynamic and flexible schemes are used. Based on structural analyses, this method tries to attribute the behavior of a system to its intrinsic structure. If the productive structure of dynamic behavior could be identified, then control and management of the system would be much possible.

The main feature of educational planning models of these approaches are their dynamism and flexibility. So that they have the capability to monitor changes over time and are also robust and stable against the occurrence of unexpected events and changing of paradigms in business environment in terms of acceptance and accountability towards flexible changes and also, sustainability and reactiveness.

Ratna and Chawla [1] expressed definitions and applications of this approach in human resource planning. Bahrami et al. [2] used system dynamics approach to determine guidelines and factors influencing the evaluation of educational groups. By presenting a dynamic model and changing its parameters, they evaluated the impact level of model variables on quality of educational groups and generalized this model for the use of other organizations. Ahmad Dardar et al. [3] examined the effect of training, job satisfaction, and availability of job opportunities on the trade volume of petroleum companies in Libya. Aburawi and Hafeez [4] examined dynamics of human resource and knowledge management in organizations through system dynamics approach. They believe that human resource management in organizations is a key sector of any organization and its related process and functions should be considered holistically as a system. Also, it was demonstrated in this research that system dynamics approach can be used to analyze issues in the field of human resource management such as training, staff deficit or surplus, etc. Using this model, they were able to develop human resource strategies and create optimal guidelines and reduce unfavorable scenarios related to staff. In the field of human resource management, Pejic Bach et al. [5] presented a dynamic model for personnel's human resource management with abovementioned conditions in knowledge-based organizations. In this research, system dynamics approach were used to help make strategic decisions in providing intellectual services. Sveiby et al. [6] designed a flight simulator model to develop knowledge-based strategies in Australian federal public service for better understanding the dynamics of existent interactive relations, and they analyzed the relation between organization profitability and investment on internal structure of organization to make more competent employees to create value added capacity.

Iatagan et al. [7] named human resource as the main component of competition in today's global economy and considered quality and initiative of human resource as equally important as computerization for economy. In this research, it has been mentioned that European countries give much attention to continuous training of personnel and consider it as very effective in organizations' development. Narahari and Narasimha [8] analyzed dynamics of enterprise resource planning in active organizations in the field of information technology.

Liu et al. [9] regard human resource management as a complex system, due to existence of multiple information feedbacks and delays in its structure, and they believe that making better judgments and decisions in this area requires an analytical view of this system. They combined the principles and methods of implementing such systems in order to achieve a basic model for making right decisions, and they also used the methodology of system dynamics to face uncertainties. Many researches have been done on issues of optimization modeling [14], [15], [16], [17], [18] and [19], [20], [25], [26]. Also using system dynamics approach for same problem modeling is common [21], [22], [23], [24], [27], [28], [29].

III. RESEARCH METHODOLOGY

There are several approaches to review and analyze the dynamic behavior of systems related to human resource, but the methodology chosen for this research is system dynamics, because of its extensive application in the field of human resource management.

This methodology was first created by J. W. Forrester at MIT in 1950. After a while, the application of this method extended to be used in other sectors of industry. System dynamics can pattern different aspects of a problem, and it is an effective method of analyzing a system by simulation [10]. It can also elucidate the unspecified or unexpected outcomes of a decision and help us with understanding complex systems. System dynamics may be used for testing different scenarios with a systemic view of the problem. So, it allows the decision maker to simulate and test his proposed policies and to see long-term outcomes of implementing each policy before making his final decision [11].

In order to solve a problem by means of system dynamics we need to pursue five steps below:

1. Identifying and defining the problem
2. Mapping causal loop diagrams
3. Developing the mathematical model (stock and flow diagram)
4. Model simulation and validation
5. Scenarios generation and evaluation, then selecting and implementing the most appropriate solution

Forrester believed that system dynamics has joined the human mind capability to modern computers' power. In the first steps of developing the model, in order to specify the appropriate variables and possible feedback iterations, we need creativity of a human mind. Computers are employed to elucidate the unexpected outcomes emerged from complexity and dynamic behavior of the system; because predicting the feedbacks and nonlinear impacts of decision variables in complex systems would be too difficult for humans. People often consider the relations among variables as linear in order to predict the outcomes which can clearly lead to wrong inferences [30].

System dynamics is often employed to analyze complex social and economic systems; as these systems dynamically change due to many unknown causes. Sterman [12] describes the steps of system dynamics modelling according to figure 1.

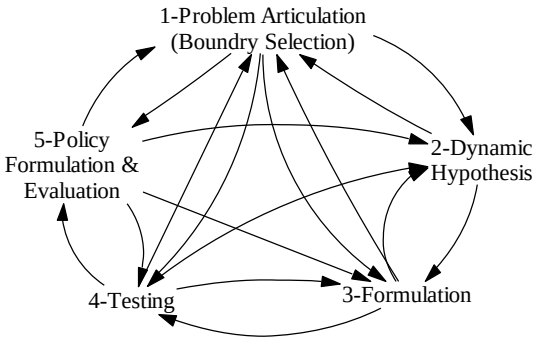

Figure 1-Iterative and cyclic feedback process of modelling based on system dynamics methodology [12]

As it can be seen from figure 1, this modelling is not a linear sequence of steps, but it is a feedback process. This modelling process is iterative and cyclic, so it improves our understanding of the problem in each iteration by providing more and more feedbacks [12].

Wolstenholm [13] believes that through analyzing human systems by system dynamics approach, one can gain a good insight of their performance even without help of computer software.

This approach is a continuous simulation method which make it possible for model developers to see system's behavior and changes of values, quantitative data, or state variables over a specific period of time under different policies. System dynamics models use *what if* approach to determine optimal policies for human systems. This methodology helps managers with identifying important rules of decision making and shows them how to continuously improve policies to achieve their long-term goals in human resource management [14].

IV. DYNAMIC MODELLING

4.1. Problem Statement & Dynamic Hypothesis

The new structure and recent changes of our case study, the commercial bank, including the sale of shares in stock market, acceptance of corporate governance, improvements in productivity and other performance indicators, competition in national monetary and banking market, move towards modern banking e.g. e-banking, corporate banking, private banking, virtual banking, as well as active presence in international currency market have all led to many new open positions and new jobs in the organization.

In response to these wide range of changes, and in order to make suitable arrangements for new defined jobs, there is an obvious necessity for appropriate training and educational planning for the staff in all sectors of organization. Plus, new effective mechanisms are needed in order to increase organizational learning. Additionally, as a result of shift from a branched service-oriented retail bank to a great service corporation, the set of employees' skills must be expanded. If financial majors and specialties sufficed before to manage bank affairs, now with expansion in the scope of bank's activities, graduates from new interdisciplinary fields seem to be required. In the past, according to the type of activities in branches, lower levels of education were sufficient for the established positions or jobs e.g. high school diplomas, associate's degrees, or bachelor's degrees. However now, regarding the emerging new paradigms in banking industry, there is a need for the presence of highly-educated people with master or even PhD degrees.

Considering the trend of higher education system during the recent years, we find that due to the heavy number of graduates in recent years, the proportion of the graduates with a master or PhD degree to the graduates with an associate's or bachelor's degree has increased. However in most of organizations, despite fundamental changes in the nature of activities, jobs suitable to abilities and skills of new employees are not designed, and allocation of personnel is often disproportional which has had a significant negative impact on organizational growth and its productivity.

Now, given the existent paradigms and great desires in staff for studying in higher education levels, we need to see whether today's organizations have a robust plan to expand knowledge of their employees, if they have mechanisms and policies to control their educational demographic, and whether they are able to reconcile their educational demographic with requirements of new jobs in long-term and to be ready to face the changes in business environment?

In fact, obtaining a proper and proportionate educational demographic for playing new roles in the future is the main subject of this research, and in this regard, a decision support system for simulating different scenarios of changes in educational demographic would be very effective in organization policy-making.

To achieve this goal, we backtrack to five years ago and calculate necessary rates using reference charts based on historical data and then, results of adopting different policies would be simulated in a twenty-year horizon until 2031.

Followed by problem identification and statement during an appropriate time window, the dynamic hypothesis is theorized. The dynamic hypothesis is called dynamic as it should represent the dynamic features of the problem according to important feedbacks, state structure, and flow of the system. It is also called a hypothesis as it is always temporary and might be revised based on model developer's learning from the modeling process and the real world. Briefly, dynamic hypothesis is an elaboration (of the type of a closed system) with a dynamic and systematic perspective.

The dynamic hypothesis for analyzing the issue of Staff educational demographic in a bank can be defined as follows. At first, a number of staff were hired by the bank with diploma, associate and bachelor's degrees. Employment is an iterative feedback mechanism for each of these levels, and factors e.g. layoff, retirement, mission, transfer, and morality are part of a balancing mechanism of the system. Personnel with diploma degrees can continue their education for two or four years to achieve associate and bachelor degrees. A percentage of personnel with bachelor's degrees can become master graduates with two years of delay, and then again get their PhD with another five years of delay. Of course, organization positions which require higher qualifications can be filled both through activation of the mechanism of old staff continuing their education to higher levels and also, through direct employment of new personnel with higher degrees. At each level of qualification with regard to the number of available jobs, a desirable level is assumed, which specifies the surplus or deficit of personnel at each level. Then the organization needs to adjust this level to the desired level in a reasonable time. In figure 11, schematic illustration of the dynamic hypothesis is shown in a causal loop diagram.

4.2. Data Analysis and Reference Modes

Overall structure of Staff educational demographic of the bank's human resource in 2011 is shown in figure 2.

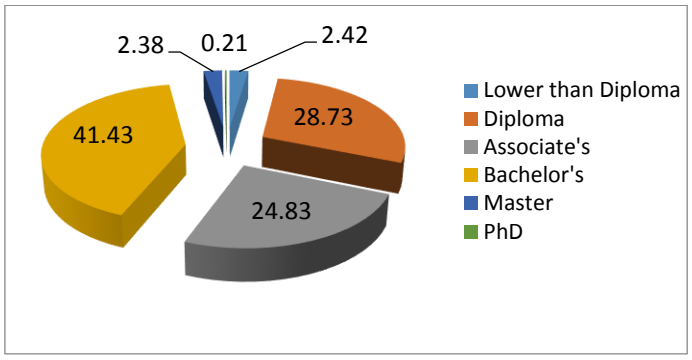

Figure 2-Staff educational demographic in the bank in 2011

Also, personnel dynamics of each level from 2011 to 2015 based on reported data is as figure 3 and 4.

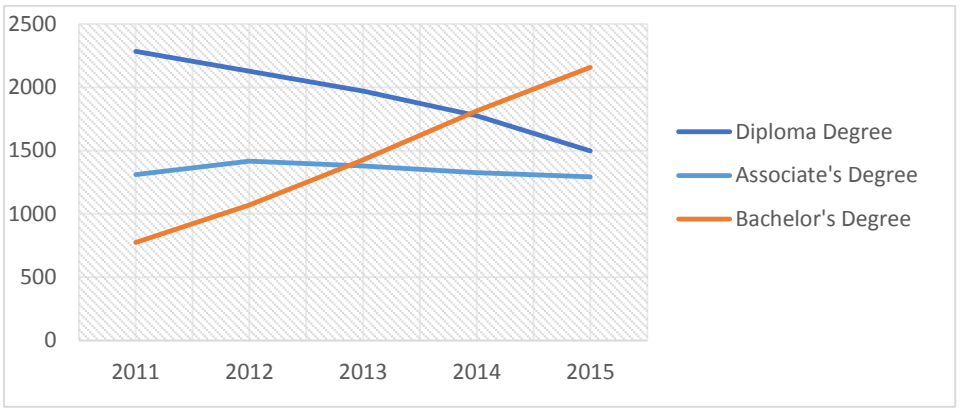

Figure 3-Trend of demographic change in personnel with diploma, associate's and bachelor's degrees

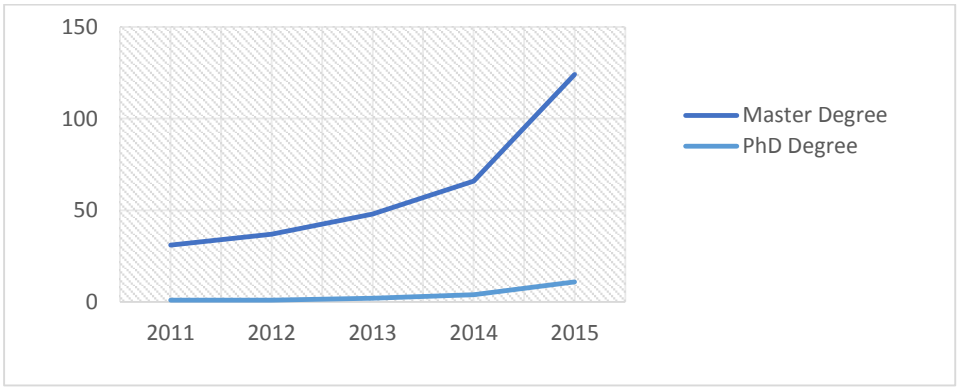

Figure 4-Trend of demographic change in personnel with master and PhD degrees

The most significant factors influencing the dynamism of educational demographic are employment, continuing education, transfer, retirement, mission and layoff. Trends of their changes in the five-year period is shown at figure 5.

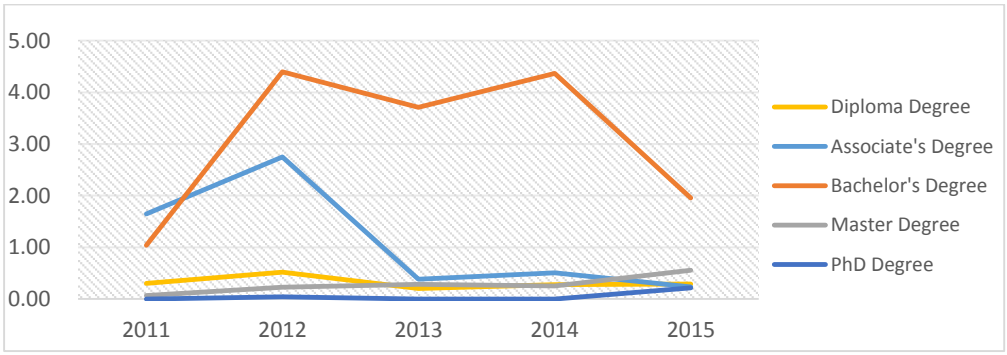

Figure 5-Trend of personnel employment rate at different levels

Based on historical data, geometric mean of personnel absorption or employment rate at each level is calculated and the results are reported in table 1.

Table 1-Average precentage of personnel employment at each educational level during five years

Educational Level	Geometric Mean of Personnel Employment Rate
High School Diploma	0.30
Associate's Degree	0.73
Bachelor's Degree	2.71
Master Degree	0.23
PhD Degree	0.05

Furthermore, factors leading to reduction in number of personnel such as death, retirement, mission, layoff, and resignation are all integrated to calculate the leaving rate of personnel. Based on the reported data, the trend of personnel leaving rate at each educational level in the five-year period was examined which is shown in figure 6.

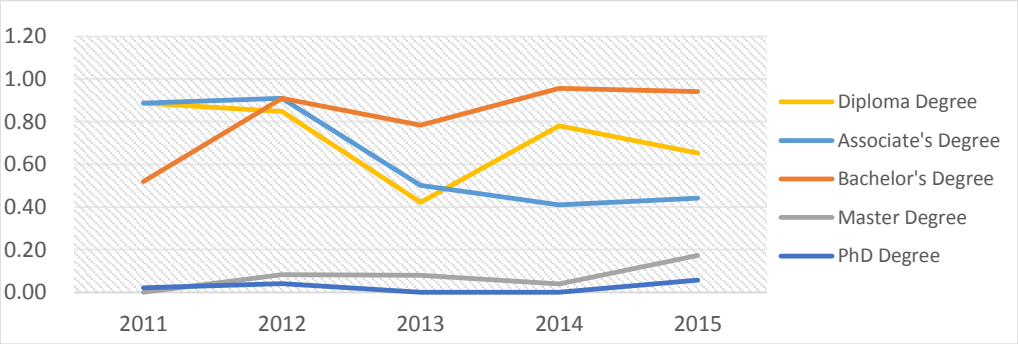

Figure 6- Trend of personnel leaving rate at each educational level

Based on historical data, geometric mean of personnel leaving rate at different levels is calculated and the results are reported in table 2.

Table 2-Average precentage of personnel leaving the bank at each educational level during five years

Educational Level	Geometric Mean of Personnel Leaving Rate
High School Diploma	0.69
Associate's Degree	0.59
Bachelor's Degree	0.80
Master Degree	0.07
PhD Degree	0.02

The number of jobs requiring each educational level and also the number of these jobs which are already occupied are shown in charts of figure 7. Using this figure one can determine the number of personnel deficit or surplus at each level.

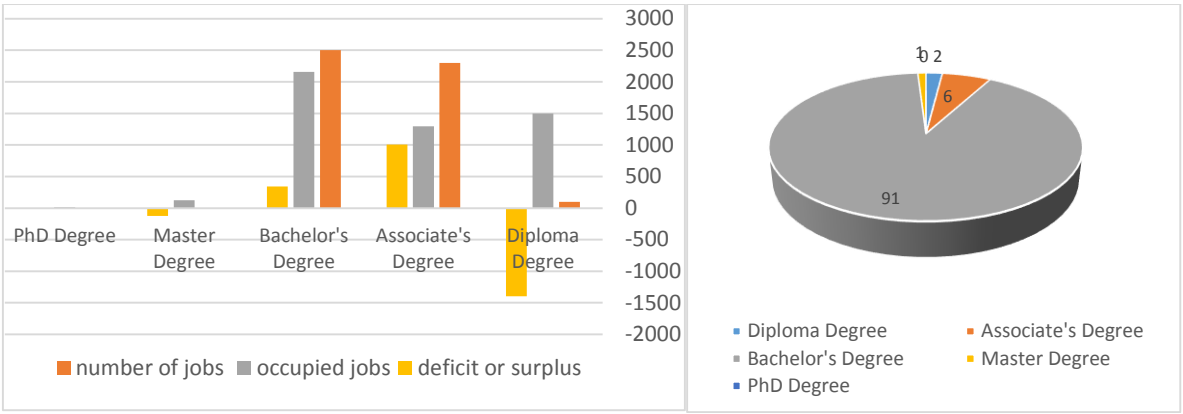

Figure 7-percentage of Defined jobs, defined and occupied number of jobs at each level of education

4.3. Causal Model

Causal loop diagram of the system is the result of interactions and feedback communications among different subsystems involved in the problem and is presented at figure 8.

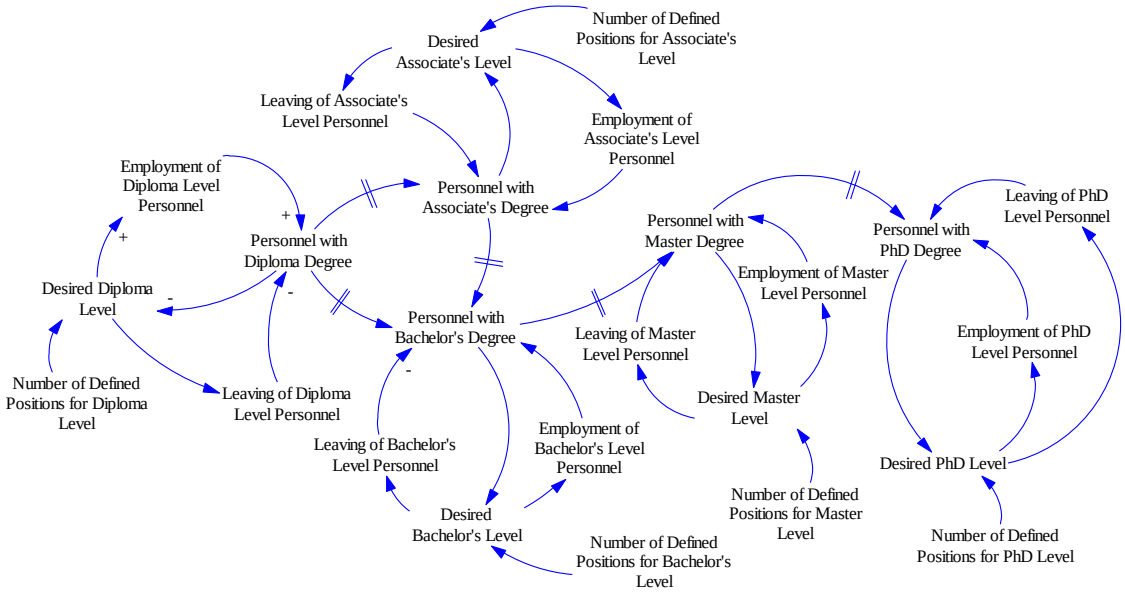

Figure 8-Causal loop diagram of educational demographic model

4.4. Stock and Flow Diagram

After determining the stock and flow structure, the final Stock and flow model was achieved based on figure 8. Some of existent variables in the flow model are described in table 3.

Table 3-Some of existent variables in system stock and flow model

Variable Name	Variable Description	Variable Type
Personnel with Diploma Degree	Personnel with diploma degree	Level
Personnel with Bachelor's Degree	Personnel with bachelor’s degree	Level
Personnel with Master Degree	Personnel with master degree	Level
Personnel with PhD Degree	Personnel with PhD degree	Level
Personnel with Associate's Degree	Personnel with technical diploma degree	Level
D-Hiring Rate	Employment rate of staff with diploma degree	Rate
B-Hiring Rate	Employment rate of staff with bachelor’s degree	Rate
A-Hiring Rate	Employment rate of staff with Associate's Degree	Rate
M-Hiring Rate	Employment rate of staff with master degree	Rate
PhD-Hiring Rate	Employment rate of staff with PhD degree	Rate
D-Edu Rate 1	Rate of continuing education from diploma to associate’s degree	Rate
D-Edu Rate 2	Rate of continuing education from diploma to bachelor’s degree	Rate
A-Edu Rate	Rate of continuing education from Associate's Degree to bachelor’s	Rate
B-Edu Rate	Rate of continuing education from bachelor’s to master degree	Rate
M-Edu Rate	Rate of continuing education from master to PhD degree	Rate
D-Out Rate	Leaving rate of personnel with diploma degree	Rate
B-Out Rate	Leaving rate of personnel with bachelor’s degree	Rate
A-Out Rate	Leaving rate of personnel with Associate's Degree	Rate
M-Out Rate	Leaving rate of personnel with master degree	Rate
PhD-Out Rate	Leaving rate of personnel with PhD degree	Rate
D-Hiring Fraction	Employment percentage of personnel with diploma degree	Constant
B-Hiring Fraction	Employment percentage of personnel with bachelor’s degree	Constant
A-Hiring Fraction	Employment percentage of personnel with Associate's Degree	Constant
M-Hiring Fraction	Employment percentage of personnel with master degree	Constant
PhD-Hiring Fraction	Employment percentage of personnel with PhD degree	Constant
D-Out Fraction	Leaving net percentage of personnel with diploma degree	Constant
B-Out Fraction	Leaving net percentage of personnel with bachelor’s degree	Constant
A-Out Fraction	Leaving net percentage of personnel with Associate's Degree	Constant
M-Out Fraction	Leaving net percentage of personnel with master degree	Constant
PhD-Out Fraction	Leaving net percentage of personnel with PhD degree	Constant
TAD 1	Duration of continuing education from diploma to Associate’s degree	Auxiliary
TAD 2	Duration of continuing education from diploma to bachelor’s degree	Auxiliary
TAD 3	Duration of continuing education from technical diploma to bachelor’s	Auxiliary
TAD 4	Duration of continuing education from bachelor’s to master degree	Auxiliary
TAD 5	Duration of continuing education from master to PhD degree	Auxiliary

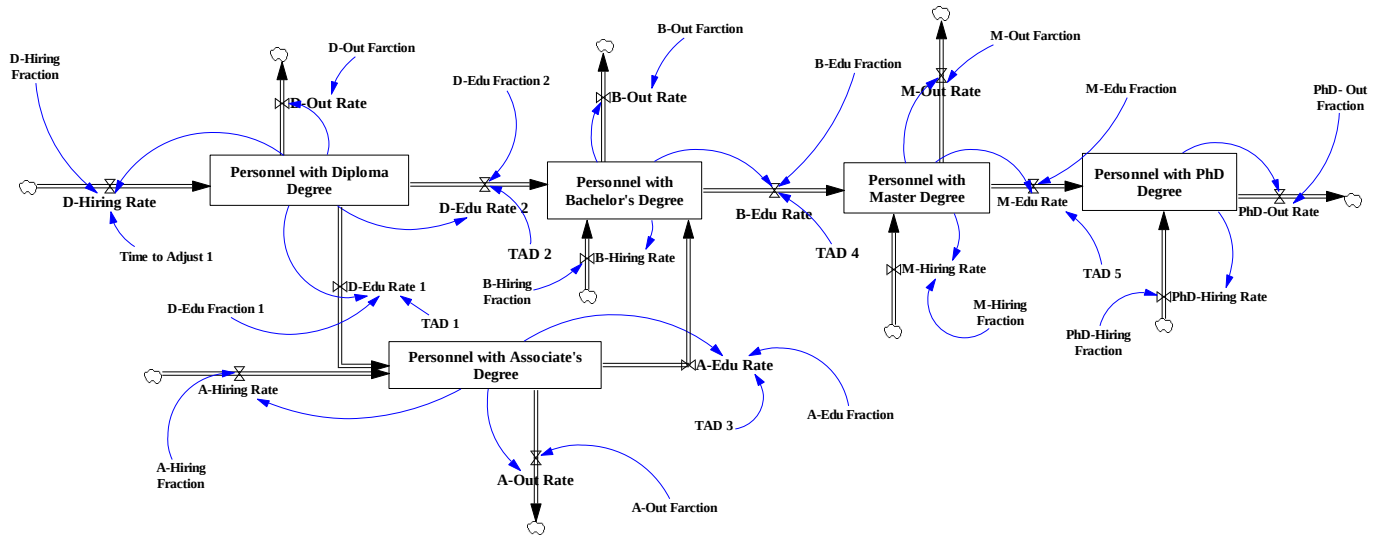

Figure 9-Stock and flow diagram of educational demographic of human resource

4.5. Levrage Points Identification and Scenario Generation

In order to generate scenarios, leverage points of the problem should first be identified. Considering the structure of staff educational demographic, ideas of human resource managers, and existent variables in the casual model, leverage points of proposed model would be as follows:

A) Number of personnel with bachelor's degree

B) Duration of educating at each level

C) Rate of continuing education from bachelor's to master level

Scenarios are designed based on identified leverage points in staff educational demographic chain. Meantime, current situation of educational demographic is considered as the base case, and changes resulting from adopting different scenario and decision policies is compared with the current situation and the results of simulating the model in each scenario are analyzed.

Based on identified leverage points in the dynamic model of educational demographic of human resource, following scenarios were implemented to predict the behavior of educational demographic:

1) First scenario: prolonging current situation of educational demographic

This scenario means that no changes would be made in current trends of staff educational demographic in the organization. In this scenario, it is assumed that procedures of personnel employment and attending continuing education programs are similar to the estimates made based on historical data of the recent five-year period (the base case).

2) Second scenario: changing time duration parameter

Since one of the leverage points of the model is duration of education at each level, second scenario can be designed based on it. This variable is exogenous and uncontrollable if we assume that employees must attend formal courses at universities like other full or part time students; however, the organization do not necessarily have to acquire the required level of knowledge for achieving a good performance in jobs by having their employees attend the continuing education program out of organization. Instead, organizations can simply adopt equivalent intra-organizational service training policies. Since compression of training periods in this type of training is easily possible, here we can assume that the time duration parameters are endogenous, and can be reduced as desired.

3) Third scenario: changing employment rates

The nature of jobs requiring associate's degree is different from the jobs which need bachelor's degree. So, we can employ fewer staff with diploma and associate's degree, and increase employment rate of staff with master or PhD degree after 2015. For this purpose, we can outsource jobs relating to personnel with diploma and associate's degree, and perform jobs relating to master and higher qualified personnel internally.

4) Fourth scenario: restructuring staff educational demographic

Previous scenarios were based on changing the parameters of the system. But the behavior of the system do not only depend on its parameters, but also, we can lead system's behavior towards a desired change by changing its structure. In this scenario, we change the current structure of staff educational demographic and try to eliminate personnel surplus or deficit in

a three-year period according to the current statistics of number of defined jobs and number of available personnel. With regards to personnel's desire to pursue higher educational levels, this scenario tries to find out if the current educational demographic is able to respond to the shocks occurred as the result of an increase in the number of favorable jobs for master and PhD levels given the changing nature of activities in the bank by 2025. According to this scenario, the stock and flow structure of the bank educational demographic will be as figure 9.

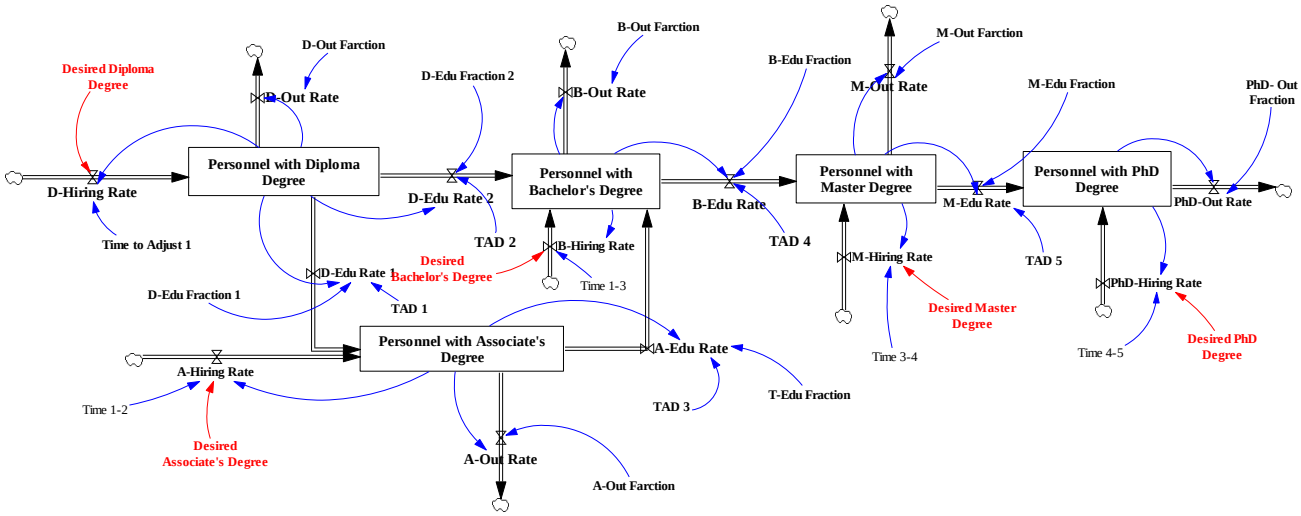

Figure 10-Stock and flow diagram of restructured system

In this scenario, instead of using annual employment rate, desired levels of staff with each degree are considered, and necessary actions to eliminate personnel surplus or deficit at each level is planned in a three-year horizon.

4.6. Model Validation & Scenarios Simulation

Regarding the standard methods for the validation of system dynamics models, presented model has been tested against conformity with structural behavior of the real system. On the other hand, given the structure of staff educational demographic, parameters and model equations have been obtained in accordance with existent facts of the system. So, we can claim that numerical behavior of model is largely valid. In order to validate the proposed model, different tests have been carried out. The presented model was tested for adopting the structural behavior of the real world system considering the system dynamics approach. Additionally, in order to validate the model following tests have been carried out:

- *Extreme Condition Test:* the consistency and significance of variable's behavior was tested by setting the parameters to their extreme values.
- *Boundary Adequacy for Structure Test:* the adequacy level of the model boundaries was confirmed by asking for the ideas of five experts.
- *Structural Behavior Test:* the compatibility level of behavior generated by the model was determined by the reference variables' behavior.
- *Dimensions Consistency Test:* the dimensions of all variables in all equations was reviewed and it was determined that the dimensions of two sides of equations were in balance.

After validation, different scenarios were generated and simulated by VENSIM software, and the results of adopting different policies to the problem were evaluated and analyzed.

1) Results of first scenario simulation

As it is clear in figures 11 and 12, share of personnel with diploma and associate's degrees are descending and a decreasing goal-seeking behavior is being witnessed. System's behavior for staff with bachelor's degree is ascending, and the number of people with master and PhD degrees are increasing exponentially. These behaviors are logical regarding the historical data.

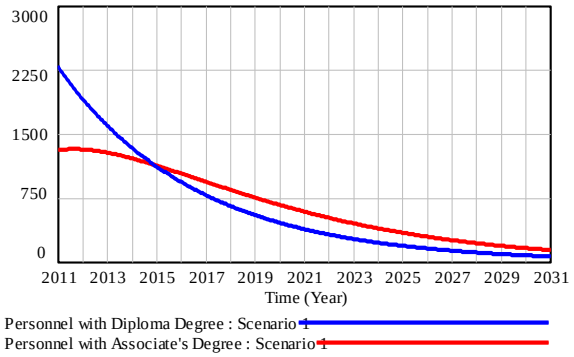

Figure 11-Simulated effects of prolonging current situation of educational demographics on the number of personnel with diploma and associate's degrees

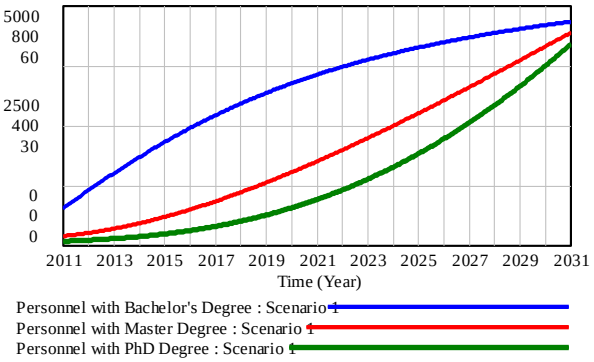

Figure 12-Simulated effects of prolonging current situation of educational demographics on the number of personnel with bachelor's, master, and PhD degrees

2) Results of second scenario simulation

In the second scenario, in order to control the duration time of educating and to better managing staff educational demographic, instead of encouraging and supporting personnel for attending external continuing education programs, the bank signs contracts with universities and scientific research centers for developing intra-organizational equivalent programs of master and PhD which are more fit to bank's processes but take less time from personnel in order to get their degrees. After graduation, valid certificates will be issued for personnel by these universities and scientific research centers. If this could reduce the necessary time for studying master and PhD courses by half, then we would witness variable changes shown in figures 12 and 13.

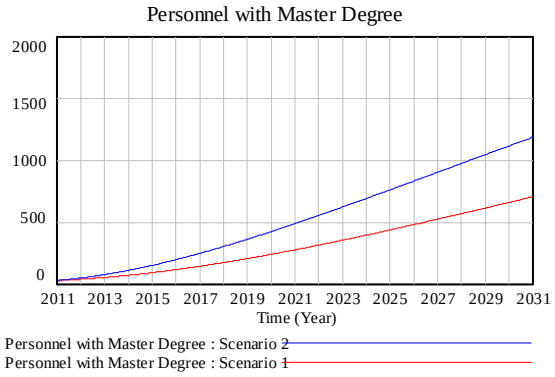

Figure 13-Simulated effects of reducing time duration parameter on the number of staff with master degree

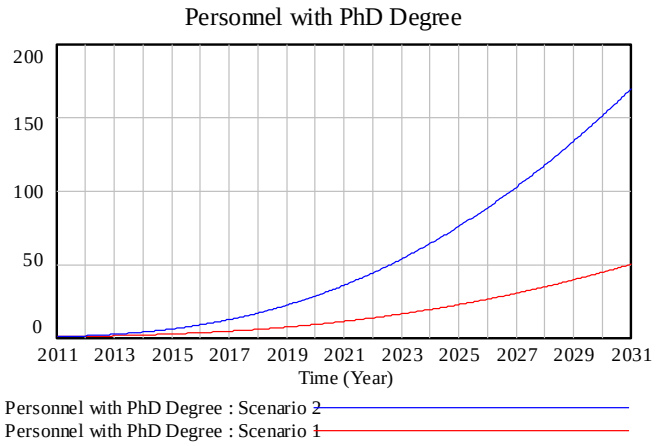

Figure 14-Simulated effects of reducing time duration parameter on the number of staff with PhD degree Simulated effects of reducing time duration parameter on the number of staff with PhD degree

In the second scenario, it can be seen that by reducing duration time of studying courses by half, the number of master and PhD graduated personnel could increase to double.

3) Results of third scenario simulation

In the third scenario it is demonstrated that if we increase employment rate of personnel with master and PhD degrees to double after 2015, system's behavior would not respond to these changes.

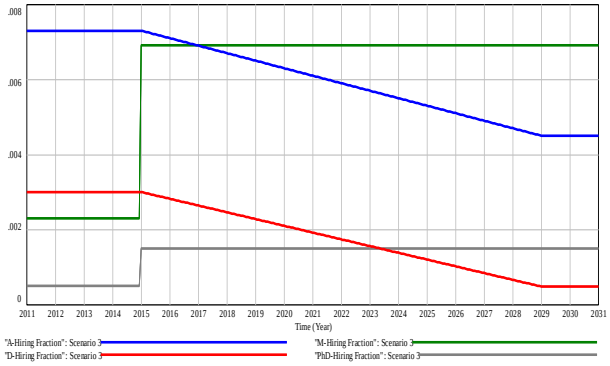

Figure 15-Simulated effects of changing employment rates on number of staff with diploma, associate's, master, and PhD degrees

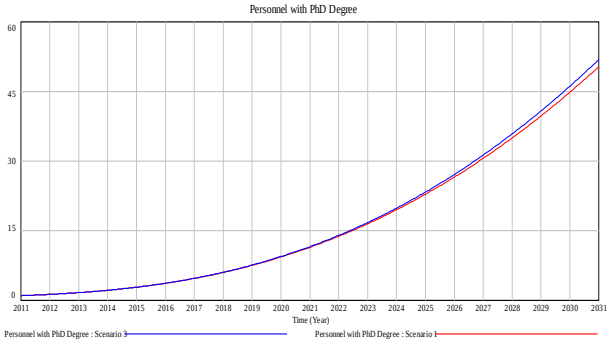

Figure 16-Simulated effects of changing employment rates on the number of staff with PhD degree

4) Results of fourth scenario simulation

Based on the fourth scenario, the structure of personnel employment would change. In a three-year horizon, necessary planning are implemented to eliminate personnel surplus or deficit in each level. The results of adopting this policy are shown at charts of figure 17.

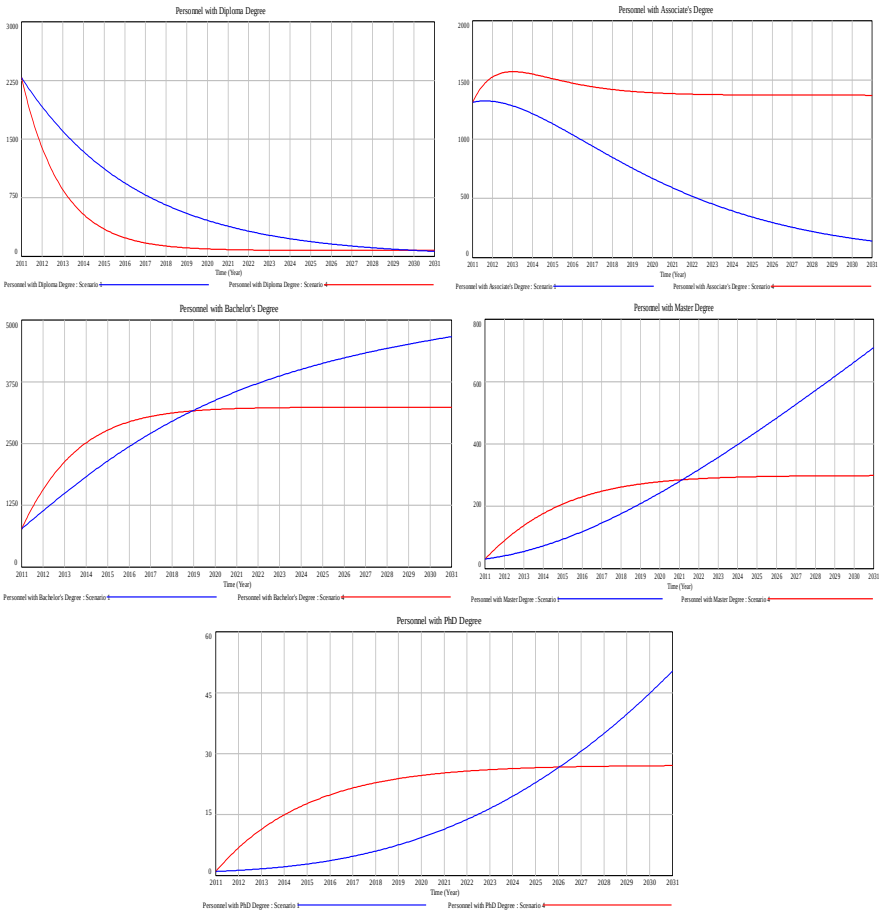

Figure 17-Simulated effects of restructuring staff educational demographic on the number of personnel with all degrees

By applying this scenario and changing bank's demographic structure, the extra number of personnel with diploma would reduce over time. But in other levels, due to deficit of work forces, we witness an increase in number of personnel. The number of personnel with a bachelor's degree would reach a stable level after 2015. The same issue would happen for personnel with master degree after 2020. For the PhD, an equilibrium would be achieved near the end of horizon.

V. CONCLUSION AND FUTURE RESEARCH

Given the purposes of this research and with regards to dynamic structure of staff educational demographic, it can be said that the proposed model, with a high level of flexibility in policy making and decision making, is able to represent the dynamic behavior of the system, and can be introduced as a dynamic model for educational demographic of an organization. Additionally, the most important feedback loops of this system are related to personnel with bachelor's and master degrees which have major effects on dynamic behavior of the system. Furthermore, variables of duration of study, employment rate, and number of personnel with associate's and bachelor's degrees were identified as leverage points of staff educational demographic. This model facilitates the process of decision making in areas related to human resource for managers of banks or other similar organizations.

This investigation tries to present a dynamic model as a flexible tool to design and implement policies in systems which involve human resource with continuous and complex causal relations. The developed model, regarding its features, is able to simulate different scenarios from which the most important ones were chosen and results of adopting them were predicted.

In the first scenario, results of prolonging current situation of the system was simulated. This policy resulted in an increase in the number of personnel with master and PhD degrees. In the second scenario, policy of reducing the duration time needed for training personnel and its effects on existent variables of the system was simulated and the results were analyzed. Results showed that system is highly sensitive to changes of this parameter. In the third scenario, by increasing the employment rate of master and PhD personnel, it was shown that educational demographic is not sensitive to this parameter, as there were no significant reaction. Ultimately, in the fourth scenario, the consequences of eliminating personnel surplus or deficit were studied. This scenario would sooner or later lead to balanced conditions in all levels.

In this model, dynamic behavior of staff educational demographic was studied over a simulation period of 20 years, including educational levels of high school diploma to PhD. It is recommended for future studies to develop dynamic models with variable rates and parameters over time and to consider more various and detailed parameters in the model of staff educational demographic; e.g. role of compensation and reward systems, productivity, etc.

REFRENCES

[1] Ratna, R. & Chawla, S., 2011. *Human Resource Planning: Functioning and Contribution*. International Journal of Research in IT, Management and Engineering, 1(3), pp. 203-216.

[2] Bahrami, A., Yadegarzadeh, G. & Parand, K., 2007. *Identifying Guidelines and Factors Influencing the Internal Evaluation of Educational Teams: System Dynamics Approach*. The Journal of Research and Planning in Senior Education, Volume 44, pp. 49-78.

[3] Ahmad Dardar, A. H., Jusoh, A. & Rasli, A., 2012. *The Impact of Job Training, Job Satisfaction and Alternative.* Pattaya, Thailand, The 2012 International Conference on Asia Pacific Business Innovation & Technology Management.

[4] Aburawi, I., & Hafeez, K., 2009. *Managing Dynamics of Human Resource and Knowledge Management in Organizations through System Dynamics Modeling*. International Journal of Science and Techniques of Automatic control & Computer Engineering, 3(2), pp. 1108-1125.

[5] Pejic Bach, M., Knezevic, B. & Strugar, I., 2005. *Application of System Dynamics Model in Management of Highly Qualified Human Resource.* Venice, Italy, International Conference on Dynamical Systems and Control.

[6] Sveiby, K. E., Linard, K. & Dvorsky, L., 2002. *Building a Knowledge-Based Strategy: A System Dynamics Model for Allocating Value-Adding Capacity*. Palermo, Italy, 20th International Conference of the System Dynamics Society.

[7] Iatagan, M., Dinu, C. & Stoica, A. M., 2010. *Continuous Training of Human Resource-A Solution to Crisis Going Out.* Procedia Social and Behavioral Science, Volume 2, pp. 5139-5146.

[8] Narahari, N. & Narasimha, M., 2009. *System Dynamics Modeling of Human Resource Planning for a Typical IT Organization*. CURIE Journal, 2(3), pp. 33-45.

[9] Liu, X. Long, L. & Xue, C., 2012. *A Study on Human Resource Management Based on System Dynamics*. Advances in Asian Social Science *(AASS),* 3(3), pp. 680-685.

[10] Ahmadvand, A., Varandinaderi, A., Bastan, M., Yahyaei, M. (2014). *Analysis of Tehran Construction and Demolition Waste Management with System Dynamics Approach*. Asian Journal of Research in Business Economics and Management, 4(8), 234-242.

[11] Bastan, M., Abdollahi, F., Shokoufi, K. (2013). *Analysis of Iran's Dust Emission with System Dynamics Methodology*. Technical Journal of Engineering and applied sciences.3 (24), 3515-3524

[12] Sterman, J. D., *Business Dynamics: Systems Thinking and Modeling for a Complex World*, Vol. 19: Irwin/McGraw-Hill Boston, 2000.

[13] Wolstenholm, E., 1990. *System Enquiry: A System Dynamics Approach.* Sussex, UK: John Wiley & Sons.

[14] Salmasnia, A., Bastan, M., & Moeini, A. (2012). A robust intelligent framework for multiple response statistical optimization problems based on artificial neural network and Taguchi method. International Journal of Quality, Statistics, and Reliability, 2012.

[15] Hejazi, T. H., Salmasnia, A., & Bastan, M. (2013). Optimization of Correlated Multiple Response Surfaces with Stochastic Covariate. International Journal of Computer Theory and Engineering, 5(2), 341.

[16] Mokhtari, H., Salmasnia, A., Bastan, M. (2012). Three Dimensional Time, Cost and Quality Tradeoff Optimization in Project Decision Making. Advanced Materials Research. Vols. 443-440 pp.5746-5752.

[17] Mohajeri, M. Moradi, M. Akbarpour, H., Rashidi, A., Bastan, M. (2014). Knowledge based prediction of nanostructured Silicon carbide. 5th International Conference on Nanostructures (ICNS5), Kish Island, Iran.

[18] Moradi, M., Akbarpour, H., Mohajeri, M., Bastan, M. (2014). Pore Diameter of Nano-porous Anodic Alumina Membrane: Experimental Study and ANN Modeling. 5th International Conference on Nanostructures (ICNS5), Kish Island, Iran.

[19] Tabandeh, M., Bastan, M. (2014). Customer's classification according to the grey-based decision-making approach and its application to bank queue systems. Asian Journal of Research in Banking and Finance, 4(7), 349-372.

[20] Akbarpour, H. Bastan, M., Mohammad Hosseini Abdoli, Sh., AkbarPour, S. (2014). Investigation on short-term inflation rate in Iran using artificial neural network. The 1st National Conference on Development in Monetary and Banking Management, Tehran, Iran.

[21] Bastan, M., Mosaed, M., Kashef, F. (2013). Dynamic Analysis of Housing Cost Changes in Tehran. 9th International Conference on Industrial Engineering, Khajeh Nasir Toosi University of Technology, Tehran, Iran.

[22] Khoshneshin, F., Bastan, M. (2014). Analysis of dynamics of crisis management in the earthquake and performance Improvement using system dynamics methodology. 10th International Conference on Industrial Engineering, University of Tehran, Tehran, Iran

[23] Ahmadvand, A., Bastan, M., Nasiri, M. (2013). Strategic map Explanation dynamics analysis using a system Dynamics approach. 9th International Conference on Industrial Engineering, Khajeh Nasir Toosi University of Technology, Tehran, Iran.

[24] Ahmadvand, A., Ghanei, N. Bastan, M. (2013). System Dynamics Application in investigation on the Behavior of Effective Affecting Factors on the Organization's Productivity and Human Resource Planning. 9th International Conference on Industrial Engineering, Khajeh Nasir Toosi University of Technology, Tehran, Iran.

[25] Akbarpour, H., Moradi, M., & Mohajeri, M. (2014). Experimental investigation and artificial neural network modeling of interpore distance of nanoporous anodic alumina membrane. Paper presented at the 5th International Conference on Nanostructures (ICNS5).

[26] Mohajeri, M., & Akbarpour, H. (2013). Knowledge-based prediction of pore diameter of nanoporous anodic aluminum oxide. Journal of Electroanalytical Chemistry, 705, 57-63.

[27] Hesamamiri, R., & Bourouni, A. (2016). Customer support optimization using system dynamics: a multi-parameter approach, Kybernetes, Vol. 45 No. 6, pp. 900-914.

[28] Kiani, B., Hosseini & S.H., Hesamamiri, R. (2009). Examining the Hubbert Peak of Iran's Crude Oil: a System Dynamics Approach, European Journal of Scientific Research, Vol.25 No.3, pp. 437-447.

[29] Jafari, M., Hesamamiri, R. & Bourouni, A. (2008) an Interpretive Approach to Drawing Causal Loop Diagrams, Proceedings of the 26th International Conference of the System Dynamics Society., Athens, Greece.

[30] Abbasi, E., Bastan, M., Ahmadvand, A. (2016). A System dynamics model for Mobile Banking Adoption. 12th International Conference on Industrial Engineering. Kharazmi University, Tehran, Iran.