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Presenting a Dynamic Model of Manpower Demand in the Tax Affairs Organization of Iran

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Abstract

Providing qualified human resources is one of the main issues of today's organizations. Since the Tax Affairs Organization of Iran is a governmental and specialized organization, so the manpower required by the organization; In terms of having special features need time; are not available to the organization, which makes planning to anticipate manpower demand inevitable. The main purpose of this study is to provide a dynamic model for manpower demand in the Tax Affairs Organization of Iran, as an effective device in financing the country. In the present study, an attempt has been made to dynamically model the demand for manpower using the data obtained from the Delphi and Fuzzy DEMATEL methods, through the systems dynamics method. In this study, 9 effective endogenous and exogenous factors were localized and selected by Delphi method by experts. Then the Fuzzy DEMATEL method was used to determine the relationships, intensity and effectiveness and finally the dynamic research model in addition to possible scenarios is expressed.

Keywords: Manpower Demand, Dynamic Model, Delphi Method, Fuzzy DEMATEL, Experts.

Introduction

Human resource planning in an organization is a key activity for that organization. Human resource planning allows to forecast the future manpower requirements and also to forecast the number and type of employees who will be required by the enterprise in a near future (Koltnerová et al., 2013).

Lack of a coherent system and lack of organizations' managers' awareness of resources or human resources cause many unfortunate consequences for every organization. Thus is of such great importance that all organizational goals depend on human resource planning and accurate planning for human resource supply (Mohammadi & Fakher, 2011).

As one of the basics of human resource planning, human resource demand prediction has always been emphasized by researchers, especially experts (Slangen, 2020).

Demand production is a process used for human resource planning by which the number of individuals, skills, and proficiencies required for an organization are estimated. The annual budget and long-run plan of organizations are the basics of this process (Ivan et al., 2020).

It is worth noting that the informed development plans considered within three programs proposed by the Iranian National Tax Administration have emphasized the reduction in public human resources and staff working for the government to reconstruct the state and improve governance effectiveness. The programs mentioned above have suggested reducing the number of government staff and new recruitments. Considering the existing analyses and information obtained from international standards, however, the Iranian National Tax Administration needs to increase the number of employees up to five times, especially because of its weaker tax information infrastructures compared to tax organizations in developed countries. Because of dynamism and changes i.e., higher unemployment, recession, and inflation rates, phenomena must be viewed dynamically instead of static procedures to understand them better and make policies to improve the changing procedures (Mashayekhi, 2018).

Accordingly, the extant study was conducted to provide a dynamic model for human resource demand in Iranian National Tax Administration, which is a governance system playing a vital and effective role in budget provision.

Theoretical Foundations

Human Resource Demand and its Prediction

Forecasting human resource demand is defined as the estimation of the future quantity and quality of individuals required for satisfying the upcoming needs of the organization (Ghimire, 2020).

Forecasting manpower needs in modern conglomerates is an essential part of future strategic planning and a very important different nature of business imperatives (Adisak, 2015).

On the other hand, human resource planning concerns forward-looking analysis of current and future human resource development needs, issues, and challenges facing a particular occupation such as supply and demand of skilled people, the impact of changing technology, and efficiency of the existing training (Aburawi & Hafeez, 2009).

Demand forecasting is influenced by both internal factors and external factors. External factors include competition, economic climate, laws and regulatory bodies, changes in technology, and social factors whereas internal factors are budget constraints, production level, new products and services, organizational structure, and employee separations (Ghimire, 2020).

System Dynamics (SD)

System Dynamics (SD), founded by Jay Forrester at MIT in 1961 is defined as an accurate method for qualitative description and analysis of complex systems in terms of processes, information, and strategies (Dalalah & Bataineh, 2009).

System dynamic is a feedback thinking-based methodology (Ricciardi et al., 2020), suited to study complex, large, and dynamic systems (Gao et al., 2016).

SD methods are used in different disciplines since they can offer an overview of the structure and behavior of non-linear and feedback systems (Merkac & Zoroja, 2013).

Different authors introduce stocks, flows, internal feedback loops, and time delays as elements of SD (Pejic Bach et al., 2020).

Literature Review

(Slangen, 2020), conducted a study entitled "Dynamic human resource management decision support model based on tactical aircraft maintenance demand forecasts." Slangen, states that the long and therefore expensive training of aircraft maintenance technicians underlines the need for accurate demand forecasts that allow for dynamic control of acquisition and training rate of personnel. This control enables human resource management to react swiftly to increases in workforce demand at times of technician shortages. The analysis was conducted using aggregated structural repair data of a fleet of wide-body passenger aircraft in the first ten years of its introduction. The results of this study showed the potential of the proposed model as it was robust for varying amounts of non-constant workforce outflow and different fleet sizes. Furthermore, the model could be applied efficiently from one year after the acquisition of the first new aircraft. The novelty of this study was the direct integration of personnel training and acquisition with workforce demand forecasts.

(Choudhari & Gajjar, 2018), carried out a study entitled "simulation modeling for manpower planning in the electrical maintenance service facility." The purpose of this paper was to present the simulation model for manpower planning in electrical maintenance service facilities and evaluate different scenarios to improve resource utilization while meeting the desired service level. The simulation results obtained for the proposed changes in the system indicated the potential improvement in resource utilization while meeting the average waiting time expectations of customers. The paper considered the computer simulation in modeling complex real-life systems for understanding the resource requirement of an electrical fault maintenance facility to improve resource utilization while meeting the desired service level.

(Jiawei, 2010), studied modeling and planning of manpower supply and demand. According to this research, effective manpower planning is important and beneficial to a country's development. Engineers are an important part of the workforce, especially in countries moving towards economic development. Artificial Intelligence tools were applied to support the modeling process when parts of the system structure were unknown.

(Ulferts et al., 2009), carried out a study entitled "human resource planning in academia." They argue that a strategic plan guides an organization is successfully meeting its mission. Based on the strategic

plan, an organization can develop a human resource plan that will allow it to make management decisions in the present to support the future direction of the organization. Human resource management identified the future needs of the organization after analyzing the organization's current human resources, the external labor market, and the future human resource environment. The analysis of issues external to the organization, and developing scenarios about the future, are what distinguishes human resource management from operational planning. (Norcliffe et al., 2004), conducted a study entitled "human resource modeling using system dynamics." This paper described how system dynamics may be used as a tool to model and analyze the human resource planning problems associated with staff recruitment, staff shortages, and staff surpluses. The proposed model was mapped onto a petrochemical company's staff recruitment using real data.

Methods

In the extant paper, the SD approach was used to provide a dynamic model for manpower demand in Iranian National Tax Administration and simulate how factors affect the human resource demand in this organization. Delphi method and relevant literature were used to identify variables and their relationships. To do this, two groups of academic (n=5) and organizational (n=10) experts were chosen. After the Delphi method was completed, the list of nine factors with the highest effects on manpower demand was introduced by the panel experts. The identified factors were given to panel experts to run the Fuzzy DEMATEL method in form of a Fuzzy DEMATEL questionnaire (Table 1).

Table 1. The list of factors extracted from the Delphi method

Law	Budget	Culture of society
Technology	New activities	Tax policy
Strategic plan	Retirement	Downsizing (Smallization)

After the Delphi method was done, the researcher-made questionnaire was distributed among eight experts, and then the Fuzzy DEMATEL method was performed. In this research, Chung's Fuzzy linguistic scale was used to avoid any ambiguity in experts' evaluation. The different impact degrees were as follows:

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Table 2. Converting the linguistic (verbal) questionnaire to Fuzzy questionnaire-Chung

Linguistic variable	Triangular fuzzy variables
Very low (VL)	(0,0,0,25)
Low (L)	(0,0,25,0,5)
Medium (M)	(0,25,0,5,0,75)
High (H)	(0,5,0,75,1)
Very High (VH)	(0,75,1,1)

After paired comparison matrixes of experts were collected, and the given scores converted to triangular fuzzy numbers, the Fuzzy Direct Relationship Matrix (average value of experts' ideas) was calculated using the fuzzy average. In such cases, the Fuzzy DEMATEL method is a possible technique that can be used (Bashan & Demirel, 2018).

In the early stage of Fuzzy DEMATEL, factors affecting the research problem are determined, and then relations between the identified factors are reflected through a survey, which means evaluating the impact rate of each factor and determining a quantitative table for these relations (Gao & Chen li-shan, 2018).

In this step, eight academic and organizational experts in human resource cases were employed. In the next step, opinions of experts were used based on (Table 2), to convert the linguistic questionnaire to a fuzzy questionnaire in which, Z is named as the expert primary fuzzy matrix.

$$z = \begin{bmatrix} 0 & a_{12} & \cdots & \\ a_{21} & 0 & \cdots & \\ \vdots & \vdots & & \vdots \\ a_{n1} & a_{n2} & \cdots & \end{bmatrix}$$

$$= \begin{bmatrix} 0 & (a_{12}^L, a_{12}^M, a_{12}^U) & \cdots & \\ (a_{21}^L, a_{21}^M, a_{21}^U) & 0 & \cdots & \\ \vdots & \vdots & & \vdots \\ (a_{n1}^L, a_{n1}^M, a_{n1}^U) & (a_{n2}^L, a_{n2}^M, a_{n2}^U) & \cdots & 0 \end{bmatrix}$$

Equation 1. (Fu et al., 2019) and (Seker & Zavadskas, 2017)

In the next step, the normalized matrix of direct fuzzy relation was obtained by using the equation below:

$$S = \max_{1 \le i \le n} \sum_{j=1}^{n} Z_{ij}^{U}$$

Equation 2. (Mahmoudi et al., 2019) and (Fu et al., 2019)

Then, the total matrix was calculated based on the equation below for upper, middle, and lower boundaries individually:

$$T = X + X^2 + X^3 + \cdots$$

Equation 3. (Fu et al., 2019)

In the next step, Defuzzification was done using the equation below, and then the sum of columns and rows was calculated. The Sum of elements per row (D) for each factor indicates the effect of that factor on other factors of the system (effect of variables) and the sum of elements of column (R) for each factor indicates the influence of other factors on that factors (influence received from other variables).

$$b = \frac{(a_1 + a_3 + 2a_2)}{4}$$

Equation 4. (Si et al., 2018) and (Farooque et al., 2020)

Therefore, the horizontal vector (D+R) illustrates the strength of influences that are given and received of the considered factor in the system. In other words, the higher the value of R + D, the more interaction between factor and other factors will be. The vertical vector (R - D) shows the strength of the effect of each factor. In general, if (R - D) is positive, then the variables is considered as the cause (has to influence on the other factors); if it is negative, the variables is considered as effect variable (influenced by other factors).

Ultimately, a model with the SD approach was proposed. The relevant diagrams in system dynamics were illustrated based on the data obtained from Delphi and Fuzzy DEMATEL methods, as well as field and bibliographic studies. The gathered data besides information obtained from field research were used to meet information requirements. System dynamics modeling

technique that is based on the causal relations between system's elements includes three basic tools indicating how the system is influenced by the relations between the identified variables (Shah Moradi et al., 2020).

The first tool includes stocks showing cumulative variables that are displayed in form of rectangles (Shepherd, 2014).

The second tool includes input or output flows that indicate variables that increase or decrease stocks (Kumar & Umadevi, 2011, 5); flows are illustrated as tubes or valves on them to control input and output flow (Shepherd, 2014).

The third tool used in SD modeling includes connectors that create a relation between variables. Connecters are shown as arrows. Connectors consist of some information, including value, constant, algebraic relations, and graphical relations. Connectors only connect stocks o flows to flow variables. In other words, stocks are changed only by flows. Connectors not only in causal diagrams but also in stock-flow diagrams can be illustrated with positive and negative signs that indicate their polarity (Samara et al., 2012).

Findings

In this research, factors affecting manpower demand of the Iranian National Tax Administration were identified based on the research literature, experts' ideas within Delphi, and Fuzzy DEMATEL techniques. (Table 3), was designed based on the Fuzzy DEMATEL so that three numbers were obtained then converted to one number by using Equation (4).

Table 3. Defuzzificated relations in the extant study

Def	a	b	c	d	e	f	g	h	i
a	-0.44	-0.49	-0.46	-0.43	1-0.5	-0.28	-0.35	3-0.3	-0.43
b	-0.21	-0.39	-0.31	-0.28	-0.21	-0.25	2-0.2	-0.27	-0.23
c	-0.27	-0.38	-0.61	-0.46	-0.45	-0.32	-0.27	-0.32	-0.42
d	-0.24	-0.35	-0.27	-0.39	-0.32	-0.15	-0.22	-0.26	-0.27
e	-0.33	-0.35	-0.45	-0.40	-0.56	-0.31	-0.29	-0.28	-0.36
f	-0.32	-0.46	-0.41	-0.36	-0.41	-0.37	-0.19	-0.36	-0.38
g	-0.30	-0.48	-0.52	-0.45	-0.49	4-0.3	-0.43	-0.34	-10.5
h	-0.32	-0.47	-0.49	-0.45	-0.49	1-0.4	-0.30	-0.53	-0.56
i	-0.32	-0.50	-0.48	-0.44	-0.51	-0.29	-0.30	-0.35	-20.6

In the next step, relations and the importance of variables were reported in (Table 4). D+R represents the priority vector so that the higher the value of the index, the more the interaction between the considered factor and other factors, and the system indicating its importance. D-R or relation vector indicates the net influence of the factor on the system.

If D-R is greater than 0, the factor will be definitively effective, while the factor will be definitely influenced if the value is less than 0. (Table 4) indicates the relations and importance of criteria of factors affecting manpower demand in Tax Administration.

Table 4. Relations and importance of research criteria

	R	D	D+R	D-R
a	-2.81	-3.74	-6.55	-0.92
b	-3.92	-2.41	-6.33	1.51
c	-4.04	-3.54	-7.50	0.49
d	-3.69	-2.52	-6.26	1.13
e	-3.99	-3.37	-7.35	0.63
f	-2.74	-3.31	-6.04	-0.55
g	-2.59	-3.89	-6.48	-1.29
h	-3.08	-4.06	-7.14	-0.97
i	-3.81	-3.83	-0.97	-0.02

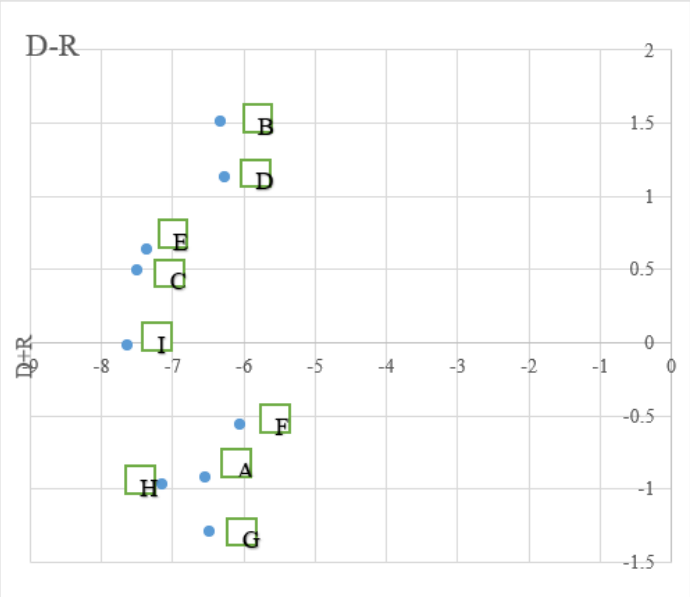

Figure 1. Relations and importance of criteria

Then, the results obtained from Fuzzy DEMATEL were used to plot the causal diagram seen in (Figure 1). The relations between variables obtained from the Fuzzy DEMATEL method and the impact of variables on each other were illustrated and confirmed by experts. In this part of the study that created a dynamic model to estimate manpower (human resource) demand, the SD modeling technique was used to find the causal relations between variables through time. In the next step, the main elements of

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the dynamic model of human resource demand were extracted in the form of the conceptual model, and relations between these elements were extracted through the Fuzzy DEMATEL method. It was necessary to illustrate the relations between elements within causal loop diagrams and convert them to stock-flow diagrams to simulate the dynamic model through software. A Stock-flow diagram is another tool that shows the interaction between variables of a system. This diagram is usually plotted based on the opinions of experts, literature review, research background, and information obtained from field studies. Although many details are not shown in this diagram, this diagram is not much vague about the relation. If all details are seen, it will be difficult to understand the diagram. On the other hand, the logic of relations will be removed if just an overview of the diagram is illustrated. This diagram is a foundation besides other ones to onset the SD modeling process (Table 5).

Table 5. List of variables used in the dynamic model of manpower demand

Row	Variable name	Kind	Type	Indicators
1	Society's culture	Exogenous	Control	culture
2	Change in tax norms	Exogenous	Covariate	norm
3	Smallization policy	Exogenous	Control	spo
4	Organizational productivity	Endogenous	Control	productivity
5	New jobs of the organization	Endogenous	Stock	NEWJ
6	Job design	Endogenous	Covariate	jobd
7	Training	Endogenous	Covariate	train
8	Organization's technology	Endogenous	Stock	TECH level
9	Prediction of manpower demand	Endogenous	Stock	DEMAND FORC
10	Manpower recruitment	Endogenous	Flow	RECRUIT
11	Number of staff	Endogenous	Stock	STAFF
12	Internal and international policies	Exogenous	Control	intp
13	Oil sales	Exogenous	Control	oils
14	Tax-based budget provision policy	Exogenous	Control	taxpo
15	Government income	Exogenous	Control	Gincome
16	Organization's budget	Endogenous	Stock	BU LEVEL
17	Law	Exogenous	Control	law
18	Strategic plan	Endogenous	Stock	ST LEVEL
19	Organization's recruitment and maintenance pattern	Endogenous	Covariate	pattern
20	Retirement	Endogenous	Flow	RETIRE
21	Budget rate	Endogenous	Flow	BUinf
22	Strategic plan rate	Endogenous	Flow	STinf
23	Manpower demand rate	Endogenous	Flow	DEMandinf
24	Technology rate	Endogenous	Flow	TEchinf
25	New jobs rate	Endogenous	Flow	NEWJinf

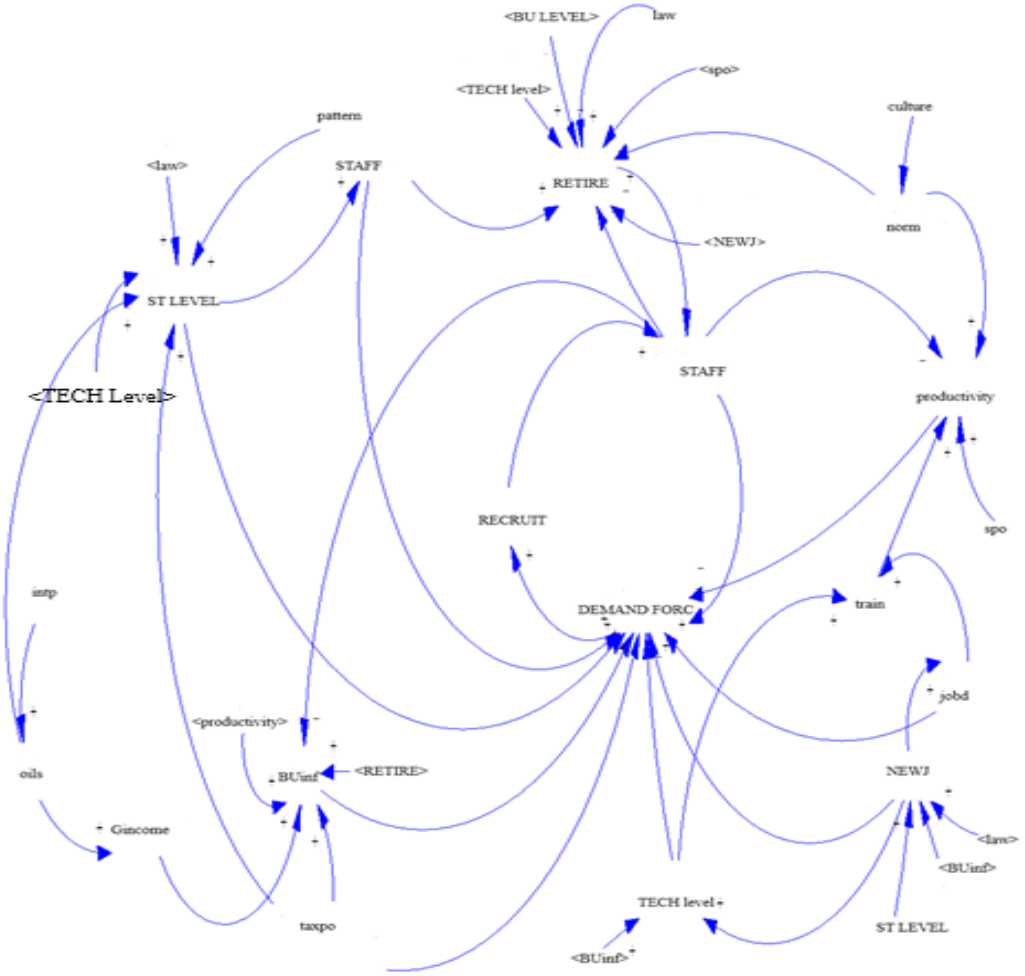

Figure 2. Causal Diagram

Since system dynamics looks for feedback loops to study system function, a feedback loop is a closed chain of causal relations that finally affects the initial variables. Feedback loops include positive (reinforcement loop) and negative (balancing loop) feedback loops. The balancing loop is a circle in which when a factor is changed towards a direction then the circle amplifies the changes towards that direction. Positive loops reinforce what occurs in the system. A negative feedback loop is a circle in which when a factor is changed towards a direction then the circle opposes the changes in that factor towards that direction. Negative loops serve as neutralizers that prevent changes. After the required variables are determined, the variables are connected to corresponding input flows by connectors seen in the causal diagram. Ultimately, the dynamic model of

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factors affecting the manpower demand of Tax Administration (stock-flow diagram) was illustrated in (Figure 2), through Vensim software.

As shown in the output of the Fuzzy DEMATEL technique, variables affect each other with different coefficients that are influenced by the degree of influence between factors and calculated in Fuzzy DEMATEL through multiplying the influence rate of variables by their main values (Figure 3).

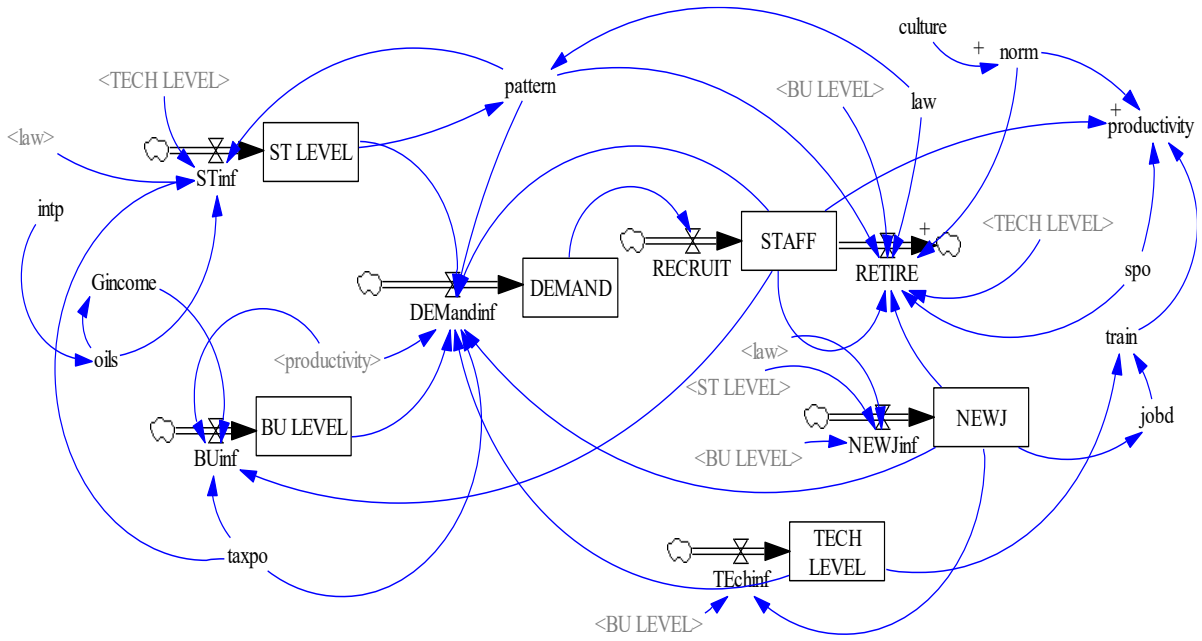

Figure 3. Stock-flow diagram

To prevent excessive complexity of the model, the most important factors affecting the manpower demand were entered into the model based on the experts' opinions and results of the Fuzzy DEMATEL method. Hence, the model could well illustrate the system status and interaction between key elements. After data were gathered through studies and surveys on the relationship between variables, the predetermined relations in the studied area or numerical functions extracted from opinions' experts were used to find the relationship between variables, and the model's behavior in the previous part was observed. In this step, the stock-flow diagram was designed based on a logical process, by using the Delphi method, Fuzzy DEMATEL, and causal diagram. After model simulation and running it through Vensim software, some scenarios were designed to analyze the manpower demand model in Iranian National Tax

Administration. The obtained results have been proposed herein.

First Scenario: Manpower demand situation after improving strategic plan

Since the strategic plan of an organization is a substantial factor that affects manpower demand in tax organizations and plays a vital role in the organization's policymaking in affairs related to human resources, improvement of a strategic plan can be done by this organization. In this case, the increased effect of the strategic plan from 2027 contributes to lower manpower demand, which, in turn, influences other factors, such as new jobs of organization, technology, and organization's recruitment and maintenance pattern (Figure 4).

Figure 4. Manpower demand situation after improving strategic plan

Second Scenario: Manpower demand situation after improving organization's technology level

Technology is one of the important factors affecting the manpower demand of tax organizations. Accordingly, this organization can make policies on the improvement of technology level to achieve the goals associated with human resource planning. In this case, the increased technology level of organization from 2027 leads to mild growth in manpower demand during 2026-2029, then it experiences a dramatic decline compared to the normal case. However, this factor can also affect other factors, including training, productivity, demand rate, retirement, and strategic plan of organization (Figure 5).

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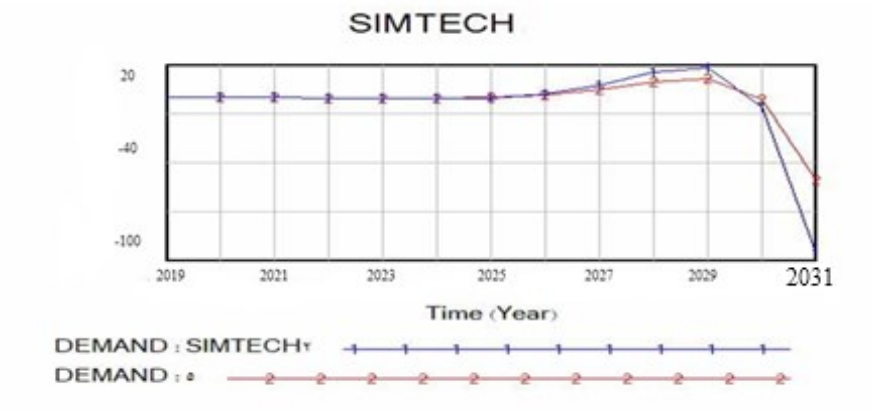

Figure 5. Manpower demand situation after improving organization's technology level

Third Scenario: Manpower demand situation after improving new jobs of the organization

New organizational jobs serve as one of the important factors affecting the manpower demand of tax organizations. An increased number of new jobs can improve organizational efficiency regarding the model and the effect of this factor on the job design and the organization's technology level. This case reduces manpower demand by influencing organizational budget and retirement rate. In this case, the increased effect of this factor from 2029 leads to a minor decline in manpower demand, which indicates not a considerable effect of this factor compared to other ones (Figure 6).

Figure 6. Manpower demand situation after improving organization's new jobs

Fourth Scenario: Manpower demand situation after improving organization's budget

Followed by training, budget is a factor that leads to a decline in manpower demand by affecting the organization's technology, new jobs, productivity, and higher capabilities to use technology. This case occurs during 2029-2031 and before this time leaves a mild ascending effect compared to the normal case (Figure 7).

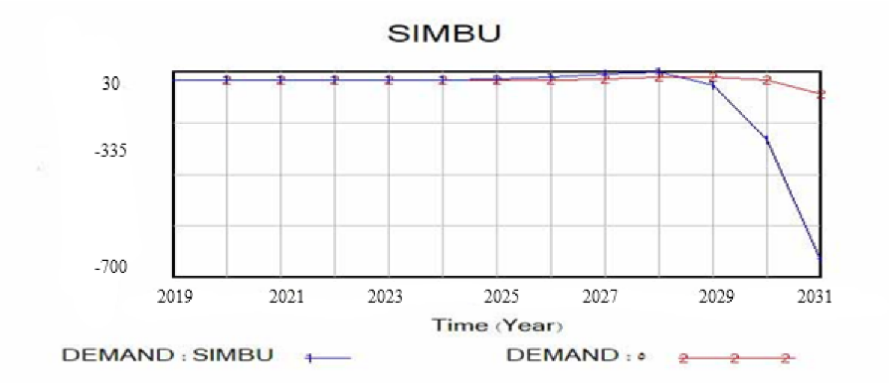

Figure 7. Manpower demand situation after improving organization's budget

Discussion

In the real world, it is not possible to change a part of the system without changing other parts of it. Application of system dynamics in the design of the dynamic model of human resource demand allowed analyzing the mutual effects caused by possible decisions before implementing them in the real case. Since the simulation model was used in extant research to examine the manpower demand in Iranian National Tax Administration, it was possible to change various variables of the model in different modes without spending high cost and observe the behaviors imposed by changed policies to select the best method. It is worth noting that evaluation of policies through real experiences causes high cost and long time, which leads to loss of resources. On contrary, the simulation method can be used to assess the results of numerous policies by spending low cost and time.

The results obtained from statistical analyses have been interpreted herein. The main purpose of the present paper was to provide a dynamic model for manpower demand in the Iranian National Tax Administration based on the causal relations between affective factors and their degrees of influence. Accordingly, Delphi and Fuzzy DEMATEL methods were used based on the SD modeling and relevant data. The dynamic models of the study were designed and

implemented through Vensim software. In the Delphi step, the statistical sample size comprised 15 academic and organizational experts in human resource planning, while it comprised eight experts in the Fuzzy DEMATEL stage. In the Fuzzy DEMATEL method, the causal model of effective factors and the degree of influence of each factor on the identified factors were studied. The mentioned variables were used to design the dynamic model of study.

The modeling step was based on the results obtained from data analysis through Delphi and Fuzzy DEMATEL methods. Experts' opinions were also used to design models. In the present research, not only the factors affecting manpower demand in tax organizations were identified but also causal relations and the degree of their influence. Finally, a system dynamics model was proposed based on the studied factors. An important point of the present paper was the calculation of the degree of influence of factors. Hence, the proposed dynamic model can be used in an organization specifically. In this case, organizations can employ different methods (e.g., AHP, ANP, DEMATEL, Fuzzy DEMATEL, etc.) to calculate the degree of influence of each factor on the all identified factor as model input, to determine the cause or effect nature of factors using the dynamic mode, the most important causal factor, the most important effect factor, to rank factors based on their effects on the system, and to rank factors based on the influence of system on them in the considered organization. It is worth noting that the design of a dynamic model based on the explained method has been done in studies conducted by (Jafari et al., 2008), (Enshaei et al., 2008), (Chaker & El Manouar, 2015). The designed model included some time-dependent factors affecting manpower demand that indicate the effect of changes on the model. On the other hand, the degree of changes imposed on different sectors of the area in question could be observed, calculated, and examined because the proposed model was a simulation of a real system based on the opinions of academic and organizational experts. However, changes must be applied to non-dynamic models to see the effects. If the changes are incorrect, they may cause harmful consequences for the organization. Therefore, it can be stated that the model proposed in the present paper was superior to static models.

Conclusion

According to reviewed literature on manpower demand, various factors affected this demand. Many authors have identified these factors over years. In the extant study, opinions of experts were asked, relevant literature was reviewed, and the most effective factors were chosen from identified factors by using Delphi and Fuzzy DEMATEL methods. Surveys were used to design the model.

There is a dynamic relation between manpower demand factors; therefore, manpower demand, effective endogenous, and environmental factors are also dynamic.

Therefore, managers should not choose a single method, but they can select various methods. The model proposed in the extant study can be used to simulate the selected methods and choose the best solution based on the current conditions.

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