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Comparison of the deterministic and fuzzy approaches in HR planning

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Abstract
Supplying required human resource is one of the strategic goals of an organization. Therefore, organizations plan and predict the required human resources in order to prevent this problem. Present study using practical approach seeks to assist organizations to achieve their various goals in human resources planning. The designed model in this study clarifies vague, inaccurate, and fuzzy expressions and gives credit to planning model. The basic assumption in this study was the significant difference between the results of the deterministic and the fuzzy human resource planning models in the statistical society. The data were obtained with the help of lingo software. Then, these data were analyzed using paired samples T test and SPSS software. The comparison of the measure of objective function with unfavorable deviations from goals in deterministic and fuzzy models indicated that the fuzzy model had less unfavorable deviations from goals and provided results that were more accurate. Further, the results indicated that the organization should pay more attention to the teleworking manpower in order to achieve its goals in the human resource management.

Key words: Manpower, planning, goal programming, fuzzy logic**.**

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Introduction

The planning function, in general, involves defining an organization's goals, establishing a strategy for achieving those goals, and developing a comprehensive set of plans to integrate and coordinate activities (Robbins & Judge, 2011). Human resource planning involves identifying staffing needs, forecasting available personnel, and determining what additions or replacements are required to maintain a staff of the desired quantity and quality to achieve the organization's goals (Lunenburg, 2012, p. 2). Human resource planning is a useful tool for human resource management in large organizations (Feyter, 2007, p25) and it is based on the belief that people are the most important strategic resource of an organization. Human resource planning identifies the human resource needs both qualitatively and quantitatively, and answers to two basic questions: first, how many people, and second, what sort of people? HRP also looks for wider issues related to the ways in which people are recruited and developed to improve the effectiveness of the organization. So the HRP is an important part in the strategic human resources management (Armstrong, 2006, p 363). In a comprehensive view of human resource planning, James Kraft describes human resource planning as a process of moving an organization to its desired status, with the right kind of people in the right jobs at the right time to maximize the amount of creativity, which helps the employers to effectively gain staffing requirements (Saaty, Peniwati, Shang, 2007, p1042). Forecasting and modeling, have always been an important aspect of human resources planning process in a variety of government agencies and commercial institutions. More reliable forecasts of supply and demand can provide a basis for better decisions to avoid additional investments and provide a balanced and efficient growth of industry and economic development (Park, Lee, Yoon and Yeon, 2008, pp 380-381). Predicting is a basic and essential knowledge and should be used in the process of decision-making to facilitate planning (Wong, Chan and Chiang, 2007, p3030).Although the manpower forecast is a containment tool for decision makers, such as potential candidates, employers and policy makers, it is still in early stages. The most notable problem in this area is not the lack of advanced models, but the lack of reliable time series data. Therefore, forecasters have to use the available data in combination with a suitable model and some judgmental decisions (Harvey and Murvey, 1988, p 551). Manpower forecasting deals with planning human resource supply and demand particularly with its professional and training structure (Eijs and Borghans, 1996, p 257). However, due to external uncertainties in the market, it is difficult to determine precise work force needs. This issue creates many challenges for many organizations (Mutingi, Mbohwa, 2012, p. 874).

Less attention was paid in the past to the manpower planning especially in less developed or developing countries due to the lack of suitable methods and models and the accurate computing devices. In the past decade, the rapid development of computing technology made the effective manpower planning possible which helped to improve the use of resources for government agencies and companies (Jian Li and et al, 2004, p 15).

With recent inventions of different methods that can solve the issues of previous models and advent of advanced software with multiple capabilities, manpower planning has been taken more seriously. Among these methods, goal-programming techniques to meet the multiple and at the same time contradictory goals are suitable methods for manpower planning for the organizations that operate in complex and turbulent environments. Fuzzy technique came to help the exiting methods in order to disambiguate the imprecise goals to improve the results of mathematical models of manpower planning and gave credit to the human resource modeling. Although considerable efforts have been focused on corporate manpower planning, none of them took the model structure and parameters of manpower planning in a dynamic fuzzy environment into consideration (Mutingi, Mbohwa, 2012, p. 874). The purpose of this research is to answer the question of whether there is a significant difference between Deterministic and Fuzzy models of HRP in the Statistical Center of Iran.

Literature review

In the recent decades, many mathematical methods have been developed to choose better options. Among these methods the MCDM (multi criteria decision making), as a discipline that supports the decision-makers, has encountered numerous and sometimes contradictory evaluations. These methods have attracted the attention of scholars and practitioners (Eshlaghy, Homayonfar, 2011, p 86**). T**he goal programming is one of the most promising techniques to analyze multi-objective decision. (Sinha, Sen, 2011, p 1410).The concept of the goal programming is to reach such a satisfactory solution that is the closest to achieve the stated goals according to the given restrictions.

Many issues were solved with introduction of goal programming. However, many of them, such as assuming deterministic and exact goal levels, values and parameters of the model, still seemed impossible. How can vague and inaccurate data be turned to exact and constant parameters in order to achieve a real optimum solution? Most of the time, in the real world, priority factors of decision-makers and sometimes, even, weights that are given to goals are inaccurate by nature. In such situations, the use of Fuzzy theory can be helpful. Fuzzy set quantitates the vague terms of the decision makers so that they can be used for the decision making (Al-azzaz and Abo-sina, 1998, p 42). In 1965, Lotfi Zadeh introduced fuzzy logic as a means to model and handle uncertainty in natural language. Fuzzy logic describes the qualitative aspects of the object while conventional logic systems focus on their quantitative aspects (Shaout, Yousif, 2014, p.2).

Models that are designed with Fuzzy set approach have the following features:

1. combine multiple objectives,
2. facilitate the intervention of each decision maker,
3. are accurate and easy to use,
4. flexible enough to easily add more goals and restrictions in accordance with the changing environment,
5. accept a group decision-making that is somewhat common in today's business environment by embracing multidirectional values.
6. adopt ideas of decision makers (Kwak and Shi, 2003, p228).

Formulation of mathematical model of HRP for statistical center of Iran

Goal mathematical models have decision and deviant variables. The decision variables are:

1. Recruiting people from education level of D at different section B for the year t**:** $P_{(B,D,t)}$
2. Separating people at education level of D at different section B for the year t**:** $S_{(B,D,t)}$
3. Inventory of human resources at education level of D at different section B for the year t**:** $I_{(B,D,t)}$

4. Tele-working human resources at education level of D at different section B for the year t**:**J(B,D,t)

D shows the set of educational levels that include four degrees: the first degree includes doctoral and master's degree; the second degree includes bachelor's; the third degree includes associate degree; and finally, the fourth degree includes diploma and lower than diploma.

B shows the set of sections that includes five sections: top management, deputy of statistical plans, deputy of Economic and National calculation, deputy of Human Resources Development and Support and ICT.

T shows time that covers five years. Deviation variables of the model include:

More than the goal realization of human resources total expenditure: DEPt

1. Less than the goal realization of human resources total expenditure: DENt
2. More than the goal realization of teleworking human resources: DJPt
3. Less than the goal realization of teleworking human resources: DJNt
4. More than the goal realization of expert human resources: DID1Pt
5. Less than the goal realization of expert human resources: DID1Nt
6. More than the goal realization of support human resources: DIBPt
7. Less than the goal realization of support human resources: DIBNt
8. More than the goal realization of recruitment inexpert human resources: DPDPt
9. Less than the goal realization of recruitment inexpert human resources: DPDNt

What makes the model closer to the reality is that it distinguishes between more and less unfavorable deviations. Consequently, weight, importance, and priority of each unfavorable deviation is determined and incorporated. For this purpose, questionnaires were distributed among the senior managers and policy makers of HR planning at Statistical Center of Iran. The weight of deviation variables in the objective function were calculated with AHP technique as follows:

1. More than the goal deviation weight of total expenditure of human resources: WEP
2. Less than the goal deviation weight of teleworking human resources: WJN
3. Less than the goal deviation weight of expert human resources: WID_1N
4. More than the goal deviation weight of support human resources: WIBP
5. More than the goal deviation weight of recruitment inexpert human resources: WPDP

Calculation of the number of the variables:

Considering degrees and sections, the model has 400 variables illustrated in the Table 1.

Table 1: The number of the variables

Variable	Number of degree	Number of section	Number of years	Number Of variable
Recruitment $P_{(B,D,t)}$	4	5	5	4*5*5=100
Separating $S_{(B,D,t)}$	4	5	5	4*5*5=100
Existing human resource $I_{(B,D,t)}$	4	5	5	4*5*5=100
Teleworking $J_{(B,D,t)}$	4	5	5	4*5*5=100

The other variables in the model are the positive deviation variables (P) and negative deviation variables (N).The number of the deviation variables is twice the number of the goals. There are 25 goals in this model; therefore, we have 50 deviation variables. Considering the deviation variables the model has 450 variables.

Designing Deterministic Mathematical Model of Human Resource Planning for Statistical Center of Iran

Model goals:

- Minimize human resource costs of Statistical Center of Iran in the next five years based on educational levels and sections.
- Maximize teleworking human resources of the Statistical Center of Iran in the next five years based on educational levels and sectors.
- Maximize expert human resources (Master's and PhD) in the Statistical Centre of Iran in the next five years in all sections.
- Minimize supportive forces (top management, financial and administrative sections) in the Statistical Centre of Iran in the next five years based on educational levels.
- Minimize recruitment in the Statistical Center of specialists with undergraduate and lower degrees in the next five years in all sections.

The objective function:

In goal programming, objective function tries to minimize unfavorable deviations. In this model, the objective function is to minimize the weighted sum of values of all excess and shortage variables.

$$Min\ Z = \sum_{t=1}^{5}(WEP,\ DEP_t) + \sum_{t=1}^{5}(WJN\ ,DJN_t) + \sum_{t=1}^{5}(WID_1N\ ,DID_1N_t) + \sum_{t=1}^{5}(WIBP\ ,DIBP_t) + \sum_{t=1}^{5}(WPDP\ ,DPDP_t)$$

Systematic limitations:

1. Existing human resource limitation for different degrees and sections in five years:

$$\sum_{B=1}^{5}\sum_{D=1}^{4} I_{(B,D,t)} = \sum_{B=1}^{5}\sum_{D=1}^{4} I_{(B,D,t-1)} + \sum_{B=1}^{5}\sum_{D=1}^{4} P_{(B,D,t)} - \sum_{B=1}^{5}\sum_{D=1}^{4} S_{(B,D,t)} \quad ;\forall t \in T$$

T=1,…,5
B=1,…,5
D=1,…,4

This limitation shows that existing human resources for t year is equal to existing human resources for t-1 year plus recruitment for t year minus separation for t year.

2. Human resource budget limitation for different degrees and sections in five years:

$$\sum_{B=1}^{5}\sum_{D=1}^{4} CEP_t . P_{(B,D,t)} + \sum_{B=1}^{5}\sum_{D=1}^{4} CES_t . S_{(B,D,t)} + \sum_{B=1}^{5}\sum_{D=1}^{4} CEJ_t . J_{(B,D,t)} + \sum_{B=1}^{5}\sum_{D=1}^{4} CEH_t .(I_{(t,B,D)} - J_{(B,D,t)}) \leq BHR_t \quad ;\forall t \in T$$

T=1, …, 5
B=1, …, 5
D=1, …, 4

This limitation shows that human resource expenditures for recruitment, separation, teleworking and maintaining in statistical center of Iran should be less than or equal of the Human resources budget. CEP_t parameter in this limitation shows per capita expenditure for human resource recruitment in t year. CES_t parameter shows per capita expenditure for human resource separation in t year. CEJ_t parameter shows per capita expenditure for human resource teleworking in t year. CEH_t parameter shows per capita expenditure for human resource maintain in t year.

3. Office space limitation for different degrees and sections in five years:

$$CL.(\sum_{B=1}^{5}\sum_{D=1}^{4} I_{(B,D,t)} - \sum_{B=1}^{5}\sum_{D=1}^{4} J_{(B,D,t)}) \leq \alpha; \forall t \in T$$

T=1,…,5
B=1,…,5
D=1,…,4

This limitation shows that per capita space for each employee multiplied by total existing human resource minus the teleworking human resource must be less than or equal to the available space of organization. In this limitation, the CL is per capita space for each employee according to the law and α is the total available space of organization.

4. Overtime limitation for different degrees and sections in five years:

$$\sum_{B=1}^{5}\sum_{D=1}^{4} CF_{(B,D,t)}.I_{(B,D,t)} \leq 0, \sum_{B=1}^{5}\sum_{D=1}^{4} I_{(B,D,t)}; \forall t \in T$$

T=1,…,5
B=1,…,5
D=1,…,4

This limitation shows that per capita overtime in all different sections and degrees of organization in year t multiplied by the total existing human resource of organization must be less than or equal to per capita overtime determined by law multiplying in the total existing human resource of organization. In this limitation $CF_{(B,D,t)}$ parameter is the per capita cost of overtime in all sections and degrees in year t, and O parameter is the per capita overtime that is laid down by law.

Goal limitations:

1. Minimizing human resource expenditure of organization in sections and degrees:

$$\sum_{B=1}^{5}\sum_{D=1}^{4} MEJ_{(B,D,t)}.J_{(B,D,t)} + \sum_{B=1}^{5}\sum_{D=1}^{4} MEP_{(B,D,t)}.P_{(B,D,t)} + \sum_{B=1}^{5}\sum_{D=1}^{4} MES_{(B,D,t)}.S_{(B,D,t)} + \sum_{B=1}^{5}\sum_{D=1}^{4} MEH_{(B,D,t)}.(I_{(B,D,t)} - J_{(B,D,t)}) + DEN_t - DEP_t = R_e.BTOT_t \quad ; \forall t \in T$$

T=1,…,5
B=1,…,5
D=1,…,4

This limitation shows that the amount of organization's human resource optimal expenditure is equal to a multiple of the total budget of the organization (BTOT). This amount is a goal. In this limitation $MEJ_{(B,D,t)}$, $MEP_{(B,D,t)}$, $MES_{(B,D,t)}$ and $MEH_{(B,D,t)}$ are the average cost of teleworking, recruitment, separation and maintenance, respectively. R_e is the ratio of human resources expenditure to the total budget of organization. If the actual amount of expenditure is less than the corresponding goal, the shortage will be compensated with positive deviation of goal (DEP_t) and if the actual amount of expenditure is more than the corresponding goal, the shortage will be compensated with negative deviation of goal (DEN_t).

2. Maximizing teleworking human resources in sections and degrees:

$$\sum_{B=1}^{5}\sum_{D=1}^{4} J_{(B,D,t)} + DJN_t - DJP_t = R_j.\sum_{B=1}^{5}\sum_{D=1}^{4} I_{(B,D,t)} \quad ; \forall t \in T$$

T=1,…,5
B=1,…,5
D=1,…,4

This limitation shows that the amount of teleworking human resources of organization is a ratio of the total existing human resources of organization. This amount is a goal. R_j is the ratio of the teleworking human resource to the total of existing human resource. If the actual amount of teleworking human resource is less than the corresponding goal, the shortage will be compensated with positive deviation of goal (DJP_t) and if the actual amount of teleworking human resource is more than the corresponding goal, the shortage will be compensated with negative deviation of goal (DJN_t).

3. Maximizing expert human resources (master and PhD) in sections:

$$\sum_{B=1}^{5} I_{(B,1,t)} + DID_1N_t - DID_1P_t =$$
$$R_i . \sum_{B=1}^{5} \sum_{D=1}^{4} I_{(B,D,t)} ; \forall t \in T$$

T=1,…,5
B=1,…,5
D=1,…,4

This limitation shows that the optimal amount of existing human resource in degree 1and in all sections is a ratio of the total existing human resource of the organization. This amount is a goal. R_i is the ratio of expert human resource to the total existing human resource. If the actual amount of expert human resource is less than the corresponding goal, the shortage will be compensated with positive deviation of goal (DID_1P_t) and if the actual amount of expert human resource is more than the corresponding goal, the shortage will be compensated with negative deviation of goal (DID_1N_t).

4. Minimizing supportive forces (top management, financial and administrative sections) in degrees:

$$\sum_{D=1}^{4} I_{(1,D,t)} + \sum_{D=1}^{4} I_{(4,D,t)} + DIBN_t - DIBP_t$$
$$= R_b . \sum_{B=1}^{5} \sum_{D=1}^{4} I_{(B,D,t)} ; \forall t \in T$$

T=1,…,5, B=1,…,5, D=1,…,4

This limitation shows that the optimal amount of existing human resource in top management section and financial and administrative section in all degrees is a ratio of the total existing human resource of the organization. This amount is a goal. R_b is the ratio of supportive human resource to the total existing human resource. If the actual amount of supportive human resource is less than the corresponding goal, the shortage will be compensated with positive deviation of goal ($DIBP_t$) and if the actual amount of supportive human resource is more than the corresponding goal, the shortage will be compensated withnegative deviation of goal ($DIBN_t$).

5. Minimizing human resource recruitment of specialists with undergraduate and lower degrees in all sections:

$$\sum_{B=1}^{5} P_{(B,2,t)} + \sum_{B=1}^{5} P_{(B,3,t)} +$$
$$\sum_{B=1}^{5} P_{(B,4,t)} + DPDN_t - DPDP_t =$$
$$R_p . \sum_{B=1}^{5} \sum_{D=1}^{4} P_{(B,D,t-1)} ; \forall t \in T$$

T=1,…,5
B=1,…,5
D=1,…,4

This limitation shows that the optimal amount of recruitment of specialists with undergraduate, associate, high school degrees and lower in all sections is a ratio of the previous year recruitment. This amount is a goal. R_p is the recruitment rate of human resources with undergraduate and lower degree. If the actual amount of human resource recruitment is less than the corresponding goal, the shortage will be compensated with positive deviation of goal ($DPDP_t$) and if the actual amount of human resource recruitment is more than the corresponding goal, the shortage will be compensated with negative deviation of goal ($DPDN_t$).

In this model, there are four systematic limitations for five years. Totally twenty systematic limitations will be applied in the model. The total number of the model limitations, including goal limitations will be (20 +25)=45.

Box, Jenkins and moving average models were used to measure and forecast model parameters on the basis of available information from previous years. Box and Jenkins approach is one of the techniques that are widely used for prediction because its structured modeling gives basic and reasonable prediction (Wong, Chon, Chiang, 2011, p12). Model Parameters and measurement methods are illustrated in the Table 2.

Table 2: Parameters and measurement methods

Row	Type of parameters or data	Methods
1	Weight of deviation variables in the objective function	Group AHP method via comparative matrices
2	allocated and proposed budget	Using the Box and Jenkins model (ARIMA)
3	Coefficients of teleworking, expertise and support personnel and recruiting expert personnel and expenditure goals	Considering measures and policies of the organization and interview with senior managers
4	The average expenditure of maintenance and separation across sections and degrees for five years and per capita expenditure of maintenance and separation for five years	Using Moving Averages method
5	The average expenditure of recruitment and teleworking across sections and degrees for five years and per capita expenditure of recruitment and teleworking for five years	Calculating the trend of the rate of the previous years and calculate future trend using the trend rate
6	per capita space per employee and per capita overtime	It is set based on law.
7	Existing space of organization	Includes the organization's available space.
8	Tolerance interval of fuzzy goals	Interviews with policymakers and manpower planning organization

Given the above considerations, brief version of deterministic model of human resource planning for the statistical center is as follows:

$$Min\ Z = \sum_{t=1}^{5}(WEP, DEP_t) + \sum_{t=1}^{5}(WJN, DJN_t) + \sum_{t=1}^{5}(WID_1N, DID_1N_t) + \sum_{t=1}^{5}(WIBP, DIBP_t) + \sum_{t=1}^{5}(WPDP, DPDP_t)$$

S.t

Goal limitation of the total human resource expenditure:

$$\sum_{B=1}^{5}\sum_{D=1}^{4} MEJ_{(B,D,t)}.J_{(B,D,t)} + \sum_{B=1}^{5}\sum_{D=1}^{4} MEP_{(B,D,t)}.P_{(B,D,t)} + \sum_{B=1}^{5}\sum_{D=1}^{4} MES_{(B,D,t)}.S_{(B,D,t)} + \sum_{B=1}^{5}\sum_{D=1}^{4} MEH_{(B,D,t)}.(I_{(B,D,t)} - J_{(B,D,t)}) + DEN_t - DEP_t = R_e.BTOT_t \quad ;\forall t \in T$$

Goal limitation of teleworking:

$$\sum_{B=1}^{5}\sum_{D=1}^{4} J_{(B,D,t)} + DJN_t - DJP_t = R_j.\sum_{B=1}^{5}\sum_{D=1}^{4} I_{(B,D,t)} \quad ;\forall t \in T$$

Goal limitation of expert human resource (master and PhD):##

$$\sum_{B=1}^{5} I_{(B,1,t)} + DID_1N_t - DID_1P_t = R_i.\sum_{B=1}^{5}\sum_{D=1}^{4} I_{(B,D,t)} \quad ;\forall t \in T$$

Goal limitation of supportive human resource (top manager and administrative and finance):

$$\sum_{D=1}^{4} I_{(1,D,t)} + \sum_{D=1}^{4} I_{(4,D,t)} + DIBN_t - DIBP_t = R_b.\sum_{B=1}^{5}\sum_{D=1}^{4} I_{(B,D,t)} \quad ;\forall t \in T$$

Goal limitation of inexpert human resource (undergraduates and lower):

$$\sum_{B=1}^{5} P_{(B,2,t)} + \sum_{B=1}^{5} P_{(B,3,t)} + \sum_{B=1}^{5} P_{(B,4,t)} + DPDN_t - DPDP_t = R_p.\sum_{B=1}^{5}\sum_{D=1}^{4} P_{(B,D,t)} \quad ;\forall t \in T$$

Systematic limitation of existing human resource:

$$\sum_{B=1}^{5}\sum_{D=1}^{4} I_{(B,D,T)} = \sum_{B=1}^{5}\sum_{D=1}^{4} I_{(B,D,t-1)} + \sum_{B=1}^{5}\sum_{D=1}^{4} P_{(B,D,t)} - \sum_{B=1}^{5}\sum_{D=1}^{4} S_{(B,D,t)} ;\forall t \in T$$

Systematic limitation of budget:

$$\sum_{B=1}^{5}\sum_{D=1}^{4}CEP_t.P_{(B,D,t)}+$$
$$\sum_{B=1}^{5}\sum_{D=1}^{4}CES_t.S_{(B,D,t)}+$$
$$\sum_{B=1}^{5}\sum_{D=1}^{4}CEJ_t.J_{(B,D,t)}+$$
$$\sum_{B=1}^{5}\sum_{D=1}^{4}CEH_t.(I_{(B,D,t)}-J_{(B,D,t)}\leq BHR$$
$$;\forall t\in T$$

Systematic limitation of official space:

$$CL.(\sum_{B=1}^{5}\sum_{D=1}^{4}I_{(B,D,t)}-\sum_{B=1}^{5}\sum_{D=1}^{4}J_{(B,D,t)})\leq\alpha;\forall t\in T$$

Systematic limitation of overtime:

$$\sum_{B=1}^{5}\sum_{D=1}^{4}CF_{(D,B,t)}.I_{(t,B,D)}\leq 0,\sum_{B=1}^{5}\sum_{D=1}^{4}I_{(B,D,t)};\forall t\in T$$

T=1,…,5

B=1,…,5

D=1,…,4

$I,J,P,S\in 1$

Other variables ≥ 0

Design of fuzzy mathematical model of HRP for the statistical center of Iran:

In the deterministic model, coefficients and parameters were assumed constant. However, in practice the goals of human resources in the statistical center face with many uncontrollable, imprecise, and ambiguous factors. Considering the fuzzy logic's potential of using ambiguous and inaccurate information, one can set the new mathematical models with this logic in a way that it fixes the previous model's drawbacks while maintaining its advantages.

The equivalent deterministic model of fuzzy model of HRP for the statistical center of Iran:

In order to solve Fuzzy models, it is essential to clarify these models or in other words, these models should be converted to their equivalent deterministic models. Briefly, the equivalent deterministic model of Fuzzy model of HRP for Statistical Center of Iran is as follows:

$$Min\ Z=\sum_{t=1}^{5}(WEP,DEP_t)+$$
$$\sum_{t=1}^{5}(WJN,DJN_t)+$$
$$\sum_{t=1}^{5}(WID_1N,DID_1N_t)+$$
$$\sum_{t=1}^{5}(WIBP,DIBP_t)+$$
$$\sum_{t=1}^{5}(WPDP,DPDP_t)$$

S.t

Goal limitation of human resource total expenditure:

$$(\sum_{B=1}^{5}\sum_{D=1}^{4}MEJ_{(B,D,t)}.J_{(B,D,t)}+$$
$$\sum_{B=1}^{5}\sum_{D=1}^{4}MEP_{(B,D,t)}.P_{(B,D,t)}+$$
$$\sum_{B=1}^{5}\sum_{D=1}^{4}MES_{(B,D,t)}.S_{(B,D,t)}+$$
$$\sum_{B=1}^{5}\sum_{D=1}^{4}MEH_{(B,D,t)}.(I_{(B,D,t)}-J_{(B,D,t)}))/$$
$$[R_e.BTOTP_{t\,\mathrm{Re}}.BTOT_t]+DEN_t-DEP_t$$
$$=R_e.BTOT\ /[R_e.BTOTP_t-R_e.BTOT_t]\ ;\forall t\in T$$

Goal limitation of teleworking:

$$\sum_{B=1}^{5}\sum_{D=1}^{4}J_{(B,D,t)}/\Delta d-DJP_t=$$
$$R_j.\sum_{B=1}^{5}\sum_{D=1}^{4}I_{(B,D,t)}/\Delta d;\forall t\in T$$

Goal limitation expert human resource (master and PhD):

$$\sum_{B=1}^{5}I_{(B,1,t)}/\Delta m+DID_1N_t-DID_1P_t$$
$$=R_i.\sum_{B=1}^{5}\sum_{D=1}^{4}I_{(B,D,t)}/\Delta m;\forall t\in T$$

Goal limitation of supportive human resource (top management and official and financial):

$$\sum_{D=1}^{4}I_{(1,D,t)}+\sum_{D=1}^{4}I_{(4,D,t)}/\Delta p+DIBN_t$$
$$-DIBP_t=R_b.\sum_{B=1}^{5}\sum_{D=1}^{4}I_{(B,D,t)}/\Delta p;\forall t\in T$$

Goal limitation of recruitment of inexpert human resource (undergraduate and lower):

$$\sum_{B=1}^{5}P_{(B,2,t)}+\sum_{B=1}^{5}P_{(B,3,t)}+$$
$$\sum_{B=1}^{5}P_{(B,4,t)}/\Delta g+DPDN_t-DPDP_t$$
$$=R_p.\sum_{B=1}^{5}\sum_{D=1}^{4}P_{(B,D,t-1)}/\Delta g;\forall t\in T$$

Systematic limitation of existing human resource:

$$\sum_{B=1}^{5}\sum_{D=1}^{4} I_{(B,D,t)} = \sum_{B=1}^{5}\sum_{D=1}^{4} I_{(B,D,t-1)} + \sum_{B=1}^{5}\sum_{D=1}^{4} P_{(B,D,t)} - \sum_{B=1}^{5}\sum_{D=1}^{4} S_{(B,D,t)}; \forall t \in T$$

Systematic limitation of budget:

$$\sum_{B=1}^{5}\sum_{D=1}^{4} CEP_t . P_{(B,D,t)} + \sum_{B=1}^{5}\sum_{D=1}^{4} CES_t . S_{(B,D,t)} + \sum_{B=1}^{5}\sum_{D=1}^{4} CEJ_t . J_{(B,D,t)} + CEH_t .(I_{(B,D,t)} - J_{(B,D,t)}) \le BHR_t$$

$\forall t \in T$

Systematic limitation of official space:

$$CL.(\sum_{B=1}^{5}\sum_{D=1}^{4} I_{(B,D,t)} - \sum_{B=1}^{5}\sum_{D=1}^{4} J_{(B,D,t)}) \le \alpha; \forall t \in T$$

Systematic limitation of overtime:

$$\sum_{B=1}^{5}\sum_{D=1}^{4} CF_{(B,D,t)} . I_{(B,D,t)} \le 0, \sum_{B=1}^{5}\sum_{D=1}^{4} I_{(B,D,t)}; \forall t \in T$$

T=1,…,5, B=1,…,5, D=1,…,4

$I, J, P, S \in 1$

Other variables ≥ 0

Findings

After formulating the deterministic model and its equivalent Fuzzy model, the data collected from the Statistical Center of Iran was used to solve the model by Lingo10software. Then, the results of the deterministic and fuzzy models were extracted for all four variables. The results of both models were then analyzed using SPSS software and paired test. This test compares two variables related to a society and both of them should be quantitative (Momeni and Faalghayumi, 2001, p.77).The results of paired test for deterministic and fuzzy results are shown in Table 3.

Table 3: The results of paired test

	Paired Differences					T	Df	Sig
	Mean	Std. Deviation	Std. Error Mean	%95 Confidence Interval of the Difference				
				Lower	Upper			
Fuzzy-Deterministic	0.392	3.593	0.1796	0.039	0.74576	2.184	399	0.03

The sig value of less than 0.05 shows that there is a considerable difference between the results of deterministic and Fuzzy models at confidence level of 95 percent. Since the upper and lower limits of 95 percent confidence interval are positive, the fuzzy model's average is more than that of deterministic model. The findings indicate that Statsitical Center of Iran should:

- Determine the optimal amount of existing human resources across different sections and levels in five years.
- Determine the optimal amount of human resource recruitment across different sections and levels in five years
- Determine the optimal amount of teleworking human resources across different sections and levels in five years
- Determine th eoptimal amount of separation of human resources across different sections and levels in five years

Each of the mentioned items contains information and tips that will help the organization's management with planning, decision-making and control of human resources.

The most interesting result in this model is the amount of the teleworking variable. Teleworking is a new field that organizations and statistics center have little experience in. Nevertheless, both Fuzzy and Deterministic human resource planning models have proposed an increase in teleworking at the Statistical Center of Iran, particularly for the first year. With regard to all conflicting goals of the organization, this issue has attracted the attention and showed that the teleworking is a good strategy to achieve organizational goals. In addition, the analysis of the objective function in both Deterministic and Fuzzy human resource planning shows that the sum of unfavorable deviations from the goal in Fuzzy model (object value = 0.81725) is less than the sum of unfavorable deviations from the goal in Deterministic model(object value = 27.09).

Conclusion

According to this study, it seems that fuzzy mathematics can somewhat compensate the inefficiency of the conventional models in the field of human resource planning. However, this potential ability faces a lot of complexity in terms of applying it in an organization. However, the application of fuzzy mathematics in HRP modeling will improve the results and increase the validity of HRP models. Finally, in conclusion, the following key results are significant:

- Fuzzy models are more flexible than deterministic models. This will facilitate access to optimal response.
- Fuzzy models are more complex than deterministic models in the implementation phase; but if these models are properly formulated, they can be more efficient than similar deterministic models.
- According to the studied organization, it seems that the fuzzy models are more efficient in the organizations, which have inaccurate data.

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