Designing a human resource development causal model using the fuzzy Dematel method

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Abstract

Nowadays, human resource development is the concept of thought and idea by the organization's staff, and its new concept requires employees to be equipped with qualities and skills that, with full compassion and commitment fulfill their capabilities, energy, expertise and thought to fulfill their mission. Put the organization. This paper is aimed at designing the causal Pattern of Human Resources Development at Islamic Azad University based on the general policies of the administrative system transformation according to the fuzzy Dematel method. In this study, information about 16 experts and professors at Islamic Azad University, forms a statistical sample. The results show that individual, environmental, educational, social, economic and management factors affect human resource development at Islamic Azad University. The fuzzy Dematel-based method has also shown that the training factor with an average effect of 1.65 is the most important factor in this study. On the other hand, environmental factors with an average effect of 0.520 are a factor with the least effect.

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1 Introduction

Human resource is considered as the main assets of the organization having a key role in achieving the organization goals. In the modern society, with the high competition among companies, the possession of efficient resources of labor is extremely significant. Without skilled and efficient human resources, even the organizations with highest levels of technology and facilities will not be able to influence the market and win the ongoing competition. The more efficient this asset gets, the more likely the organization thrives, survives and gets promoted. Universities have always been the main centers of creating and expanding knowledge with scientific innovation being their main function. The human resource existing in the university has a significant effect in the realization of this function. Thus, universities attempt to promote these assets through the available resources uplifting the HR potential both qualitatively and quantitatively. HR development is contingent upon issues such as the general policy of administration system transformation. The function of HR development includes the design and presentation of training and developmental schemes for increased efficiency of the organization [2, 3, 4, 5, 6].

As a pioneer in HR development theory, Nadler in 1960 defined HR development as teaching the learned lessons and the refined organizational policies by the employer within a given time frame with the aim of increased performance and

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individual personnel improvement [28]. The framework built for HR development helps personnel develop necessary skills, knowledge, vision, behavior and individual and organizational capabilities based on the general policies of AST to ultimately achieve organizational goals. Thus, a main driver of comprehensive growth and development of human resources in the modern society is the application of AST policies. The administrative system policies in each country represent the government's perspective on the state's administration and management. A main element in the transformation of administrative system is the structural transformation of administrative system aimed to enhance and accelerate general services. The administrative system transformation is a critical factor and a main tool of the government in achieving political, social, cultural and economic goals of the country [1, 7, 8].

Iran's administrative system, with its significant role in the country's affairs, is considered as a main infrastructure of development which, if neglected, can lead to uncompensable damages in achieving organizational goals, realization of the macro plans, public satisfaction etc. It should be noted that organizations have always been attempting to make reforms in the administrative system in different levels and by different means. However, problems such as inadequate knowledge, lack of exact definitions for administrative policies, failure to develop strategies and getting entangled in daily issues have impeded the realization of reforms and achieving the mentioned goals [3, 21]. Thus, instead of driving the organization growth and development, the administrative system structure in its current form hinders the development of the organization. Inasmuch as the reforms are considered not only inevitable but also a mandatory task, not implementing these reforms properly will linger the growth and waste a large part of the organization resources leading to a widening gap between the current and ideal situations. Based on the issuance of the administrative system by the supreme leader and the emphasis of Iran's president on reforming the administrative system, it is a suitable occasion to develop common values among all administrative system actors and using the linking conditions to provide ground for deep reforms in the administration as the substrate for organizational development [1, 10].

To do its fair share of creating the necessary grounds for the growth and prosperity of the organization, the Islamic Azad University has inaugurated the office of HR studies and training. Based on its mission, the office attempts to plan and hold courses and training workshops for short-term on-the-job training for the personnel. These courses focus on management training on increasing the capabilities of staff and faculty. Given the significant annual investment on these programs, it is essential to refine the strategies sought by the university in the HR development. Optimizing the time and cost of HR development is a crucial task for any organization like IAU to achieve the envisioned results. Adopting a suitable strategy based on scientific approaches can lead to the best and optimal results in terms of time, cost and efficiency. The purpose of this research is the design of a competent pattern for HR development in IAU based on the general policies of the administrative system transformation [32].

2 Theoretical framework and research background

Man, as the basic pillar of organizational development, plays an important role in the framework of group and organizational activities. Nowadays, the growth and development of organizations depends on the correct use of human resources [4]. The theorists of management science, recognizing human as a complex element in the organization, consider the human factor as the most important element for maintaining the existence and survival of organizations [9] and they have made the increasing attention to human resources as a powerful tool in organizational changes and transformations [10]. It seems that the biggest capital of successful organizations is human capital [11]. Without considering the needs of human resources, it is not possible to direct the energy and resources of the organization in a direction that achieves the desired goals [12]. Considering today's turbulent world, which has been called the era of change, organizations are exposed to many challenges, one of the most important of which is the challenge of human resources [13].

In today's competitive world, one of the important tools for creating transformation and survival of the organization and achieving the desired goals and missions is the human element [15]. In the meantime, what gives life to the category of transformation and guarantees the survival of the organization is human resources, the role of man in the organization and the way he is viewed will have a significant contribution to the success or failure of the organization. With the beginning of the third millennium, human resources have become more prominent and now it is referred to as the only factor of achieving success and sustainable competitive advantage in the organization [14]. This is especially true in today's knowledge economy. However, human resource management in organizations is faced with many challenges, including globalization, lack of skilled and committed workforce, decision making pyramid, lack of recognition of employees' needs, lack of planning, lack of meritocracy, discrimination, inadequate productivity of human resources, lack of motivation, non-participation of employees, and leaving the cooperation of long-standing employees of the organization [16]. However, human resource managers can solve these challenges or prevent most

of them by empowering their employees. Capable employees cooperate with managers in order to solve challenges, because in empowering human resources; motivation, participation, commitment, creativity and loyalty are hidden [16].

The active presence of Islamic Azad University in the field of competition and technology and the emergence of new jobs and the need for multi skilled employees has made empowering them inevitable [17]. Through empowerment programs, work capacities increase by delegating authority, increased responsibility, autonomy in decision making and self -efficacy are increased, and as a result, productivity and effectiveness of Islamic Azad University also increases [18]. To do this, infrastructure such as capital, motivated human resources and attitudes are needed, and what is achieved in addition to addressing the challenges of human resource management is increasing the loyalty and sense of belonging of the employees to the Islamic Azad University, which is manifested in active participation and providing initiative and creativity, and will ultimately create the means to improve the productivity of the Islamic Azad University. The presentation of the initiative and creativity will eventually produce the productivity of Islamic Azad University [18]. It should be noted that until employees acquire the necessary capacities to change in the direction of empowerment, there will be no success, especially if there is no funding and capital needed to implement [19]. Today, despite the extraordinary importance of empowerment, unfortunately in Iran for a variety of reasons, including the ambiguity of organizational goals, lack of proper definition of work and personal relationships, lack of proper performance evaluation system, lack of definition of appropriate indicators to measure the productivity of human resources and some factors in the market that result from the non-competitiveness of the business environment and the economic structure of the country has caused that a specific mechanism for the qualitative improvement of human resources has not been defined and not even taken seriously [20, 30].

In the process of economic growth and development, there is a special need to empower and develop human resources as the main production factor in advancing macroeconomic and social goals and policies at the national and regional levels. Experience has shown that the impact of human capabilities on the process of development of societies and organizations is greater than other inputs, including physical inputs [21]. The importance of human resource performance in the development of societies has led researchers and planners to manage human resources.

Bossi & Abur [22], in their research on the relationship between migration and the development of nurses' human resources in Ghana, they showed that there is a large difference in salaries and wages, as well as the establishment of networks to facilitate migration to foreign countries, and the existence of career advancement for nurses and strong education for their children abroad. The country, as well as avoiding their employment in rural and deprived areas, is among the factors and findings that have been obtained in this study as the causes of the lack of development of human resources in nurses in Ghana. Moslehifar and Ebrahim [23] in a research titled human resource development of interns that they conducted in one of the universities in southern Malaysia showed that oral communication skills play a vital role in the understanding of human resource development in the workplace. In addition, among these, the most important communication activities are establishing a correct relationship with clients, solving problems with the help of colleagues, providing training through discussions and educational workshops as effective factors on the development of trainees.

Kesti [24] stated in a study of the relationship between human resources development and business efficiency that human resource development, quality of work life, human resource structure and business results need to be studied in combination. Marin [27] in research and innovation in educational policies and strategy for human resource development states that the continuous process of professional development requires teachers' initial education, initiation and enrollment in educational activities, as well as their lifelong learning. Knowledge Database is essential for formal education and requires teachers to study all their lives and to be educated. Due to these tips, the variety of methods through which we achieve the professional development of education and also the evaluation of the validity of the stages of professional development are essential.

If we want to have a continuous, practical, and efficient education system, in addition, organizational responsibility is determined and activated at various stages of professional education, which requires specifying the status and concept of special structures. To this end, one of the places to achieve success in the field of restructuring the education process is by creating and supporting a network of educational institutions in universities, in order to organize and implement specific regulations, with separate financing for the development of professional abilities and capacities of human resources in education. As a result of their findings in knowledge management research for the development of human resource management systems, Morkherji, Gansen and Hashemi [25] stated that knowledge management provides recognition, documentation and distribution of knowledge to improve performance and plays a special role in analyzing educational needs, educational planning, and gaining strategic results. Knowledge management provides capacities for role-playing of facilitation roles, human resource brokerage and managers' rapid reaction experts.

Rizvi [31] in a research entitled "Human capital development role of Human Resource" reported that training and development programs for soft skills (81 percent), training and development programs (technical skills, 67 percent) and team-oriented training programs (64 percent) were reported by managers. The average human resource development score has been reported 44, which has the highest value compared to the average criterion in the report, and the development of human capital is one of the important human resource roles by managers. Sung [26], as a result of his studies on leadership style and human resource development, stated that supportive leadership and goal-oriented leadership are good predictors in the development of human resources, and functional culture has a mediating role in the relationship between leadership style and human resource development.

3 Effective parameters on IAU's HR development

3.1 Individual factors

Individual factors are among the main influencing parameters on professional HR development in an organization. Two parameters, namely the literacy level and the work experience, are considered here.

3.1.1 Literacy level

The world is transitioning from an industrial to information-based society. Now the type and level of literacy and information is different from the past. Therefore, people across all ages and generations need to be educated and re-educated in a modern way. In an information-based society, an individual with basic or even higher-level training who can't efficiently utilize the internet is not considered as a literate person. This means a significant transformation should be implemented in education system. Based on UNESCO's definition, a person is considered literate when having all the below properties.

3.1.2 Work experience

By work experience, we mean the duration of the individual's collaboration with the organization which somehow represents how professional the individual is behaving in the organization.

3.2 Environmental factors

Psychological studies show that the physical conditions of the work environment have significant impact on the mental health of staff. These studies suggest that a suitable physical condition of the work environment can increase the efficiency and quality of the staff performance. Different criteria are used to assess the work situation's effect on people. Three of these criteria include the physiological, mental and output criteria along with many other criteria not discussed here. The working situation determines the most suitable criterion. The physiological criteria are assessed based on some physiological processes. During work, especially when it is physical, several different physiological changes happen in a person. Long and difficult labor may decrease the physical strength to its lowest level. The reduced strength of the body for further work can be readily observed. To demonstrate the physiological changes of the organism, different criteria such as the heartbeat, blood pressure, oxygen intake, respiration rhythm, blood combination and the skin's electrical resistance can be employed. Definitely, physiological changes are more important in physical than mental jobs. However, it has been shown that some of the physiological criteria, such as the skin's electrical resistance, can also be used to study fatigue impacts of mental activities. In addition to the normal physiological changes such as physical fatigue, psychological changes can also occur during work or when the person faces special circumstances. The level and characteristics of these psychological changes have not been fully determined. However, two main parameters can be considered in this regard. The first is commonly known as sickness caused mainly by doing works which are not interesting for the person. This can also be seen when the work is repetitive or very simple. It should be noted, however, that no work in its essence is sickening. Rather, it is the reaction of the person against that particular work that gives it the characteristic of sickness. Indeed, sickness is how the worker describes their work rather than the work having some unique features that make it sickening. The second variable which is sometimes encountered is the mental fatigue which causes some of the well-known states such as contusion, reluctance to work, disinterest and even quitting the job. This variable is also called the psychological fatigue. The third criterion which enables the study of different working conditions on the workers is the output or any credible metric of the result of the performed work. Some studies evaluate the reduction in output for this purpose.

3.3 Training factors

3.3.1 Number of participations in training courses

Professional on-the-job training is necessary for enhanced performance of the personnel. A training course is considered useful when it provides noticeable positive effects on the personnel's behavior, performance and their organizational interests. To ensure this effect, it is required to measure the efficiency of the training based on performance metrics. There are different definitions available for training. For instance, training is defined as expanding the knowledge, insight, skills and behavioral patterns required by the staff for better performance in a certain job. Robins [27] defines training as a learning-based experience which brings relatively per meant changes in the person helping them better carry out the assignments, improve capabilities, enhance skills and increase knowledge, insight and social behavior. Thus, training means the change in knowledge, vision and interaction with colleagues. From the viewpoint of Singer [28] training entails the use of envisaged programs for improving the merits of personnel leading to gained knowledge, skills and capabilities in a way that facilitates the performance improvement.

3.3.2 Characteristics of training programs

Given the importance of training, every organization attempts to create opportunities for growth and development of its human resources. The daily advancement of science and technology along with transformations in cultural, social and economic areas entail that the human resources as the main development factor of the organization keep pace with these advances and, in doing so, do not rely on the trainings prior to or upon landing the job in the organization. Thus, they will require training programs during their service which are supposed to make the people more active and efficient in pursuing the individual and organizational goals. Today, on-the-job trainings are commonly undertaken not only in educational organizations but also in any organization which aims to achieve constant qualitative and quantitative improvement in scientific and professional aspects. On-the-job trainings are effective only if they are based on the real needs of the personnel with voluntary participation. The training needs and expectations of the personnel are important factors in determining the training goals, the syllabi, training method, the way the course is conducted as well as the type of examinations.

3.4 Social factors

3.4.1 Job promotion

When an individual is hired in an organization, he/ she will gain experience and after acquiring the necessary skills will attempt to get promotion within the organization. It is absolutely normal for a person with necessary skills and experience as well as leadership capabilities to seek promotion. In modern organizations, especially the big ones, only doing loads of hard work will not suffice for getting promoted and landing higher positions. It is just as important that the managers deduce the competency and merit of the worker through his/ her behavior and performance and find him/her entitled to get promoted. Although focusing on one's performance and trying to get the output speak for itself is superior to its mere description, the experience shows that this is not always the case. Therefore, the worker should also try to better present their quality and performance through some additional activities other than their main assignment so as to gain the management's interest and confidence. By envisioning the ultimate goal and position within the organization, any individual worker can strive to gain the approval of higher-level managers. There are several important aspects in gaining the promotion that are required to be taken care of by any individual who seeks higher positions.

3.4.2 Job satisfaction

Several definitions and interpretations have been proposed for job satisfaction some of which are presented here. Job satisfaction first came into attention during the economic recession of 1970s and 1980s. During this period, many workers lost interest in their jobs as a result of the economic stagnation and recession. This drew the employers' attention to the concept of job satisfaction. Job satisfaction is a key element for increased efficiency and self-satisfaction within the organization. Managers try their most so their workers get more satisfied with their jobs. Fisher and Hannah [29] considered job satisfaction as a psychological factor which corresponds to emotional compatibility with the job and its circumstances. This, in essence, means that if a job creates a better overall situation, the person will approve of their jobs. When, on the other hand, the job does not bring better conditions or enjoyment to the worker's life, they will complain and try to leave the job.

Hapak considers the job satisfaction as a multi-dimensional concept linking it with different physical, psychological and social factors. As he argues, not any single element will bring job satisfaction to an individual. Rather, a

combination of different elements is required to give the satisfaction to the person at any given period. Based on the significance of different factors such as the income, social position, work environment etc. the person will have a certain level of job satisfaction. In fact, job satisfaction is the level of positive attitude of the individual towards their job. When an individual claims a high job satisfaction, they mean they really like their job, have a good feeling toward the job and gives high priority and importance to their job. Job satisfaction is the type of satisfaction the worker gains, spiritually and physically, from their job. Job satisfaction is a set of compatible and incompatible feelings which the individual has toward their job. Ginsburg et al have considered the job satisfaction through two main factors [30].

3.4.3 Commitment toward organization

As a dependent variable, the organizational commitment defines the power driving the individual to stay with the organization and work toward achieving the organizational goals. Thus, the organizational commitment is accompanied with a set of driving behaviors. A person with high organizational commitment stays with the organization accepts its goals and attempts to achieve these goals. This attempt may even show itself in the form of some sacrifice. The 3-element organizational commitment model has gained the focus of several empirical studies. Based on this model, the organizational commitment constitutes three elements.

3.5 Economic factors

3.5.1 Payment to the experts

The payment to experts essentially means their salary which can highly influence their performance in the organization and its regular payment can also positively impact their working quality.

3.5.2 Financial bonuses

Financial bonuses are considered as some form of aid which belongs to the members of a firm because of their effective contribution in the firm's achievements. The financial bonuses are paid to all participants as a part of the investment capital. The workers should get suitable bonuses for high quality of their work and as an incentive to continue with high job performance. The managers often neglect the positive effect of even some small bonuses on the performance of their staff. In this regard, consider this example. Suppose you have sacrificed your and your family's leisure time in order to finish a job assigned by your manager. In return, however, your manager doesn't even nod or give you a simple approval smile. Then what will you do in the future assignments? Will you carry out the job with the same enthusiasm or get discouraged?

Many researches indicate that not receiving bonuses will hamper the constantly high performance of the staff. The managers may believe that the regular monthly salary is the ultimate due return against the work of the staff. Although the monthly salary is the main element in maintaining the staff performance, the workers expect to be paid bonuses against their elevated performance. The bonus can be both materialistic and non-materialistic. This encompasses a wide range from a simple smile, to verbal complement and nodding as a sign of approval etc. It is necessary for managers to maintain the high performance within the staff through different types of bonuses. It is noteworthy that a mere distribution of bonuses among employees will not guarantee the high performance. Rather, besides the bonuses it is required to improve knowledge, capabilities, skills and the experience of the employees to achieve the desired goals. High-quality workers are those who meet a collection of different criteria to best carry out the assignments and this is when the bonuses will have the most powerful impact. The optimal bonus payment system is the one which combines three elements namely the job satisfaction, drive, performance with bonuses. For example, a simple drive and desire toward the job without sufficient knowledge and expertise cannot guarantee that the bonuses will improve the staff performance.

3.6 Management factors

3.6.1 Supervision conditions

Supervisors carry out the assignments through their downstream staff and, while leading them, are responsible for their welfare. The job description for supervising responsibility has changed a lot throughout the years. Nowadays, the presence of more deserved employees with higher training than the supervisors is posing significant challenges to the working life of the supervisors. Supervisors apply their skills to strike balance between focusing on the jobs and on the employees doing the job. Therefore, they should learn how to behave properly in the workplace so as to play their role as the guarantors of the stable movement toward higher efficiency in achieving organizational goals. Supervisors

are in fact managers with a key role in work flow of the organization and the term supervisor should not be used to separate this sector with the managerial society.

Supervisors should be capable of changing and improving the work flow in their jurisdiction. The main responsibility of the supervisor is to manage the employee in different organizational levels. Sometimes supervisors are considered the same as managers of the organization whereas their tasks and position in the organization hierarchy is wholly different. The managers sometimes consider supervisors as human relation specialists. Thus, the supervisors take care of the human resource affairs of the organization and the manager works on the technical issues. The supervision is not; however, a peripheral role and carries out part of the assigned tasks, too. In the meantime, the supervisor is not the main character of the organization since he/she is a behavioral specialist focusing on the human resource problems.

3.6.2 Performance evaluation and measurement method

Performance evaluation is a process aimed to determine the merit of the employees in terms of successful fulfillment of the assigned works and organizational responsibilities. In this process the senior managers of the institute, firm or organization measure the working behavior of their staff so as to give them necessary feedback on their strengths and weaknesses. In other words, performance evaluation is the task of assessing the employee's behavior in conjunction with the particular assigned job in a certain time period relative to the standard execution of that job. This evaluation is carried out with the purpose of determining the potentials and talents of the employees to deliver their fullest potential.

3.6.3 Merit-based staff promotion

According to Dr. Abolalaei, proper connection should be established between the tendencies, insight and capabilities of employees with their job position and promotion within the organization. This mechanism will help the organization assign the most suitable people to critical and strategic positions while giving the employees the required incentives to be dedicated to the organization. In this framework, it is assumed that all employees have the necessary potential and should be given the opportunity to demonstrate their capabilities. In addition, the organization should provide necessary mechanisms such as job rotation, job development, inter-organizational transfers and even filling the available vacancies so that people can get to new and higher positions with more diverse responsibilities upon succeeding in previous roles.

3.6.4 Delegation of authority to the employees

Authority delegation is a process by which the manager or supervisor assigns part of their own authority to their staff without transferring the ultimate responsibility. Chris Argeris believes that the expansion of individual responsibility is beneficial both for the organization and the staff. Granting employees the opportunity to grow and further develop while performing the assigned tasks will help them exhibit further capabilities in the realization of the organizational goals. Although not all the staff wants to be assigned higher responsibilities or face additional issues while performing their work, Argeris believes that the number of people who can be well driven by being given extra responsibilities and authority is much greater than the managers often presume.

4 Research queries

1. What are the aspects and constituents of HR development pattern in the Islamic Azad University according to the general policies of the administrative system transformation?

2. What is the causal pattern of the HR development in IAU based on administrative system transformation using the fuzzy Dematel approach?

5 Statistical society of the research

The statistical society in this research includes all the elites and faculty members of IAU. Based on fuzzy Dematel approach, 16 people will suffice for the sample space.

6 Research approach

From the viewpoint of data gathering and analysis, this is a descriptive research while it is application in purpose with a documentary approach. To gather the necessary data, paired comparison questionnaire tools are used.

7 Fuzzy Dematel approach

Fuzzy sets can well encounter the ambiguity in human thinking and expression in the decision-making process. The linguistic assessment can be effectively used to remove the ambiguities of decision-making process. A lingual variable represents values in the form of expressions and sentences in a natural language. Lingual variables are used as variables with values which are not in the form of numbers but lingual expressions which can effectively describe quantitative expressions. The lingual expression method is a natural and effective approach for decision-makers to express their assessment. Actually, lingual values can be represented by fuzzy values. For this purpose, triangular fuzzy numbers are often used.

A fuzzy set $\tilde{A}$ is a subset of expression X which is itself a set of ordered pairs. The membership function $\mu_{\tilde{A}}(x)$ is defined as $\mu_{\tilde{A}}(x) : X \to [0,1]$. The value of $\mu_{\tilde{A}}(x)$ for the fuzzy set $\tilde{A}$ is the value of X's membership in $\tilde{A}$ which indicates the degree by which x belongs to the fuzzy set $\tilde{A}$ It is assumed that $\mu_{\tilde{A}}(x) : X \in [0,1]$ where $\mu_{\tilde{A}}(x) = 1$ indicates that x fully belongs to $\tilde{A}$ whereas $\mu_{\tilde{A}}(x) = 0$ shows that x does not belong to $\tilde{A}$ at all.

$$\tilde{A} = \{x, \mu_{\tilde{A}}(x)\}, \quad x \in X \tag{7.1}$$

where $\mu_{\tilde{A}}(x)$ a membership is function and $X = \{x\}$ represents a set of x members. A triangular fuzzy number (l, m, r) can be defined as a three-element tuple (l, m, r) and a membership function $\mu_{\tilde{N}}(x)$ as below:

$$\mu_{\tilde{N}}(x) = f(x) = \begin{cases} 0 & x < l, \\ (x-l)/(m-l) & l \le x < m \\ (r-x)/(r-m) & m \le x < r \\ 0 & x \ge r \end{cases} \tag{7.2}$$

where m, l and r are actual numbers with $l < m < r$. Considering the characteristics of triangular fuzzy numbers and the mentioned development principle, the operational rules for two triangular fuzzy numbers, $\tilde{A} = (a_1, a_2, a_3)$ and $\tilde{B} = (b_1, b_2, b_3)$ are as follows: Summation of Fuzzy numbers

$$(a_1, a_2, a_3) \oplus (b_1, b_2, b_3) = (a_1 + b_1, a_2 + b_2, a_3 + b_3).$$

Subtraction of Fuzzy numbers

$$(a_1, a_2, a_3) \ominus (b_1, b_2, b_3) = (a_1 - b_1, a_2 - b_2, a_3 - b_3).$$

Multiplication of Fuzzy numbers

$$(a_1, a_2, a_3) \otimes (b_1, b_2, b_3) = (a_1 b_1, a_2 b_2, a_3 b_3).$$

Multiplication of one fuzzy number and one real number:

$$k \otimes (a_1, a_2, a_3) = (ka_1, ka_2, ka_3).$$

Division of two fuzzy numbers

$$(a_1, a_2, a_3) \oslash (b_1, b_2, b_3) = (a_1/b_1, a_2/b_2, a_3/b_3).$$

To overcome the group decision making problems in a fuzzy environment, an effective fuzzy accumulation tool is required. Human judgement through lingual variables is in fact a set of fuzzy numbers which requires a defuzzification technique to convert them into definite values. The CFC defuzzification technique (conversion of fuzzy data to Crisp points) is based on left and right points using minimum and maximum fuzzy values and the overall score is a weighted average based on membership functions. This gives a more suitable definite time value compared to other approaches. To actually implement the dematel approach for group decision making in a fuzzy environment the following process is executed.

Stage 1: design of a fuzzy lingual scale: in order to overcome evaluation ambiguities, the lingual variable of "effect" with five lingual expressions, namely No, Very low, Low, High, Very high, are used and represented by positive triangular fuzzy numbers (r_{ij}, m_{ij}, l_{ij}) as given in Table 1.

Table 1: Fuzzy numbers

Triangular fuzzy numbers	Exact numbers	Language options
(0.75,1,1)	4	Very high impact
(0.5,0.75,1)	3	High impact
(0.25,0.5,0.75)	2	Medium impact
(0,0.25,0.5)	1	Low impact
(0,0,0.25)	0	Effect less

Stage 2: fuzzy calculation of the direct effect matrix: according to the viewpoints of the experts with lingual scales, the natural language and the connection between elements can be used to obtain the fuzzy direct effect matrix $\tilde{D}$ as below:

$$\tilde{D} = [\tilde{d}_{ij}]_{n \times n}, \quad \text{that} \quad \tilde{d}_{ij} = (d_{ij}^l, d_{ij}^m, d_{ij}^r) \tag{7.3}$$

Thus, matrix D is obtained from the direct relations with pair-wise comparison between the cause and effect elements. Assume n number of variables is affected by this system. The direct effect matrix D will be as below:

$$\begin{bmatrix} 0 & d_{12} & \cdots & d_{1n} \\ d_{21} & 0 & \cdots & d_{2n} \\ \vdots & \vdots & \ddots & \vdots \\ d_{n1} & d_{n2} & \cdots & 0 \end{bmatrix}$$

Stage 3: normalization of the fuzzy direct effect matrix: based on the fuzzy direct effect matrix $\tilde{D}$, the normaled fuzzy direct effect matrix $\tilde{N}$ can be obtained as:

$$\tilde{N} = \tilde{D}/u \tag{7.4}$$

where

$$i, j \in \{1, 2, \cdots, n\}, \qquad u = \max_{i,j} \left\{ \max_i \sum_{j=1}^n d_{ij}, \ \max_j \sum_{i=1}^n d_{ij} \right\}$$

$$\tilde{N} = [\tilde{e}_{ij}]_{n \times n}, \quad \text{that} \quad \tilde{e}_{ij} = (e_{ij}^l, e_{ij}^m, e_{ij}^r) \tag{7.5}$$

Stage 4: calculation of the total fuzzy direct effect matrix: after calculating the fuzzy normalized direct effect matrix $\tilde{N} = (N_l, N_m, N_r)$, where $N_l = [e_{lij}]_{n \times n}$, $N_m = [e_{mij}]_{n \times n}$ and $N_r = [e_{rij}]_{n \times n}$, the fuzzy total effect matrix $\tilde{T}$ is calculated by the below expression in which I is the unit matrix:

$$\tilde{T} = [\tilde{t}_{ij}]_{n \times n}, \quad \text{that} \quad \tilde{t}_{ij} = (t_{ij}^l, t_{ij}^m, t_{ij}^r) \tag{7.6}$$

Stage 5: defuzzification to definite values: using CFCS approach as shown in the previous relations, the fuzzy total effect matrix $\tilde{T} = []_{n \times n}$ is converted to the total effect matrix with definite value $T = []_{n \times n}$.

$$x = [\tilde{t}_{ij}]_{n \times n}, \quad \text{that} \quad \tilde{t}_{ij} = (t_{ij}^l, t_{ij}^m, t_{ij}^r) \tag{7.7}$$

Stage 6: determination of the threshold value: the threshold value is calculated as the average of the defuzzified matrix values

$$x = [\tilde{t}_{ij}]_{n \times n} \ a = \frac{(\sum_{I}^N = 1 \sum_{J}^N = 1[T_{IJ}])}{N} \tag{7.8}$$

Stage 7: Analysis of the results: in this stage, the sum of rows (effect given) and the sum of columns (effects received) are separately calculated as the effective vector $d = (d_1, \cdots, d_i, \cdots, d_n)'$ with parameter j $(j = 1, 2, \cdots, n)$ and the effective vector $r = (r_1, \cdots, r_i, \cdots, r_n)'$ with parameter i $(i = 1, 2, \cdots, n)$ using the below relation. Then for $i, j \in 1, 2, \cdots, n, i = j$, the horizontal axis vector $(d + r)$ is obtained as the sum of vector D and vector R which represent the significant effects of each criterion. Similarly, the vertical axis vector $(d - r)$ is obtained by deducting vector D from vector R which may divide the criterion into a cause group and an effect group. In general, for high $d_i - r_i$ values the criterion belongs to the cause group while for low $d_i - r_i$ values, the criterion belongs to the effect group. Thus, the cause-and-effect graph can be drawn using the data sets of $(d_i - r_i)|(d_i + r_i)$ $\{i = 1, 2, \cdots, n\}$.

$$T = [t_{ij}]'_{n \times n}, \quad i, j \in \{1, 2, \cdots, n\} \tag{7.9}$$

$$d = \left[\sum_{j=1}^{n} t_{ij} \right]_{n \times 1} = [t_i]_{n \times 1} = [d_j]_{n \times 1} \tag{7.10}$$

$$r = \left[\sum_{i=1}^{n} t_{ij} \right]'_{n \times 1} = [t_j]_{n \times 1} = [r_j]_{n \times 1} \tag{7.11}$$

Here, $d = (d_1, \cdots, d_i, \cdots, d_n)'$ and $r = (r_1, \cdots, r_i, \cdots, r_n)'$ are the vectors representing sum of rows and columns, respectively, of the total effect matrix $T = [t_{ij}]_{n \times n}$.

8 Result of data analysis

Data analysis is a multi-stage process which in the initial steps involves data gathering and the calculation of those variables related to the research queries. Then, the obtained information is examined and the answers to the questions are determined based on the obtained results.

8.1 Question 1

What are the constituent elements of the HR development pattern in IAU as per the general policies of the administrative system transformation? Based on the theoretical principles of section 2, 6 main elements have been identified by the results of this research to be effective on the AST-based HR development pattern of IAU:

1. individual factors
2. environmental factors
3. training factors
4. social factors
5. economic factors
6. managerial factors

To draw the cause-and-effect analysis among those factors affecting the HR development in IAU, the dematel method is employed. First, the pair-wise comparison questionnaire was distributed among 16 elite members and then the dematel technique was applied to the obtained data.

8.2 Question 2

What is the causal pattern of HR development in IAU as per the general policies of the AST based on fuzzy dematel approach?

In this section, the cause-and-effect analysis between different aspects of HR development in IAU is presented. For this purpose, the results of each stage of the fuzzy dematel technique are presented below.

Stage 1: fuzzy lingual scale design: in order to eliminate the ambiguities related to human assessment, the lingual variable of "effect" with five categories of "No, Very low, Low, High, Very high" are used and accordingly expressed in terms of positive triangular fuzzy values l_{ij}, m_{ij}, r_{ij}.

Table 2: Fuzzy lingual scales

Triangular fuzzy values	Definite values	Lingual terms
(0.75,1,1)	4	Very high impact
(0.5,0.75,1)	3	High impact
(0.25,0.5,0.75)	2	Medium impact
(0,0.25,0.5)	1	Low impact
(0,0,0.25)	0	Effect less

Stage 2: Fuzzy calculation of direct effect matrix: based on the expert opinions with lingual scales, and using the natural language and the relation between elements, the fuzzy direct effect matrix $\tilde{D}$ is obtained as:

$$\tilde{D} = [\tilde{d}_{ij}]_{n \times n}, \quad \text{that} \quad \tilde{d}_{ij} = (d_{ij}^l; d_{ij}^m; d_{ij}^r) \tag{8.1}$$

Table 3 gives the fuzzy direct effect matrix resulting from the expert opinions for the six mentioned factors.

Table 3: Fuzzy direct effect matrix for the six main factors

Matrix D	Individual factors	Environmental factors	Educational factors	Social factors	Economic factors	Management factors
Individual factors	0.00 0.00 0.25	0.03 0.27 0.52	0.00 0.03 0.28	0.02 0.22 0.47	0.00 0.03 0.28	0.00 0.05 0.30
Environmental factors	0.00 0.03 0.28	0.00 0.00 0.25	0.00 0.08 0.33	0.00 0.00 0.25	0.00 0.05 0.30	0.00 0.02 0.27
Educational factors	0.50 0.75 0.98	0.75 1.00 1.00	0.00 0.00 0.25	0.70 0.95 1.00	0.25 0.50 0.75	0.00 0.22 0.47
Social factors	0.00 0.05 0.30	0.03 0.25 0.50	0.00 0.00 0.25	0.00 0.00 0.25	0.00 0.03 0.28	0.00 0.07 0.32
Economic factors	0.00 0.25 0.50	0.32 0.57 0.82	0.00 0.02 0.27	0.03 0.23 0.48	0.00 0.00 0.25	0.00 0.03 0.28
Management factors	0.03 0.25 0.50	0.53 0.78 0.98	0.00 0.02 0.27	0.05 0.23 0.48	0.25 0.50 0.75	0.00 0.00 0.25

Stage 3: normalized fuzzy direct effect matrix: given the fuzzy direct effect matrix $\tilde{D}$ the normalized fuzzy direct effect matrix $\tilde{N}$ is obtained as:

$$\tilde{N} = [\tilde{e}_{ij}]_{n \times n}, \quad \tilde{e}_{ij} = (e_{ij}^l; e_{ij}^m; e_{ij}^r) \tag{8.2}$$

Table 4 presents the normalized fuzzy direct effect matrix obtained based on the expert opinions for the six main factors.

Table 4: Normalized fuzzy direct effect matrix for the six main factors

Matrix D	Individual factors	Environmental factors	Educational factors	Social factors	Economic factors	Management factors
Individual factors	0.00 0.00 0.06	0.02 0.08 0.12	0.00 0.01 0.06	0.01 0.06 0.10	0.00 0.01 0.06	0.00 0.01 0.07
Environmental factors	0.00 0.01 0.06	0.00 0.00 0.06	0.00 0.02 0.07	0.00 0.00 0.06	0.00 0.01 0.07	0.00 0.00 0.06
Educational factors	0.23 0.22 0.22	0.34 0.29 0.22	0.00 0.00 0.06	0.32 0.28 0.22	0.11 0.15 0.17	0.00 0.06 0.10
Social factors	0.00 0.01 0.07	0.02 0.07 0.11	0.00 0.00 0.06	0.00 0.00 0.06	0.00 0.01 0.06	0.00 0.02 0.07
Economic factors	0.00 0.07 0.11	0.14 0.17 0.18	0.00 0.00 0.06	0.02 0.07 0.11	0.00 0.00 0.06	0.00 0.01 0.06
Management factors	0.02 0.07 0.11	0.24 0.23 0.22	0.00 0.00 0.06	0.02 0.07 0.11	0.11 0.15 0.17	0.00 0.00 0.06

Stage 4: Calculation of the fuzzy total effect matrix: when the normalized fuzzy direct effect matrix N is obtained, the fuzzy total effect matrix $\tilde{T}$ is obtained as below where I is the unit matrix:

$$\tilde{T} = N * (I - N)^{-1} \tag{8.3}$$

Table 5 shows the fuzzy total effect matrix obtained from the fuzzy direct effect matrix for the six factors.

Table 5: Fuzzy total effect matrix for six main elements

Matrix D	Individual factors	Environmental factors	Educational factors	Social factors	Economic factors	Management factors
Individual factors	0.00 0.01 1.16	0.02 0.09 0.26	0.00 0.01 0.13	0.01 0.07 0.21	0.00 0.02 0.16	0.00 0.02 0.14
Environmental factors	0.00 0.02 0.15	0.00 0.01 1.19	0.00 0.03 0.13	0.00 0.01 0.15	0.00 0.02 0.15	0.00 0.01 0.12
Educational factors	0.23 0.25 0.42	0.37 0.38 0.51	0.00 0.01 1.19	0.32 0.31 0.43	0.11 0.17 0.35	0.00 0.08 0.25
Social factors	0.00 0.02 0.16	0.02 0.08 0.25	0.00 0.00 0.12	0.00 0.00 1.15	0.00 0.01 0.15	0.00 0.02 0.14
Economic factors	0.00 0.08 0.23	0.14 0.19 0.35	0.00 0.01 0.14	0.02 0.08 0.23	0.00 0.01 1.17	0.00 0.01 0.15
Management factors	0.02 0.09 0.26	0.26 0.27 0.43	0.00 0.01 0.16	0.02 0.09 0.26	0.11 0.15 0.30	0.00 0.01 1.16

Stage 5: Defuzzification into definite values: using the CFCS values, the fuzzy total effect matrix is converted, by the following equation, into the defuzzified total effect matrix. Table 6 gives the defuzzied matrix of the fuzzy total effect matrix for the six main factors.

$$T^D = \frac{T_l + 2T_m + T_r}{4} \tag{8.4}$$

Stage 6: Calculation of the threshold value

Total sum= 5.22

Threshold value = 0.145126

In the defuzzified relations table, those links with values less than the obtained threshold value are ignored.

Based on the results of this table, the training factors have a net effect on all other factors except managerial factors but it does not get affected by any of the factors except again by the managerial factor. Further, the managerial factor is not affected by any other factor.

Table 6: Defuzzified (definite value) matrix for the six main factors

Matrix D	Individual factors	Environmental factors	Educational factors	Social factors	Economic factors	Management factors
Individual factors	0.293	0.116	0.039	0.089	0.048	0.044
Environmental factors	0.047	0.303	0.045	0.042	0.047	0.034
Educational factors	0.285	0.412	0.305	0.345	0.202	0.101
Social factors	0.050	0.107	0.031	0.290	0.045	0.045
Economic factors	0.098	0.217	0.040	0.101	0.296	0.045
Management factors	0.115	0.310	0.047	0.116	0.181	0.294

Table 7: Net defuzzified matrix for six main factors

Matrix D	Individual factors	Environmental factors	Educational factors	Social factors	Economic factors	Management factors
Individual factors	1	0	0	0	0	0
Environmental factors	0	1	0	0	0	0
Educational factors	1	1	1	1	1	0
Social factors	0	0	0	1	0	0
Economic factors	0	1	0	0	1	0
Management factors	0	1	0	0	1	1

Stage 7: Determination of the significance, effectiveness and affectability of each factor

Table 8 shows the amount of effectiveness (D) and affectability (R), the level of connection with other factors $(D - R)$ and the significance $(D + R)$ for the mentioned factors.

Table 8: Significance and effectiveness of the factors (in the form of definite values) for six main factors

	D	R	D-R	D+R
Individual factors	0.629	0.887	-0.258	1.517
Environmental factors	0.520	1.465	-0.945	1.985
Educational factors	1.650	0.506	1.143	2.156
Social factors	0.567	0.983	-0.416	1.551
Economic factors	0.796	0.820	-0.024	1.615
Management factors	1.063	0.563	0.500	1.626

Based on the data of table 8, the training factor has the highest effectiveness of 1.650 among all factors. Also, it has the lowest affectability among all factors with a value of 0.506. Also, training factors have the highest connection equal to 1.143 with a significance of 2.156. Thus, this factor earns the highest rank for significance and effectiveness and can be proclaimed the most important factor. For HR development, the six main factors, namely individual factor, environmental factors, training factors, social factors, economic factors and managerial factors should be controlled.

Based on the results of this study, through the improvement of training factor, other factors can be positively affected. Hence, the HR development in IAU can be realized with the least cost and time. Based on the cause-and-effect relations established in this study between different factors, the mapping model between the training and other factors is obtained as Fig. 1.

8.3 Influence analysis interdependence of domestic marketing factors

Based on the level of dependence and influence of factors, a coordinate system can be established and divided into four regions. The analysis is based on the influencing power (or effectiveness) and the level of dependence (affectability) of each variable to make further evaluation of the factors possible. The sum of rows in the final achievement matrix for each element represents the level of influence and the sum of columns denotes the level of dependency. Factors in the lower levels of the model are called driving factors given their propelling power while factors in the upper levels are called their followers. Based on the influence and dependence level, four groups of elements can be identified as follows:
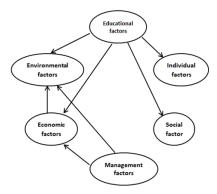
Figure 1: Model obtained by the data analysis.

Connected (linked): factors with high influence and dependence power. In other words, the effectiveness and affectability of these criteria are high and any small change in these factors will result in significant changes to the system.

Independent: factors with high influence but low dependence. In other words, these factors have high effectiveness and low affectability.

Autonomous: factors with low influence and dependence. These factors are in fact not much related to the system and have weak connections to other system elements. Changes in these variables will not significantly affect the system.
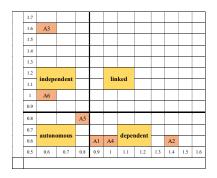

Figure 2: Influence-dependence analysis of the main factors of HR development.

Dependent: factors with low influence and high dependence. These factors have low effectiveness and high affectability against the system.

This approach in evaluating the results is intended to determine the power of influence and the level of dependence of the system elements in structural analysis. The values obtained for each index are given separately in Fig. 2 which is a classification of system elements in terms of influence and dependence

In the influence-dependence analysis, the variables are classified to four categories based on their power of influence and dependence. Connected (linked) variables i.e., those with high influence and dependence level, are situated in the first quarter. These variables are non-stationary as any change in them will affect the whole system. Ultimately, the feedback from the system will again change these variables. In the current research, no connected (linked) variables exist. The independent variables, with strong influence and low dependence, are located in the second quarter. This group acts as the foundation of the system structure and a significant change in the system will entail manipulation of these variables. In the present research, the training and managerial factors are evaluated as the independent variables and hence located in the second quarter. The autonomous factors, with low influence and dependence, are located in the third quarter. These variables are somehow disconnected from the system and have very weak connections.

The economic factors are situated in this quarter and therefore considered as autonomous elements. Finally, the dependent variables of the system, with low influence but high dependence levels, are located in the fourth quarter. In the current research, the individual factors, social factors and environmental factors have the lowest influence and highest dependence. Therefore, these elements are considered dependent and located in the fourth quarter.

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