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A study on important factors influencing on the effectiveness of futures research, training and employment

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ABSTRACT

This paper presents an empirical investigation to find out important factors influencing future research, training and employment in Iranian scientific environment. The proposed model of this paper prepares a questionnaire consists of various questions and distributes it among some experts and analyze them using DEMATEL model. The model divides the 7 factors into two groups of cause and effect. On the cause side, there are four factors including preventing future unemployment crises, detecting future skills, finding future profitable/unprofitable job opportunities and prevention on having open position with no volunteer to work. On the effect factors, there are three factors influencing the future research including detecting the present risk associated with jobs, detecting necessary standards for future works and creating a balance between demand and supply.

1. Introduction

During the past two decades, there have been tremendous changes on information technology and scientific development in many areas. Many business units appear, which are solely relying on knowledge-based sciences. The development on knowledge-based organizations is so fast that there is a necessity to plan for future job requirements in advance. Obviously, there are different factors influencing future jobs such as job security, level of knowledge needed, etc. Therefore, in prioritizing possible factors influencing future jobs, we need to use multiple criteria decision making techniques. There are literally various techniques used for ranking different factors influencing future job opportunities such as analytical hierarchy process, data envelopment analysis, etc.

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Bottani and Rizzi (2006), for instance, used **T**echnique for **O**rder **P**reference by **S**imilarity to **I**deal **S**olution (TOPSIS) for outsourcing activities. TOPSIS, originally developed by Hwang and Yoon in 1981, is a simple but sophisticated ranking methodology used in many real-world applications of science and engineering (Chang et al., 2010). The standard TOPSIS method chooses alternatives, which simultaneously have the shortest distance from the positive ideal solutions and the longest distance from the negative-ideal solutions. The positive ideal solution maximizes the desirable criteria and minimizes the undesirable criteria, whereas the negative ideal solution maximizes the undesirable criteria and minimizes the desirable criteria.

TOPSIS makes full implementation of attribute information, provides a cardinal ranking of alternatives, and does not need attribute preferences to be independent. To apply this technique, attribute values must be numeric, monotonically increasing or decreasing, and have commensurable units (Chen & Hwang, 1992; Yoon & Hwang, 1995). Hsu and Hsu (2008), for instance, used TOPSIS with an adatpation of entropy for optimizing the information outsourcing practices of primary care medical organizations. To handle outsourcing decision-making problems, Opricovic and Tzeng (2007) used an extended VIKOR method in comparison with outranking methods for an application of outsourcing problem.

Amiri et al. (2011) presented a method to prioritize the locations of distribution centers in a supply chain using balanced scorecard to categorize the most important attributes affecting the location of distribution centers and the attributes are ranked based on decision making trial and evaluation laboratory (DEMATEL) method (Fontela & Gabus, 1976). The implementation of the proposed model of this paper was also applied for a real-world case study of oil company and the results are analyzed under different scenarios. Tseng (2009) in another assignment used a causal and effect decision making model of service quality expectation based on another extension of DEMATEL technique called grey-fuzzy DEMATEL approach. Zhou et al. (2011) determined critical success factors in emergency management using a fuzzy DEMATEL method. Klaas et al. (2001) performed another investigation on the effect of outsourcing human resources on increasing the efficiency of organizations. Lin et al. (2011) used DEMATEL method to explore the core competences and causal effect of the IC design service company for an empirical case study.

The organization of this paper first presents details of our survey characteristics in section 2 and section 3 demonstrates details of our results. Finally, concluding remarks are given in the last to summarize the contribution of the paper.

2. The proposed DEMATEL technique

As explained earlier, DEMATEL is a multi-criteria decision making technique for constructing a structural model involving causal relationships among complex factors (Gabus & Fontela, 1972, 1973). DEMATEL was originally developed by the science and human affairs plan of the Battelle Memorial Institute of Geneva. It was then implemented to handle the complicated and intertwined problem group. The infrastructure, based on the properties of objective affairs, can verify the interdependence among the variables/attributes and restrict the relationships, which preserve the properties of the system and development trend. The procedures of the DEMATEL method (Fontela & Gabus, 1976) as follows,

Step 1: *Generating the direct relationship matrix.* We implement five scales for measuring the relationship among various criteria: 0 (no influence), 1 (low influence), 2 (average influence), 3 (high influence), and 4 (very high influence). Then, decision makers obtain sets of the pair-wise comparisons in terms of impacts and direction among criteria. Next, the initial data can be prepared as the direct-relation matrix in terms of an $n \times n$ matrix A where each element of a_{ij} denotes the degree in which the criterion i influences the criterion j.

Step 2: *Normalize the direct relationship matrix.* Normalization is executed using the following,

$$X = k.A \tag{1}$$

$$k = \frac{1}{max_{1\le i\le n}\sum_{j=1}^{n} a_{ij}}.\ \ i,j = 1,2,\dots,n \tag{2}$$

Step 3: *Attain the total relationship matrix.* Once the normalized direct relationship matrix *X* is built, the total relationship matrix *T* can be acquired by using Eq. (3), where *I* denotes as the identity matrix

$$T = X(1-X)^{-1} \tag{3}$$

Step 4: *Produce a causal diagram.* The sum of rows and the sum of columns are summarized in vector *D* and vector *R* through Eqs. (4-6). Then, the horizontal axis vector (*D* + *R*) named ‘‘Prominence’’ is constructed by converting *D* to *R*, which discloses the relative importance of each criterion. Similarly, the vertical axis (*D* - *R*) named ‘‘Relation’’ is constructed by subtracting *D* from *R*, which may divide criteria into a cause-effect groups. Normally, when (*D* - *R*) becomes positive, the criterion belongs to the cause group and when the (*D* - *R*) becomes negative, the criterion represents the effect group. Therefore, the causal diagram is obtained by mapping the dataset of the (*D* + *R*, *D* - *R*), providing some insight for making decisions.

$$T = \left[t_{ij}\right]_{n\times n}, \quad i,j = 1,2,\dots,n \tag{4}$$

$$D = \left[\sum_{j=1}^{n} t_{ij}\right]_{n\times 1} = [t_{i.}]_{n\times 1} \tag{5}$$

$$R = \left[\sum_{i=1}^{n} t_{ij}\right]_{1\times n} = \left[t_{.j}\right]_{1\times n} \tag{6}$$

where vector *D* and vector *R*, respectively represent the sum of rows and the sum of columns from total- relation matrix $T = [t_{ij}]_{n\times n}$.

Step 5: *Calculate the inner dependence matrix.* In this step, the sum of each column in total relationship matrix becomes 1 using the normalization method, and then the inner dependence matrix can be prepared.

3. The case study

In this paper, we perform an empirical investigation to find the important factors influencing future research in some Iranian firms. Table 1 demonstrates some of the most important factors affecting future research, which are determined based on Delphi investigation on some Iranian organizations.

Table 1
Important factors influencing future research

Factor	Description	Factor	Description
X_1	Detecting the present risk associated with jobs	X_5	Help to detect future profitable/unprofitable job opportunities
X_2	Detecting necessary standards for future works	X_6	Creating a balance between demand and supply
X_3	Preventing future unemployment crises	X_7	Preventing on having open position with no volunteer to work
X_4	Help to detect future skills		

Table 2
The relative effects of all 7 factors

	X_1	X_2	X_3	X_4	X_5	X_6	X_7	Total
X_1	0	0	0	0	0	0	0	0
X_2	4	0	0	0	0	3	0	7
X_3	4	3	0	2	0	0	0	9
X_4	4	3	3	0	0	1	2	11
X_5	3	4	0	0	0	1	1	9
X_6	4	0	0	0	0	0	3	7
X_7	3	3	0	0	2	2	0	10

Next, we calculated I-M where the results are summarized in Table 3 as follows,

Table 3
The summary of I-M matrix

	X_1	X_2	X_3	X_4	X_5	X_6	X_7
X_1	1.0000	0	0	0	0	0	0
X_2	-0.3636	1.0000	0	0	0	-0.2700	0
X_3	-0.3636	-0.2700	1.0000	-0.1800	0	0	0
X_4	-0.3636	-0.2700	-0.2700	1.0000	0	0.0900	0
X_5	-0.2700	-0.3636	0	0	1.0000	0.0900	0.0900
X_6	-0.3636	0	0	0	0	1.0000	-0.2700
X_7	-0.2700	-0.2700	0	0	-0.1800	-0.1800	1.0000

Next, we present the results of direct effects, which are summarized in Table 4 as follows,

Table 4
The summary of direct effects

	X_1	X_2	X_3	X_4	X_5	X_6	X_7
X_1	1.0000	0	0	0	0	0	0
X_2	0.5056	1.0270	0	0	0.0145	0.2931	0.0804
X_3	0.6292	0.3456	1.0511	0.1892	0.0058	0.1166	0.0320
X_4	0.7173	0.3796	0.2838	1.0511	0.0103	0.2083	0.0572
X_5	0.5553	0.4157	0	0	1.0280	0.2327	0.1554
X_6	0.5259	0.0999	0	0	0.0536	1.0854	0.2979
X_7	0.6011	0.3701	0	0	0.1986	0.3164	1.1033

In addition, the indirect effects are also calculated using Eq. (3) and Table 5 demonstrates the results of our computations.

Table 5
The summary of indirect effects

0	0	0	0	0	0	0
0.1420	0.0270	0	0	0.0145	0.0231	0.0804
0.9623	0.3069	0.5108	0.0920	0.0513	1.0390	0.2849
0.4867	0.5248	0.0511	0.0092	0.0121	0.2449	0.0672
0.3537	0.1096	0.0138	0.0511	0.0103	0.1183	0.0572
0.2852	0. 0521	0	0	0.0280	0.1428	0.0654
0.1623	0.0999	0	0	0.0536	0.0854	0.0279
0.3310	0.1000	0	0	0.0186	0.1364	0.1033

Next, we present details of cause and effect relationships in Table 6 as follows,

Table 6
The cause and effect relationships

	D	R	D-R	D+R
X_1	0	3.5344	-3.5344	3.5344
X_2	0.9206	1.6379	-0.7173	2.5585
X_3	1.3695	0.3349	1.0349	1.7044
X_4	1.7076	0.2403	1.4673	1.9479
X_5	1.3871	0.3108	1.0763	1.6979
X_6	1.0627	1.2525	-0.1898	2.3152
X_7	1.5895	0.7262	0.8633	2.3157

The implementation of DEMATEL model yields the causal and effect factors given in Table 3 as follows,

Table 7
Causal and effect factors

Cause (D-R)	X_3	X_4	X_5	X_7
Effect (D+R)	X_1	X_2	X_6	

As we can observe from the results of Table 7, the implementation of DEMATEL has provided us some insight to detect cause-effect factors influencing future research and works. On the cause side, there are four factors including preventing future unemployment crises, detecting future skills, detecting future profitable/unprofitable job opportunities and preventing on having open position with no volunteer to work. On the effect factors, there are three factors influencing the future research including detecting the present risk associated with jobs, detecting necessary standards for future works and creating a balance between demand and supply. Fig. 1 demonstrates the summary of causal effects.

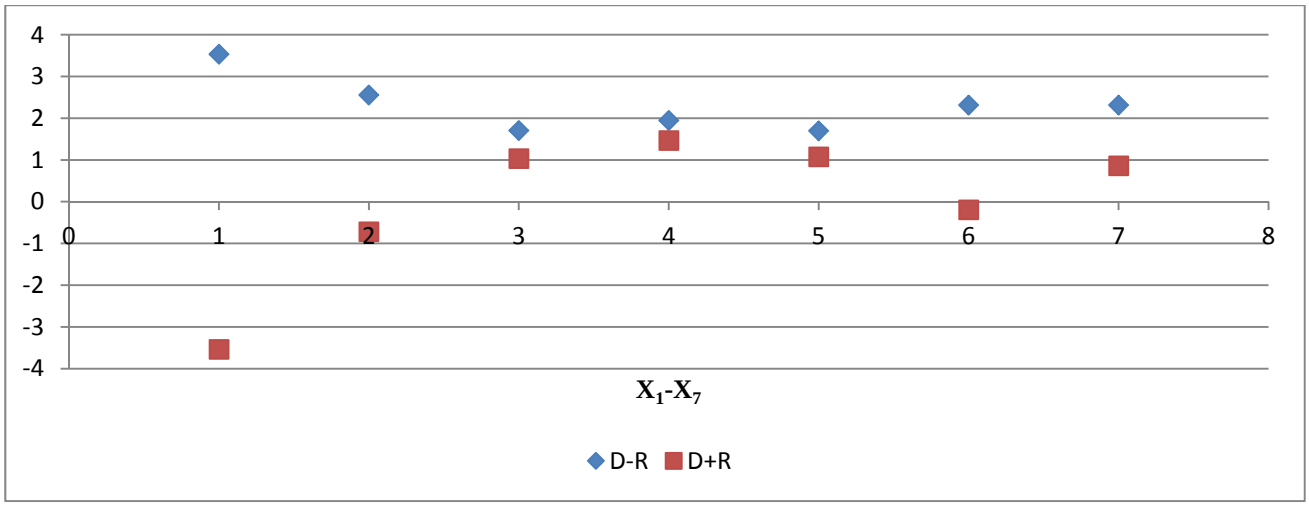

Fig. 1. The cause and effect factors

4. Conclusion

In this survey, we have implemented DEMETL technique to find the causal and effect factors impacting future research in Iran. The proposed model of this paper designed and distributed a questionnaire among some experts who work some Iranian firms. The proposed model divided 7

factors into two groups of cause and effect factors. On the cause side, there were four factors including preventing future unemployment crises, detecting future skills, finding future profitable/unprofitable job opportunities and preventing on having open position with no volunteer to work. On the effect factors, there are three factors influencing the future research including detecting the present risk associated with jobs, detecting necessary standards for future works and creating a balance between demand and supply.

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