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Expansion of DEMATEL Technique to Identify and Prioritize the Effective Factors on Knowledge Sharing

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ABSTRACT

Today's world is the knowledge world, and here intellectual capital is considered one of the most critical assets of any organization. Knowledge management is an instrument for the manager to produce or absorb appropriate knowledge, one of the most crucial variables affecting the organizations' competition in the knowledge era. In the knowledge management process, knowledge sharing, which is related to its voluntary sharing in the organization to its stability, is considered a basic concept. In knowledge-based organizations such as universities, it is an important issue. Therefore, the present study has addressed the most critical factors affecting knowledge sharing in one of the universities. Then, using the developed DEMATEL technique, which has solved a part of the conventional DEMATEL technique problem, has examined their Causal priority. Results showed that organizational trust is the most important Causal factor in knowledge sharing, and then, organizational culture, participation, and collaboration are placed in the following positions.

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1. Introduction

The knowledge era is a new topic related to the present and near future [1]. In this era, knowledge as intellectual capital is one of organizations' valuable properties (assets). Its correct management leads to obtaining the competitive advantage and finally succeeding in the competitive arena [2]. Many experts believe that knowledge is the most important source of an organization and is the only source that the Competitors do not imitate. Therefore, it is considered a unique source for an organization [3]. Knowledge management is a process that is consisted of knowledge creation activities through discovering and acquiring valuable knowledge from outside resources, choosing the required knowledge, changing the knowledge resources status, and placing the knowledge outside the organizational information [4]. In order to efficient knowledge management, knowledge sharing, which is related to voluntary knowledge sharing among people and teams of an organization [5], is considered as an important and fundamental concept [1,6]. Knowledge sharing can be considered as a set of opinions (ideas) and behaviors that lead to the development of learning among various people or an organization [7], promotion of organization efficiency (utilization) [8], and reduces the training costs and risks of unreliability [9]. Successful knowledge sharing leads to the distribution of intellectual capital and increment of important resources of the organization [8]. Knowledge sharing and transmission occur at various levels of an organization, including people, from people to prominent resources, people to groups, groups, and groups to the organization [10].

The importance of knowledge sharing is more than sharing simple information; it means exchanging the information, experiences, and thoughts (opinions) among people. It is also not occurred for only an individual [1]. The importance of knowledge sharing is because the organization knowledge has been established in the mind of people, groups, and organizational units during the time, and the central part of executive processes is considered its customs and rules [11]. Organizational knowledge is ultimately stored in the people and not the organization [12]. If the potential knowledge stored in the mind of people cannot be shared efficiently, it is gradually trimmed in the mind and losses its profitability and efficiency [13]. Therefore, by leaving of organization's prominent people, its knowledge is also disappeared, and it can because by enormous damage to the organization. The only way to save the organization from these damages is the knowledge sharing of organization members [11]. Because only when individual and collective knowledge is converted into organizational (corporate) knowledge, the organization will able to manage these valuable resources [14] effectively. Naturally, this damage is seriously considered about knowledge-base and professional organizations such as Universities that the knowledge and expertise is the main component for their survival. As the knowledge production systems, universities create new knowledge and acquire it from various sources and apply it in the education environments [15]. This matter clarifies the importance of knowledge sharing in organizations because knowledge sharing performs the knowledge life cycle in the organization, especially knowledge distribution throughout the university [16]. Unfortunately, despite the increased focus on knowledge management in the industry, this issue has been less regarded in higher education [17].

Knowledge management depends on the organization's members' interest [18]. Organizational citizen behavior is a voluntary issue [10], but motivating and making ready the people to knowledge sharing involuntary form is not a simple task. Hence, it is possible that people are not always motivated to share knowledge with others [19]. Despite many notifications and discussions about the knowledge sharing benefits, there are obstacles and limitations to access to the implicit knowledge that exists in the mind of an organization's individuals [1]. One of the challenges about knowledge sharing is that knowledge is considered the power, and individuals do not have a tendency to give others anything which is their power and importance or the guaranty of their jobs' continuity [9,11]. There are two viewpoints about knowledge sharing: the spontaneous and engineering points of view. From the spontaneous viewpoint, knowledge cannot be managed, but from the engineering viewpoint, knowledge can be managed through motivation and preparing a suitable environment [20].

Today, knowledge is a valuable resource for competitive advantage in organizations [21]. In a world where goods and services are highly knowledge-based, Asset Knowledge is the key to competitive advantage. The success of any organization depends more on the organization's intellectual capital than on the value of its physical resources and tangible assets [22]. To enlargements a sustainable competitive advantage, employees must share and apply knowledge in practice [23]. Knowledge sharing is one of the primary activities in organizational operations. The strategic importance of knowledge is identified in the knowledge-based perspective of the company [24]. Organizations and institutions are forced to seek knowledge sharing to compete because modern organizations face increasing pressure to find new ways to compete efficiently in a dynamic global market [25]. Knowledge sharing defines a mutual idea or process between individuals that leads to shared facts. Likewise, knowledge itself is a guide as a combination of experiences, values, background information, and expert insights [26]. Knowledge sharing is problematic because it works on the principle of people's willingness to share or integrate their ideas with others [27]. Swift et al. (2010) stated that sharing ideas and information can be crucial in achieving quality performance in any context. Higher education centers and universities are considered the axis of development and the main center for training specialized and trained human resources in any society. In such centers, faculty members are considered valuable assets. Having such assets can be valuable and empowering when the knowledge of individuals in the organization flows. They can share their knowledge with internal and external members of the organization [28]. Suppose the culture of knowledge sharing in the university environment is accepted. In that case, the scientific interaction resulting from the acceptance of this culture by faculty members will enable the creation of efficient education and practical learning in the university environment [29]. Like many other organizations, universities are in a competitive environment, and it is essential to ensure that knowledge is created, transferred, and shared between individuals in this environment. In the meantime, faculty members are the essential building blocks in knowledge production and application [30]. In line with macro policy for implementing knowledge management and subsequent knowledge sharing, programs and strategies by organizations and educational and research institutions are considered. Among the programs that can be considered are holding seminars and conferences, holding training workshops or providing the conditions for participating in it as a lecturer or learner, holding scientific and informal parties, etc. [31].

2. Literature Review

Table 1 illustrates past research on knowledge sharing.

Table1
Literature review.

Title	Finding	Reference
New Model for Encouraging Academic Staff in Saudi Universities to Use I.T. for Knowledge Sharing to Improve Scholarly Publication Performance	The results show that computer-mediated communication and the nature of knowledge are the primary factors that positively affect knowledge sharing in Saudi universities, and scholarly publications are the primary indicator for measuring research productivity.	[32]
Knowledge generation and sharing in U.K. universities: A tale of two cultures?	Each institution exemplified a distinct path-dependency that underpinned cultural expectations. However, in each case, internal and external factors were necessitating knowledge sharing and generation changes, which affected individual perspectives and organizational structures.	[33]
Motivation and Willingness to Participate in knowledge Sharing Activities Among Academics in a Public University	Knowledge is intensively created and disseminated in the university through research and publication. Academicians will play their roles as knowledge providers and then transfer and share their knowledge via teaching presentations at seminars and conferences and through continuous research programs.	[34]
Exploring the Challenges, Trends, and Issues for Knowledge Sharing Practices: A Study on Employees in Public Sector Universities	The results reveal that hoarding knowledge to gain power, authority, influence, promotion opportunities, and employee favoritism negatively influence K.S. practices. Furthermore, an unsupportive culture and a poor linkage between K.S. and rewards negatively influence K.S. practices in public sector universities.	[35]
Factors Analysis on Knowledge Sharing at Telkom Economic and Business School (TEBS) Telkom University Bandung	This factor can explain 54,8% of all knowledge-sharing factors. In contrast, 17,4% is explained from organizational culture and is represented by working culture, employee attitudes, and motivation to share.	[36]
Identifying and Ranking Factors Influencing Knowledge Sharing Using Multi-Criteria Decision-Making Methods: A Case Study	The most effective factors influencing knowledge sharing were found to be trusted, organizational culture, and communication, whereas organizational structure and technology were considered to be the least effective factors	[37]
Influence of knowledge management enablers in manufacturing organizations: a multi-criteria decision making in the Indian context	The finding suggests that better implementation of KMEs results in improved K.M. performance, resulting in enhanced organizational performance.	[38]
What drives inter-organizational knowledge management? The cause-and-effect analysis using a multi-layer multi-criteria decision-making framework	The findings of this paper assess the ranking of the different elements from experts' opinions and discuss important theoretical and managerial implications. The influential factors were identified through an extensive literature review, which combined with the views of experts from academia and industry (international firms).	[39]
Prioritizing Different Types of Barriers to Knowledge Sharing: A Cause-and-Effect Analysis of the Views of Academics in Turkey	The study reveals that organizational and individual knowledge-sharing barriers have a more substantial effect than technological barriers. "Corporate structure", "power relations", and "supportive corporate culture" are the driving forces for the knowledge sharing among the academics in Turkey.	[40]

Therefore, the engineering perspective proposes the necessity for planning and management of knowledge sharing. Accordingly, the first step in knowledge management in universities is to identify the factors that affect knowledge sharing. Therefore, the objectives of this study are: identifying effective factors on sharing knowledge by the Academics and ranking them. The method used to gain the first objective was the library studies and subject literature review. The Dermatol technique was used and developed (by the authors) to achieve the second objective.

3. Extraction of effective factors on knowledge sharing in universities

As previously explained, few studies have been conducted about knowledge sharing in scientific environments. The present study has tried to extract the effective factors on knowledge sharing in scientific environments using the papers prepared in this field. To identify the factors, three keywords were searched on google scholar include knowledge management, knowledge sharing, and university. Then, factors that have a higher frequency and further emphasis were studied. Accordingly, Table2 illustrates the effective factors on knowledge sharing and a brief explanation of each factor, resources, and symbols used to the factor.

Table2. Effective factors on knowledge sharing in academic environments

Factor	Factor description	symbol	resources
Impellent organizational structure	Recognition level and decision-making focus	C_1	[20,41]
Organizational culture	Set of opinions, values and common perceptions of individuals toward the knowledge sharing	C_2	[20,33]
Technology	Information and communication technology	C_3	[20,42]
Trust between members	Trust and confidence to collaboration, knowledge and expertise of colleagues	C_4	[43–48]
Perception the importance and benefits of knowledge sharing	Information of share maker (multiplexer) about the importance of knowledge sharing and its advantages and benefits	C_5	[9,49–51]
Open and strong social relationships between people	Openness, wideness and Convenience between system's people	C_6	[33,43,52]
Existence of encouraging systems	Evaluation system of shared knowledge and giving appropriate reward to trustee or trustees	C_7	[9,43,53,54]
Participation and collaboration	Willingness to work together to achieve goals	C_8	[14,51,55]
Attitude toward knowledge sharing	Overall feeling and individual understanding about desirability or undesirability of knowledge sharing	C_9	[49,56–59]

More flexible organizational structures are the encouraging factors of academics in knowledge sharing. Results of studies showed that the faculty members are reluctant to share the knowledge based on inflexible and formal structures [41]. Complexity, concentration, and formality of organizational factors have the inverse effect on knowledge sharing because they reduce the need for knowledge sharing in the organization [60].

Organizational culture determines individual and group behavior and has an essential role in the success of knowledge management planning. Also, it can act as a critical obstacle for knowledge sharing [61]. For example, if there is low attention in the organizational environment, little willingness to aid can be seen among members of the organization, and heed to the organization is not a common value in the organization's culture [62]. Naturally, knowledge sharing is not considered a desired behavior in such situations.

Implicit and explicit knowledge, either in standard form or informal, is shared through a set of communication channels supported by technological capabilities. An organization's technology's high power and capacity accelerate and extend knowledge sharing [63]. Technologic factors are related to access to information and communication infrastructures and factors such as internet self-efficacy [29].

Trust is an experience that emerged due to the interaction of values, approaches (attitudes), and mental and emotional status of people. When two organizations or individuals trust each other, they can share their knowledge and skills with more tendencies and without any concern about distrust [29].

Group work is a factor that can fade out many obstacles of knowledge sharing. Reinforcement of group working can replace competition among people, which is an obstacle of knowledge sharing by the cooperate condition [64]. This factor can also cause the weakness of evading social phenomenon. The evading social phenomenon is related to the individual's intention to reduce group activities. Usually, group individuals do not doubt evading knowledge sharing [65].

4. Method

DEMATEL technique is one of the multi-criterion decision-making techniques, based on graph theory, which Fontola and Gaboos have provided from 1972 to 1926 [66,67] to solve complicated problems such as starvation and energy, and environmental protection with a simple method. The final product of this technique is the provision of network relationships between elements and dividing them into two cause and effect groups. Therefore, using this method, we can structure the effective factors on a cause, resulting from extraction stage of factors, based on information obtained by expertise verdict in a systematic form that shows the direct and indirect relationship between them [68]. These steps are calculating the mean matrix, calculating a normalized matrix of primary direct relationships, and calculating the Total relationship matrix (***T***). In the classic DEMATEL method, the priority of causal factors is not considered.

In contrast, this priority is significant for decision-makers, because decision-makers seek the way to identify the effect level of each variable on the system under his management, and also given

the available resources, he tries to make decisions that with the lowest cost obtain the most level of desire changes. Some papers rank all elements entered in the model based on the $\mathrm{R}+\mathrm{C}$ criterion, arguing that this value shows the total importance of elements. It should be noted that this value does not show the causal priority of elements because this value has added the taking effect and affect the level of variables with each other. Maybe it can be said that to solve this problem; we can take advantage of $R-C$ criterion, same as some authors [69,70]. This criterion is not appropriate due to the following reasons:

1. This factor shows the affecting level of a variable, irrespective of variable importance in the system. It is possible that the issue led to an increase in the R and $R-C$ criterion for that element. However, if the influenced variable does not have high importance, practically, this effect is not considered for the overall system.

2. Because these criteria were obtained from the summation of the effect level of each variable, it does not have any respect to variable effects. For example, two variables may have the same R level, but the first variable has obtained the first rank in affecting other variables (e.g., five times). In contrast, the second variable has obtained the rank only once.

It is noteworthy that in many studies, the output of the DEMATEL technique is used as the input of network analysis method. However, it should be noted that this method, first, does not satisfy the purpose of a specific article because results have only considered the priority of variables in terms of importance level. Second, usually, in order to depict the network analysis method, a threshold is used, and actually, many causal relationships between variables will be ignored.

In this paper, to eliminate the proposed problems, the developed DEMATEL technique is provided as follows. Steps of this technique, following the steps of the classic DEMATEL technique, are as follow:

preparing the ranking matrix of variables

$$R = \begin{array}{c} \\ C_1 \\ \vdots \\ C_i \\ \vdots \\ C_n \end{array} \begin{array}{c} \begin{array}{cccccc} C_1 & \cdots & C_j & \cdots & C_n \end{array} \\ \begin{bmatrix} r_{11} & \cdots & r_{1j} & \cdots & r_{1n} \\ \vdots & \ddots & \vdots & \iddots & \vdots \\ r_{i1} & \cdots & r_{ij} & \cdots & r_{in} \\ \vdots & \iddots & \vdots & \ddots & \vdots \\ r_{n1} & \cdots & r_{nj} & \cdots & r_{nn} \end{bmatrix} \end{array}$$

The ranking matrix of variable or R, is a matrix that shows the rank of each row variables in terms of effect level on a column variable. The matrix is prepared based on matrix T so that in each column of matrix T, a row with maximum value obtains the rank 1 in the corresponding entry of matrix R and so other elements of matrix R are completed.

So that r_{ij} from this matrix shows the effect rank of ith variable on jth variable, among n variables and naturally its correct value is between 1 to$n$.

calculation of a weighted matrix of variables ranking

Appropriately calculate the Index weights W_j, for example, using the AHP method, and then a weighted matrix is formed that for n ranks and also for n options are as follow:

$$Q_G = \begin{array}{c} \\ C_1 \\ \vdots \\ C_i \\ \vdots \\ C_n \end{array} \begin{array}{c} \begin{array}{cccccc} \text{Rank} & & & & & \\ & 1 & \cdots & t & \cdots & n \end{array} \\ \begin{bmatrix} q_{11} & \cdots & q_{1j} & \cdots & q_{1n} \\ \vdots & \ddots & \vdots & \iddots & \vdots \\ q_{i1} & \cdots & q_{ij} & \cdots & q_{in} \\ \vdots & \iddots & \vdots & \ddots & \vdots \\ q_{n1} & \cdots & q_{nj} & \cdots & q_{nn} \end{bmatrix} \end{array}$$

Elements of this matrix are obtained as follow:

$$q_{it} = \sum_{j=1}^{n} \pi_{itj} \,.\, w_j$$

So that$\pi_{itj} = 1$. If $the\ i$th variable in tth rank affects the jth variable, otherwise is equal to zero.

solving allocation problem

An allocation problem should be solved based on the following model with zero variables and a hit to specify the final causal priorities of variables.

$$Max = \sum_{i=1}^{n} \sum_{t=1}^{n} q_{it} \,.\, h_{it}$$

$s.t$:

$$\sum_{i=1}^{n} h_{it} = 1 \,;\, t = 1, \dots, n$$

$$\sum_{t=1}^{n} h_{it} = 1 \,;\, i = 1, \dots, n$$

$$h_{it} = \begin{cases} 1 \\ 0 \end{cases}$$

In the final solution, if tth rank is allocated to the jth option,$h_{it} = 1$ otherwise is equal to zero.

5. Case study

To determine the causal relationship between effective factors on knowledge sharing in academic environments, nine variables extracted from the literature were given to expertise time, and their comments were taken. Expertise time is consisted of 8 people of full professors of Shiraz University due to the years of presence in academic environments and familiarity with the environment, qualify comment. The mean matrix which is obtained from the expert opinions is as follow:

$$A = \begin{bmatrix} 0.00 & 2.12 & 0.50 & 1.41 & 1.87 & 1.84 & 0.24 & 1.92 & 1.33 \\ 0.24 & 0.00 & 0.36 & 2.56 & 2.14 & 2.36 & 1.84 & 2.64 & 2.14 \\ 1.21 & 1.87 & 0.00 & 1.32 & 1.14 & 1.05 & 0.00 & 1.16 & 1.74 \\ 0.12 & 2.78 & 0.12 & 0.00 & 2.84 & 2.73 & 0.50 & 2.83 & 2.07 \\ 0.34 & 1.43 & 0.50 & 2.34 & 0.00 & 1.53 & 0.36 & 2.45 & 1.93 \\ 1.43 & 2.65 & 0.24 & 2.67 & 2.14 & 0.00 & 0.36 & 2.42 & 1.76 \\ 0.48 & 1.65 & 0.00 & 1.54 & 1.41 & 0.62 & 0.00 & 1.40 & 1.31 \\ 1.65 & 2.76 & 0.87 & 1.98 & 2.04 & 1.43 & 0.84 & 0.00 & 1.93 \\ 0.36 & 1.62 & 0.87 & 1.83 & 1.68 & 1.35 & 2.16 & 1.73 & 0.00 \end{bmatrix}$$

In this step, based on the second step of the normalized matrix, primary direct relationships are calculated as follow:

$$D = A \times \frac{1}{16.88} = \begin{bmatrix} 0.000 & 0.125 & 0.029 & 0.084 & 0.110 & 0.108 & 0.014 & 0.113 & 0.078 \\ 0.014 & 0.000 & 0.021 & 0.151 & 0.126 & 0.129 & 0.108 & 0.156 & 0.126 \\ 0.071 & 0.110 & 0.000 & 0.078 & 0.067 & 0.062 & 0.000 & 0.068 & 0.103 \\ 0.007 & 0.164 & 0.007 & 0.000 & 0.168 & 0.161 & 0.029 & 0.167 & 0.122 \\ 0.021 & 0.084 & 0.029 & 0.138 & 0.000 & 0.90 & 0.021 & 0.145 & 0.114 \\ 0.084 & 0.156 & 0.014 & 0.158 & 0.126 & 0.000 & 0.021 & 0.144 & 0.104 \\ 0.028 & 0.097 & 0.000 & 0.091 & 0.083 & 0.036 & 0.000 & 0.082 & 0.077 \\ 0.097 & 0.163 & 0.051 & 0.117 & 0.120 & 0.084 & 0.049 & 0.000 & 0.114 \\ 0.021 & 0.095 & 0.051 & 0.108 & 0.099 & 0.079 & 0.127 & 0.102 & 0.000 \end{bmatrix}$$

In the third step, matrix T is calculated according to the following formula:

$$T = D(I-D)^{-1} = \begin{bmatrix} 0.103 & 0.408 & 0.098 & 0.366 & 0.380 & 0.343 & 0.149 & 0.408 & 0.331 \\ 0.142 & 0.364 & 0.104 & 0.487 & 0.457 & 0.420 & 0.264 & 0.511 & 0.429 \\ 0.153 & 0.348 & 0.059 & 0.313 & 0.298 & 0.265 & 0.117 & 0.320 & 0.311 \\ 0.137 & 0.509 & 0.094 & 0.361 & 0.494 & 0.443 & 0.198 & 0.526 & 0.430 \\ 0.123 & 0.370 & 0.097 & 0.404 & 0.276 & 0.326 & 0.155 & 0.427 & 0.356 \\ 0.200 & 0.497 & 0.098 & 0.487 & 0.454 & 0.299 & 0.185 & 0.499 & 0.407 \\ 0.102 & 0.310 & 0.052 & 0.299 & 0.288 & 0.220 & 0.104 & 0.306 & 0.265 \\ 0.206 & 0.486 & 0.128 & 0.439 & 0.433 & 0.361 & 0.204 & 0.355 & 0.403 \\ 0.122 & 0.378 & 0.114 & 0.380 & 0.365 & 0.310 & 0.248 & 0.391 & 0.254 \end{bmatrix}$$

In this step, a causal ranking matrix of variables is prepared as follow:

$$R = \begin{bmatrix} 8 & 4 & 5 & 6 & 5 & 4 & 7 & 5 & 6 \\ 4 & 7 & 3 & 2 & 2 & 2 & 1 & 2 & 2 \\ 3 & 8 & 8 & 8 & 7 & 8 & 8 & 8 & 7 \\ 5 & 1 & 7 & 7 & 1 & 1 & 4 & 1 & 1 \\ 6 & 6 & 6 & 4 & 9 & 5 & 6 & 4 & 5 \\ 2 & 2 & 4 & 1 & 3 & 7 & 5 & 3 & 3 \\ 9 & 9 & 9 & 9 & 8 & 9 & 9 & 9 & 8 \\ 1 & 3 & 1 & 3 & 4 & 3 & 3 & 7 & 4 \\ 7 & 5 & 2 & 5 & 6 & 6 & 2 & 6 & 9 \end{bmatrix}$$

weighted matrix of causal ranking of variables is performed as follow:

$$Q_G = \begin{bmatrix} 0 & 0 & 0 & w_2 + w_6 & w_3 + w_5 + w_8 & w_4 + w_9 & w_7 & w_1 & 0 \\ w_7 & \sum_{i=4}^{6} wi + \sum_{i=8}^{9} wi & w_3 & w_1 & 0 & 0 & w_2 & 0 & 0 \\ 0 & 0 & w_1 & 0 & 0 & 0 & w_5 + w_9 & \sum_{i=2}^{4} wi + \sum_{i=6}^{8} wi & 0 \\ w_2 + \sum_{i=5}^{6} wi + \sum_{i=8}^{9} wi & 0 & 0 & w_7 & w_1 & 0 & w_3 + w_4 & 0 & 0 \\ 0 & 0 & 0 & w_4 + w_8 & w_6 + w_9 & \sum_{i=1}^{3} wi + w_7 & 0 & 0 & w_5 \\ w_4 & \sum_{i=1}^{2} wi & w_5 + w_8 + w_9 & w_3 & w_7 & 0 & w_6 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & 0 & w_5 + w_9 & \sum_{i=1}^{4} wi + w_{6-8} \\ w_{1+}w_3 & 0 & w_2 + w_4 + \sum_{i=6}^{7} wi & w_5 + w_9 & 0 & 0 & w_8 & 0 & 0 \\ 0 & w_3 + w_7 & 0 & 0 & w_2 + w_4 & w_{5-6} + w_8 & w_1 & 0 & w_9 \end{bmatrix}$$

Weights obtained from the AHP method show the weight of each effective variable on knowledge sharing and are as follow:

$$W_i = [0.073 \quad 0.191 \quad 0.035 \quad 0.127 \quad 0.095 \quad 0.175 \quad 0.078 \quad 0.123 \quad 0.103]$$

By locating the above values in the causal ranking weighted matrix of variables, we have:

$$Q_G = \begin{bmatrix} 0 & 0 & 0 & 0.366 & 0.253 & 0.230 & 0.078 & 0.073 & 0 \\ 0.078 & 0.623 & 0.035 & 0.073 & 0 & 0 & 0.191 & 0 & 0 \\ 0 & 0 & 0.073 & 0 & 0 & 0 & 0.198 & 0.729 & 0 \\ 0.687 & 0 & 0 & 0.078 & 0.073 & 0 & 0.162 & 0 & 0 \\ 0 & 0 & 0 & 0.250 & 0.278 & 0.299 & 0 & 0 & 0.095 \\ 0.127 & 0.264 & 0.321 & 0.035 & 0.078 & 0 & 0.175 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0.198 & 0.802 \\ 0.108 & 0 & 0.571 & 0.198 & 0 & 0 & 0.123 & 0 & 0 \\ 0 & 0.113 & 0 & 0 & 0.318 & 0.393 & 0.073 & 0 & 0.103 \end{bmatrix}$$

Finally, about the above matrix, the allocation is performed as follow:

$MAX = 0.366h_{14} + 0.253h_{15} + 0.078h_{21} + \cdots + 0.103h_{99}$

$\boldsymbol{s.t}$:

$$h_{11} + h_{12} + h_{13} + h_{14} + h_{15} + h_{16} + h_{17} + h_{18} + h_{19} = 1$$
$$h_{21} + h_{22} + h_{23} + h_{24} + h_{25} + h_{26} + h_{27} + h_{28} + h_{29} = 1$$
$$h_{31} + h_{32} + h_{33} + h_{34} + h_{35} + h_{36} + h_{37} + h_{38} + h_{39} = 1$$
$$h_{41} + h_{42} + h_{43} + h_{44} + h_{45} + h_{46} + h_{47} + h_{48} + h_{49} = 1$$
$$h_{51} + h_{52} + h_{53} + h_{54} + h_{55} + h_{56} + h_{57} + h_{58} + h_{59} = 1$$
$$h_{61} + h_{62} + h_{63} + h_{64} + h_{65} + h_{66} + h_{67} + h_{68} + h_{69} = 1$$
$$h_{71} + h_{72} + h_{73} + h_{74} + h_{75} + h_{76} + h_{77} + h_{78} + h_{79} = 1$$
$$h_{81} + h_{82} + h_{83} + h_{84} + h_{85} + h_{86} + h_{87} + h_{88} + h_{89} = 1$$
$$h_{91} + h_{92} + h_{93} + h_{94} + h_{95} + h_{96} + h_{97} + h_{98} + h_{99} = 1$$
$$h_{11} + h_{21} + h_{31} + h_{41} + h_{51} + h_{61} + h_{71} + h_{81} + h_{91} = 1$$
$$h_{12} + h_{22} + h_{32} + h_{42} + h_{52} + h_{62} + h_{72} + h_{82} + h_{92} = 1$$
$$h_{13} + h_{23} + h_{33} + h_{43} + h_{53} + h_{63} + h_{73} + h_{83} + h_{93} = 1$$
$$h_{14} + h_{24} + h_{34} + h_{44} + h_{54} + h_{64} + h_{74} + h_{84} + h_{94} = 1$$
$$h_{15} + h_{25} + h_{35} + h_{45} + h_{55} + h_{65} + h_{75} + h_{85} + h_{95} = 1$$
$$h_{16} + h_{26} + h_{36} + h_{46} + h_{56} + h_{66} + h_{76} + h_{86} + h_{96} = 1$$
$$h_{17} + h_{27} + h_{37} + h_{47} + h_{57} + h_{67} + h_{77} + h_{87} + h_{97} = 1$$
$$h_{18} + h_{28} + h_{38} + h_{48} + h_{58} + h_{68} + h_{78} + h_{88} + h_{98} = 1$$
$$h_{19} + h_{29} + h_{39} + h_{49} + h_{59} + h_{69} + h_{79} + h_{89} + h_{99} = 1$$

$h_{it} = \begin{cases} 1 \\ 0 \end{cases}$

Results of solving 0 and 1 problem based on the Hungarian method are as follow:

$$v_4 > v_2 > v_8 > v_1 > v_5 > v_9 > v_6 > v_3 > v_7$$

The above priority shows the total effect level of each variable on the overall system.

6. Conclusions

As mentioned in this paper, the DEMATEL technique was developed in Shiraz University about the importance of the influenced variable to prioritize the effective variables on knowledge sharing more exactly. In order to more exact consideration of results and evaluate the results obtained from conventional and developed DEMATEL technique table.3 is investigated. The table shows the priority of variables from the viewpoint of two techniques.

Table 3
Priority of variables based on conventional and developed DEMATEL technique.

PRIORITY	Based on various criteria of the conventional DEMATEL technique						Developed DEMATEL
	Variable	$\boldsymbol{R}$	Variable	$\boldsymbol{R+C}$	Variable	$\boldsymbol{R-C}$	Variable
1	C_8	3.74	C_2	6.85	C_5	0.9147	C_4
2	C_2	3.67	C_8	6.76	C_8	0.7263	C_2
3	C_4	3.5	C_4	6.73	C_9	0.6026	C_8
4	C_5	3.4	C_6	6.11	C_2	0.4944	C_1
5	C_9	3.16	C_5	5.98	C_4	0.3445	C_5
6	C_6	2.98	C_9	5.73	C_6	−0.1437	C_9
7	C_7	1.62	C_1	3.88	C_7	−0.3216	C_6
8	C_1	1.29	C_7	3.57	C_1	−1.299	C_3
9	C_3	0.84	C_3	3.03	C_3	−1.338	C_7

As seen in the above table, the results of the two techniques have a considerable difference. Although the first three variables in the priority based on the developed DEMATEL technique and R+C and R criteria i are equal (same), their locating in positions are different. In the developed DEMATEL technique, the trust variable (fourth variable) has the priority. Based on R+C criteria, the organizational culture variable (second variable) has the first priority, and the trust variable has the third priority. Also, the participation and collaboration variable (eighth variable) have the first priority based on R criterion. Accordingly, it can be said that the organization manager can help the reinforcement of the organization by reinforcing these three variables, trust, organization culture, and participation and collaboration. However, change in parameters is very difficult due to their smooth nature, namely their dependency on human factors. In this situation, the manager generally has to choose one of the variables to plan due to resource limitations. The modified DEMATEL technique can effectively help this choice, and it recommends that reinforcement of organizational trust be emphasized more than any other

variables. Because based on the importance of influenced variable, the causal effect of this variable on other variables is greater and more considerable.

Investigation on the variable placed in the fourth position based on the developed DEMATEL technique, namely encouraging organizational structure variable (first variable), and its comparison with the conventional DEMATEL, show the unique power of the developed DEMATEL technique. In the conventional DEMATEL technique, this variable is in the lower rank based on two criteria, $\boldsymbol{R}$ and $\boldsymbol{R}+\boldsymbol{C}$.

Based on the results of this study, management is recommended that in order to reinforce the knowledge sharing in an academic environment, trust between members should be considered and applied and, if it is possible, provide plans for change the organizational culture in order to knowledge sharing and reinforce the participation and collaboration manner.

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