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Identification and order preference of effective factors on establishment of Information Systems in Engineering Council Organization at Alborz Province (Iran)

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Abstract. In today organizations, establishment of Management Information Systems (MISs) is deemed as one of the cases, which will be led to improvement in performance of organizations. The present research is mainly intended to identify and prioritize the facilitating and constraint factors in establishment of information systems in Engineering Council Organization. The methodology of the current investigation is of applied type in terms of objective and it is descriptive- surveying study in terms of method and nature type. The statistical population of this study includes experts in Engineering Council Organization out of which 10 experts from this organization have been employed for the current research. Primarily, the researcher has screened the identified criteria based on screening inventory to collect data in this survey and after recognizing of final criteria in the given research, 5 criteria (environmental, technical, administrative, organizational, and human) have been identified. Afterwards, the researcher has tried to extract the comments from the experts by using pairwise comparison questionnaire. To analyze the collected data, the researcher has adopted fuzzy analytical hierarchy process method. The results suggest this point that the human, organizational, and technical factors are more effective in establishment of information systems while the administrative and environmental criteria have the lowest effect on establishment of information systems.

Keywords: Management Information Systems, Fuzzy Analytical Hierarchy Process, Environmental, Organizational, Administrative, Human, and Technical Factors

1. INTODUCTION

One of the greatest concerns for today directors of the organizations in modern accelerated and stressful world is to survive in the competition scene. Nowadays, the world managers need to accurate, proper, and on time information more than any time in the past thereby they may make the best possible decision at the shortest period of time and implement them practically. Thus, the organizational information systems have especially drawn attention and they have been turned into one of the foremost organizational arteries [1] and for this reason several organizations tend to be able to overtake their rivals [2] In fact, being exposed to rising complexity in decision making, today management has been found that with respect to very extraordinary importance of the information, the existing wide and decentralized and often irrelevant manual systems could not provide the required information and present them at appropriate time and many managers of organizations are exposed to a mass of data and/ or a great deal of information records, which are not so effective for them in making decision, planning, organizing, and proper control and guiding The presence of these systems in modern world signifies that the information to be put at disposal of managers and organizational decision-makers with respect to factors of speed and accuracy. But the results of the studies have shown that the rate of failure in establishment of information systems is high in organizations and the managers may fail to acquire the results as they deemed them as appropriate versus these systems In fact, there are major reasons in today organizations where establishment of these systems may be affected by them. Three factors have been called as the major factors in failure and success for these projects in the current research and these factors

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include human, technical and organizational, administrative and environmental factors. Occasionally, the directors start establishing information systems in their organizations without looking at subject of establishment of information systems systematically and this may lead to encountering of many problems in execution of these systems [3] For instance, they may implement information systems regardless of personnel's resistance against changes in the heart of organization. Whereas the organizational workforce is the users of such systems and also irrespective of this fact that it is the manpower, who gives identity to these systems, this trend will be led to failure and improper use of these systems since sometimes these systems are assumed as a threat for their occupational security from personnel's viewpoint and on the other hand these systems are not accompanied with adequate trainings so this will lead to create a type of fear from employing these systems by the users. One could also refer to organizational structure and culture as the main factors in implementation and establishment of information systems regarding organizational factors. If the given organization has not been prepared adequately for changes in terms of culture and organizational structure the establishment of these systems will encounter several problems since employing these systems will lead to omission of mediating factors in structure and among middle- rank managers or in other words this type of systems forms so that the information trend may flow with higher speed in the organization. If the organizational culture and structure are not changed in coordination with such systems this will be led to encountering some problems and finally the technical factor is deemed as another significant factor in establishment of information systems and if the organization does not support from these systems and not separate the useful and user's information from other data the directors will encounter information bombardment and this will be led to performance weakness in application of these systems. Engineering Council Organization is one of the organizations, which are deemed as sensitive and wide organizations in terms of activities and functional field. Lack of establishment of this type of information systems in a wide organization in terms of geographical and functional field of activity may extremely challenge the Engineering Council Organization in terms of acceleration in occupational and functional processes. In fact, lack of using and non- establishment of these systems will cause Engineering Council Organization to encounter some problems in making decisions due to lack of access to their related information of the given functional field so this issue will be able to affect adversely on productivity and efficiency of this system. In the present investigation, the researcher tends to find facilitator and constraint criteria against each of the factors in establishment of information systems in order to know which criterion is higher preferred with more effect on realization and improving achievement of establishment of these systems in the organization. The main issue in this study that the researcher has been preoccupied with execution of it is this point that lack of application of these system may lead to a type of information disorder inside the organization and on the other hand as we referred to it, the failure in these projects leads to incurrence of a lot of costs by the organization so this leads to making the subject of establishing information systems sensitive in the organization.

Theoretical bases:

Information Technology (IT) advances with rising speed at age of information explosion. Various computer systems have progressed in several economic, social, industrial, and administrative institutions of the world constantly and this have led to essential transformation in process of making decisions and intraorganizational planning. Similarly, this trend has increased yield of production and efficiency and productivity of organizations and it has led to fineness and enhancing the quality of the manufactured products and services, increase in competitiveness power, innovation, and invention of modern products, creation of technical developments in industries, and eventually economic development in the countries.

About three previous decades namely the time when organizations and directors were experiencing industrial age, application of information quantitatively and qualitatively was assumed as obsolete and out of mind. Most of plans and activities in organizations were

designed and executed with reliance on manpower and machines and these two factors were considered as criteria for evaluation of power in an organization. But during some recent years the organizations witnessed noticeable developments in the field of management with passing through age of communication and entering into age of information [3]. Age of Information and/ or Age of Information and Communication is one of these names in current period at human life. This terminology is used in fact due to paying a lot of attention and wide activities, which have been and are executed during this period in the fields of data collection, processing, and transfer. At present age, the managers are required to identify the information relating to the activities in which they are involved and they need to collect, analyze, and organize and also exchange them with observance of three important factors including speed, accuracy, and costs, which are seen in all of activities in organizations at present time without exception. Some of management experts assume these factors as synonymous to decision-making. Therefore, the manager should be aware of the status or the related problems to the subject for which s/he intends to make decision so that s/he may be able to make rational decision for the organization. The information inside any system at any moment of time possesses the certain structure that forms knowledge and awareness on that system. Such knowledge has been created gradually and over the time by absorbing various information segments or data and converted into the information. If the system continuously acquires information from the surrounding environment, its knowledge will be constantly increased and expanded and it is changed from the current simple and plain condition into complex and diversified status. The secret of achievement for any director and management system in any organization is in this point that s/he can link the new data to organizational previous knowledge step by step and prepare the grounds for receiving and preparation of modern information while trying to enhance the potential of organization to receive information at higher level as it appropriate for the organization and with respect to several levels in subordinates of that organization. S/he should be careful on the one hand that the organization not to be exposed to invasion of new data when it is not prepared to acquire or accept them and on the other hand not to create a deep gap between the former assets and the new findings since if it occurs otherwise, the management system will be not be able not only to link the new information with organizational body because of many existing missing links, but also it will lose the potential to make proper decision for advancement and development as well in terms of alienation of organization to new information [1].

Information system:

James and Maracas [4] argue that an information system may include the organized composition of personnel, hardware, software, and communication networks and sources, which collected information in an organization and they transform and publish it . An information system should be proportional to identical requirements and activities, which are employed by that system. Of course, it does not necessitate using computer in any information system. However as usual, due to the great volume of intra- and extraorganizational information, the computer- based information system is utilized in organizations [5].

An information system may be defined professionally as a group of relevant elements together in which it collects the information in order to support from the organizational decisions and to control in an organization and or retrieves, processes, stores, and distributes them. In addition to supporting from decision-making, coordination and control, the information system contribute to the managers and personnel in analysis of problems, embodiment of complex subjects, and producing of new products . In a definition proposed by Laudon and Laudon, they have defined the information system as follows: An information system is composed of a group of humans and tools, which they execute, the purposeful operation in information. The information systems are those systems, which are tasked with storing data and processing of them within framework of the information goals for the institute and also providing the needed information for the managers in making economic decisions, which are designed and established in institutes

through participation of directors and designers of system, who enjoy the adequate knowledge regarding computer technology [6]. The theoretical bases on information systems have been defined as follows: An information system is created through operational coordination between personnel, equipments, and routines for doing of tasks, data, and other resources thereby it can produce uniform, reliable, and accurate information. Preparation of accurate and right information for right person at right time and within right format is deemed as the paramount issue in information systems.

Effective factors on success for implementation of information systems

Several studies have been carried out to explore the effective factors on achievement of information systems out of which one of the foremost samples of them is the study in model of Delone- McLean. These two authors acknowledge that many studies have been conducted about the effective factors on achievement of information systems at past time; as a result, several researchers have considered different aspects of success for this issue and this in turn has made comparison of them as difficult [7] These two researchers have posited several investigations for organizing and more comprehensive approaches about concept of success in information systems and their comprehensive classification. This classification assumes six dimensions intervening in achievement of information system including quality of system, quality of information, use, user's satisfaction, individual and organizational effects. Then by considering these dimensions, these two researchers reviewed about 180 empirical and conceptual articles and classified and organized them based on class of dimension and thereby presented a comprehensive model. In a model proposed by these two researchers, each of quality of system and quality of information separately and together with dimensions of use and user's satisfaction affect in model. In addition, rate of use may positively or negatively affect on rate of user's satisfaction where it also applies properly vice versa. The use and user's satisfaction are deemed as direct antecedents of individual effect and at last such an effect should also influence in individual performance and finally in the organization as well. Figure (1) shows Delone-McLean model.

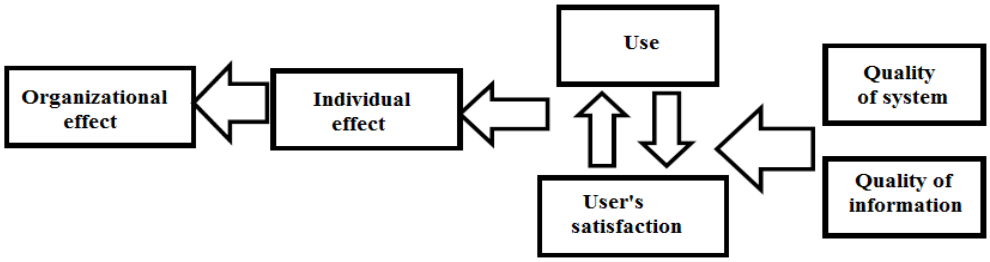

Figure 1. Model of achievement factors for information system by Delone- McLean [7].

A short period after publishing of Delone- McLean model, the active researchers in the field of information systems have suggested some modifications for this model. For example, the researchers suggested adding dimension of 'quality of service' to this model and this offer was also accepted by Delone- McLean. With respect to the conducted studies on this model and the proposed suggestions regarding improvement of that model, Delone and McLean tended to modify this model that is shown in Fig (2) [8].

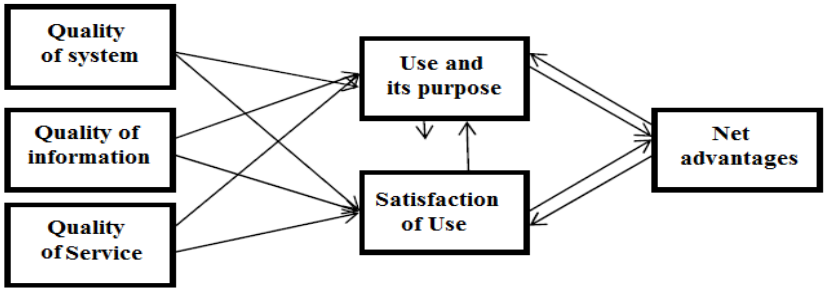

Figure 2. The modified model for success of information system [8].

As it observed in Fig (2), dimension of quality of service was added to the model similar to a structure. The other modification in this model was to consider this point that the information systems might affect on the levels rather than individual and organizational levels. In other words, achievement of information systems might affect on work group, industries, and even communities. Hence, Delone- McLean replaced the elements of individual effect and organizational effect with 'net advantages', which denote the advantages at several analytical levels. The final modification employs the higher resolution of element. The authors explain this element as follows:

The use, as a concept of procedure, should be prior to 'user's satisfaction' but positive experience from this use may lead to further satisfaction of user. Hence, they imply that further satisfaction of user may increase the purpose and intention toward use and this in turn will lead to further use. In the following, the researcher will discuss about various factors as cumulative approach and within technical, organizational, environmental, human, and administrative criteria [8]

Technical factors:
One can refer to that class of factors regarding the related infrastructures and standards to technology and technical subject in discussion about technical factors. Sometimes, the organizations lack various infrastructures for exploitation from information systems so in the case of providing these infrastructures, they can use information systems more quickly and with higher productivity [9]. On the other hand, various producers of information systems may employ different technical standards. For example, computer data processing unit that is produced by IBM Co includes different technical standards compared to that of Apple Mackintosh Inc. This may create problem in integration of computer network in an organization.

Human factors
Also today the users' resistance is characterized as a main concern in execution and establishment of information systems in organizations. Many directors have failed in using supporting systems for decision making and management in the field of their activity. The primary reasons for their failure are as follows: Fear from modern technology, lack of reliance on capability of technology, and lack of appropriate supporting headquarter in the organization [1]. The method of organizational management may be changed through information systems with smoothening of hierarchy pyramid and developing data flow in horizontal and inter-tasking form and such a change may be considered as a threat to the power and even their professional security according to directors' assumption [10] The middle- rank directors are worry that the expansion of computer- based management information system endangers their authority. Therefore, they may resist against implementation of such systems in the organization [11] The head of a tasked district may be worry for this reason that developing of computer network in the organization to flow as inter- tasking trend and this may restrict his/ her capability in control of data flow inside and outside the given unit. If lack of control on data flow negatively affects on power of director, it is more likely that the given director creates hurdle in path of execution of the information system [12].

Structural factors:
As it already implied, the effect of organizational (structural) factors on success of information system has been noticed by several researchers in such a way that they have utilized several terms such as backgrounds, variables, and factors, which are related to the organizational factors [13] For instance, Lowang has attributed the existing structural type as an organizational parameter. In a study, Sanders and Johns have referred to organizational variables such as mission, size, goals, hierarchy of execution of information system, maturity of activity in

information system, rate of activity of information system, culture, and the amount of budget in information system [14] Similarly, Ang et al in their research have implied that the organizational factors such as organizational structure, size of organization, knowledge management of IT, financial sources, the coordination of goal and clear orientation might affect on application of IT. In fact, it may be asserted that as these factors are provided further in an organization, they can facilitate better establishment of information systems while lack of these factors may have important impacts on establishment of information systems [15].

Administrative factors:
With respect to cost- consuming nature of establishment and utilization from information systems, the director may not probably assume the responsibility for the needed supports from execution of these systems to exercise experiences in the field of implementation and establishment of information systems while the presence of CEOs' support may act as an effective factor to accelerate its implementation [16] In several researches, some factors including directors' style and CEOs' support from implementation of information systems have been introduced as the effective factors in process of implementation of information systems. In fact, if the directors have experienced this point that they could not acquire suitable earnings for their organization with respect to the costs incurred in this type of systems for various reasons, they do not necessarily support from this type of systems [17].

Environmental factors:
As we know, the environmental factors refer to that class of factors, which are not at disposal of organization and management but they may affect on process of implementation of information systems. On some occasions, some factors such as embargoes and lack of technical knowledge regarding information systems are assumed as factors, which may influence in implementation of information systems [3] In fact, one can infer that as the external environment is more consistent and organization can find which systems have the highest effect on performance with what techniques in the current markets, the information systems may be established more quickly. While, some factors such as dependence on technology along with factors including embargoes may affect on speed and level of their implementation [18].

Analysis method

Analytic Hierarchical Process (AHP) technique
In 1983, Laarhoren and Padrycz suggested the method of analytic hierarchical process (AHP). This applied technique is composed of process of hierarchical analysis with fuzzy logic. The verbal criterion resulting from analytical hierarchy may be expressed as fuzzy uncertainty when the decision-maker makes a decision. Thus, Fuzzy Analytical Hierarchy Process technique converts the experts' comments about predefined values into fuzzy numbers and membership functions in order to achieve more reasonable evaluation. With respect to the suggested method by Laarhoren and Padrycz, it is identified that many concepts are ambiguous in real world situation. The steps of analytic hierarchical process are as follows:

Determination of problem: Initially, we identify the given problems in order to solve it. In this problem, it is aimed at determining the order preference of effective factors on establishment of information systems.

Creation of hierarchical structure: It deals with determination of appropriate structure in order to identify levels for criteria by the given literature. The criteria have been extracted in this survey by exploring the given literature and they are classified by means of experts' comments. Terminology and sizes of pairwise comparison are given for this technique in Table (2).

Table 2. Verbal terms and their fuzzy values for pairwise comparison of criteria.

Completely preferred	(9, 9, 9)
Medium	(9, 8, 7)
Very strong	(8, 7, 6)
Medium	(7, 6, 5)
Strong	(6, 5, 4)
Medium	(5, 4, 3)
Relatively strong	(4, 3, 2)
Medium	(3, 2, 1)
Identical	(1, 1, 1)

Pairwise comparisons: They include formation of sizes in pairwise comparisons among all of criteria within dimensions of hierarchical system. The verbal terms are allocated to pairwise comparisons by expressing this question that among two criteria which one and how much it is preferable than other in order to form the following decision- making matrix:

$$\tilde{A} = \begin{pmatrix} 1 & \tilde{a}_{21} & \cdots. & \tilde{a}_{21} \\ \tilde{a}_{21} & 1 & \cdots & \tilde{a}_{21} \\ \tilde{a}_{21} & \tilde{a}_{21} & \cdots & 1 \end{pmatrix} = \begin{pmatrix} 1 & \tilde{a}_{21} & \cdots. & \tilde{a}_{21} \\ \frac{1}{\tilde{a}_{21}} & 1 & \cdots & \tilde{a}_{21} \\ \frac{1}{\tilde{a}_{21}} & \frac{1}{\tilde{a}_{21}} & \cdots & 1 \end{pmatrix}$$

The bipolar distance scale in fuzzy analytic hierarchical process technique:

$$\tilde{a}_{ij} \begin{cases} \tilde{9}^{-1}, \tilde{8}^{-1}, \tilde{7}^{-1}, \tilde{6}^{-1}, \tilde{5}^{-1}, \tilde{4}^{-1}, \tilde{3}^{-1}, \tilde{2}^{-1}, \tilde{1}^{-1}, \tilde{1}, \tilde{2}, \tilde{3}, \tilde{4}, \tilde{5}, \tilde{6}, \tilde{7}, \tilde{8}, \tilde{9} & i \neq j \\ \tilde{1} & i = j \end{cases}$$

We employ a certain technique by using geometric mean in order to determine fuzzy geometric mean and fuzzy values for any criterion where this method has been introduced by Hosier et al (2004).

$$\tilde{r}_i = (\tilde{a}_{i1} \otimes \tilde{a}_{i2} \otimes \ldots \otimes \tilde{a}_{in})^{\frac{1}{n}}$$

$$\tilde{w}_i = \tilde{r}_i \otimes (\tilde{r}_1 \oplus \tilde{r}_2 \oplus \ldots. \oplus \tilde{r}_n)^{-1}$$

Where, in above formula $\tilde{a}_{ij}$ denotes fuzzy comparison value of criterion, i is the ratio to criterion j. Therefore, $\tilde{r}_i$ is the geometric mean of i^{th} value of comparisons of criterion in respect of other criteria and $\tilde{w}_i$ denotes fuzzy value of criterion than can be expressed as a fuzzy triangular number $\tilde{w}_i = (lw_i, mw_i, uw_i)$. lw_i, mw_i, and uw_i are the low, medium, and high value of fuzzy value in i^{th} criterion, respectively. In order to acquire defuzzified weights, we utilize the following formula:

$$w_j = \frac{lw_i + 4mw_i + uw_i}{6}$$

Table 3. The effective criteria on establishment of information systems extracted from research literature and history.

Effective criterion on establishment of information systems	Sign of criterion
Human factors	C1
Administrative factors	C2
Organizational factors	C3
Technical factors	C4
Environmental factors	C5

Oder preference of criteria by means of fuzzy analytic hierarchical process technique

Given that the quantity of experts is 10 in this technique so there are 10 different matrices for comparison of criteria. We initially convert these matrices into a single matrix in fuzzy analytical hierarchical process technique. Using of geometric mean is one of the best techniques in order to compose pairwise comparisons table for all of respondents. It is because of the fact that the pairwise comparisons create data in form of proportion and at the same time reciprocal nature of pairwise comparisons may justify using this technique further since geometric mean conserves reciprocal property in matrix of pairwise comparisons. If we suppose $\tilde{a}_{ij}^{k}$ is the related component to K^{th} respondent for comparison of criterion i with respect to criterion j, geometric mean for the correspondent components is calculated from the following formula:

$$\tilde{a}_{ij} = \left(\prod_{k=1}^{n} \tilde{a}_{ij}^{k} \right)^{\frac{1}{n}} \quad \tilde{a}_{ij} = \left(\tilde{a}_{ij}^{1} \otimes \tilde{a}_{ij}^{2} \otimes .... \otimes \tilde{a}_{ij}^{10} \right)^{\frac{1}{10}}$$

According to viewpoint of group and by means of above formula, the comparison of criteria will be as follows:

The initial matrix of pairwise comparison for criteria after integration of comments from experts

	C1			C2			C3			C4			C5		
C1	1	1	1	0.5	1.317	2.5	0.4	0.791	2	1	1.331	2	1	1.632	2.5
C2	0.4	0.759	1	1	1	1	0.4	0.804	2	0.5	1	1.5	0.5	1	1.5
C3	0.5	1.264	2.5	0.5	1.243	2.5	1	1	1	0.5	1.1	2	0.5	1.449	2.5
C4	0.5	0.751	1	0.667	1	2	0.5	0.909	2	1	1	1	1	1.127	2
C5	0.4	0.613	1	0.667	1	2	0.4	0.069	2	0.5	0.888	1	1	1	1

Calculation of fuzzy weights of criteria

With respect to technique of fuzzy analytic hierarchical process, the information of integrated matrix of criteria is analyzed through the following steps: Primarily, we identify value of j^{th} criterion in respect of other criteria by means of geometric mean with the following formula:

$$\tilde{r}_1 = (\tilde{a}_{11} \otimes \tilde{a}_{12} \otimes \tilde{a}_{13} \otimes \tilde{a}_{14} \otimes \tilde{a}_{15})^{\frac{1}{5}}$$

Fuzzy value of pairwise comparisons of criteria

$\tilde{r}_i$	lr_i	mr_i	ur_i
$\tilde{r}_1$	0.725	1.177	1.9037
$\tilde{r}_2$	0.525	0.906	1.351
$\tilde{r}_3$	0.574	1.202	1.9905
$\tilde{r}_4$	0.699	0.949	1.5157
$\tilde{r}_5$	0.556	0.519	1.3195

Then, in order to determine fuzzy weights for criteria, we act as follows. We multiply value of each of criteria to reciprocal of fuzzy sum of values of criteria. For example, in order to derive fuzzy value of first criterion, we act as follows:

$$\tilde{W}_1 = \tilde{r}_1 \otimes (\tilde{r}_1 \oplus \tilde{r}_2 \oplus \tilde{r}_3 \oplus \tilde{r}_4 \oplus \tilde{r}_5)^{-1}$$

Fuzzy and deterministic weights of criteria

Rank	Defuzzified weights of criteria	uw_j	mw_j	lw_j	W_j	Effective criteria on establishment of information systems
1	0.244	0.236	0.248	0.235	W1	Human factors
2	0.183	0.167	0.191	0.171	W2	Administrative factors
3	0.241	0.246	0.253	0.186	W3	Organizational factors
4	0.202	0.188	0.200	0.227	W4	Technical factors
5	0.130	0.163	0.109	0.181	W5	Environmental factors

As it is observable in results of pairwise comparison, the human, organizational, and technical criteria had the highest effect on establishment of information systems. It can be inferred in fact that paying more attention to these factors may be followed by further noticeable effects on establishment of these information systems and also they may play higher role in success of implementation of these systems more than ever.

Conclusion:

As we know, today with respect to competitive and complicated environment that encompasses the surroundings of organizations, the director will not be able efficiently to identify and make decision regarding different issues because of being exposed to numerous factors for decision making and identifying the organizational problems and issues. Inter alia, today some systems called as information systems have contributed to the managers. These systems may do several tasks in various organizational units including operational units (transactional processing systems) and higher units (e.g. supporting systems for decision making). Therefore, it may be implied that these system will extremely contribute to organizations for summarizing and classification of information and data. Thus, whatever has been so far discussed about it may suggest this point that establishment of information systems will be assumed as an undeniable requisite in organizations at private and public sectors and finally the governmental sector. But among them, there are several problems against the path of organizations, which may deprive organizations from acquisition to advantages caused by total establishment of information systems. Sometimes, human- made problems, which are characterized under title of personnel's resistance in organization and other time technical factors such as lack of appropriate infrastructures and many other factors against access of organizations to perfect advantages of using these system, may act as restrictive factors and on the other hand one can imagine in this way by changing one's viewpoint that the capable personnel tend to improve level of their own awareness and performance in their organization where this factor may be considered in realizing establishment of information systems as facilitator. As it already implied, the results of research suggest that from experts' viewpoint, the human factors are the most frequent and facilitating factor in establishment of information systems. In fact, as the rate of direct user's satisfaction is higher with information systems and personnel and users possess such a feeling, these information systems may not threaten individual's job and occupational security and certainly this will not remove the rate of resistance and fear in workforce from establishment of information systems. More simply, this is manpower that interacts with this type of systems and utilizes from their data and information. Therefore, the rate of their satisfaction with this type of systems may prepare the grounds for further application of these systems in the organization

and on the other hand as rate of this application is improved further, the rate of realization and establishment of these systems will be enhanced. The organizational criterion is the next effective criterion on establishment in the current research. In fact, each of factors including outlook, goals, missions, and organizational structure are assumed as an important factor in establishment of information systems. As the organizational objectives and outlooks have been further focused according to utilization from information systems, certainly the rate of establishment and realization of these systems will be higher in organization. The next effective criterion on establishment of information systems is technical factors in this investigation. In fact, it could not be expected that these system can be easily established in organization before presence of the needed technical backgrounds and infrastructures.

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