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Identification and Prioritization of Factors Causing Delays in ICT Projects Based on PMBOK Standards Using Fuzzy Delphi & Fuzzy Delphi Hierarchical Analysis

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ABSTRACT

Due to the importance of Information and Communication Technology (ICT) projects and lack of research on such projects in the petroleum industry, the present study mainly aimed to identify and prioritize the factors affecting the delay of ICT projects in Masjid-i-Solieman Oil and Gas Production Company as the case study. This investigation seeks the causes of undesirable conclusions of the ICT petroleum industry. The results are crucial to prevent the wastage of financial resources or time (due to sanctions and the difficulty of supply resources in Iran), also are very important for the project management of the oil and gas industry. On the other hand, it can be helpful all over the world.
According to the obtained prioritization, the most significant impact was the wrong sequence and definition of prerequisite relationships, prioritization instructions and lack of review of the priority in allocating limited resources to project components, and lack of timely allocation of financial resources, respectively, with the highest importance.

Information Technology (IT) projects are a vital factor in the growth of businesses and organizations. With so many project management mechanisms in place, why are so many IT projects failing? (Iriarte and Bayona, 2020).

Because of the competitive markets and limited available resources in the developed countries, organizations try to find the cause of delay in projects to solve them and give the most benefits. The most crucial indicator of project success (especially achieving the desired goals and cost-effectiveness) is completing on time (Farughi et al., 2017). Besides, due to the ambiguity of the projects, we must be careful in allocating resources (Olfat et al., 2010).

The complexity of IT and ICT projects makes the management of these projects requires special knowledge (Morcov et al., 2020).

To this end, identifying the critical success factors is essential to avoid unexpected problems and reduce the risk of failure during all project implementations, including Information and Communication Technology (ICT) projects. ICT is use in all fields, and carrying out these projects has a massive contribution to the development of organizations and companies. Therefore, it can be considered a competitive advantage for organizations (Gholamnejad et al., 2017).

Nevertheless, reports show that up to 50% of ICT projects fail, 83% of them do not meet the delivery time or price, and 30% of them are entirely terminate before the delivery. However, the impact of successful ICT projects on achieving better positions for organizations, managers, and the people involved in the projects is undeniable (Clancy, 2008).

According to the reports from the Project Management Institute (PMI), 55% of ICT projects reviewed by the year 2016 have failed at all or one of their targets, and a similar report in the 2017 shows that only 34% of ICT projects completed on time (PMI Report, 2018).

The use of ICT is inevitable today. These technologies facilitate communication and increase the accuracy of control over information. As a result, by improving coordination between different parts of the organization, ICT will play a significant role in achieving organizational goals. Despite the importance of these projects, they face many problems during the implementation of ICT projects. The occurrence of time gap during the execution conduces to lose resources and competitive advantage of projects. Also, the justifiability of continuing implementation in these projects because of the dynamic nature and very rapid growth of the world's technology may be threatening or disappearing.

Similarly, the complicated volume of operations in the oil and gas industry has led to special management conditions to conduct projects. Failure or delay in oil and gas industry projects can have irreparable consequences. In addition to the complexity of the relationship between executive agents in oil and gas ICT projects, finding scientific solutions to identifying and predicting delay factors can avoid waste of financial resource or time. Traditional relationships are not sufficient to solve project problems, and employers engage in a time-consuming and costly process to remove barriers to the projects (Tsiga et al., 2017). In addition, the nature of ICT projects, especially in the oil industry, depends on the world's technology and are often measured and timed in line with the speed and growth of ICT. Hence, the need to identify delay factors in such projects and prioritize them according to a valid global standard is undeniable. To this end, to identify these factors, a logical prioritization should be provide. A logical relationship should be create between external and internal factors, stakeholders, and officials, which is up-to-date, advanced, and flexible (Heim et al., 2019).

ICT projects follow specific standards and frameworks, such as ISO 27002 regarding information security management or Cobit on controlling the goals of information technology. Therefore, such projects need more efficient and different methods than other organization projects in all three phases of design, implementation, and operation (Kashiwagi, 2019). In contrast, no detailed study has done on the delay factors of ICT projects in the petroleum industry of Iran, to the best of our knowledge.

The international project management body of knowledge (PMBoK) is a comprehensive and flexible standard to conduct a project successfully. The main areas at this standard are project scope, project time, project cost, and project quality management. Therefore, the use of the PMBoK standard can be beneficial in identifying and prioritizing the obstacles in the path of ICT projects.

Project managers use those to predicting barriers and achieving the goals of time, cost, quality, and risk management (Varajão et al., 2017). On the other hand, in most organizations, information technology does not own the core function. Paying too much attention to it diverts the organization from focusing on the core functions. Outsourcing ICT functions is a solution that allows the organization to manage such operations while maintaining the organization’s focus on core operations (Khansarizadeh and Shirmohammadi, 2015). Masjid-i-Solieman Oil and Gas Production Company considers its essential activities in the production and continuous exploitation of oil and gas resources. At the same time, it attaches less importance to information technology projects. An important issue here is the protection of information to preserve national resources. Information is considered a very critical factor for the success of the organization. Therefore, the highest level manager is responsible for the organization's success and accountable for protecting organizational information (Ozkan and Karabacak, 2010). In addition, due to the expansion and complexity of oil and gas industry projects, there may be many differences or problems between the management of each sector that can further delay the project process. If these factors do not identify on time, it is possible to impose high costs on projects, especially ICT projects limited in providing resources due to political conditions and sanctions on the oil industry. Also, these delay factors may make the continuation of the project unjustifiable due to the rapid growth of the technology world. Therefore, it is vital to conduct research to identify and evaluate the factors causing delays in ICT projects based on an international standard and provide a solution for these projects accordingly. To this end, the present study aimed to identify and prioritize the delay factors in ICT projects based on PMBOK standard using the Fuzzy multi-criteria decision-making method. We used the ICT management of Masjid-i-Solieman Oil and Gas Production Company as our case study.

2. Literature Review

Garcia-Quevedo et al. (2018) investigated the role of financial constraints in the failure of innovation projects. They studied innovative Spanish companies from 2013 to 2015 to predict how these projects are abandon and their relationship to the percentage of project innovation. They found that during the conceptual phase, financial constraints had the most significant impact on stopping the project from continuing. They also found that companies are susceptible to internal financial resources during the project design phase, while external financial resources during the implementation phase affect them more.

Montequin et al. (2016) examined the success factors and reasons for the failure of projects. They conducted their research on 17 different types of projects in 13 geographical areas. Their findings show that the four factors, including incomplete or insufficient knowledge of customer demands, continuous changes in internal requirements, inadequate estimation and scheduling, and inadequate documentation of project requirements, play an essential role in project failure. Also, four factors of a clear vision of project goals, continuous communication between stakeholders, a commitment of the project manager, clear and complete details of project needs have been key factors in the success of projects. Also, the four factors clear vision of project goals, continuous communication between stakeholders, a commitment of the project manager, and clear and complete details of project needs are the key factors in the project success.

Panahi and Norouzi (2018) studied the risk management process in projects of Kermanshah Petroleum Company. In their study, essential risks affecting the project were identified and weighed by hierarchical analysis. The results identified the factors working space of machines, injuries caused by drilling to adjacent devices, soil shedding during maintenance of retainers, respiratory pollution caused by exhaust gases were as risk factors in Kermanshah Petroleum Company projects.

Radgohar and Motameni (2017) investigated the failure factors of oil industry construction projects. They used Shannon Entropy and TOPSIS combined methods to identify the factors that are likely to disrupt or fail the project. Based on the presented priority, the necessary forecasts can be included in planning and prevent its occurrence. According to the calculations, they found that human resource management has the most significant impact on project failure factors, and procurement management, integrated management, and scope management are other factors involved in the failure of projects in the oil industry.

In addition, Kumar Gupta et al. (2019) systematically reviewed previous research on the failure of IT projects. They sought to provide the right approach and appropriate areas for future research. They studied 111 articles published by 76 academic journals as of 2016. They found that topics around strategies about project failure risk reduction have the most attention among other issues. Another issue that was of great importance was the study of organizational structure and organizational behaviour in projects.

3. Methodology

The present work is a descriptive survey study in terms of data collection with an exploratory mode. Here, by reviewing and studying the research background of specialized books, articles, and specialized publications, the existing documents in ICT projects has been collected. Also, the method that used in the survey section to collect the required data is a semi-structured interview and the Fuzzy Delphi questionnaire. Thus, at first, the factors affecting the delay of ICT projects identifying by reviewing the research literature and the opinions of technical experts. Then a questionnaire was designed using the mentioned factors and distributed among the experts. The options were adjusted from very low to very high with the scores in a table (1) to use the dialogue variables and clear up ambiguities.

Tab.1. Triangular fuzzy number

Triangular fuzzy number	**dialogue variables**
(0.75 , 1 , 1)	**Very high**
(0.5 , 0.75 , 1)	**high**
(0.25 , 0.5 , 0.75)	**medium**
(0 , 0.25 , 0.5)	**low**
(0 , 0 , 0.25)	**Very low**

Finally, after passing the steps and obtaining the desired consensus, the factors were weighed and prioritized using the Fuzzy Delphi (FD) and the Fuzzy Delphi-Analytical Hierarchy Process (FDAHP) Approach. The statistical population of this study included ICT projects relevant managers, experts, and professionals of Masjid-i-Solieman Oil and Gas Production Company, of which eight persons have been select as the sample. The selection of these experts is base on the following criteria:

1. Technical knowledge (minimum bachelor's degree).
2. Sufficient experience in the subject (two years of work in the field consideration).
3. Sufficient willingness and time to cooperate in research.

We must declare that this study avoids any prejudice against the results, considers summarizing the opinions of a range of experts in the comprehensive identification of influential factors with a comprehensive approach and not one-dimensional (e.g. only executive). Therefore, this research tried to select experts in all aspects of ICT projects of the oil industry (experts in the field of management, executive experts, technical experts, etc.).

3.1. The Steps of FD Approach:

The Delphi method is using to reach the most reliable group agreement between the opinions of experts. After collecting information from field studies, the experts' opinions are collected. Various experts and professionals are surveyed. They could express their idea about the parameters affecting a phenomenon or decision qualitatively or, if possible, quantitatively. Because the experts differed in their experiences and backgrounds and their expertise in the project, they each looked at

the research topic and the results of the field studies from a different angle. Thus, using several steps of semi-structured interviews, 16 components that were or are currently encountered based on their project records were identified as practical components in delaying ICT projects.
A questionnaire is prepare using 16 components. Each respondent is ask to give their opinions based on the importance of each component in the five-point Likert range of verbal variables between very high, high, medium, low, and shallow importance options. Because the evaluation of components is entirely subjective and qualitative, it is difficult to express opinions using numerical values, so spoken words are used instead of exact numbers. Also, to clear up the ambiguities, the verbal expressions are converted to fuzzy triangular numbers according to the table (1).
As a result, the experts' opinion about each component is express as a triangular fuzzy number such as Equation (1). Also, the average fuzzy views of the experts for each component are obtain according to Equation (2).

Equation (1): $A_{ij} = (a_{ij}, m_{ij}, b_{ij})$, i=1,...,8 , j=1,...,16

Equation (2): $A_j = (\frac{1}{8}\sum_{i=1}^{8} a_{ij}, \frac{1}{8}\sum_{i=1}^{8} m_{ij}, \frac{1}{8}\sum_{i=1}^{8} b_{ij})$, j=1,... ,16

At each step of the fuzzy Delphi method, the results of the previous step, including the average of the experts' view on each component and the last opinion of each expert, are provided to the experts with a new questionnaire to correct their opinions about the components wherever they see fit. If the difference between the two steps of the survey is less than the threshold (0.1), the polling process stops(Cheng Lin et al., 2002).

3.2. The Steps of FDAHP Approach:

3.2.1. Survey view of experts and professionals:

At this step, according to the group agreement reached in the final step of fuzzy Delphi and the pairwise comparison of the components with each other obtained by each of the experts, eight matrix comparison matrices are obtained. The range of verbal expressions used in pairwise comparisons is base on Table (2).

Tab.2. The verbal expressions used in pairwise comparisons

Verbal phrase	Definitive numbers
Very high	**9**
High	**7**
Medium	**5**
Low	**3**
Very low	**1**

3.2.2. Fuzzy numbers calculation:

The opinions obtained from the survey of experts are considered directly To calculate the fuzzy numbers. Fuzzy numbers can be calculating based on various functions, such as the triangular or the trapezoidal method. In this research, the triangular form used due to its extensive application and ease of calculating. In this case, a fuzzy number is defining according to the following equations (Liu and Chen, 2007):

Equation (3): $a_{ij} = (\alpha_{ij}, \delta_{ij}, \gamma_{ij})$

Equation (4): $\alpha_{ij} = Min(\beta_{ijk}), k = 1, \dots, n$

Equation (5): $\delta_{ij} = (\prod_{k=1}^{n} \beta_{ijk})^{1/n}, k = 1, \dots, n$

Equation (6): $\gamma_{ij} = Max(\beta_{ijk}), k = 1, \dots, n$

In the above equations, "β_{ijk}" indicates the relative importance of parameter "i" over parameter "j" from the point of view of the k^th expert. "γ_{ij}" and "α_{ij}" show the upper and lower limits of the respondents' opinions, respectively, and "δ_{ij}" is the geometric mean of the respondents' views. The components of the fuzzy number are defining in such a way that $\gamma_{ij}<\delta_{ij}<\alpha_{ij}$.

3.2.3. Formation of Fuzzy Inverse Matrix:

In this step, according to the fuzzy numbers obtained in the previous step, the matrix of fuzzy pair comparison between different parameters is formed as follows (Liu and Chen, 2007):

Equation (7): $\tilde{A} = [\widetilde{a_{ij}}]\widetilde{a_{ij}} \times \widetilde{a_{ij}} \approx 1 \; \forall \; i,j = 1,2,\dots,n$

Or

Equation (8):

$$\tilde{A} = \begin{bmatrix} (1,1,1) & (\alpha_{12},\delta_{12},\gamma_{12}) & (\alpha_{13},\delta_{13},\gamma_{13}) \\ (1/\gamma_{12},1/\delta_{12},1/\alpha_{12}) & (1,1,1) & (\alpha_{23},\delta_{23},\gamma_{23}) \\ (1/\gamma_{13},1/\delta_{13},1/\alpha_{13}) & (1/\gamma_{23},1/\delta_{23},1/\alpha_{23}) & (1,1,1) \end{bmatrix}$$

3.2.4. The parameters' relative weight Calculation:

The parameters' relative importance is calculating as follows:

Equation (9): $\tilde{Z} = [\widetilde{a_{ij}} \otimes \dots \otimes \widetilde{a_{in}}]$

Equation (10): $\widetilde{Z_i} = \tilde{Z}^{1/n}$

Equation (11): $\widetilde{W_i} = \widetilde{Z_i} \times (\widetilde{Z_1} \oplus \dots \oplus \widetilde{Z_n})^{-1}$

Where $\tilde{a}_1 \otimes \tilde{a}_2 = (\alpha_1 \times \alpha_2, \delta_1 \times \delta_2, \gamma_1 \times \gamma_2)$ and, $\otimes$ and $\oplus$ are the symbols of fuzzy numbers multiplication and addition. Also, $\widetilde{W_i}$ is a row vector representing the fuzzy weight of the i^th parameter.

3.2.5. Defuzzification of the parameters' weight:

In this step, according to the following equation, the geometric mean of the fuzzy number components is obtained. Thus, the importance of the parameters is expressing as a definite number (Liu and Chen, 2007).

Equation (12): $W_i = (\prod_{j=1}^{3} W_{ij})^{1/3}$ or $W_i = (\frac{1}{3}\sum_{j=1}^{3} w_{ij})$

As a result, the FDAHP can determine the importance of the components, also prioritize them through scientific analysis of the pairwise comparison matrix obtained from experts' opinions.

4. Data analysis

Following to literature review results and semi-structured interviews, 16 components were identified as the influential factors in the delay of ICT projects as follows:

1. Wrong sequence and definition of prerequisite relationships.
2. Prioritization instructions and lack of review the priority in allocating limited resources to project components.
3. Incompatibility of a workforce's quality with his/her assigned activity - lack of skilled labour
4. Weakness of the project manager: Poor management technical and managerial knowledge and lack of proper policy determination.
5. Lack of coordination and effective relations between the engineering and executive departments of the project.
6. Delays due to changes in workload and staff scope.
7. Insufficiency of contractual issues and insufficient transparency in defining the job description and scope of the parties' authority.
8. Inadequate speed and quality of information transfer and approval of documents and technical specifications.
9. Method of holding tender offers and selection of subcontractors.

10. The problems for clearance and customs formalities.
11. Long duration of supply of equipment and facilities and lack of coordination with suppliers.
12. Lack of timely allocation of financial resources.
13. Long duration of administrative bureaucracy.
14. Increased inflation.
15. Lack of use of a project management standard.
16. Type of contract or accepting the lowest rate in the tender offers.

4.1. The First step of the Fuzzy Delphi:

At this step, a questionnaire consisting of 16 components is provide to the experts, and they are ask to express their opinions about each component. After collecting the questionnaires in this step and preparing the mean view of experts, the results of table (3) are obtained.

Tab.3. Results of The First Phase Fuzzy Delphi Questionnaire

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No.	Component	Fuzzy mean	Defuzzified mean
1	Wrong sequence and definition of prerequisite relationships	(0.656 , 0.906 , 1)	0.854
2	Prioritization instructions and lack of review the priority in allocating limited resources to project components	(0.375 , 0.75 , 0.937)	0.687
3	Incompatibility of a workforce’s quality with his/her assigned activity - lack of skilled labour	(0.375 , 0.75 , 0.937)	0.687
4	Weakness of the project manager: Poor management technical and managerial knowledge and lack of proper policy determination	(0.625 , 0.875 , 0.968)	0.822

5	**Lack of coordination and effective relations between the engineering and executive departments of the project**	**(0.5 , 0.75 , 0.906)**	**0.718**
6	Delays due to changes in workload and staff scope	(0.468 , 0.718 , 0.937)	0.707
7	Insufficiency of contractual issues and insufficient transparency in defining the job description and scope of the parties' authority	(0.5 , 0.75 , 0.906)	0.718
8	Inadequate speed and quality of information transfer and approval of documents and technical specifications	(0.375 , 0.75 , 0.937)	0.687
9	Method of holding tender offers and selection of subcontractors	(0.437 , 0.687 , 0.906)	0.676
10	The problems for clearance and customs formalities	(0.562 , 0.812 , 0.968)	0.78
11	Long duration of supply of equipment and facilities and lack of coordination with suppliers	(0625 , 0.875 , 1)	0.833
12	Lack of timely allocation of financial resources	(0.718 , 0.906 , 1)	0.874
13	Long duration of administrative bureaucracy	(0.562 , 0.812 , 0.968)	0.78
14	Rising inflation	(0.531 , 0.781 , 0.937)	0.747
15	Not using the project management standard	(0.5 , 0.75 , 0.972)	0.74
16	Type of contract or accept the lowest rate in the tender	(0.531 , 0.781 , 0.937)	0.747

4.2. The Second step of the Fuzzy Delphi:

At this step, the results of the previous step, including the average opinions of experts about each component and the last view of each expert, along with a new questionnaire, were provided to experts to express their views about the details again and wherever they see fit To correct. Table (4) shows the results of the second step questionnaire.

Tab.4. Results of Fuzzy Delphi Questionnaire phase 2

NO.	Component	fuzzy mean	Defuzzified mean
1	Wrong sequence and definition of prerequisite relationships	(0.656 , 0.906 , 1)	0.854
2	Prioritization instructions and lack of review the priority in allocating limited resources to project components	(0.593 , 0.843 , 0.968)	0.799
3	Incompatibility of a workforce's quality with his/her assigned activity - lack of skilled labour	(0.468 , 0.718 , 0.906)	0.697
4	Weakness of the project manager: Poor management technical and managerial knowledge and lack of proper policy determination	(0.593 , 0.843 , 0.937)	0.791
5	Lack of coordination and effective relations between the engineering and executive departments of the project	(0.468 , 0.718 , 0.906)	0.697
6	Delays due to changes in workload and staff scope	(0.468 , 0.718 , 0.937)	0.707

7	Insufficiency of contractual issues and insufficient transparency in defining the job description and scope of the parties' authority	(0.406 , 0.687 , 0.875)	0.656
8	Inadequate speed and quality of information transfer and approval of documents and technical specifications	(0.531 , 0.781 , 0.937)	0.747
9	Method of holding tender offers and selection of subcontractors	(0.593 , 0.843 , 0.968)	0.799
10	The problems for clearance and customs formalities	(0.406 , 0.656 , 0.906)	0.656
11	Long duration of supply of equipment and facilities and lack of coordination with suppliers	(0.562 , 0.75 , 1)	0.77
12	Lack of timely allocation of financial resources	(0.468 , 0.843 , 1)	0.77
13	Long duration of administrative bureaucracy	(0.562 , 0.812 , 0.937)	0.77
14	Rising inflation	(0.562 , 0.812 , 0.968)	0.78
15	Not using the project management standard	(0.593 , 0.843 , 0.968)	0.799
16	Type of contract or accept the lowest rate in the tender	(0.593 , 0.843 , 0.937)	0.791

According to the table (4), the difference between the fuzzy average of the first and second steps is as follows:

Table (5). The difference between the fuzzy average of the first and second steps

NO.	**COMPONENT**	**Step 1**	**Step 2**	**The difference**
1	Mistakes in sequencing and defining prerequisite relationships	0.854	0.854	**0**
2	Priority guidelines and lack of priority review in allocating resources limited to project components	0.687	0.799	**0.112**
3	A mismatch between labour quality and activity - shortage of specialist workforce	0.687	0.697	**0.01**
4	Weakness of the project manager: Poor management technical and managerial knowledge and lack of proper policy determination	0.822	0.791	**0.031**
5	Lack of coordination and lack of effective relationships between the engineering and executive departments of the project	0.718	0.697	**0.021**
6	Delay caused by changing workload and employee scope	0.707	0.707	**0**
7	Failure of contractual issues and insufficient transparency in defining the job description and scope of the parties' powers	0.718	0.656	**0.062**
8	Inappropriate speed and quality of information transfer and confirmation of documents and technical specifications	0.687	0.747	**0.06**
9	How to hold tenders and select subcontractors	0.676	0.799	**0.123**

10	Customs clearance problems and formalities	0.78	0.656	**0.124**
11	Long supply of equipment and credits and lack of coordination with suppliers	0.833	0.77	**0.063**
12	Lack of allocation on financial resources	0.874	0.77	**0.104**
13	Long administrative bureaucracy	0.78	0.77	**0.01**
14	Rising inflation	0.747	0.78	**0.033**
15	Not using the project management standard	0.74	0.799	**0.059**
16	Type of contract or accept the lowest rate in the tender	0.747	0.791	**0.044**

If the difference between the two steps of the survey is below the shallow threshold (0.1), the polling process stops (Cheng Chin et al., 2002). The second, ninth, tenth and twelfth components have a difference of more than 0.1, and the difference between the decontaminated mean of the rest of the component is less than 0.1. Therefore, for the second, ninth, tenth and twelfth components of the survey, it will enter the third step.

4.3. The third step of the Fuzzy Delphi:

At this step, the second phase of the survey, along with the difference between the average opinions of experts and a new questionnaire about four components that have an average difference above the threshold of 0.1, are presented to experts. Table (6) and table (7) shows the third phase of the Fuzzy Delphi survey.

Tab.6. Results of Phase III Delphi Questionnaire

NO.	Components	fuzzy mean	Defuzzified mean
1	Priority guidelines and lack of priority review in allocating resources limited to project components	(0.468 , 0.843 , 1)	0.77
2	How to hold tenders and select subcontractors	(0.562 , 0.812 , 0.968)	0.78
3	Customs clearance problems and formalities	(0.375 , 0.625 , 0.875)	0.625
4	Lack of allocation on financial resources	(0.656 , 0.906 , 0.968)	0.843

Tab.7. The difference between the fuzzy average of the second and third steps

NO.	COMPONENT	Step 2	Step 3	The difference
1	Priority guidelines and lack of priority review in allocating resources limited to project components	0.799	0.77	**0.029**
2	How to hold tenders and select subcontractors	0.799	0.78	**0.019**
3	Customs clearance problems and formalities	0.656	0.625	**0.031**
4	Lack of allocation on financial resources	0.77	0.843	**0.073**

According to the results of the third phase of the Fuzzy Delphi survey, it is observe that all differences between the fuzzy averages of all 16 components in steps 2 and 3 have reached below the threshold of 0.1. As a result, the survey steps stop here. Table (8) shows the final results of the fuzzy Delphi steps.

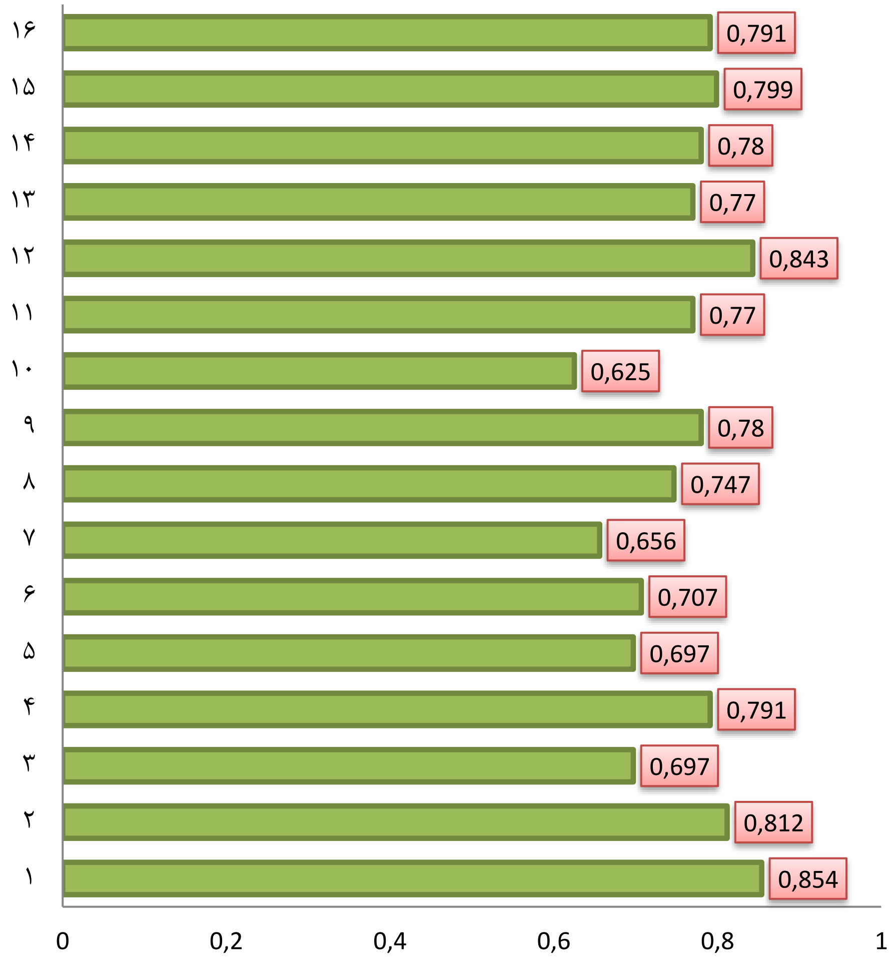
Tab.8. The mean values for the experts' opinions after completion of the Fuzzy Delphi technique steps

No.	Component	Fuzzy mean	Defuzzified mean
1	Wrong sequence and definition of prerequisite relationships	(1, 0.906, 0.656)	0.854
2	Prioritization instructions and lack of review the priority in allocating limited resources to project components	(1, 0.843, 0.593)	0.812
3	Incompatibility of a workforce's quality with his/her assigned activity - lack of skilled labour	(0.906, 0.718, 0.468)	0.697
4	Weakness of the project manager: Poor management, technical and managerial knowledge and lack of proper policy determination	(0.937, 0.718, 0.593)	0.791
5	Lack of coordination and effective relations between the engineering and executive departments of the project.	(0.906, 0.718, 0.468)	0.697
6	Delays due to changes in workload and staff scope	(0.937, 0.718, 0.468)	0.707
7	Insufficiency of contractual issues and insufficient transparency in defining the job description and scope of the parties' authority	(0.875, 0.687, 0.406)	0.656
8	Inadequate speed and quality of information transfer and approval of documents and technical specifications	(0.937, 0.781, 0.531)	0.747
9	Method of holding tender offers and selection of subcontractors	(0.968, 0.812, 0.562)	0.78
10	The problems for clearance and customs formalities	(0.875, 0.625, 0.375)	0.625
11	Long duration of supply of equipment and facilities and lack of coordination with suppliers	(1, 0.75, 0.562)	0.77
12	Lack of timely allocation of financial resources	(0.968, 0.906, 0.656)	0.843
13	Long duration of administrative bureaucracy	(0.937, 0.812, 0.562)	0.77
14	Increased inflation	(0.562, 0.812, 0.968)	0.78
15	Lack of use of a project management standard	(0.968, 0.843, 0.593)	0.799
16	Type of contract or accepting the lowest rate in the tender offers	(0.937, 0.843, 0.593)	0.791

Since the Fuzzy Delphi technique is used both for data collection and consensus of experts and is a method for analysis and decision process, we can use the Defuzzified mean values obtained at the final step (according to the table (8)) to prioritize the components. This prioritization is be use to compare the components of importance from the FDAHP approach that is discussed in the following.

Prioritization of components according to the Fuzzy Delphi technique is depicted in Figure (1).

Fig.1. The final Defuzzified mean values obtained from Fuzzy Delphi steps



4.4. Fuzzy Delphi Analytical Hierarchical (FDAHP) survey:

First, according to the experts' answers in the final step of the fuzzy Delphi questionnaire and the table (2), we form the pairwise comparison matrices of the components based on the expert opinions. Then, based on equations (3), (4), (5), and (6), extract the fuzzy pair Delphi comparison matrix. The results of the above calculations are showing in table (9).

Tab.9. Fuzzy pair Delphi comparison matrix

NO.	5	6	7	8
1	(1 , 1.246 , 1.8)	(0.778 , 1.233 , 1.8)	(1 , 1.286 , 1.8)	(0.778 , 1.158 , 1.8)
2	(0.778 , 1.17 , 1.8)	(0.778 , 1.158 , 1.8)	(1 , 1.208 , 1.8)	(0.778 , 1.087 , 1.4)
3	(0.556 , 1 , 1.4)	(556. , 0.989 , 1.8)	(0.714 , 1.076 , 1.8)	(0.714 , 0.929 , 1.8)
4	(0.556 , 1.146 , 1.8)	(0.556 , 1.134 , 1.8)	(0.714 , 1.233 , 1.8)	(0.556 , 1.0649 , 1.8)
5	(1 , 1 , 1)	(0.714 , 0.989 , 1.8)	(0.556 , 1.076 , 1.8)	(0.556 , 0.929 , 1.4)
6	(0.556 , 1.01 , 1.4)	(1 , 1 , 1)	(0.714 , 1.087 , 1.4)	(0.714 , 0.939 , 1.4)
7	(0.556 , 0.929 , 1.8)	(0.556 , 0.919 , 1.4)	(1 , 1 , 1)	(0.556 , 0.863 , 1.4)
8	(0.714 , 1.076 , 1.8)	(0.714 , 1.064 , 1.4)	(0.714 , 1.11 , 1.8)	(1 , 1 , 1)
9	(0.778 , 1.122 , 1.8)	(0.714 , 1.11 , 1.4)	(0.556 , 1.208 , 1.8)	(0.714 , 1.042 , 1.4)
10	(0.556 , 0.9 , 1.4)	(0.714, 0.89 , 1)	(0.714 , 0.969 , 1.8)	(0.556 , 0.836 , 1.4)
11	(0.778 , 1.134 , 1.8)	(1 , 1.122 , 1.4)	(1 , 1.221 , 1.4)	(0.778 , 1.054 , 1.4)
12	(0.556 , 1.233 , 1.8)	(1 , 1.22 , 1.8)	(0.778 , 1.272 , 1.8)	(0.714 , 1.146 , 1.8)
13	(0.556 , 1.076 , 1.8)	(0.714 , 1.064 , 1.4)	(0.714 , 1.158 , 1.8)	(0.556 , 1 , 1.8)
14	(0.778 , 1.122 , 1.8)	(0.714 , 1.11 , 1.4)	(0.556, 1.158 , 1.8)	(0.714 , 1.043 , 1.8)
15	(0.778 , 1.158 , 1.8)	(0.714 , 1.146 , 1.4)	(0.556 , 1.246 , 1.8)	(0.714 , 1.076 , 1.8)
16	(0.556 , 1.146 , 1.8)	(0.714 , 1.133 , 1.8)	(0.778 , 1.182 , 1.8)	(0.556 , 1.065 , 1.8)

14	(0.556 , 0.9 , 1.286)	(0.556 , 0.958 , 1.286)	(0.714 , 1.122 , 1.8)	(0.556 , 0.979 , 1.8)
15	(0.556 , 0.929 , 1.286)	(0.556 , 0.989 , 1.286)	(0.714 , 1.158 , 1.8)	(0.556 , 1.01 , 1.8)
16	(0.556 , 0.919 , 1.286)	(0.714 , 0.978 , 1.286)	(0.556 ,1.146 , 1.8)	(0.556 , 1 , 1.8)

Continuation of the tab.9..

NO.	9	10	11	12
1	(0.778 , 1.11 , 1.8)	(1.286 , 1.384 , 1.8)	(0.778 , 1.098 , 1.286)	(0.778 , 1.01 , 1.8)
2	(0.778 , 1.043 , 1.8)	(1 , 1.3 , 1.8)	(0.778 , 1.032 , 1.286)	(0.778 , 0.949 , 1.8)
3	(556. , 0.89 , 1.4)	(0.714 , 1.11 , 1.8)	(0.556 , 0.881 , 1.286)	(0.556 , 0.81 , 1)
4	(0.556 , 1.021 , 1.8)	(0.714 , 1.272 , 1.8)	(0.556 , 1.01 , 1.286)	(0.556 , 0.929 , 1.8)
5	(0.556 , 0.89 , 1.286)	(0.714 , 1.11 , 1.8)	(0.556 , 0.881 , 1.286)	(0.556 , 0.81 , 1.8)
6	(0.556 , 0.872 , 1.4)	(1 , 1.122 , 1.4)	(0.714 , 0.89 , 1)	(0.556 , 0.819 , 1)
7	(0.556 , 0.827 , 1.8)	(0.714 , 1.031 , 1.4)	(0.714 , 0.818 , 1)	(0.556 , 0.753 , 1.286)
8	(0.556 , 0.929 , 1.4)	(0.714 , 1.195 , 1.8)	(0.714 , 0.948 , 1.286)	(0.556 , 0.872 , 1.4)
9	(1 , 1 , 1)	(0.714 , 1.246 , 1.8)	(0.556 , 0.989 , 1.286)	(0.714 , 0.91 , 1.4)
10	(0.556 , 0.777 , 1.4)	(1 , 1 , 1)	(0.714 , 0.793 , 1)	(0.556 , 0.73 , 1)
11	(0.778 , 1.01 , 1.8)	(1 , 1.26 , 1.4)	(1 , 1 , 1)	(0.778 , 0.919 , 1.4)
12	(0.714 , 1.098 , 1.4)	(1 , 1.369 , 1.8)	(0.714 , 1.087 , 1.286)	(1 , 1 , 1)
13	(0.556 , 0.958 , 1.8)	(1 , 1.195 , 1.4)	(0.714 , 0.948 , 1.286)	(0.556 , 0.872 , 1.286)
14	(0.778 , 1 , 1.286)	(0.714 , 1.246 , 1.8)	(0.556 , 0.989 , 1.286)	(0.714 , 0.91 , 1.4)
15	(1 , 1.031 , 1.286)	(0.714 , 1.286 , 1.8)	(0.556 , 1.021 , 1.286)	(0.714 , 0.939 , 1.4)
16	(0.556 , 1.021 , 1.4)	(0.714 , 1.272 , 1.8)	(0.714, 1.01 , 1.286)	(0.556 , 0.929 , 1.8)

Continuation of the tab.9.

NO.	13	14	15	16
1	(1 , 1.158 , 1.8)	(0.778 , 1.11 , 1.8)	(0.778 , 1.076 , 1.8)	(0.778 , 1.087 , 1.8)
2	(0.778 , 1.087 , 1.8)	(0.778 , 1.043 , 1.8)	(0.778 , 1.01 , 1.8)	(0.778 , 1.021 , 1.4)
3	(0.556 , 0.929 , 1.4)	(0.556 , 0.891 , 1.4)	(0.556 , 0.863 , 1.4)	(0.556 , 0.872 , 1.8)
4	(0.556 , 1.064 , 1.8)	(0.556 , 1.021 , 1.8)	(0.556 , 0.989 , 1.8)	(0.556 , 1 , 1.8)
5	(0.556 , 0.929 , 1.8)	(0.556 , 0.891 , 1.286)	(0.556 , 0.863 , 1.286)	(0.556 , 0.872 , 1.8)
6	(0.714 , 0.939 , 1.4)	(0.714 , 0.9 , 1.4)	(0.714 , 0.872 , 1.4)	(0.556 , 0.882 , 1.4)
7	(0.556 , 0.863 , 1.4)	(0.556 , 0.827 , 1.8)	(0.556 , 0.836 , 1.8)	(0.556 , 0.811 , 1.286)
8	(0.556 , 1 , 1.8)	(0.556 , 0.958 , 1.4)	(0.556 , 0.929 , 1.4)	(0.556 , 0.939 , 1.8)
9	(0.556 , 1.043 , 1.8)	(0.778 , 1 , 1.286)	(0.778 , 0.969 , 1)	(0.714 , 0.979 , 1.8)
10	(0.714 , 0.836 , 1)	(0.556 , 0.802 , 1.4)	(0.556 , 0.777 , 1.4)	(0.556 , 0.786 , 1.4)
11	(0.778 , 1.054 , 1.4)	(0.778 , 1.01 , 1.8)	(0.778 , 0.979 , 1.8)	(0.778 , 0.99 , 1.4)
12	(0.778 , 1.146 , 1.8)	(0.714 , 1.098 , 1.4)	(0.714 , 1.064 , 1.4)	(0.556 , 1.076 , 1.8)
13	(1 , 1 , 1)	(0.714 , 0.958 , 1.8)	(0.556 , 0.929 , 1.8)	(0.556 , 0.939 , 1.8)
14	(0.556 , 1.043 , 1.4)	(1 , 1 , 1)	(0.778 , 0.989 , 1.286)	(0.714 , 0.979 , 1.8)
15	(0.556 , 1.076 , 1.8)	(0.778 , 1.032 , 1.286)	(1 , 1 , 1)	(0.714 , 1.01 , 1.8)
16	(0.556 , 1.065 , 1.8)	(0.556 , 1.021 , 1.4)	(0.556 , 0.989 , 1.4)	(1 , 1 , 1)

Continuation of the tab.9.

Then with the calculation of equation (7), (8), (9), and (10) will have the parameters' relative weight.

Tab.10. Results of equation (9), (10)

NO.	$(\tilde{Z})$	$(\tilde{Z}_i)$
1	(0.104 , 8.444 , 3443.693)	**(0.868 , 1.142 , 1.663)**
2	(0.0382 , 3.064, 1259.94)	**(0.815 , 1.072 , 1.562)**
3	(0.000317 , 0.259 , 500.198)	**(0.604 , 0.919 , 1.474)**
4	(0.000317 , 2.301 , 2460.327)	**(0.604 , 1.053 , 1.629)**
5	(0.000317 , 0.259 , 542.641)	**(0.604 , 0.919 , 1.482)**
6	(0.00121 , 0.297 , 110.708)	**(0.657 , 0.926 , 1.342)**
7	(0.000247 , 0.0832 , 130.719)	**(0.595 , 0.856 , 1.356)**
8	(0.000672 , 0.78 , 544.66)	**(0.633 , 0.984 , 1.482)**
9	(0.002 , 1.649 , 459.468)	**(0.678 , 1.031 , 1.466)**
10	(0.000408 , 0.0468 , 26.564)	**(0.614 , 0.825 , 1.22)**
11	(0.04917 ,1.956 , 592.943)	**(0.828 , 1.043 , 1.49)**
12	(0.005968 , 7.131 , 1157.602)	**(0.726 , 1.13 , 1.554)**
13	(0.000942 , 0.84 , 826.859)	**(0.647 , 0.989 , 1.521)**
14	(0.00184 , 1.613 , 590.876)	**(0.674 , 1.03 , 1.49)**
15	(0.002369 , 2.726 , 759.697)	**(0.685 , 1.064 , 1.513)**
16	(0.00057 , 2.206 , 1157.602)	**(0.626 , 1.05 , 1.554)**
-	**...** $\oplus\tilde{Z}_{16}\tilde{Z}_1\oplus$	**(10.858 , 16.033 , 23.798)**
-	$(\tilde{Z}_1\oplus\ldots\oplus\tilde{Z}_{16})^{-1}$	**(0.042 , 0.0624 , 0.092)**

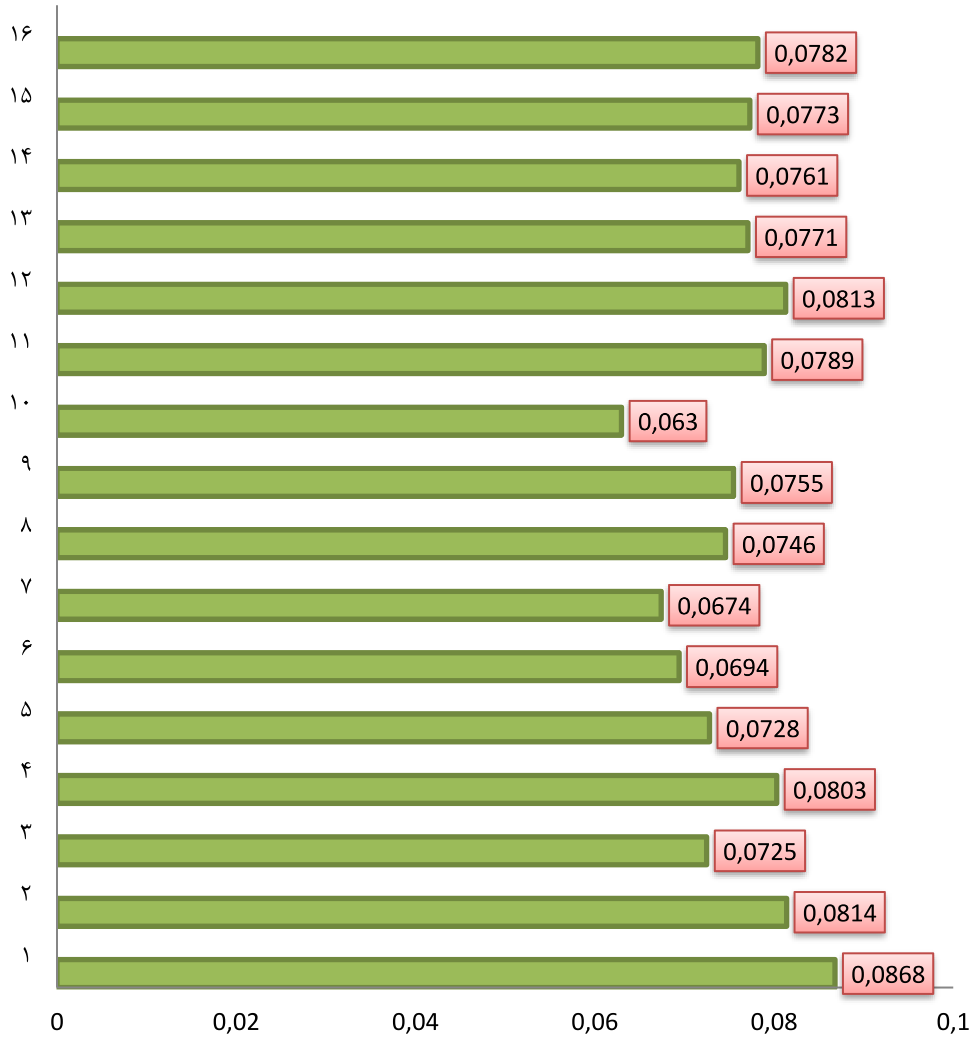
Table (11) and Figure (2) present the prioritization of components based on weights obtained from the FDAHP approach.

Tab.11. Fuzzy and Defuzzified weight of the components

Component No.	$(\tilde{W}_i)$	Defuzzified weight
1	(0.153, 0.071, 0.0364)	0.0868
2	(0.144, 0.066, 0.0342)	0.0814

3	(0.135, 0.0573, 0.0253)	0.0725
4	(0.15, 0.0657, 0.0253)	0.0803
5	(0.136, 0.0573, 0.0253)	0.0728
6	(0.123, 0.0578, 0.0275)	0.0694
7	(0.124, 0.0534, 0.025)	0.0674
8	(0.136, 0.0614, 0.0265)	0.0746
9	(0.134, 0.0643, 0.0284)	0.0755
10	(0.112, 0.0514, 0.0258)	0.063
11	(0.137, 0.065, 0.0348)	0.0789
12	(0.143, 0.0705, 0.0304)	0.0813
13	(0.14, 0.0617, 0.0271)	0.0771
14	(0.137, 0.063, 0.0283)	0.0761
15	(0.139, 0.0642, 0.0287)	0.0773
16	(0.143, 0.0655, 0.0262)	0.0782

Fig.2. Prioritization of components based on FDAHP results



Therefore, the list of components is as follows in order of priority:
1. Wrong sequence and definition of prerequisite relationships (Component 1).
2. Prioritization instructions and lack of review the priority in allocating limited resources to project components (Component 2).
3. Lack of timely allocation of financial resources (Component 12).
4. Weakness of the project manager: Poor management technical and managerial knowledge and lack of proper policy determination (Component 4).
5. Long duration of supply of equipment and facilities and lack of coordination with suppliers (Component 11).
6. Type of contract or accepting the lowest rate in the tender offers (Component 16).
7. Lack of use of a project management standard (Component 15).
8. Long duration of administrative bureaucracy (Component 13).
9. Increased inflation (Component 14).
10. Method of holding tender offers and selection of subcontractors (Component 9).
11. Inadequate speed and quality of information transfer and approval of documents and technical specifications (Component 8).
12. Lack of coordination and effective relations between the engineering and executive departments of the project (Component 5).
13. Incompatibility of a workforce's quality with his/her assigned activity - lack of skilled labour (Component 3).
14. Delays due to changes in workload and staff scope (Component)

15. Insufficiency of contractual issues and insufficient transparency in defining the job description and scope of the parties' authority (Component 7).
16. The problems for clearance and customs formalities (Component 10).

5. Conclusion

According to the obtained weights and prioritization, the most significant impact on the delay of the ICT projects belonged to these three components:
- Wrong sequence and definition of prerequisite relationships.
- Prioritization instructions and lack of review the priority in allocating limited resources to project components.
- Lack of timely allocation of financial resources.

In contrast, the components clearance problems and customs formalities, insufficiency of contractual issues and insufficient transparency in defining the job description and scope of the parties' authority, delays due to changes in workload and staff capacity and, increased inflation achieved the lowest weights. It may express two essential points:
1. Delays or possibly failure of ICT projects often result from internal factors than external aspects of the organization.
2. What delays ICT projects is not a change in workload or a shortage of ICT-related workforce. Instead, it lacks knowledge in project management, prioritization processes, resource allocation, and project control.

Therefore, the human resources departments of petroleum production companies consider this issue in developing staff training programs to eliminate the identified training weakness. In addition to the two components that achieved the highest weights and important priority, it is suggest that definition relationships processes and preferences between them in the ICT projects of the petroleum companies must evaluate and review for identifying their weaknesses.

Another critical point is that in this research, the interviewees did not have the same level of knowledge and background; therefore, it is suggest that future analyses, experts are graded by different scientific methods before conducting research processes and steps. So that weights can be considered for their answers accordingly.

As mentioned earlier, according to the research gap on this issue in the oil and gas production industry, each of the components that have gained the highest priority can be the target for future researches. The results of this research are based on factors and characteristics that experts and specialists have experienced in the oil and gas industry. Undoubtedly, other factors may appear in the future, which have not been investigated in this study. Therefore, it is recommended that the entire oil and gas industry make plans to repeat such research to review and update the results.

The biggest problem we faced during the research process was the research gap in Iran, especially in the oil and gas industry. It has led to many unknown reasons for the delays in ICT projects. On the other hand, the specialists and experts were not concentrated in the same sections and departments. Also, the Delphi method requires spending a lot of time for multiple visits and interviews of experts, so it was possible that the experts would get tired of continuing to work. In addition, the presence of Covid-19 made the interview conditions much more difficult.

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