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Identification and Evaluation of the Risks of Information and Communication Technology Projects

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Abstract. A few minutes of risk management on even the smallest project gets a good return for the effort. We just need to scale risk management, so the payback is proportional to the cost. In this era, because of the quick technological changes, globalization and the development of enterprises activities, possessing of an efficient information system is necessary to attain a competitive advantage. This article shows the importance of risk management. Using risk recognition methods, the effective risks of the projects of information and communication technology in Fars Telecommunication Company are determined and qualified by Failure Mode Effect Analysis (FMEA) algorithm. For this purpose, based on FMEA model these factors" occurrence, intensity and indication" indices have been considered. After providing the guide table for assigning numbers between one and ten for these factors, the experts assign a number to each risk factor and then the model categorizes the risks according to their priority numbers. Another method of evaluating the risks is Topsis from Multiple Attribute Decision Making (MADM) model which help us to categorize the risks. In some cases the results from FMEA and TOPSIS models have some differences. For improving validity of the research, the non-parametric correlation test have been done, the result shows that there is a high correlation between FMEA and TOPSIS models.

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1. Introduction

To assemble teamwork, it would be included Communication, Conflict resolving, and leadership. Ironically, those are not considered in team building in the organizations. Actually, this is the time to manage the knowledge of project, according to scientific methods (Ali and Hasani, 2006).

Because of unpredicted risks, fulfillment of projects encounters to the plenty of delays which declines the influential time period of project and make them detrimental. Sometimes, changes stem from time suspension and restarting of the projects. As though, the nature of activities is the same. But, in most cases, the project faces to time delay, besides, the nature of activities subject to changes. The risk factors are being identified and diminished their impacts by risk management (Malekzadeh and Sakhtianchi, 2006).

An enterprise would be able to attain to competitive advantage by dint of its opportunities exploitation. The cardinal factor in changing is decision making process, which should be according to the exhaustive information with a high level of outputs certainty. However, in the real world, decision making process builds on deficient information with a low level of outputs certainty that results in the risk and precariousness (Hue and Boading, 2007). Therefore, risk is the inherent part of project management (Malekzadeh and Sakhtianchi, 2006).

There are some methods to control the risks which developed by researchers. In recent decades, Chapman and the other scholars, Stephan and Kerzner (1983), have presented a systematic approach to design, schedule, project control, and risk analysis. The risks of any project depend on some exclusive factors such as project realm, activities field, users, internalities, and externalities which are different from other projects (Hargraves, 2005).

Accordingly, wielding of Risk Management Information System (RMIS) would be helpful to the risks identification (Ameli et al., 2005).
As Zwikael and Sadeh (2006) said: The optimization of the schemes of the project can conduct the projects [with a high level of risks] forward to more achievement. Consequently, they suggest some terms to discover the amount of high level of risk impact on planning quality. In this view, projects with greater schemes should have four dimensions, included: Comprehensive planning, Total costs, Technical performance, and Costumer, s satisfaction which make the projects improved (Zwikae and Sadeh, 2006).

Risk & Importance of the project risk management

The expressive changes, in the commerce and the routine life, named Risk. The risk describes any situation that is not adapted to its normal criterion.
An event beyond control which may lead to an inevitable, and undesirable consequences, is called the risk of a project. Such a project causes the following consequences:

1- The costs of project will be increased above the budget.
2- The completion of project will be longer than expected.
3- The project may not be completed as expected, (cost, quality, etc).
4- The process project completion may not fit the standards.
5- Loss of credibility and good will of customs for further reference (Hargraves , 2005).

There are some definitions for the risks of project. One of them is the amount of facing to unpredicted events and its backwashes which can damage the aims of the project (Ali and Hasani, 2006). The risks and uncertainties are two important factors which would be harmful to any section of the project during implementation. As a whole, a kind of risk can amplify the other kind of risks, effect. The risk management is an intransitive requirement to realize the goals of project (Mohtashami et al., 2010).

Risk management of the project

Searching for the uncertainties and preventing them, is one of the main

ideas in the risk management. The premier section [that creativity is the basic element in it] is the risk identification. The effective design and the development of the risk response need a new idea. Although, the risk identification is not sufficient solely, and if an adequate response is not shown, the depth of the risk would be stayed unchangeable. "Doing something repetitive and deferent outcome expectancy is madness" Einstein said (Hilson, 2005).

How to plan for project risk management

1- Determine the level of risk assessment for your project.
2- Incorporate risk management activities into the project schedule.
3- Make risk management agenda item for regularly scheduled project meetings.
4- Communicate the importance of risk management to the entire project team.
5- Establish the expectation that risk will be managed, documented and reported (Washington state department of transportation, 2010).

The risk assessment process named risk analysis. But using risk analysis in order to make a strategic decision for decreasing the risk or risk reformation, named risk management (Galway, 2004).

Firelli held a seven phase's view in the risk management:

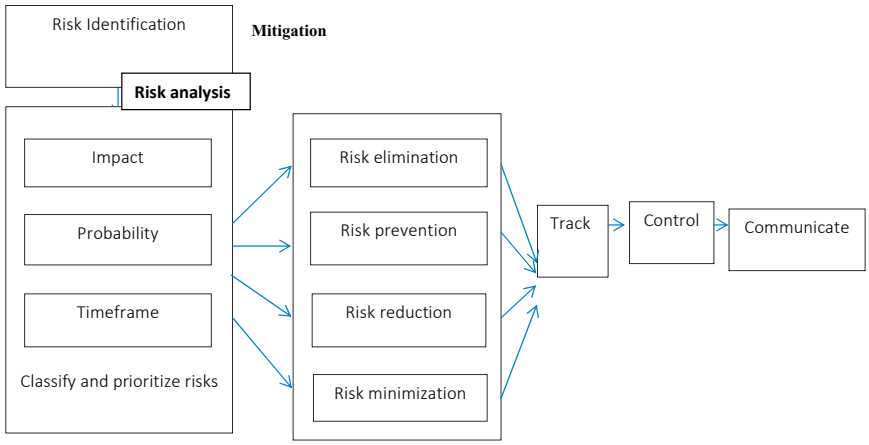
1- Risk factors identification.
2- The probability estimation of the risk occurrence and the amount of its effect.
3- Suggesting solutions to modify the identification risks.
4- Regulating on the risk factors.
5- Offering a probability plan.
6- Managing the crisis.
7- Rehabilitation of the organization after crisis (Project management group, 2010).

The primary process of the risk management project

The risk management included a process with several phases like the rate of vulnerability to formulize the risk decreasing plan as follows:

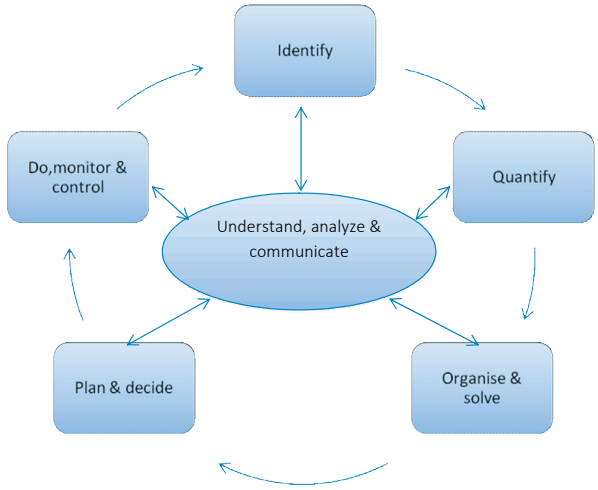
1. Risk management planning
2. Risk identification
3. Qualitative risk analysis
4. Quantitative risk analysis
5. Risk response planning
6. Risk monitoring and control (Pezzullo and De Filippo, 2009).

Diagram 1: Risk management process (Lawrence, 2000).



As shown in Diagram 1, the Risk management process

Diagram 2: The cycle of risk management project (Harrop, 2005)



As shown in Diagram 2, the cycle of risk management project (Harrop, 2005)

Risk identification process

Risk identification process contains the determination and regulation of the risks which have effect on the project and documentation of their characteristics.

The participants in the risk identification are the team of project, board members, some experts from the other departments of the executive organization related to the project subject, risk management team, shareholders, customers, the ultimate consumers, other project managers and external experts (Harrop, 2005).

Risk identification methods

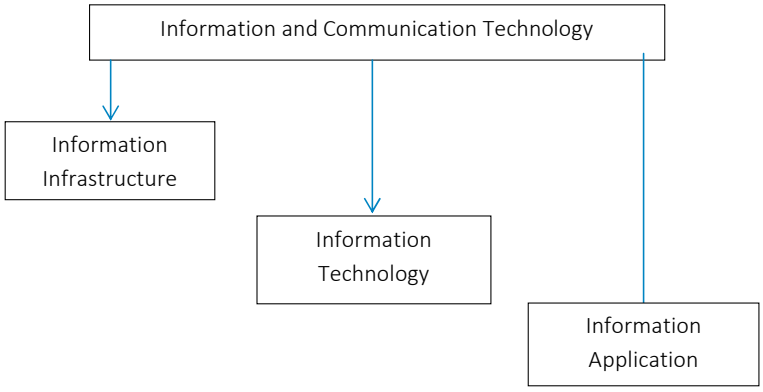
1. Revising of documentaries.
2. Gathering information techniques such as brain storming, Delphi, interview and SWOT techniques.
3. Checklists based on previous information and experiences from the other projects and the other information resources.
4. Hypotheses analysis.
5. Graphic techniques (Ahmadpor and Agharezaiee , 2005).

Information and communication Technology projects

Information and communication Technology are categorized in three essential parts as follows:

1. Information Infrastructure
2. Information Technology
3. Information Application (Soltanzadeh, 2010).

Diagram 3: Infrastructure of Information and Communication Technology



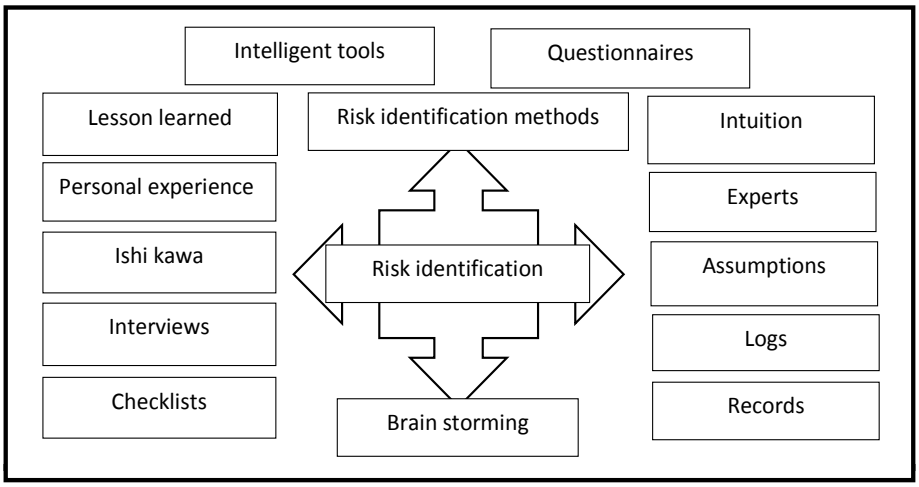
As shown in Diagram3, Infrastructure of Information and Communication Technology

Materials and Methods

Introducing some effective risks in ICT

Parallel to research implementation, at first, to recognize some commanding risks, some interviews were done with managing director, board members, managers and all of the experts related to ICT projects.

Diagram 4: Risk identification methods (Hargraves, 2005)



As shown in Diagram 4, Risk identification methods

As well as other methods like brain storming technique, checklist setting up, internet surfing, individual experiences, and past documentary revising. Finally, about over 140 risk types identified, that several items were combined to each other. According to categorization of the process development project institute, the risks classified as follows:

1. Technical(design)risks
2. External risks
3. Environmental risks
4.Organizational risks
5. Project management risks

Table 1: The influential risks on ICT projects

The influential risks on ICT projects		
1	Technical risks	Erroneousness in the methods & environment of analysis correctness
2		Plan modification because of mistake
3		Not to use of project control soft wares in implementation
4		Lack of experts & sufficient information about mobilization and systems
5		Incorrect hypotheses in the type of technique, planning and designing section
6	External risks	Insecurity of the information in the projects
7		Inattentiveness to the rate of technological changing
8		International boycotts
9		Project fulfillment with inappropriate quality
10		Changing in the will of entrepreneurs and more attention to economical justification
11	Environmental risks	No coordination between utilities centers and not to give organizational permission
12		Popular damages and prevention like material stealing…..
13		Disasters and unpredicted events
14		Environmental analysis or requiring new algorithms
15		Missing of strategic elements in the important section of project
16	Organizational risks	Inattentiveness to requirement infrastructure before project planning
17		Lack of an incentive system to consummation of the project
18		Wrong selection about consultants, contractors and executers
19		Long drawn out of the tenders
20		Damage impact of mobilization and lack of spare parts
21		Lack of risk management team and not to note to changes
22		Incorrect estimation about time period of the project
23		Individual pulling strings and a matter of opinion behaviors
24		Lack of suitable timetable between planning and execution
25		Inaccurate estimation of the costs
26		Ill definition of the goal and project quality
27	The risk of Project management	The need for formal consultants and experts in the field of risk management
28		Poor performance and lack of support from senior manager
29		Lack of precise control over personnel 's function
30		Appearing of the chronic trouble in the systematic project management
31		Incorrect management in human resources management and experts failure
32		Effective errors attack and unknown and unpredicted factors in project
33		Poor management and performance of the project

as shown in table 1, The influential risks on ICT projects

Quantitative risk analysis

After risk identification [in projects], one of the most important paces, is quantitative the probability of a risk attack and its consequences on the project or the amount of assets. The quantization is beginning with the following steps:

1. Determination of those fields of the risk which guarantees appropriate response and identifies restricted resources.
2. Determination of those areas of the risk which should take into account according to the risk prioritization.

The quantification of the risk analysis process intends to analyze the probability of events and their effects on the project objectives. Besides, it analyzes total amount of the risk of project in order to:

1. Determination of likelihood of achieving one of the certain project objectives.
2. Calculation and evaluation the amount of risk which the project is subjected to, as well as costs estimation and the time period that is needed.
3. Identification of the risks which needs more addressing and attention.
4. Identification those series of realistic objectives which are attainable in terms of the costs, scheduling, and the project realm.

Two of the most popular techniques, are interview and gathering information from the experts. First step in quantitative calculation of the risk is to carry out some interviews with shareholders and the specialists related to the project subject in Fars Telecommunication Company. The type of information depends on the type of likelihood distribution that will be used in the future. The participants in this research included managing director, board members and all of the senior managers and experts who are specialists in the field of ICT projects. All of respondents were 70 persons that 55 persons were male and 15 persons were female and their average educations were bachelor and the other specifications of them have been recorded in the following chart:

Table 2: the average of age, education and servants, age

Gender	Respondents	The average Age	The average education	The average servant^{s}, age
Male	55	42	Bachelor	24
Female	15	28	Bachelor	8

As shown in Table 2, the average of age, education and servants, age

After risk identification, in the next step, the rate of importance of these risks should be assessed. The method which used was 5 switches Likert scale technique. Finally the outputs of the Likert scale were evaluated by TOPSIS method based on multi criteria decision making method which 33 types of risks were ranked.

Topsis method is most used approaches in Multiple Attribute Decision Making to prioritization and ranking criteria. This formula and process is:

a) $r_{ij} = \dfrac{r_{ij}}{\left(\sum_{i-1}^{m} r_{ij}\right)^{\frac{1}{2}}} \quad , \quad (j = 1,..., n)$

b) $V = N_D \times W_{n*n}$

c) $= A^{-} = \{(\min_i V_{ij} \,|\, j \in J_1),\ (\max_i V_{ij} \,|\, j \in J_2) \,|\, i = 1, 2, ..., m\}$

d) $= A^{+} = \{(\max_i V_{ij} \,|\, j \in J_1),\ (\min V_{ij} \,|\, j \in J_2) \,|\, i = 1, 2, ..., n\}$

e) $A_i^{-} = \{V_1^{-}, V_2^{-}, ..., V_n^{-}\} \quad A_i^{+} = \{V_1^{+}, V_2^{+}, ..., V_n^{+}\}$

f) $J_2 = \{1, 2, ..., n \,|\, \}$, $J_1 = \{1, 2, ..., n \,|\, \}$

g) $d_i^{-} = \{\sum_{j=1}^{n} (V_{ij} - V_j^{-})^2\}^{\frac{1}{2}}$, $(i = 1, 2, ..., m)$, $d_i^{+} = \{\sum_{j=1}^{n} (V_{ij} - V_j^{+})^2\}^{\frac{1}{2}}$, $(i = 1, 2, ..., m)$

h) $C_i = \dfrac{d_i^{-}}{(d_i^{-} + d_i^{+})} \quad , \quad (i = 1, 2, ..., n)$ (Azar and Rajabzadeh, 2009).

Table 3: Results of the ranking of risks by TOPSIS method

Alternatives	*Ci*	*di+*	*di-*
A1	1	0	0.078
A8	0.972	0.002	0.075
A27	0.95	0.004	0.074
A6	0.816	0.014	0.063
A4	0.809	0.015	0.063
A9,A18	0.78	0.017	0.061
A7	0.759	0.019	0.059
A33	0.752	0.019	0.058
A31	0.745	0.02	0.058
A32	0.702	0.023	0.055
A12	0.695	0.024	0.054
A5	0.674	0.025	0.054
A30,A26	0.645	0.028	0.05
A14	0.638	0.028	0.05
A22,A11	0.624	0.029	0.048
A10	0.582	0.033	0.045
A13	0.546	0.035	0.042
A23	0.518	0.037	0.04
A19	0.489	0.04	0.038
A24	0.461	0.042	0.036
A3	0.433	0.044	0.034
A29	0.411	0.046	0.032
A17	0.383	0.048	0.03
A2	0.355	0.05	0.028
A28	0.326	0.052	0.025
A20	0.291	0.055	0.023
A16	0.255	0.058	0.02
A21	0.227	0.06	0.018
A25,A15	0.191	0.063	0.015

As shown in table 3, Results of the ranking of risks by TOPSIS method

Failure Mode Effect Analysis (FMEA) Method

The second method for risk evaluation is Failure Mode Effect Analysis (FMEA) algorithm. FMEA is a Systematic method for identifying and preventing the problem in process and product. This method Prevents imperfections, enhance safety, and increase customer satisfaction focus. Products are flawless and competitive market Potential failure modes in the system, process, product, and service to identify and prioritize. It Measures risks to eliminate or reduce them. Analysis performed with the aim of providing a complete reference for future problems, patented.

RPN: Risk Priority Number

For completing the FMEA algorithm the have to answer to these question. Under which Conditions the product can not meet the design goals and objectives or process Requirement is not met? (Identifying risks and influencing factors) What failure modes will affect the customer? (Number of Indication)(a b) How hard is the failure? (Number of intensity) c)What is the probability of failure? (Number of occurrence)

For this purpose, based on FMEA model these factors" occurrence, intensity and indication" indices have been considered. After providing the guide table for assigning numbers between one and ten for these factors, the experts assign a number to each risk factor and then the model categorizes the risks according to the Risks Priority Numbers (Beikzadeh et al., 2004).

Table 4: Final results of the average product of three factors: the occurrence, intensity and indication

The risks		RPN
1	Erroneousness in the methods & environment of analysis correctness	150.002
2	Plan modification because of mistake	197.554
3	Not to use of project control soft wares in implementation	234.451
4	Lack of experts & sufficient information about mobilization and systems	353.246
5	Incorrect hypotheses in the type of technique, planning and designing section	198.226
6	Insecurity of the information in the projects	180.229
7	Inattentiveness to the rate of technological changing	169.888
8	International boycotts	367.224
9	Project fulfillment with inappropriate quality	190.215
10	Changing in the will of entrepreneurs and more attention to economical justification	180.223
11	No coordination between utilities centers and not to give organizational permission	312.228
12	Popular damages and prevention like material stealing…..	287.69
13	Disasters and unpredicted events	158.554
14	Environmental analysis or requiring new algorithms	197.552
15	Missing of strategic elements in the important section of project	150.876
16	Inattentiveness to requirement infrastructure before project planning	210.71
17	Lack of an incentive system to consummation of the project	192.457
18	Wrong selection about consultants, contractors and executers	190.854
19	Long drawn out of the tenders	300.003
20	Damage impact of mobilization and lack of spare parts	310.536
21	Lack of risk management teams and not to note to changes	271.003
22	Incorrect estimation about time period of the project	389.225
23	Individual pulling strings and a matter of opinion behaviors	155.003
24	Lack of appropriate timetable between planning and execution	298.659
25	Inaccurate estimation of the costs	180.229
26	Ill definition of the objectives and project quality	169.001
27	The need for formal consultants and experts in the field of risk management	190.001
28	Poor performance and lack of support from senior manager	155.653
29	Lack of precise control over personnel 's function	202.965
30	Appearing of the chronic trouble in systematic project management	211.224
31	Incorrect management in human resources management and experts failure	264.559
32	Effective errors attack and unknown and unpredicted factors in project	163.456
33	Poor management and performance of the project	290.459

As shown in Table 4, Final results of the average product of three factors: the occurrence, intensity and indication.

Table 5: Mean and Std. Deviation of any risk with SPSS software

	N	Mean	Std. Deviation	Std. Error Mean
WW1	51	1.7186E2	106.26547	14.88014
WW2	51	1.2595E2	133.48789	18.69204
WW3	51	1.6589E2	153.82009	21.53912
WW4	51	2.0261E2	127.33757	17.83083
WW5	51	2.6589E2	257.60011	36.07123
WW6	51	3.1427E2	233.74239	32.73048
WW7	51	1.7223E2	160.83044	22.52077
WW8	51	2.2590E2	207.77094	29.09375
WW9	51	1.4343E2	138.24000	19.35747
WW10	51	1.9243E2	115.35111	16.15239
WW11	51	2.3109E2	220.77291	30.91439
WW12	51	2.0550E2	180.48261	25.27262
WW13	51	1.3223E2	121.90940	17.07073
WW14	51	1.2434E2	129.88413	18.18742
WW15	51	1.6864E2	131.88526	18.6763
WW16	51	83.7623E2	71.43275	10.00259
WW17	51	1.3238E2	107.65085	15.22413
WW18	51	1.6925E2	160.62228	22.49162
WW19	51	1.2271E2	106.67790	14.93789
WW20	51	1.8659E2	152.55047	21.36134
WW21	51	1.3627E2	107.50537	15.05376
WW22	51	1.5238E2	118.16598	16.54655
WW23	51	1.8260E2	160.89889	22.53035
WW24	51	1.6763E2	175.12323	24.76616
WW25	51	81.4075E2	57.72077	8.16295
WW26	51	1.6566E2	150.32464	21.04966
WW27	51	1.2739E2	102.89032	14.40753
WW28	51	1.7965E2	151.27837	21.18321
WW29	51	1.5411E2	112.00562	15.68392
WW30	51	1.3744E2	112.74830	15.78792
WW31	51	1.8317E2	181.95922	25.47939
WW32	51	2.0664E2	301.72920	42.25054
WW33	51	1.8005E2	128.52248	17.99675

as shown in Table 5, Mean and Std. Deviation of any risk with SPSS software

After those process, it is the time to compare both methods and their priority.

Table 6: Comparison of the risks ranking results by TOPSIS & RPN

Risk	*TOPSIS*	*Risk*	*RPN*
A1	1	**A1**	389.2
A8	0.972	**A8**	367.2
A27	0.95	**A27**	353.2
A6	0.816	**A6**	312.2
A4	0.809	**A4**	310.5
A9	0.78	**A9**	300
A18	0.78	**A18**	298.7
A7	0.759	**A7**	290.5
A33	0.752	**A33**	287.7
A31	0.745	**A31**	271
A32	0.702	**A32**	264.6
A12	0.695	**A12**	234.5
A5	0.674	**A5**	228.8
A30	0.645	**A30**	211.2
A26	0.645	**A26**	210.9
A14	0.638	**A14**	203
A22	0.624	**A22**	198.2
A11	0.624	**A11**	197.6
A10	0.582	**A10**	197.6
A13	0.546	**A13**	192.5
A23	0.518	**A23**	190.9
A19	0.489	**A19**	190.2
A24	0.461	**A24**	190
A3	0.433	**A3**	180.2
A29	0.411	**A29**	180.2
A17	0.383	**A17**	169.9
A2	0.355	**A2**	169
A28	0.326	**A28**	163.5
A20	0.291	**A20**	158.6
A16	0.255	**A16**	155.7
A21	0.227	**A21**	155
A25	0.191	**A25**	150.9
A15	0.191	**A15**	150

As shown in Table 6, Comparison of the risks ranking results by TOPSIS & RPN

Result

Correlation coefficient between TOPSIS and RPN

Surface structure of the project has a higher probability of error, and damages, distractions in comparison with the deep structure of the project. So, the risk management comes into existence for improving the quality of decisions, systematizing the project, and considering the each phases of the project more important (Seung et al., 2007). A successful manager must use all of the facilities and tools for improving the project, and controlling the program and the cost (Lawrence, 2000).
In focus to the TOPSIS method classifies criteria by Euclidean vector and calculates distances between the best and the worst criteria by the best and the worst responses, therefore, because of some errors attack in the questionnaire responses, the ranking was done again by FMEA and RPN risk methods. Accordingly, there was rational to calculate their correlation coefficient by Pearson and Spearman methods. In terms of ranking, in Pearson method, the correlation coefficient was there was an optimum degree of correlation that can cite to.

Table 7: The results of the Spearman correlation coefficient

Nonparametric Correlation		RPN	TOPSIS
Spearman's rho RPN	Correlation Coefficient	1.000	0.863**
	Sig.(2-tailed)	.	0.000
	N	33	33
TOPSIS	Correlation Coefficient	0.863	1.000
	Sig.(2-tailed)	0.000	.
	N	33	33

As shown in Table 7, The results of the Spearman correlation coefficient

Table 8: The results of the Pearson correlation coefficient

Nonparametric Correlation		RPN	TOPSIS
RPN	Pearson Correlation	1.000	0.787*
	Sig.(2-tailed)	.	0.000
	N	33	33
TOPSIS	Pearson Correlation	0.787	1.000
	Sig.(2-tailed)	0.000	.
	N	33	33

As shown in Table 8, The results of the Pearson correlation coefficient

Conclusion and discussion

The risk management is an actuality and we need it to encounter the risks, which introduced in this article. For the most important decision making, it needs to identify the internalities and externalities of the organizations and projects. In this research, it was concentrated on the negative aspects of the risks in terms of its detrimental effects on the results of the projects. The most important section in the addressing of the project, around paying attention to the risk management field, is the risk identification which introduces required instruments for that. According to the expansion of the project fields, during spending project studies process, some risks may not be paid attention to. However, the organizations are not able to plan all the risks. As this token, it is necessary to prioritize and quantify the risks.

One of the most popular methods to quantify the risk, have been FMEA and taking data average. This method is too simple and rational, but if the product of the occurrence and intensity of the risk doubled or more, it can not be distinguished from the risks and their ranking. As well as, this method inserts an equal scale of the occurrence intensity and the other factors in the calculation.

In the risks quantification method, by TOPSIS method, the expressed problems are covered. For this, The TOPSIS method is accurately able to rank the risks. The outputs of the TOPSIS and FMEA methods are close to each other because of their algorithmic nature in the risks ranking. The opportunity and the uncertainty are close to each other .When a risk happens, it can convert to the opportunity and the opportunity associated with the risk can exit the project from the mainstream. A more complete recognition of this fact yields a more precise plan. And we can finish the project successfully with less deviation, and more convenience related to the given time, cost, and other resources.

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