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Designing an integrated model based on the indicators Quality and Earned Value for risk management in Information Technology Projects

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Abstract

There are two effective factors on Information Technology (IT) projects risk including quality and earned value so that by controlling these two factors and their increased level in IT projects, the corresponding risk can be decreased. Therefore in present study, an integrated model was designed based on quality and earned value indicators for risk management in IT projects on a new and efficient approach. The proposed algorithm included the steps such as preparing a list of several indicators of quality and earned value through experts and professionals' comments and literature review, integrating the indicators quality and earned value and creating new indicators, modeling Fuzzy Delphi integrated approach and multivariate regression to determine the significant and effective indicators on projects risk, modeling network analysis process to determine efficacy of the significant and effective indicators on projects risk. The results indicated that quality indicators, earned value indicators and integrated quality and earned value indicators are effective on IT projects with different efficacies. Three key effective indicators on risk management of IT projects include experienced, knowledgeable individuals with high and updated skills in order to enhance project scheduling performance, suitable governance by the responsible, accountable and executive people after the project in order to decrease deviation of schedule and get a specific plan from beginning to end of the project to reduce nonconformities regarding the schedule.

Keywords: Risk management, quality, earned value, Fuzzy Delphi, Network analysis process

1. INTODUCTION

In the today world that science and technology with world-wide growth and development are considered as a major factor in the process of economic, social and cultural growth and development of human societies, training institutions gained a very important role. Increasingly attention and interest in type and development of education is undeniable necessity associated to the fast rate of changes in various areas of economic and social activities of communities.The culture of a nation is all the assets of. Our country has always been a land of culture and art, Among the different projects, IT and software development projects are of high importance in present age due to being an inseparable part of current organizations. However, it is noteworthy to consider that failure rate of IT projects has been 40-50% in the recent 15-20 years researches [1] High failure rate of IT projects can be due to managers' inattention on risks assessment and control in IT projects. To succeed in risk management of IT projects, essential success factors in risk management are required to be identified. Also for identification of essential success factors in risk management, some actions should be carried out including identification of the risks with high probability and loss resulting from the occurrence and the corresponding coping strategies as well as recognition of fundamental risks so that the projects risk can be decreased by these three factors [2] Quality and earned value are two effective factors on risk of IT projects so that by controlling these two factors and increasing their level in IT projects, the corresponding risk can be decreased [3].

Quality of a product of a service is what a customer requires. If a delivered product of service has a very high quality at some special aspects which are not demanded by the customers, it is just a paid cost which has made no value added. At a modern glance on quality it can be

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addressed that quality is a loss which is arisen from arrival moment of the product to market. This definition does not initially seem to be clear but a product can make value added when it can meet the customers' demands. In a production process, quality gets against dispersion so that in order to reach a high quality process, the process dispersion should be decreased as much as possible [4] Qualitative equipment in an organization is a basic requirement to enhance resources in order to reach a higher level of productivity and efficiency. However, risk management of a project and decision making in an organization are associated with actual and potential capacities, employees' skills development and the ability to use new resources in an organization. The integration of quality management and risk management in a project owns plenty of impacts on competitive position enhancement and can provide stability in the future performance in an organization. The organizations should try to reduce risks using quality enhancement [5] One of the main concerns of managers and project stakeholders is precise information on the progress of the work performed and compared with the amount of work expected and calculation of cost and time nonconformities with actual performance. There exist always some limitations for precise evaluation of performed work in a project but without progress measurement of what has been carried out, the project cannot be controlled. The most conventional progress measurement in a project is nonconformity or value added analysis. Analysis of deviation from schedule allows a manager to identify problems and obstacles of a project and take necessary actions to eliminate them. There are three man axes in a project including cost, time and quality which should be controlled by the project manager [6] Nevertheless, this issue is not so useful in IT projects and value added concept is rarely used in the projects associated with information technology and information systems. One of the greatest problems to employ value added management in IT projects is that a software project is taken into consideration exactly like an industrial one and the work stages were only changed. Another problem here is that, in most cases, software projects are assessed only in terms of time and cost while other success factors are ignored [6] As it can be seen, quality and earned value can be of the most important factors for risk management of IT projects while they are neglected to implement such projects. Therefore, by precise evaluation and management of these two issues and corresponding indicators, IT projects risk can be decreased. Consequently, present study designed an integrated model based on the indicators quality and earned value for risk management in information technology projects.

Literature review

The subjects associated with risk management and IT projects have been always paid into attention by researchers. One of the first studies is Chapman [7] titled "Risk analysis of large engineering projects" where Work Breakdown Structure is used for the first time to make a communication between risk response assessment model and other project management systems. Also, a methodology called Synergistic Contingency Evaluation and Response Techniques (SCERT) is presented in which each component of work breakdown structure is assessed and the risks and corresponding responses are identified and therefore this method needs high volume of studies in large projects.

Hillson [8] conducted a research work titled "Developing effective risk responses" where common procedures for the identification and selection of actions to respond to the risks are described in the form of a waterfall chart. In this method, risk avoidance strategy is initially assessed and in case of impossibility, transfer strategy is studied and in case of lack of response selection, reduction strategy is studied and ultimately risk acceptance is evaluated.

Haimes [9] carried out a research titled "Risk Modeling, Assessment, and Management" where using the efficient frontier concept, a model is presented for risks responses evaluation where using exchange of response implementation cost and risk cost after the response implementation, the efficient frontier is calculated. The proposed model is implemented in a Plant Pest Control Project whose results indicate the model efficiency.

Wan et al [10] conduct a study titled “Empirical Analysis on Risk Factors of IT Service Management Project Implementation” where 500 questionnaires were distributed among IT project managers to determine weight and also correlation of each effective factor on entire risk of the project. The results caused to categorize 25 risks into 6 groups.

Howard et al. [11] performed a study titled “The role of risk management in IT project, Journal of the Nordic Academy of Management” where risk management role is explained on success of IT projects and the way of effective IT management. It points out that organization managers mostly have recognized the role of using this technology on increased efficiency and effectiveness of organizations and higher customer satisfaction so that inattention to management techniques and delicacies in IT projects implementation will result in failure to achieve anticipated benefits and maybe failure of these projects. Their results indicate that failure of IT projects is not limited to financial and economic losses and may proceed until failure of an organization and in doing so, identification and management of observed risks before and during project implementation play a fundamental role in this study and risk management should be a preventive activity. Furthermore, success in identification and reduction of the project risks can make technical and non-technical risks and challenges visible for managers and key stakeholders and help them to assign resources in the areas with high risks and thereby manage risks in reasonable ranges by correct and measurable methods.

Jafari et al [12] carried out a study titled “The role of knowledge and IT management in risk management”. Their results indicated that risk management has not been successful due to three reasons including inefficient culture, lack of organization knowledge management and ineffective controls. However, extraordinary growth of low-cost technologies and high-speed data have formed organizational innovations as exciting and innovative items and such an operational complexity and thereby risk management are strengthened due to need to competition for quick response on the market changes. Therefore, a major part of the risk management problems are not resulted by risk management but it is often caused by lack of knowledge and interpretation of its meaning. Shakeri [13] conducted a study titled “a methodology to select the best prediction indicator of the final results of a project in earned value management system”. He pointed out that clearly an indicator never can be the best therefore the most precise indicators are different depending on three factors including contractor company, the project type and progress percentage. Hence, given the particular importance of information on the final cost and projects completion date, a methodology was proposed in this study to select the most suitable forecast indicators for final results of the projects in terms of cost and time. Dorijani et al [14] carried out a study titled “Risk strategic management pattern” where initially drought risk management strategies were identified and then categorized into the groups "Irrigation Technology", "Crop", "Institutional" and "Legal" by the corresponding experts. Next, the questionnaires associated with effective strategies were distributed among 39 experts and analytic hierarchy process decision making pattern was employed to rank mentioned strategies. Their results indicate that the regional planners and policy makers should put plans and policies of drought effects mitigation into a high priority and in a suitable strategies framework.

Mousakhani et al [15] performed a study titled ”determination of key success factors in risk management of IT projects in virtual organizations”. The study aimed to identify essential success factors in risk management of IT projects in virtual organizations and to increase success impact of risk management of IT projects in virtual organizations. In this work, the risks existing in IT projects were identified, categorized and evaluated. Ultimately, with establishment of focal groups, fundamental risks were extracted and essential success factors were determined for the risks with high priority. Goldoust [16] carried out a study titled “Integrated model for risk management of the project and earned value management to improve cost management process of the projects”. He presented a model to illustrate the way of risk

management and earned value management integration into three areas including: the base plan amendment, final cost forecast and integrated management of violations from the project forecasts. Then, in order to ensure the model accuracy using arguments, reasonable analysis and logical relations and sequences, the model components were created and the relations between them were drawn. Next, in order to validate proposed model, the model was tried to be made based on existing models and using experts' vision, the model would be presented along the former ones. Finally, in order to measure performance of proposed model in actual projects, the mentioned model was implemented in an actual project.

Methodology

Present study was conducted based on whatever existed and with no researcher's intervention in terms of phenomena control and execution methods as well as data collection and data and statistics analysis; therefore, the research method was analytical and descriptive and author tried to use experts and professionals' comments to find the factors. The study employed this method to actually and regularly describe specifications of a fact or phenomenon. The author tried to describe whatever exists with no intervention and most of the field studies here were descriptive ones. Therefore, present study can be considered as a descriptive work. Also, since questionnaire was used in the field form to measure the research variables, the study can be known as a survey and casual-comparative work. The statistical universe included all stakeholders of IT projects and the data was required to be gained from some specific people to get reliable and valid result. In this regard, nonprobability and purposive (judgment) methods were employed for sample size calculation and sampling. The statistical sample included 30 active experts in IT projects and 30 professionals including university professors, researchers and scholars. The proposed algorithm is shown in Diagram (1) for risk management in IT projects.

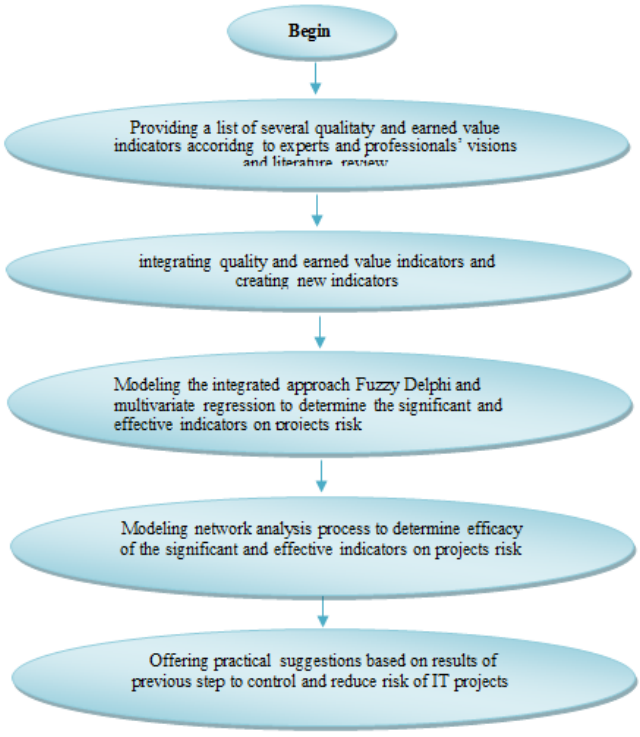

Diagram 1. Proposed algorithm for risk management in IT projects.

Findings

For risk management in IT projects, operational steps of the proposed algorithm were implemented. The regarding results are presented as follows:

Providing a list of qualitaty and earned value indicators

In this step, in order to identify key indicators, initially the corresponding literature was completely reviewed. The mentioned factors were collected from different references and a list of key indicators was prepared. Then in the second phase, the experts and professionals did a survey. Therefore, a questionnaire was designed to receive experts and professionals' visions. Following assurance of reliability, the experts and professionals were provided with the questionnaires. Finally, a list of key indicators was prepared.

Integrating quality and earned value indicators and creating new indicators

In this step, according to the identified quality and earned value indicators in the former step, the quality and earned value indicators were integrated and new indicators were created.

Modeling the integrated approach Fuzzy Delphi and multivariate regression to determine the significant and effective indicators

In this step, initially the visions were received using Fuzzy Delphi approach. After receiving the visions in Fuzzy form, the data should be entered into the regression. Therefore, fuzzy numbers got defuzzy. Then, the obtained numbers entered into the software SPSS Ver. 21 and significant and effective indicators on the projects risk were identified.

Modeling network analysis process to determine efficacy of the significant and effective indicators on projects risk

In this step, the different stages of network analysis process were implemented to determined efficacy of the significant and effective indicators on the projects risk so that the corresponding results are presented as follows:

1. Modeling:

Modeling network analysis process requires a framework. For desired framework design, the identified significant and effective indicators on the projects risk at the former step were categorized under three components including quality indicators, earned value indicators and integrated indicators and the desired framework was designed. After designing the required framework, it will be the turn for the network modeling and design. The designed network at present study is shown in Figure (1).

After the project design, it was the turn for pairwise comparisons. Therefore, pairwise comparisons questionnaires were designed in this stage and the experts and professionals were provided with.

2. Determining efficacy of the significant and effective indicators on projects risk:

According to the filled pairwise comparisons questionnaires by several people, different weights were calculated. The software Super Decisions was used for mentioned weights calculation. Therefore, data was simulated and entered into this software. The simulation output is in Figure (2).

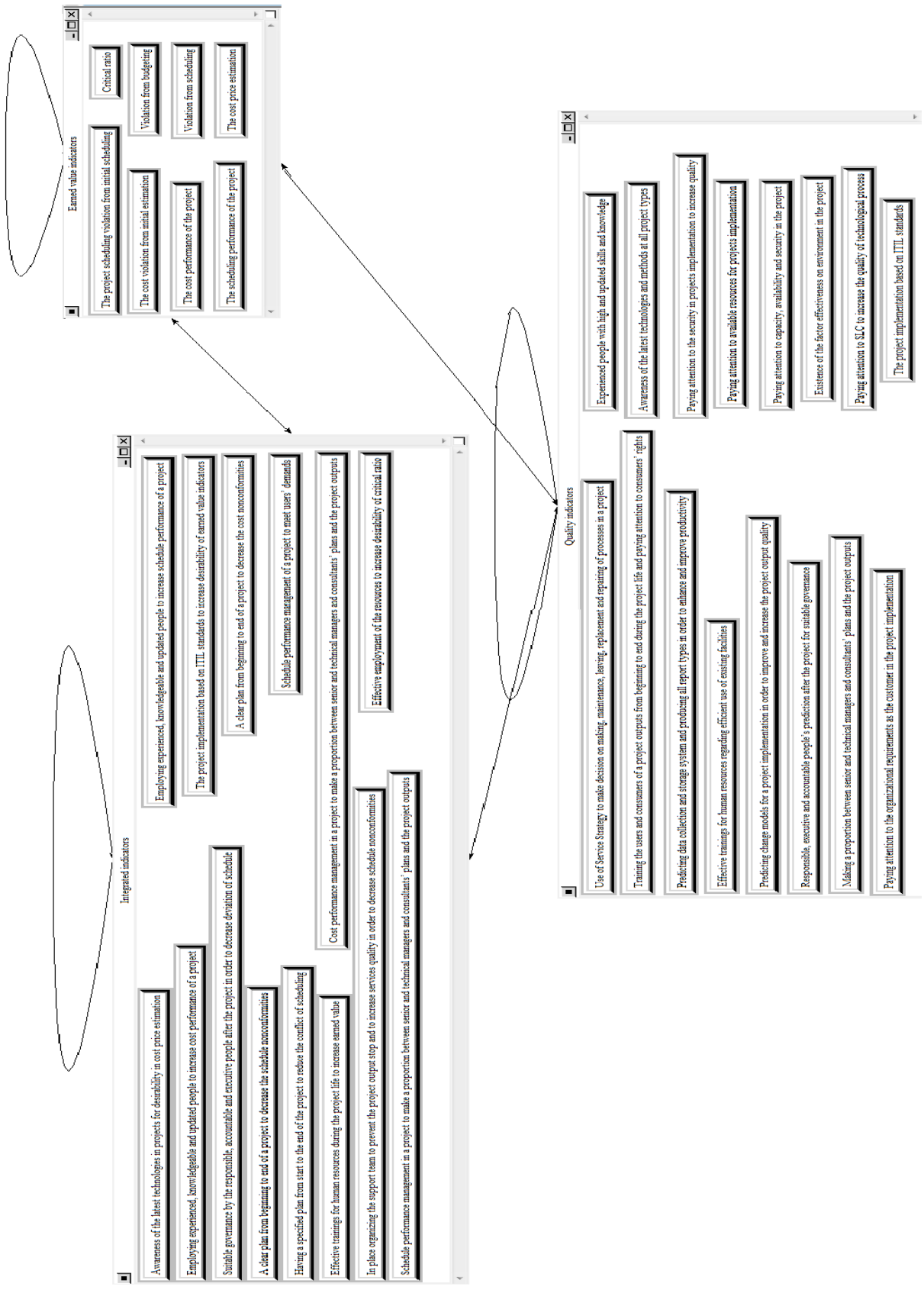

Figure 1. The network designed in platform of the software Super Decision Making pairwise comparisons.

Here are the priorities.

Icon	Name	Normalized by Cluster	Limiting
No Icon	Violation from budgeting	0.08183	0.021702
No Icon	Violation from scheduling	0.16287	0.043194
No Icon	The project scheduling violation from initial s~	0.27213	0.072169
No Icon	The cost violation from initial estimation	0.09655	0.025606
No Icon	The cost price estimation	0.07704	0.020432
No Icon	The scheduling performance of the proje~	0.16848	0.044681
No Icon	The cost performance of the project	0.08750	0.023204
No Icon	Critical ratio	0.05360	0.014215
No Icon	Awareness of the latest technologies in projects~	0.02606	0.009783
No Icon	Employing experienced, knowledgeable and update~	0.21079	0.079142
No Icon	Employing experienced, knowledgeable and update~	0.07817	0.029350
No Icon	The project implementation based on ~	0.07629	0.028645
No Icon	Suitable governance by the responsible, account~	0.02886	0.010837
No Icon	A clear plan from beginning to end of a pr~	0.08343	0.031326
No Icon	Having a specified plan from start to the end of~	0.07927	0.029763
No Icon	A clear plan from beginning to end of a pr~	0.07388	0.027738
No Icon	Effective trainings for human resources during t~	0.03929	0.014751
No Icon	Effective employment of the resources to increas~	0.02455	0.009219
No Icon	In place organizing the support team to prevent ~	0.07435	0.027916
No Icon	Schedule performance management of a project ~	0.06464	0.024271
No Icon	Schedule performance management in a project ~	0.07253	0.027231
No Icon	Cost performance management in a project ~	0.06788	0.025488
No Icon	Awareness of the latest technologies and methods~	0.08837	0.031754
No Icon	Training the users and consumers of a project o~	0.02082	0.007480
No Icon	The project implementation based on ~	0.09370	0.033669
No Icon	Use of Service Strategy to make decision on maki~	0.02224	0.007993
No Icon	Experienced people with high and updated skills ~	0.18253	0.065590
No Icon	Effective trainings for human resources regardin~	0.09170	0.032950
No Icon	Existence of the factor effectiveness on environ~	0.06250	0.022458
No Icon	Making a proportion between senior and techn~	0.04308	0.015480
No Icon	Paying attention to SLC to increase the quality ~	0.06915	0.024848
No Icon	Paying attention to the security in projects imp~	0.07717	0.027729
No Icon	Paying attention to capacity, availability a~	0.03528	0.012679
No Icon	Paying attention to available resources for ~	0.06974	0.025061
No Icon	Paying attention to the organizational requireme~	0.03792	0.013627
No Icon	Responsible, executive and accountable people's~	0.05040	0.018111
No Icon	Predicting data collection and storage s~	0.03457	0.012424
No Icon	Predicting change models for a project implementa~	0.02083	0.007485

Figure 2. The output of the software Super Decisions.

According to Figure (2), the obtained intra-cluster weights for different indicators are presented in Table (1).

Table 1. The obtained intra-cluster weights for different indicators obtained through the software Super Decisions.

Indicator type	Indicators	Weights
Quality Indicators	Experienced people with high and updated skills and knowledge	0.10253
	Awareness of the latest technologies and methods at all project types	0.08837
	Effective trainings for human resources regarding efficient use of existing facilities	0.09170
	The project implementation based on ITIL standards	0.09370
	Existence of the factor effectiveness on environment in the project	0.06250
	Paying attention to SLC to increase the quality of technological process	0.06915
	Paying attention to available resources for projects implementation	0.06974
	Paying attention to the security in projects implementation to increase quality	0.07717
	Predicting data collection and storage system and producing all report types in order to enhance and improve productivity	0.03457
	Responsible, executive and accountable people's prediction after the project for suitable governance	0.05040
	Use of Service Strategy to make decision on making, maintenance, leaving, replacement and repairing of processes in a project	0.02224
	Predicting change models for a project implementation in order to improve and increase the project output quality	0.02083
	Paying attention to capacity, availability and security in the project	0.03528
	Paying attention to the organizational requirements as the customer in the project implementation	0.03792
	Training the users and consumers of a project outputs from beginning to end during the project life and paying attention to consumers' rights	0.02082
	Making a proportion between senior and technical managers and consultants' plans and the project outputs	0.04308
Earned Value Indicators	The cost violation from initial estimation	0.09655
	The project scheduling violation from initial scheduling	0.17213
	The cost performance of the project	0.08750
	The scheduling performance of the project	0.14848
	Critical ratio	0.05360
	Violation from scheduling	0.12287
	Violation from budgeting	0.08183
	The cost price estimation	0.07704
Integrated Indicators	A clear plan from beginning to end of a project to decrease the cost nonconformities	0.07388
	A clear plan from beginning to end of a project to decrease the schedule nonconformities	0.07927
	Employing experienced, knowledgeable and updated people to increase cost performance of a project	0.07817
	Employing experienced, knowledgeable and updated people to increase schedule performance of a project	0.11079
	Awareness of the latest technologies in projects for desirability in cost price estimation	0.02606
	Effective employment of the resources to increase desirability of critical ratio	0.02455
	The project implementation based on ITIL standards to increase desirability of earned value indicators	0.07629
	Suitable governance by the responsible, accountable and executive people after the project in order to decrease deviation of schedule	0.08343

	Suitable governance by the responsible, accountable and executive people after the project in order to decrease deviation of budgeting	0.02886
	In place organizing the support team to prevent the project output stop and to increase services quality in order to decrease schedule nonconformities	0.07435
	Schedule performance management in a project to make a proportion between senior and technical managers and consultants' plans and the project outputs	0.07253
	Cost performance management in a project to make a proportion between senior and technical managers and consultants' plans and the project outputs	0.06788
	Schedule performance management of a project to meet users' demands	0.06464
	Effective trainings for human resources during the project life to increase earned value	0.03929

Offering practical suggestions to control and reduce risk of IT projects

The outputs of the software Super Decisions for integrated indicators are shown in Diagram (2) where efficacy of the different effective integrated indicators on IT projects risk are seen.

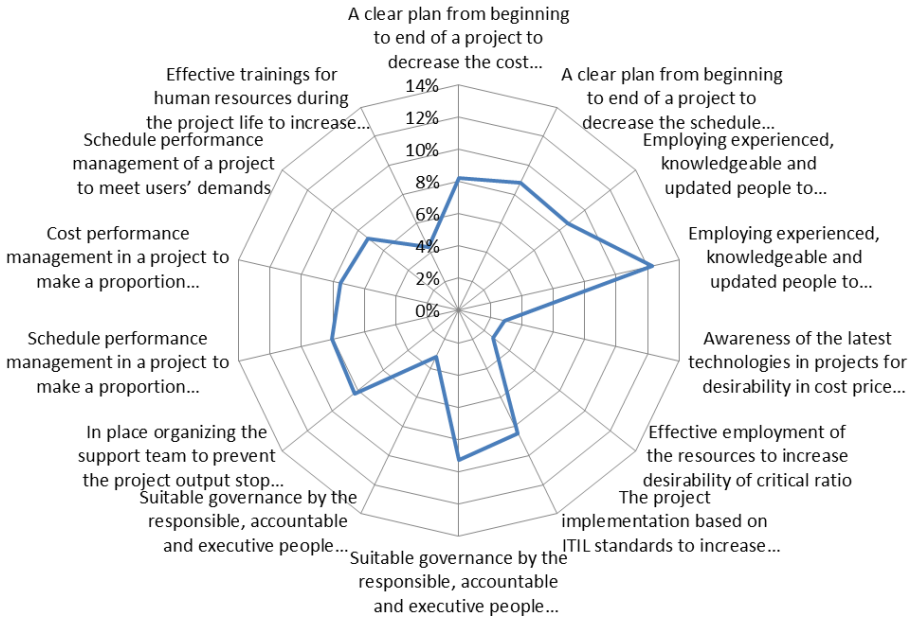

Diagram 2. Efficacy of effective integrated indicators on IT projects risk.

As it can be seen from Diagram (2), every indicator owns a relative importance and none of them is ineffective. Nevertheless according to calculated weights, 8 key integrated indicators affecting risk management in IT projects are respectively as follows:

1. Employing experienced, knowledgeable and updated people to increase schedule performance of a project
2. Suitable governance by the responsible, accountable and executive people after the project in order to decrease deviation of schedule
3. A clear plan from beginning to end of a project to decrease the schedule nonconformities
4. Employing experienced, knowledgeable and updated people to increase cost performance of a project
5. The project implementation based on ITIL standards to increase desirability of earned value indicators
6. In place organizing the support team to prevent the project output stop and to increase services quality in order to decrease schedule nonconformities

7. A clear plan from beginning to end of a project to decrease the cost nonconformities
8. Schedule performance management in a project to make a proportion between senior and technical managers and consultants' plans and the project outputs.

Therefore, the managers who intend to implement IT projects can effectively manage risk in their projects by suitable management of above mentioned indicators. Therefore, in order to reach effective risk management in a project, managers are recommended to employ the experienced people with high and updated knowledge and skills in order to increase the schedule performance of the project, to use proper governance by responsible, executive and accountable people after the project to reduce violation from the schedule, to use a clear plan from beginning to end of a project to decrease the schedule nonconformities, to employ experienced, knowledgeable and updated people to increase cost performance of a project, to implement the projects based on ITIL standards to increase desirability of earned value indicators, to organize support team in place to prevent the project output stop and to increase services quality in order to decrease schedule nonconformities, to use a clear plan from beginning to end of a project to decrease the cost nonconformities, and to manage schedule performance in a project to make a proportion between senior and technical managers and consultants' plans and the project outputs.

Conclusion

Among different projects, IT and software development projects are of high importance in present age due to being an inseparable part of current organizations. However, it is noteworthy to consider that failure rate of IT projects has been 40-50% in the recent 15-20 years researches. There are two effective factors on IT projects including quality and earned value so that by controlling these two factors and their increased level in IT projects, the projects risk can be decreased. Therefore, present study tried to assess risk management in IT projects based on the indicators quality and earned value by a new and efficient approach. Consequently, following results were gained:

- ✓ Quality indicators are effective on risk of IT projects.
- ✓ Earned value indicators are effective on risk of IT projects.
- ✓ The integrated indicators of quality and earned value are effective on risk of IT projects.
- ✓ Several indicators are effective on risk of IT projects with different efficacy.

As a result, in order to reach effective risk management in a project, the managers who intend to implement Information Technology projects are recommended to employ the experienced people with high and updated knowledge and skills in order to increase the schedule performance of the project, to use proper governance by responsible, executive and accountable people after the project to reduce violation from the schedule, to use a clear plan from beginning to end of a project to decrease the schedule nonconformities, to employ experienced, knowledgeable and updated people to increase cost performance of a project, to implement the projects based on ITIL standards to increase desirability of earned value indicators, to organize support team in place to prevent the project output stop and to increase services quality in order to decrease schedule nonconformities, to use a clear plan from beginning to end of a project to decrease the cost nonconformities, and to manage schedule performance in a project to make a proportion between senior and technical managers and consultants' plans and the project outputs.

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