A Comprehensive Framework for Integrated Management of Opportunities and Threats by Using Dynamic System

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Received: December 2007 Last Revised: February 2009 Accepted: May 2009

Abstract: *Risks mean cases of uncertainty of project, the impact of which is realized as a threat (negative aspect) and/or opportunity (positive aspect). The traditional viewpoint on risk is a negative viewpoint that implies damages, loss and harmful consequences. Judgments such as this on risk merely emphasize on risks management and pay less attention to opportunities management. It is clear that some uncertainties might be profitable for the project; as in many cases, it could be the source of loss. In a developed attitude, focus is made on a common process that could address the integrated management of both opportunities and risks to aim at maximizing the positive effects- opportunities-, and minimizing negative effects- risks-. Therefore, existence of causal-effect relations between risks, relationship, effects of risks and opportunities on each other and variety of strategies in facing risks gives no alternative for risk management team than taking integrated management of risks and opportunities. In another word, reaction to risks, with respect to risks and/or relevant opportunities, separately, will be never effective. In this paper, for the purpose of integrated management of risks and opportunities, the stages of quality analysis and reactions to risk are combined. The method which is used for reaction towards risk is a procedure based on dynamic system. Dynamic system is highly important among uncertainties due to considering the type and intensity of effects. By using dynamic system and attention to the relationship between uncertainties (risks/ opportunities), reaction to risk and decision making on employing suitable strategies to face risks will be more precise and accurate.*

Keywords: *Uncertainty, risk management, risk qualitative analysis, dynamic system, cause and effect relations.*

1. Introduction

It is obvious that some uncertainties might be profitable for the project; however, in many cases, they could be the resource or loss and harm. In the developed view, the common process that could work on the integrated management of opportunities and risks is discussed and focus is made on maximizing the positive effects (opportunities) and minimizing negative effects (risk). Therefore, the important point in risk management is that, one should not only think of risk management; but, in the light of attention to risks, opportunities should be also considered. In another word, one should not content himself to preventing the loss. By analyzing project risk, it might be possible to bring unimaginable exceptional opportunities for the project. The important point is that management should cover both risks and opportunities.

Focus on the risks of project is nothing than performing failure mode and effect analysis project in which, the error modes and their effects are analyzed [1]. Risk management is far more than these issues; for, by employing mixed strategies on the risks and opportunities management and viewing their relationship, the focus is on lowering the effects of undesirable events and increasing their positive effects on the projects goals [2]. In PMBOX standard in the risks quality analysis section (in form of Matrix PI) that discusses priority and classifying identified risks [3] the two factors of "probability of risk even" and "amount of risk effect" are considered and with respect to determining a quantity named "risk degree" the "identified risks classifications are discussed.

Risk degree = (The value of the effects of that risk in project results) * (Value of probability of events)

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Then, a threshold is defined to accept the risk and the risks higher than threshold limit are considered as important and examinable and other risks with less than threshold limit are taken as lower important risk. In this method, risks with high probability and effects (jointly) are put in higher priority; however in some other sources, criteria such as "ability of organization in reaction to risk" [4] and/or "assessment of uncertainty" [5] are discussed along with the indexes of probability of event and effects of the risks .Because the probability assessment and effects of risks are considered as an uncertainty themselves.

Lambert et al offered a quality method to classify risks resources. To do so, they used three indices of "event probability", "potential effect on project" and "speed in facing the risk"[6]. Employing indexes such as mentioned above; because, first, it draws attention of the team to assess the probability and effects of each one of the risks and second, it leads to spending sources on cases with more probable reaction. Another point which should be considered is that, by increase of the indexes on risks priority, the weight and importance of indexes on one hand and their lack of collaboration with others, on the other hand, led to focusing on Multi-Criteria Decision Making-MCDM- methods [7].

2. Risks evaluation and priority

The goal of quality analysis of risks is to put priority on risks and determining high effective risks for showing reactions to then. The obvious fact is that, using a risk degree alone is not proper for this purpose and the output of the mentioned procedure will not give appropriate priority of risks. As an example, there might be risks with high effectiveness are taken average or low importance due to relatively less probability to occur while in case that due to their effects on project, the company will face serious challenges.

In order to put priority on risks, the two criteria of probability of occurrence and amount of risk effect are used and the assessment of the identified risks is done based on the two criteria mentioned above. However, Matrix PI (as presented in PMBOK Standard) it will not have sufficient efficiency due to following reasons:

- Considering only two criteria of the probability and effects is not sufficient for risks assessment and other factor and criteria should be considered as well.
- This method introduces priority risks as the input of entry of reactions to risk in which case, only by contending on the results of this stage (risks priority), employing their conventional strategies is discussed. The important fact is that, in this method, the risks are studied in abstract and neither their correlation nor their effects on each other are considered in the stage of reaction to risks.
- In Matrix PI, risks with equal degree are taken in the same classification while never two risks with equal degree will have same importance; for, the probability of event and the effect of risk are not important in the same way.
- Classifications of risks based on the criteria of risk degree causes taking improper decisions in risks assessment; because, they might cause omitting risks with lower risk degrees. As an example, a risk might have lower degree (in the worst condition, have low probability and effects) while in case of occurrence, they might lead to the occurrence of other effective risks.

The multi-criteria decision making methods are more efficient than the probability-effect method due to their ability to view variable indexes. The TOPSIS method [7] is one of procedures of this family; however in this method, their correlation and counter effects of risks on each other are not considered. In the multi-criteria decision making methods such as PI Matrix method, the impact of risk on project goal is not clear. A risk might be effective on goals such as time, quality, expenses and range of project. The weight of each item differs in classifying the risks [8]. In fact, in this mode, the weight of indexes varies with respect to the conditions and demands of project authorities. As an example, in a project, quality might be the most important index (projects such as producing a specific product and sensitive items with medical application). In addition, in some projects, with respect to the special conditions of the project, the time index might be very important (constructing a hotel with delivery date in mid-June).

Usually, the entropy technique or similar techniques are used to give weights to indexes. These techniques might give very good results, but one should bear in mind that using those techniques could not be applicable in any problem or project and does not necessarily give positive results. With the approach suggested in this paper, it is possible to identify the critical success factor (CSF) and key factor success (KFS) of the dynamic system graph and study the implementation of different strategies in them and ultimately, select a suitable strategy for them. By using this method, first, unlike the ordinary mode that shows reaction to risks in single, in this method, the CSFs and KFSs are studied in an integrated form and by viewing the type of relationship, intensity of effects of risks on each other; second, by employing this method, different types of combined strategies could be used to react against risks.

3. Description of the suggested structure

Since in any reliable system, precision and accuracy of inputs lead to obtaining proper and precise results, in this system too, input is highly important. As shown in figure 1, first, the risks are screened by TOPSIS algorithm and risks which have at least one of the two requisites mentioned below will be taken as input of the system:

- Risks that cause the development (origin) of other risks, although they have little effects on the goal of project.
- Risks that affect important risks

It should b noted that the share of input canals of the system is empty. In dynamic system suggested in the framework of three stages as follows, the quality analysis description and methods of reaction to risks are considered.

- Determining highly effective risks and risks as sources of other risks, such as input of the system.
- Analysis of dynamic system and introduction to CFSs and KFSs of the system.

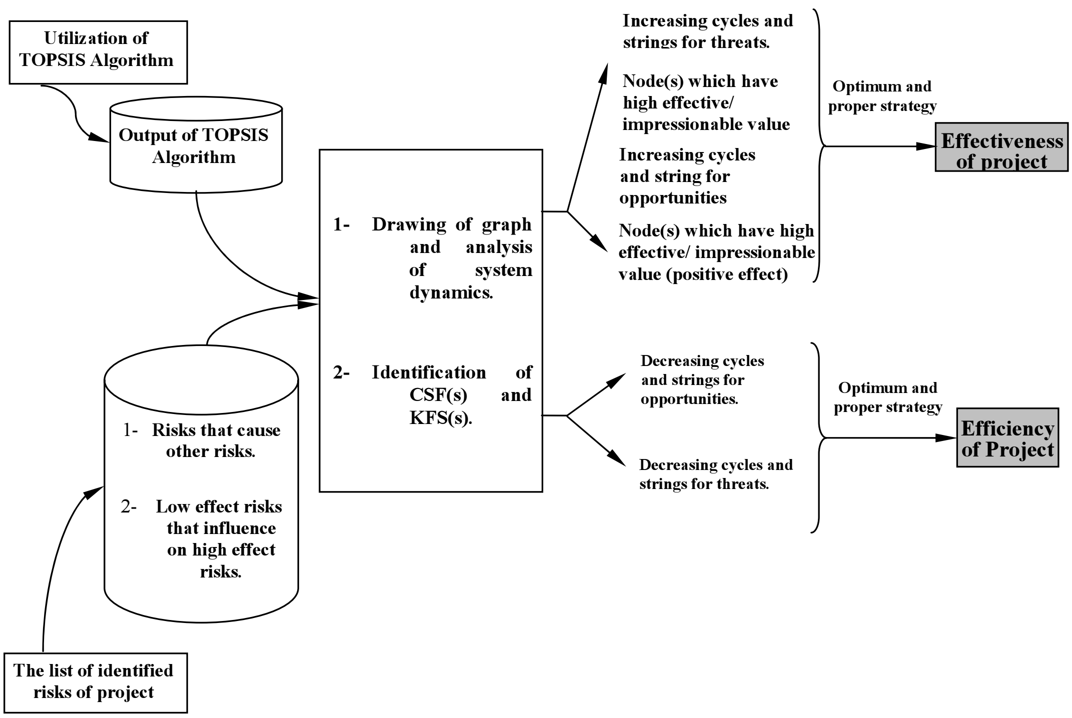

Fig. 1. The framework of suggested dynamic system for the analysis and suitable reaction to risk

- Employing suitable strategies in CSF and KFS (reaction to risks)

This method first classifies risks with high effects on the not considering low effect risks; this factor leads to omitting low effect risks from dynamic system that might be the source of important risks.

- Not considering the cause-effect relationship between risks. This factor might lead to omitting low effect risks that affect highly important risks.

Therefore, in order to arrange for more suitable feeding of the dynamic system which is suggested, risks that becomes the source of other risks in identification phase and/or affect on other risks (highly effective risks) could be considered as system input.

4. Elements of the suggested dynamic system

To analyze the system, first, the system architecture should be made. In this line, the knots, system graphs, current diagram and different loops used for determining CSF and KFS are defined [9, 10]. Knots in this system are taken as risks. Different knots are as follows:

- The effective knots (existing in which, outputs < inputs)
- Effects reception knots (entering in which, the number of inputs< number of outputs)
- End knots (graph leaves) with no arrows coming out and are absolutely affected.

As it is shown in figure 2, arrows shown in dots show the risks effects reception and the arrows in continuous form reveal the casual and effects relationship between risks; in another word:

It is clearer that in system graph, if there are cause-effect relationships (continuous arrow) certainly there would be the effective relationship (dot arrows) as well [11, 12]. Since each one of the risks in fact covers relevant opportunities and risks, the concerned system should consider the relationship of risks and opportunities obtaining from each one of the risks on each other. To do so, following symbols are used:

In order to show the effects of risk J, the mark + or – (existence of direct or reverse relations) on the relevant arrows are considered. By existence of direct relationship between risks I and J is that, if the risk I increases /decreases, the J changes in the same line and will be increased /decreased accordingly.

5. Process of suggested system

In this part, the heart of dynamic system (identification of KFSs and CSFs) is discussed in two separate levels. The suitable reaction to the CFS and its KFS in the first level causes effectiveness of the project and in the second level, increase in the efficiency of project.

CSFs: In the suggested system, knot(s) when disregarding those leads to considerably negative effects on the goals of project are taken as critical success facts.

KFSs: In the suggested system, knot(s) the attention to which cause to increase in efficiency and effectiveness of project are considered as Key Factor Success.

For this purpose (identifying KFS and CFS) one should identify following procedures in the dynamic system graph:

- The reproducing and dying loops for risks and opportunities
- Increase and decrease chains for risks and opportunities
- Knot(s) with high effectiveness reception

a_i risk effect on a_j risk $\quad a_i \dashrightarrow a_j$

a_k risk effect on a_l risk $\quad a_k \longrightarrow a_l$

Fig. 2. "effective/cause and effect" relations between risks.

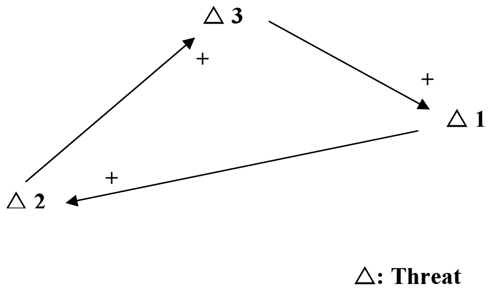

Fig. 3. Reproducing loop for threats

(positive or negative)

In continuation, the reproducing loops in suggested system are described. Whenever the opportunities/threats of more than one risk reinforce each other by making a loop, a reproducing loop is formed in the system [13]. Figure 3 shows an example of reproducing loop for threats.

As it is shown in future 3, there is a direct relationship between the threats of three risks 1, 2 and 3. In the suggested system, such loops are considered as reproducing loops ; in as much that as the threat of risk 1 increases, the threat of risk 2 and risk 3 increase accordingly and by repetition of this function (more increase) the loop becomes reproducing [14].

In continuation, as an example, two types of reproducing loops are described for opportunities / risks and an incremental chain for risks. Figure 4 shows an incremental loop for opportunities / risks. The mentioned loop, in some special condition could be the incremental loop for the contractor's opportunities. As an example, the mode when a contractor needs loss of time in project to start a profitable project in order to obtain necessary capital and power to start project or in condition when the contractor has faced time delay in another profitable project and by analyzing costs-benefit has found out that he has called his human forces from present project and employed in the other project.

In such condition, the loop is an incremental loop for other opportunities of the contractor; while in ordinary status and for an ordinary contractor (single project) the loop is an incremental loop for his threats / risk.

As it has been shown in the incremental loop above, by increase and repetition of the event "failure in delivery of materials on time", when the employer of the contractor should put in access to contractor, the claim number 4 of the contractor increases and according to this event, the employer's focus on contractor's claim and efforts for omitting or making the effects low increases. As a result, in turn, this intensifies employer's disability in supplying materials on time and the loop is created. However, with respect to the condition of the project and other effective factors in he contractor's decision-making, the loop could show a CFS and perhaps unbelievable, a merit for the contractor. In any event, the goal of this analysis is to identify the CFS and KFSs (by concerning all conditions and effective factors in contractor's decision-making) and then, performing a suitable reaction.

The same is true for dying loops. By using the procedures mentioned above, it is clear that in the suggested system, the four growth and decrease loops will exist for threats/opportunities as

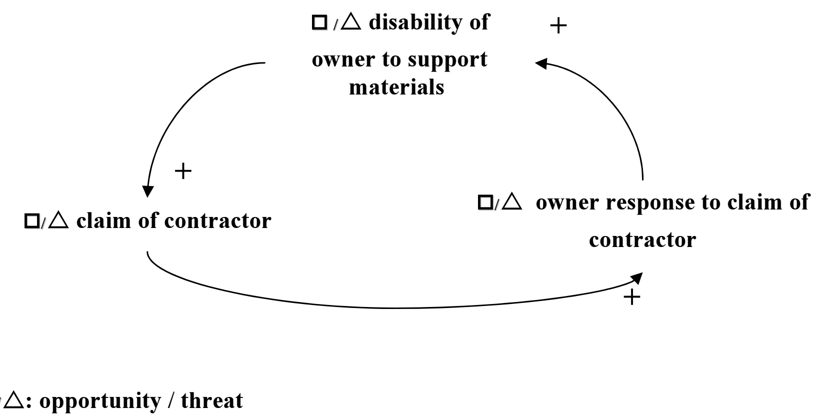

Fig. 4. Incremental loop for opportunities/ threats

follows:

- The reproducing pattern for threats/risk
- The reproducing pattern for opportunities
- The decreasing pattern for threats
- The decreasing patterns for opportunities.

If the opportunities / threats of more than one risk reinforce each other in hierarchical form and without making a loop, an incremental chain is formed in the system. Figure five shows an example of an incremental chain.

In addition, a decreasing chain is a set of knots (risks) that without making a loop, its threats/opportunities heretically weaken each other. After introducing different procedures that might be formed in the system graph, the KFSs and CFSs are discussed in two separate levels. The suitable reaction in first level goes in line with reinforcing the effectiveness of project and in second level, guaranties the increase in efficiency of project. As it has shown in figure 1, in first level, the loops and incremental chains for threats and knot(s) with high (negative) effectiveness are taken as CFS and the incremental loops and chains for opportunities and knot(s) with high (positive) effectiveness degrees are considered as KFS.

In the second level of the system, the loops and decreasing loops are CFS for opportunities and the loops and decreasing chains are KFS for threats/risk. Considering two separate levels for classifying the CFSs and KFSs are highly important to select suitable strategy in risks

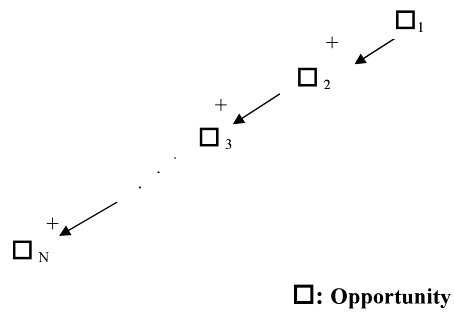

Fig. 5. An incremental chain for opportunities in the suggested system

reaction stage.

Due to lack of independency in risk, using suitable strategy in CFS and KFS of the system is highly important in the reaction stage in considering the relationships and their effects on each other. In order to have a suitable reaction to risks, the suitable strategies should be taken in the important points of the system. The important points of the system are in fact the very CFSs and KFSs of a system. In the suggested system in order to react towards the risks, different common strategies in risk management (decrease / promotion, omission / admission, transfer / participation and acceptance / refrain) are used in CFSs and KFS in optimized form.

6. Case study

This system was used for the first time in the construction phase in one of the large petrochemical projects of the IRAN country as pilot[1] and led to highly interesting results that were worthy of consideration. Figure 6 shows some of its diagrams. After using the dynamic system described in this paper and comparing the results of executing the project (the reaction to risks was identified based on method PI), following results were obtained:

1. Less important risks that due to having low risk number were omitted from the list containing risks subject of study appeared in different stages of executing project as:

A. Establishing highly effective risk
B. Effects on the effective and important risk

And significantly affected the goals of project, especially time and costs, while, by using the suggested system, many of those risks were studied and analyzed (through canal 2 in figure2).

2. Due to the procedures that govern political status of the country on the date of executing project and intensification of the issue of bans and lack of priority classification in projects goal (time, costs and quality), the risks were

[1] The dynamic system was used during execution of project and the strategies obtained from it were used for the continuation of project. In cases when the system could not be used, a comparative study was made on the results of this system and project function.

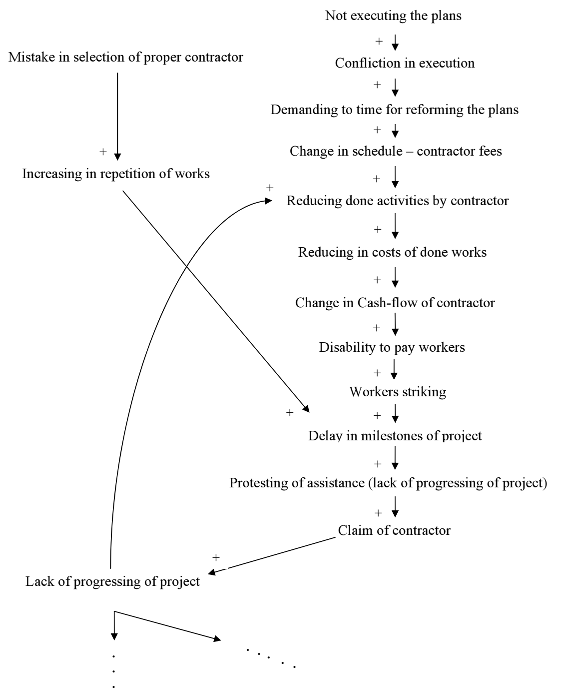

Fig. 6. Showing a part of dynamic system which is used in the project subject of study

taken similar in terms of effects of time, cost and quality. This had significant effects on the efficiency and effectiveness of project. While, in the stage of entry of the suggested dynamic system, by using TOPSIS method and determining the degree of importance and weight of project goals, those cases had been considered, in the mentioned project, due to lack of suitable analysis of those processes, in some cases, we faced excessive and irrational insistence of the employer for utilization form some phases prior to the actual time. This demand used to be accepted by the contractor only by huge increase in the amount of contract. In some cases, this could in turn lead to the contractors' utilization (through claims) and by this way, they cover their shortcomings and weaknesses in executing the project.

3. By using the suggested dynamic system in the stage of reaction to risks, it was known that many of the important risks of the project, when their control/ omission require high expenses, it is possible to spend trivial amounts and control/omit the same low effect and low important risks that were omitted in the stage of risks classification.
4. In this project, risks managements was studied and analyzed only from threats/risks viewpoints while after using the suggested system, on one hand, the control/omission of risks became possible with much lower costs and on the other hand, the joint analysis of opportunities and analysis led to establishment of exceptional and important chances in the path of project execution.
5. Instead of reaction of risks in separate and abstract form, by analyzing the reproducing and decreasing loops in opportunities and risks, highly valuable combined strategies were introduced for progress in project and continuation of the project. As an example, in some case, instead of focusing on lowering a risk, it was possible to decrease loop of threats and they were decreased considerably with a lower expenses.
6. By analyzing the increasing and decreasing processes and the reproducing and lowering loops in the framework of mentioned system, some cases received consideration that if their senior project managers had taken those items in consideration in time of concluding contract as conditions and terms of project, it would have been possible to save 120 to 150 percent of time of project and 250 to 300 percent of expenses of project.

7. Conclusion

The US project management standard in its risk management process considers the "Quality Analysis" and "Reaction to Risks" stages as two separate stages and by presenting the matrix of probability-effect and calculating the risk degree, has classified the risks and then, in the stage of reaction to risks, it studies the implementation of each one of the common strategies in this field. Employing the mentioned method is not sufficiently efficient since it does not consider the overlap and attached nature of risks. In this paper, the stages of quality analysis and reaction to risks are taken as an integrated shape in form of a dynamic system.

Alongside with transparency of the effects of risks on the goals of project, one of the methods in multi-criteria decision-making (establishment authority,) has been used. By using this approach, the effects of each one of the risks on project goals (time, costs, quality and limits of work) were studied accordingly. In the suggested system, instead of focusing on the risks in separated and abstract form, the CFSs and KFSs in two different levels are discussed. Selecting suitable strategy (by analyzing cost-benefit in CFSs and KFSs of the system) in first level, the effectiveness is guaranteed and in second level, the project efficiency will increase. In sum, following advantages could be considered for the suggested dynamic system:

- Considering the cause-effect relations between risks and effects of risks on each other
- Reaction to risk in two separate levels with respect to the demands and requirements of employer /contractors
- By considering variable goals of the project (time, cost, quality and limits of project) along with identification of risks
- Viewing the weights of indices and degree of their Importance for each class of risks
- Reaction to CFSs and KFSs instead to react to risks in abstract and single.

8. Suggestion to Future researchers

It can focus more on proposed framework to represent more comprehensive patterns to identify CSF and KFS. In other word, proposed system could identify and find patterns and procedures that are between opportunities and threats.

Additionally, by identifying of these patterns, analysis of active effects each patterns on project performance could be done, and also efficient control of each patterns could be implemented.

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