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Risk Analysis in Construction Projects in Gaza Strip "Contractor's Perspective"

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Abstract
The aim of this paper is to investigate risk analysis techniques used to analyze risks in construction projects in Gaza strip. The findings of this research indicate that the most important risk analysis techniques that contractors use to analyze risk factors to better manage risks of construction projects at the bidding cost estimate stage, are the following: comparative analysis (analyze similar projects), direct judgment using experience, action plan (scenario) analysis with project details, probability analysis using historical data, descriptive analysis, sensitivity analysis and simulation analysis using software programs. The results of this research recommended to the contractors are to select the optimal risk analysis technique to analyze and estimate risks properly and to determine the convenient preventive method to respond risk effects early, at the pricing stage of construction project.

Keywords Risk analysis, Construction projects, Contractors, Risk management, Risk factors.

تحليل الاخطار في مشاريع الانشاء في قطاع غزة
"وجهة نظر مقاولين"

ملخص
تهدف هذه الدراسة الى بحث تقنيات تحليل الاخطار المستخدمة في مشاريع الانشاء في قطاع غزة. لقد كشفت نتائج هذه الدراسة الى ان اهم وسائل تحليل الاخطار التي يستعملها المقاولون لتحسين ادارة الاخطار في المشاريع في مرحلة تقدير كلفة المناقصات هي: التحليل المقارن بتحليل المعلومات من مشاريع مشابهة – اعطاء التقييم المباشر من خلال الخبرة – تحليل (سيناريو) خطة عمل مع تفاصيل المشروع – تحليل الاحتمالات باستخدام معلومات سابقة – التحليل الوصفي – تحليل الحساسية و تحليل المحاكاة باستخدام برامج الكمبيوتر. لقد اوصت نتائج هذه الدراسة المقاول ان يختار التقنية المثلى لتحليل و تقدير الاخطار بشكل ملائم و ان يحدد الوسيلة الوقائية المناسبة للتعامل مع تأثير الاخطار في وقت مبكر ، في مرحلة تسعير مشروع الانشاء.

كلمات مفتاحية: تحليل الخطر، مشاريع الانشاء، المقاولين، ادارة الاخطار، عوامل الخطر.

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1. Introduction:

Alquier et al [1] pointed that one of the greatest factors, which improve the probability of project success is the successful project risk management. The careful and rational consideration of the risk management can help contractors to compete and succeed. Risk management may be defined as a process to control the level of risk and to mitigate its effects. The aim of risk management is to help project parties in avoiding effects of risk on contract profits. Oztas and Okmen [2] stated that risk management can be defined as a systematic controlling procedure of risks that are predicted to be faced in an investment or a project. Barrie and Paulson [3] mentioned that insurance and bonding could cover some of the risks; others can be transferred to another party by the construction contract.

Enshassi and Mayer [4] developed a model that was adapted from some other references. The model placed risk management in the context of project decision-making, while considering the overlapping context of behavioral responses, organization structure and technology. In this model, the objectives of project and construction risk management should be clearly established within the context of project decision-making and will be governed largely by the risk attitude of the project proponent. With this model emphasis is placed on how to identify and manage risks before, rather than after, they materialize into losses or claims. The processes of the model are: Risk identification, Risk analysis, Risk response, and Risk control and monitoring as shown in Figure (1).

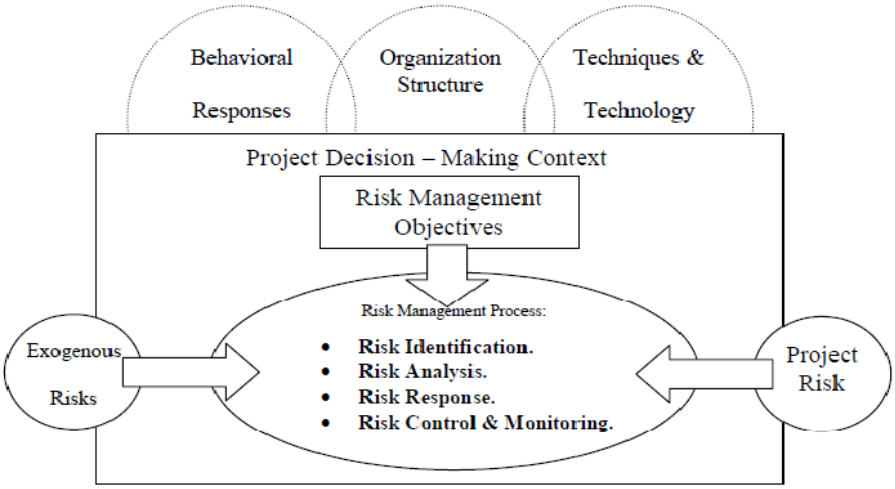

Figure 1 *Conceptual model of construction risk management [4]*

Flanagan [5] says that, the risk management process as a system aims at identifying and quantifying all risks and uncertainties, the business or project is exposed to, so that decisions can be taken on how to manage the risks. Figure (2) shows the risk management system and sequence. Flanagan [5] added that the diagram helps to provide a structure and a system for risk management but it fails to show three important issues: i.e.,: (1) the skill of the decision-maker is crucial. (2) the system depends upon reliable input information that in turn relies upon cost, time and performance from projects in use, finally, the system should both provide the plan for the future and also monitor the project in real-time so that remedial action can be taken quickly.

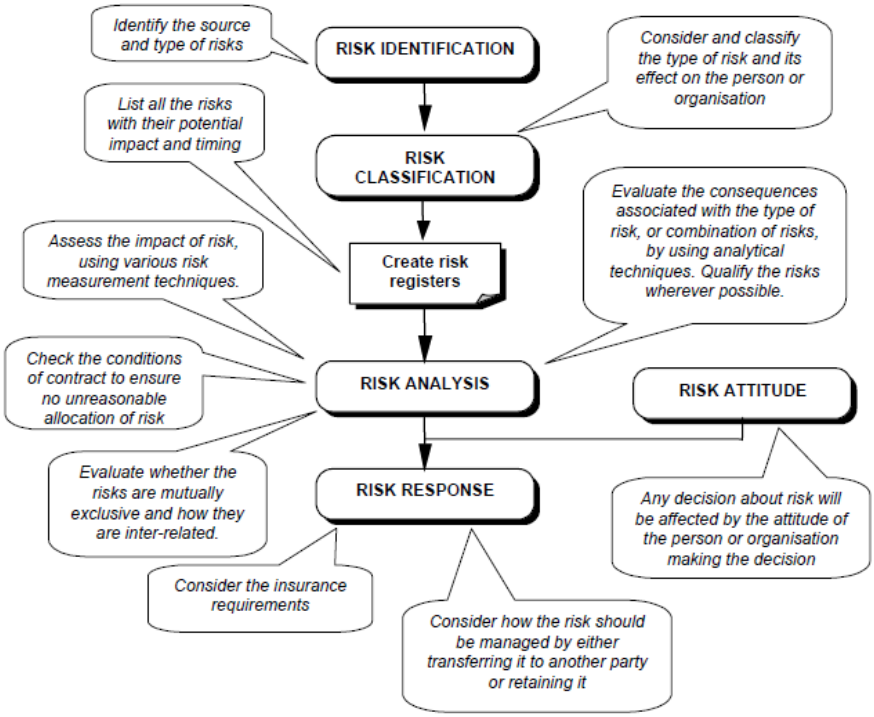

Figure 2 *The risk management system [5]*

1.1 Risk analysis:

In this stage (which follows the risk identification), the probability of risks occurring in addition to possible impact of risks, must be studied and evaluated. Oztas and Okmen [2] state that risk analysis is performed to show what happens if the project does not proceed according to the plan due to potential risks and warns the decision-maker or manager about the necessary responses to cope with risks. Furthermore, it captures all feasible options and analyses various outcomes of any decision.

PMP [6] stated that the risk analysis is a process of identifying hazards and estimating the risk regarding individual or populations, property or environment by using the available information. The need of risk analysis is important to:

1) Avoid starting a project that involves a high risk that time or cost restrictions will be exceeded.
2) Identify and control risks during the accomplishment of the project, and to obtain optimal basic data for decision-making.

Therefore, risk analysis means the identification of all parameters that may influence the work of the project. The reason for the risks may be found both inside and outside the project. The rule must be that no important decisions shall be taken before a risk analysis of the situation has been made, and that the decision-makers have understood the risks involved and what the consequences may be [6].

Flanagan and Norman [7] proposed a systematic 6-steps approach of risk analysis. These steps are as follows:

Step 1- All the various options should be considered.
Step 2- Consider the risk attitude of the decision-maker.
Step 3- Consider what risks have been identified, which are controllable and what the impact is likely to be.
Step 4- Measurement, both quantitative and qualitative.

Step 5- Interpretation of the results of the analysis and development of a strategy to deal with the risk.
Step 6- Decide what risks to retain and what risks allocating to other parties.

Flanagan and Norman [7] also highlight the techniques, which are available for risk analysis. These techniques are quantitative and qualitative. They mention that when a sufficient current data is available, then quantitative methods may give more objective results. While, the qualitative methods vary from person to person due to their response on the personal judgments and past experiences. The quantitative methods are preferred by most analysts [8]. Figure (3) illustrates the qualitative and quantitative methods.

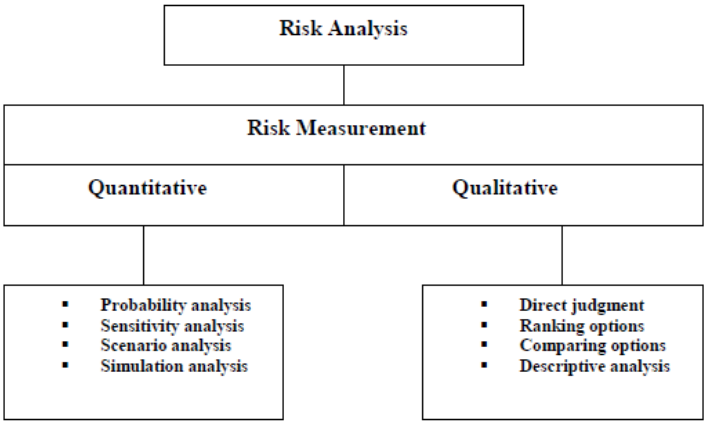

Figure 3 *Various Risk Analysis techniques [8]*

1.2 Qualitative Risk Analysis:

A qualitative risk analysis allows the main risk sources or factors to be identified. This can be done, for example, with the aid of check lists, interviews or brainstorming sessions [6]. In qualitative risk analysis, risk management acts to define the characteristics of each risk [9]. The qualitative risk assessment involves the identification of the following:

1. Risks' hierarchy which is based on the probability of risk's occurrence and its impact on the project,
2. Risks' scope, and
3. Risk occurrence factors [10].

Qualitative risk analysis assesses the risk according to its probability of occurrence and its impact in order to enable the decision makers to prioritize the risks which have a high probability of occurrence and big impact on the project and response to them accordingly. Kindinger and Darby [11] concluded the steps of risk analysis as the following :

1. List activities, tasks, or elements that make up the project.
2. Identify applicable risk factors.
3. Develop risk-ranking scale for each risk factor.
4. Rank risk for each activity for each risk activity.
5. Document the results and identify potential risk-reduction actions

1.3Quantitative Risk Analysis:

A qualitative risk analysis often involves more sophisticated techniques usually requiring computer software. To some people this is the most formal aspect of the whole process requiring:

1. Measurement of uncertainty and cost and time estimates,
2. Probabilistic combination of individual uncertainties [6].

In quantitative risk analysis, the risk is assessed numerically by estimating the probability that a project will success in meeting the planned budget and time schedule. Quantitative Risk Analysis process involves evaluation of the impact of all identified and quantified risks. The results of quantitative Risk Analysis process are more objective than those from qualitative risk analysis if enough data are available for the decision maker. In addition the personal judgment and previous experience are factors that affect this process [12].

Quantitative risk analysis suggested statistical techniques that are most easily used with specialized software. The quantitative risk analysis contains assigning probabilities or likelihood to different factors of risks and the impact of these factors in order to define the severity for each factor [13].

1.4 Methods of Quantitative Risk Analysis:

Any specific risk analysis technique is going to require a strategy. It is best to begin by providing a way of thinking about risk analysis that is applicable to any specific tool might be used [14]:

1. *Probability Analysis* is a tool in investigating problems which do not have a single value solution, Monte Carlo Simulation is the most easily used form of probability analysis.
2. *Monte Carlo Simulation* is presented as the technique of primary interest because it is the tool that is used most often.
3. *Sensitivity Analysis* is a tool that has been used to great extent by most risk analysts at one time to another. Sensitivity analysis enables the analyst to test which components of the project have the greatest impact upon the results, thus narrowing down the main simplicity and ability to focus on particular estimates [7].
4. *Breakeven Analysis* is an application of sensitivity analysis. It can be used to measure the key variables which show a project to be attractive or unattractive.
5. *Scenario Analysis* is a rather grand name for another derivative of sensitivity analysis technique which tests alternative scenarios; the aim is to consider various scenarios as options.

2. Methodology:

The researchers conducted a comprehensive literature review to explore the most important risk analysis techniques used to analyze risks in construction projects. A structured interview was also used to determine those important risk analysis techniques as well. A sample of the most-experienced and qualified contractors in Gaza Strip were the targeted experts. The panel respondents (contractors) were requested to determine the most important risk analysis techniques used to analyze risks in construction projects.

The targeted contractors are those who are classified under the first class in the various types of work fields by the Palestinian Contractors Union (PCU). A total of 56 questionnaires were randomly distributed to targeted contractors. All of them have fully completed the questionnaires accordingly. The questionnaire was designed mainly according to previous studies related to the subject of this research Abu Mousa [15].

In order to be able to select the appropriate method of analysis, the level of measurement must be understood. For each type of measurement, there is an appropriate methods that can be applied and not others. In this research, interval scales were used. The respondents were asked to give their perception and practice regarding the relative usage of the main risk analysis techniques on five-points Likert scales (5 means very often and 1 means never), as shown in Table 1, which was used in the questionnaire.

Table 1 *Relative usage of main risk analysis techniques*

No.	Risk analysis technique	Never	Rarely	Sometimes	Often	Very often
		1	2	3	4	5
1	Probability analysis using historical data					
2	Sensitivity analysis					
3	Simulation analysis using software programs					
4	Action plan (scenario) analysis with project details					
5	Direct judgment using experience					
6	Comparative analysis (analyze similar projects)					
7	Descriptive analysis					

The questionnaire has been validated by the criterion-related reliability test which measures the correlation coefficients between the factors selected for in one group and the whole groups, and structure validity test (Pearson correlation coefficients) [16].

2.1 Statistical Manipulation

To achieve the research goals, researchers used the statistical package for the Social Science software, I.e., (SPSS) for manipulating and analyzing the questionnaires collected data.

2.2 Risk analysis techniques validity:

As shown in Table 2, and using SPSS for analysis, the p-value for every risk analysis technique is less than 0.05 or 0.01, so the correlation coefficients of this domain (risk analysis techniques) are significant at $\alpha = 0.05$ or at $\alpha = 0.01$, so it can be concluded that the test is highly consistent and valid as a tool for the study.

Table 2 *Pearson Correlation coefficient for every risk analysis technique with the total degree of this domain (validity test)*

No.	Risk analysis techniques	Pearson correlation	p-value.
1	Probability analysis using historical data	0.599	sig. at 0.01
2	Sensitivity analysis	0.725	sig. at 0.01
3	Simulation analysis using software programs	0.592	sig. at 0.01
4	Action plan (scenario) analysis with project details	0.522	sig. at 0.01
5	Direct judgment using experience	0.630	sig. at 0.01
6	Comparative analysis (analyze similar projects)	0.582	sig. at 0.01
7	Descriptive analysis	0.302	sig. at 0.05

3. Results

3.1 Risk analysis techniques

As shown in Table 3, and using SPSS for analysis, the means and proportional means of all risk analysis techniques range from 4.27 (85.36%) to 2.50 (50.0%), with P- values ranges from 0.00 to 0.04 which are smaller than the level of significance $\alpha = 0.05$. Meanwhile, the sign of the (one sample T test) is positive for all techniques. So, this result proves that the means of all risk analysis techniques are significantly greater than the hypothesized value 3. Therefore, it can be concluded that the respondents' sample already accepted these items as a significant risk analysis techniques that should be taken into account at the pricing stage of construction projects' bids to analyze expected risks.

Table 3 *Arithmetic mean, proportional mean, one sample T test p-value and rank of each risk analysis technique*

No.	Risk analysis techniques	Mean	Proportional mean %	T value	P value	Rank
1	Probability analysis using historical data	3.82	76.43	5.97	0.00	4
2	Sensitivity analysis	3.20	63.93	1.45	0.04	6
3	Simulation analysis using software programs	2.50	50.00	3.42	0.00	7
4	Action plan (scenario) analysis with project details	4.11	82.14	10.33	0.00	3
5	Direct judgment using experience	4.21	84.29	14.56	0.00	2
6	Comparative analysis (analyze similar projects)	4.27	85.36	15.36	0.00	1
7	Descriptive analysis	3.34	66.79	3.30	0.00	5

The surveyed contractors ranked comparative analysis (analyze similar projects) technique at the 1st rank with a proportional mean of 85.36% and direct judgment using experience at the 2nd rank with a proportional mean of 84.29%.

This result is supported by results of Abu Mousa [15], and highlights these risk analysis techniques which involve looking at records, post completion reports and project team members' notes and recollection from previous similar projects to analyze identified risks in new upcoming projects.

According to this result also, the majority of the surveyed contractors use these techniques in analyzing risks and its consequences to better manage risks of construction projects at the bidding cost estimate stage. Of course, these techniques require more than just information about previous projects; it also requires a history of past projects that are similar, in significant ways, to the project for which risks are being analyzed and assessed.

The surveyed contractors ranked the action plan (scenario) analysis with project details at the 3rd rank with a proportional mean of 82.14% and probability analysis using historical data at 4th rank and a proportional mean 76.43%.

This result clarifies another way of risk analysis which analyze risks from the collective experience of project team members who meet in a session to share opinions and generate ideas about possible risks and in the project through an action plan of the project and its probability using a historical data. Scenario analysis tests alternative scenarios, and the aim is to consider various scenarios as options.

The surveyed contractors ranked the descriptive analysis and sensitivity analysis at the 5th and 6th ranks with proportional means of 66.79% and 63.93% respectively. This result shows that sensitivity analysis enables the contractor to test which components of the project have the greatest impact upon the results, thus narrowing down the main simplicity and ability to focus on particular estimates [7]. The advantage of sensitivity analysis is that it can always be done to some extent.

Finally, the surveyed contractors ranked the Simulation analysis using software programs at the 7th rank with a proportional mean of just 50.0%. This result shows that contractors couldn't adopt this technique significantly since the simulation software are not familiar to the majority of local contractors who prefer to use the other techniques accordingly.

4. Conclusion:

This study has successfully detected the most significant risk analysis techniques to analyze risks in construction projects in Palestine The findings of this research indicate that the most important risk analysis techniques that contractors use to analyze risk factors to better manage risks of construction projects at the bidding cost estimate stage, are the following:

1. Comparative analysis (analyze similar projects) as the 1st option.
2. Direct judgment using experience as the 2nd option.
3. Action plan (scenario) analysis with project details as the 3rd option.
4. Probability analysis using historical data as the 4th option.
5. Descriptive analysis as the 5th option.
6. Sensitivity analysis as the 6th option
7. Simulation analysis using software programs as the 7th option.

The results of this research recommended contractors to select and use which of the previous risk analysis techniques as the optimal and proper technique, to analyze and estimate risks properly and to determine the convenient preventive method to respond risk effects early, at the pricing stage of construction project.

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