Original Research

Risk Assessment of Bridge Construction Project through cost management phases

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Abstract

Risk assessment is an important factor in project cost management. This study addresses the risks associated with a 900 meter long bridge construction project. The risk of a bridge construction project is assessed to limit and quantify the impact on the project. The impact of various risks was investigated to express the impact on the total project contract value at the estimation stage. A project risk analysis is introduced to assess the percentage of risk attributed to the total cost. After assessing the impact of risks on cost using Expected Monetary Value (EMV), a new approach of including uncertainties on risk analyses, using description (C, Q, K), is discussed and its advantages and shortcomings are highlighted. Risk is then assessed at several stages of project execution during the budgeting phase, and risk-based project value (RPV) is used to assess the value of the project at each stage. RPV usually increases as the project progresses towards its goals. Due to this property, the RPV of the entire project can be categorized into the contribution value (CV) of each activity. The CV of an activity is defined as the increase in RPV after each activity completes successfully. The results highlight the positive impact of successfully completing the activities associated with the highest risk. In addition, practical solutions for risk assessment and analysis of bridge construction projects are provided for use by bridge construction contractors, project managers and project management engineers.

Keywords - Project risk assessment, expected monetary value (EMV), uncertainty (C, Q, K) description, risk-based project value (RPV), contribution value (CV)

INTRODUCTION

Bridge construction is considered one of the most strategic development projects in every country. In all countries, infrastructure projects are essential for economic and industrial development in order to improve the quality of life of populations [1]. These projects are typically characterized by large-scale, long-term, high-value investments [2]. Bridges in urban or suburban areas are particularly important in developing or developed countries. These countries can save money and time in many ways by smoothing the flow of traffic in the city, promoting and shortening road transport. The first step in carrying out a construction project is to understand the dynamic and complex nature of projects. A construction project is a mission to create a unique facility, product or service within specified limits, quality, time and cost [3].

Construction activities are performed once and are usually completed within a short period of time. Each step of the activity has a different schedule and cost estimate required. Cost estimates are intended to predict the magnitude of costs incurred in carrying out future activities. Conceptual costing is one of the most important tasks early in the life cycle of a construction project [4].

A construction project is a series of different events that constitute an expected or unforeseen risk [5]. Therefore, risk can be defined as an event having a negative impact on the desired time, cost and quality of work of the project. In construction projects, each of the three main objectives of cost, time and quality can be affected by risk and uncertainty. The uncertainties that can affect a project are based on two theories: probability and possibility [6]. Therefore, a realistic estimate is a good consideration of all the risks and uncertainties that can be predicted from experience and foresight [7]. Risk assessment has been used for decades [8], but since then analytical methods have improved significantly and more complex methods have emerged. In a recent review, Aven [8] presented a risk assessment approach, highlighting the lack of appropriate quantitative methods for assessing risk in some areas. In addition, they emphasize the need to address challenges in risk assessment practices developed to overcome highly uncertain cases. Aven and Krohn [9] assess risk by considering unforeseen / or unexpected cases, and explaining the probability of uncertainty requires the use of other tools rather than a broad perspective for studying risk. In addition, they also addressed the importance of expressing the degree of knowledge on which risk and uncertainty assessments are based. Finally, they have introduced a new approach to managing risks and inherent uncertainties that lead to avoiding extreme adverse situations and improving risk management.

Therefore, risk management needs to reduce the likelihood and impact of threats [10]. The Risk Management Process (RMP) is a logically consistent and structured approach to listing and understanding potential risk factors and assessing the outcomes and uncertainties associated with those identified risk factors. Based on this information, Tummala and Burchett [11] assess and select the best course of action to address the identified risks and achieve the desired objectives of a particular project. Different researchers have expressed different views on risk and its management. Akintoye and MacLeod [12] stated that risk management is essential to reduce losses and increase profits in construction projects. Williams et al. [13] proposed a way to observe risk management in construction projects. Xia et al. [14] studied the impact of uncertainty on risk assessment of large-scale projects and related project decisions for geotechnical engineering projects. The study focuses on model uncertainty rather than commonly treated parameter uncertainty. The resulting risk- making model has been argued by the authors to improve decision-making in some complex engineering systems. Choudhry et al. [15] proposed guidelines for the risk category of bridge construction projects in the Pakistani construction industry. In addition, Gajewska and Ropel [16] investigate the proposed risk management process and risk changes throughout the project life cycle and use simple risk management methods to define project risk in terms of duration, cost and quality. In addition, they found that the most common action against project risk was "mitigation" in construction projects.

In the literature, various risk assessment tools have been considered in bridge construction and underground engineering, including event tree analysis [17], fault tree analysis [18], probabilistic risk analysis [19], the analytical hierarchy process [20], risk-based project value [21, 22], Bayesian networks [23], fuzzy sets [24, 25], expected monetary value [26] and Monte Carlo simulations [27, 28]. Risk-based project values (RPVs) are a useful tool for determining the impact of risk on a project. RPV usually increases as the project progresses towards its goals. Due to this property, the RPV of the entire project can be categorized into the contribution value (CV) of each activity. The CV of an activity is defined as the increase in RPV after each activity completes successfully [22]. Wu et al. [21] emphasize the fact that the risks of a project occur at the same time and the sum of the negative effects of those separate occurrences is equal to the impact of their simultaneous effects, based on the Shapley value of the project's risk response. Therefore, the authors argue that this actual impact assessment helps decision makers assign an ideal risk response plan. Sato [22] explains the advantages of RPV as a dynamic project evaluation method over the general static evaluation method. The author emphasizes that RPV is evaluated considering the value of the project, profit, and the risk probabilities of the project activities. The study also highlights the benefits of using RPV to assess the impact of risk on the value of a project. Therefore, the value of the project is emphasized as a tool for assessing the potential performance of the project, and value engineering is working on this concept.

Heralova [29] uses the concept of value engineering for highway projects to balance project costs, schedules, and scope through the generation of innovative alternatives that provide solutions to potential or current problems of the project. The study concludes that value engineering supports projects in several ways, especially in terms of improved performance and significant cost savings.

Browning [30] provides a framework to quantify key attributes that affect the value of a project, such as, risks and uncertainties. In addition, it emphasizes the need for an evaluation method that takes into account other project attributes as well because the project needs to create value. These attributes affect its value, in addition to the time and cost described in the traditional earned value method. Finally, it was concluded that the framework developed is wide enough to fit into a project that conducts appropriate research to influence attributes.

In addition, Expected Monetary Value (EMV) is another important risk management technique that helps quantify and compare risks in many aspects of a project. Expected Monetary Value (EMV) analysis is not a high-level approximation, but a tool for performing risk quantification because it relies on specific numbers and quantities to perform calculations. Walke and Topkar [26] identify risk factors and classify them into different types of risk. On the basis of the risks identified, the questionnaire is organized into five risk assessment scales to analyze the risks encountered in construction projects.

The large-scale use of these risk assessment methods in bridge construction is a solid theoretical basis for the assessment and management of risks associated with bridge construction and underground engineering, to reduce the number safety accidents and manage construction costs. However, most of the above research methods consider risk assessment primarily based on outcome and possibilities [30], that is, the classical risk description method: $R = P \times C$. However, many scholars have begun to question the rationality of the above definition.

Aven and Ortwin [31] suggested that it would make more sense to use (C, U) instead of (P, C) if the "U" indicates uncertainty. The Society for Risk Analysis (SRA) in 2015 specified that the traditional definition of risk needs to be changed. The risk description associated with the definition of (C, U) can be (C, Q, K), where C indicates a specific consequences; Q is a measure of uncertainty such as probability; and K can be thought of as the background knowledge underlying the C and Q specifications and assignments [32, 33].

Therefore, the purpose of risk assessment is to provide beneficial and reliable information for decision making. The assessment should analyze the need to reduce uncertainty, primarily including objective judgments on existing results based on information and associated uncertainties, and consider the risk assessment phase from a decision-making perspective. From the above analysis, we can see that research on risk decision making has made significant advances in theoretical and technical applications. However, the above studies did not significantly consider the issue of risk assessment in terms of favorable decision making and did not clearly identify the relevance and differences between risk analysts and decision makers.

It can be inferred from the literature that risk assessment of engineering projects plays a decisive role in the success of the project. Several tools have been used to assess the risks and their consequences, and the application of these tools has been extended to all types of projects. However, risk assessment during the cost management phases of the project is not specifically emphasized.

This study employs tools from literature to develop an approach to project risk assessment during the cost estimation and budgeting phases. It is expected to help in proper estimation of contract prices before awarding and better management of detailed project activities during the budgeting phase. The proposed framework provides an outlook for activities that can have a significant impact on the value of the project. Therefore, this work provides a rare, step-by-step quantitative approach for including risk assessment during the cost management phase of a project.

MATERIAL AND METHODS

Risk Analysis and Management

Risk is a measurable part of uncertainty, which allows us to estimate the probability of occurrence and the extent of damage. The risk is considered to be a deviation from the desired level and can be positive or, in some cases, negative. Therefore, risk analysis is very important for project selection and construction coordination. Risk analysis is also considered an adverse event analysis during the planning and programming stages of a construction project. This analysis enhances the decision-making process and provides additional discussion. This helps you choose the best variant of your construction project using a multi-aspect approach. Project risk analysis and management (Figure 1) is a process that enables the analysis and management of project-related risks. Proper implementation increases the chances of a successful project completion and achieves cost, time, and performance goals.

Problem definition

The risks associated with mega-projects have a significant impact on their successful completion and therefore the profits achieved. This research presents a case study of a 900m long bridge construction project. The data used in this study was part of the project's cost estimation and budgeting phase, which evaluated the price and value of the project. In these phases, the rate of profit and risk are defined to submit the optimal project contract value [34].

Therefore, this study describes the evaluation of the project during the estimation and budgeting phase to qualify and quantify the inherent risks. Therefore, present study takes a quantitative approach to risk assessment to provide a suitable framework for use in similar projects.

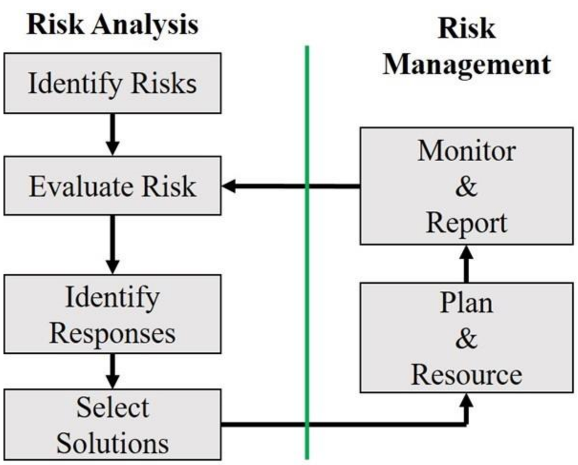

FIGURE 1: RISK ANALYSIS AND MANAGEMENT

PROJECT RISK ANALYSIS APPROACHES

The risk of a bridge construction project is assessed to limit and quantify the impact on the project. In this study, we first investigated the impact on risk and attempted to express the impact on the entire project contract at the estimation stage. Next, evaluate the risk at several stages of the project execution in the budgeting phase, and evaluate the value of the project at each stage.

Expected monetary value

Expected Monetary Value (EMV) is a risk management technique that helps quantify and compare risk in many aspects of a project. Past experience with bridge construction projects has shown that this type of project carries some of the risks shown in Table 1. These risks are categorized according to the measures taken in each situation. In addition, it includes the probability of each event occurring and its impact on cost. The actions taken in all situations are as follows, according to the risk event classification:

1. Avoid
2. Transfer
3. Mitigate
4. Accept
5. Exploit

The present study attempts to address each event with a weighted quantification that corresponds to the impact of the action on the previously estimated total cost. Expected monetary value (EMV) is used to quantify risk with an amount added to the estimated cost and is believed to overcome the consequences of these risks. The key indicator that influences survey decisions is EMV [35]. If the project's EMV is greater than 0, it must be included in the company's portfolio, so it is a reasonable decision to add value to the company's portfolio. EMV is the average of all possible financial outcomes of a project. Table 2 shows the EMV for the six specified risk, and total sum which adds **4,862,000 EGP** (Egyptian Pound) with 3.4% to estimated project price.

TABLE 1: LIST OF PROJECT RISKS

Risk name	Risk event	Probability	Impact in EGP (Egyptian Pound)
Prices increase	Avoid	80%	0
Axis crossing railway false estimation	Accept	85%	5,000,000
Local residents issues	Mitigate	20%	385,000
Equipment export issue	Transfer	35%	200,000
Special test certificate	Transfer	15%	100,000
Resource availability	Mitigate	30%	1,500,000

Parameter Uncertainty Analysis

In geotechnical engineering such as tunnels, bridge construction, and underground engineering, it is important to recognize that many of the risk sources result from geotechnical uncertainty [36]. Parametric uncertainty is one of the most common epistemological uncertainties and can be reduced by gathering more information. Several theories are used to represent uncertainty, such as interval analysis [37], possibility theory [38], and Bayesian probability theory [39]. However, they focus only on solving the hazard problem, (C, Q), ignoring the uncertainty of background knowledge (K), which is important for decision making, as explained at the introduction.

Project risk can be categorized into manageable risk events, and uncertainties, which are unmanageable and unpredictable. Therefore, the concept of risk should not be limited to the probability of risk. Alternatively, risk analysis should take into account unexpected/ or unforeseen surprises and assign more weight to the level of uncertainty and its inherent knowledge. Expressing risk as a probabilistic percentage of occurrence only leads to ignoring the low probability of occurrence and can have catastrophic consequences. One example was the March 2011 disaster at Japan's Fukushima Daiichi Nuclear Power Station, where the tsunami was unlikely to cause the malfunction of all safety precautions. In this case, decision makers did not want to spend time and effort in planning to avoid such low-probability risks [8].

TABLE 2: RISKS EMV

Risk name	Probability	Impact in EGP (Egyptian Pound)	EMV in EGP (Egyptian Pound)
Prices increase	80%	0	0
Axis crossing railway false estimation	85%	5,000,000	4,250,000
Local residents issues	20%	385,000	77,000
Equipment export issue	35%	200,000	70,000
Special test certificate	15%	100,000	15,000
Resource availability	30%	1,500,000	450,000
Total risk value			4,862,000
Total project cost			148,801,872

Therefore, risk uncertainty is more reliable in risk planning and consideration of outcomes. In addition, risk assessors need to have no connection to beneficiaries from any of the decisions made, as risk assessments are not objective and analysis is influenced by expert judgment. In addition, it is necessary to develop a measure of knowledge strength or scoring system based on probability and uncertainty.
Therefore, risk and uncertainty assessments can be explained in three dimensions.

1. Assigned probability of events/consequences (C)
2. Uncertainty (Q)
3. Strength of knowledge (K)

An explanation for this risk is given in (C, Q, K), and Aven and Krohn [9] emphasize that the form and basis of this approach is not simple and requires further investigation. However, in this task, the explanations in (C, Q, K) were used to address risk uncertainty, and Aven and Krohn's guideline [9] was to explain project uncertainty. An example is provided to illustrate the use of the approach.

Example:
Experts determine that a particular risk event has a 40% probability of occurring. Uncertainty inherent in risk is estimated to be 70% and 90% by two different groups. Knowledge strength is scored as 90% of both groups, indicating that the assessor's shows probability and uncertainty based on evidence supporting 90% of the decision.
Therefore, the probabilities of risk events with uncertainty are:
Case 1: (40%, 70%, 90%)
Probability of event=0.4x0.7x0.9=0.252
Case 2: (40%, 90%, 90%)
Probability of event=0.4x0.9x0.9=0.324
This approach supports uncertainty about possible higher risk values. Nevertheless, further investigation is needed to address different types of uncertainty and assign weights related to other aspects.
In addition, Table 3 shows the application of the risk assessment approach to the project's six risk events. The risk value is 0.5% of the total estimated project cost, which adds 710,144 EGP to the total estimated cost. The total cost of the project during the estimation phase is 144,650,016 EGP. Nevertheless, the low risk percentage is questionable, and it turns out that further investigation is needed to see if it really reflects the actual risk impact on project costs and schedules.

Risk-Based Project Value

The above two approaches are useful in the project estimation phase where the available data is not detailed enough and the risk assessment of the project is more comprehensive. However, the next phase of the project budget will require a more detailed risk analysis. In addition, the risks associated with individual activities and their impact on the value of the project need to be considered.
Risk-based project value (RPV) was introduced by Aven and Krohn [9] as a more general and integrated framework for analyzing the value of project activities. Large-scale projects, such as the construction of bridges, are highly associated with the risk of jeopardizing project completion and increasing the probability of termination [8]. In addition, uncertainty is associated with project practice, as projects need to create value and each project is unique in nature and the performance of each project may differ with the type of procurement system used [40].
Therefore, the value of project activities needs to be assessed along with risks and opportunities.
The value that contributes to the activity can be measured by the Earned Value Management System (EVMS). However, if the cost contribution of the activity is zero (or negligible), EVMS does not consider reflecting its progress in the revenue value. The RPV method, on the other hand, evaluates the value of a project based on risk probabilities. Therefore, the value of each activity is defined as an increase in RPV. Following this approach highlights the fact that the more difficult the activity (more likely to be a risk), the higher the expectations of the project if it succeeds, and the greater the contribution to the project.

TABLE 3: RISK ANALYSIS WITH UNCERTAINTY

Risk name	Risk description (C,Q,K)	Probability of event	Impact in EGP (Egyptian Pound)	Risk in estimation in EGP (Egyptian Pound)
Prices increase	(80%, 5%, 90%)	3.6%	0	0
Axis crossing railway false estimation	(85%, 10%, 90%)	7.65%	5,000,000	382,500
Local residents issues	(20%, 50%, 90%)	9%	385,000	34,650
Equipment export issue	(35%, 70%, 90%)	22%	200,000	44,000
Special test certificate	(15%, 70%, 90%)	9.45%	100,000	9,450
Resource availability	(30%, 70%, 90%)	18.9%	1,500,000	283,500
Total risk value				710,144
Total project cost				144,650,016

Project value assessment

The project value assessment evaluates the value of a project at the start, when all risk probabilities are present, and when risk-related activities complete successfully. The RPV analysis is then performed after completing the following planning steps:

a. Work breakdown structures (WBS) and activity network are developed.
b. Costs and schedules are estimated.
c. Risk probabilities are assessed.

Based on the findings of Sato [22] the RPV before the start of project activity can be calculated as follows.

$$RPV = (1 - r)S - C$$

r: activity risk probability of unsuccessful termination
S: income
C: initial cost spent upfront
After completion, the RPV is calculated as follows,

$$RPV = S - C$$

Therefore, RPV will increase when completed successfully by $\boldsymbol{rS}$

This work evaluates the project risk-based value for each activity and reflects the contribution of the work performed during the entire period to the project value. In addition, the activity contribution value (CV) is determined as follows.

$$CV = rS$$

or, for activity i, CV is the increase in RPV after the activity is complete

$$CV_i = RPV_i - RPV_{i-1}$$

Negative CVs are not possible because even if the activity is not added to the RPV, its completion keeps the project value at the same level and adds value by avoiding the uncalculated termination risk. As a result, activities with negative CV values are cancelled to zero.

Table 4 shows all project activities, the associated risks defined earlier, and the total cost and income for each activity. In addition, this table shows the expected value of project income under the risks associated with the project in a particular activity and the evolution of expected income if the activity completes successfully.

RESULTS AND DISCUSSION

The resulting analysis shows that the budget phase contract value after adding the risks and profit to the estimated phase cost is 221,0535,753.26, while the RPV at the start of the project where all risks are present is 10,258,269.31 EGP (Table 5). The value of the project after successful completion has been shown to increase to 26,118,863.26 EGP. This reflects the importance of studying how this ultimate value changes as project activity progresses. In addition, the risk-based value for successful completion of project activities at the start of the project and the overall value share of the project is 4.6%. This increases to nearly 11.8% of the total value upon successful completion of all project activities, including risk-specific activities. Therefore, the percentage (4.6%) shows how risk-specific activities contribute to the value and success of the project. It emphasizes the value of completing risk-specific activities and the benefits of assessing how achieving budget values contributes to the success of the project.

TABLE 4: PROJECT RISKS, COSTS, AND INCOME PER ACTIVITY

Activity	Associated risks	Total Cost **in EGP** (Egyptian Pound)	Income **in EGP** (Egyptian Pound)	Expected value of income **in EGP** (Egyptian Pound)
Pile Excavation	85%	3,656,281.70	4,146,223.44	68,388,462.06
Pile Steel Fixing	0	13,758,019.92	15,601,594.59	68,388,462.06
Pile Pouring RC concrete	0	9,529,604.42	10,806,571.42	68,388,462.06
Pile Bentonite	0	634,969.48	720,055.39	68,388,462.06
Pile Cashing pile head	0	112,897.80	128,026.10	68,388,462.06
Pile cap Excavation	0	58,721.25	66,589.90	68,388,462.06
PC Foundation	0	366,197.88	415,268.40	68,388,462.06
RC foundation	30%	21,983,296.0	24,929,057.68	97,697,802.94
Isolation	35%	83,719.66	94,938.09	150,304,312.22
Columns	0	28,433,245.7	32,243,300.70	150,304,312.22
Backfilling	0	349,331.46	396,141.87	150,304,312.22
Install bearings	0	194,387.60	220,435.53	150,304,312.22
Box Girder	20%	114,962,451	130,367,420.53	187,880,390.27
Painting columns and boxes	15%	360,630.22	408,954.67	221,035,753.26
Handrail	0	433,134.86	491,174.93	221,035,753.26

Table 6 shows the risk-based project value (RPV) and the contribution value (CV) of each activity after each activity of bridge construction is completed. In addition, the RPV for each activity was calculated using the expected income value for a particular activity and its cost. The highest project value (RPV) of 100,120,604.09 EGP was found to have been achieved by completing high-risk isolation activities. Moreover, pile excavation activities contributed most to the project with a CV of 54,473,911.05 EGP followed by isolation activities (52,522,789.62 EGP). Obviously, this is because it has the highest probability of a risk event and emphasizes the substantial contribution of high-risk activities to the value of the project. Interestingly, there was a negative RPV of 6,242,734.65 EGP for box girder activity. This can be explained by the dynamic of calculating the RPV of counting all previous costs of preceding activities, current activity income, and risk probability. At this stage of the project, the box girder activity's income does not cover the upfront cost and the inherent risk probability, and hereby the negative value. The succeeding activity's RPV shows that project income is recovered by successful completion of the current activity and subsequent activities of the project. In fact, this dynamic of the RPV attribute demonstrates the valuable indication of using the concept to evaluate risks in the project and plan actions ahead. Moreover, Table 6 also shows the negative contribution values (CV) of some activities. Negative CVs are not possible because even if the activity is not added to the RPV, its completion keeps the value of the project at the same level and adds value by avoiding the uncalculated end risk. As a result, activities with negative CV values are cancelled to zero.

TABLE 5: PROJECT VALUE AT START AND AFTER COMPLETION

At start	
Contract value	221,035,753.26
Risk-specific activities contribute to the value and success of the project	0.046
RPV	10,258,269.31
After successful completion	
Risk-specific activities contribute to the value and success of the project	0.118
RPV	26,118,863.26

In addition, Figure 2 shows that the highest project value (RPV) achieved by completing high-risk quarantine activities was obtained. This is the result of its high risk, and its completion, along with other risk-related activities completed, contributes significantly to the value of the project. In addition, Figure 3 shows the contribution value of various project activities. The highest risk-related activity has the highest contribution value (CV). In addition, pile excavation activities contributed most to the project, followed by isolation activities.

TABLE 6: RPV AND CV FOR DIFFERENT PROJECT ACTIVITIES

Activity	RPV	CV	CV-modified
Pile Excavation	64,732,180.36	54,473,911.05	54,473,911.0
Pile Steel Fixing	50,974,160.44	-13,758,019.9	0
Pile Pouring RC concrete	41,444,556.02	-9,529,604.42	0
Pile Bentonite	40,809,586.53	-634,969.48	0
Pile Cashing pile head	40,696,688.74	-112,897.80	0
Pile cap Excavation	40,637,967.48	-58,721.25	0
PC Foundation	43,928,051.30	3,290,083.81	3,290,083.81
RC foundation	47,597,814.47	3,669,763.17	3,669,763.17
Isolation	100,120,604.09	52,522,789.62	52,522,789.6
Columns	71,687,358.32	-28,433,245.7	0
Backfilling	71,338,026.86	-349,331.46	0
Install bearings	71,143,639.26	-194,387.60	0
Box Girder	-6,242,734.65	-77,386,373.9	0
Painting columns and boxes	26,551,998.12	32,794,732.77	32,794,732.7
Handrail	26,118,863.26	-433,134.86	0

Conclusions

Larger projects are more likely to be risky, so it was necessary to assess the value of bridge construction projects in the presence of potential risks. A risk analysis at the estimation stage of the project concludes that the risk of bridge construction is 3.4% of the estimated cost and the final total cost of the project is 148,801,872 EGP. In addition, an approach is presented to explain the risk analysis and the uncertainty of the assigned probabilities. This approach helps explain the high degree of uncertainty. Nonetheless, further research is needed to fully utilize this approach in risk analysis.

For the budgeting phase, after defining associated risks to activities, RPV was assessed before the start of the project when all risks exist to be 10,258,269.31 EGP, and after completion of all activities the value increased to be 26,118,863.26 EGP. This highlighted the benefits of successful completion of the risk-associated activities. Furthermore, RPV at each activity was calculated using expected value of income at this specific activity and its costs. Patently, the activity to contribute the most to the project is the one that carried the highest risk event probability, which stressed the substantial contribution of high-risk activities to the project value.

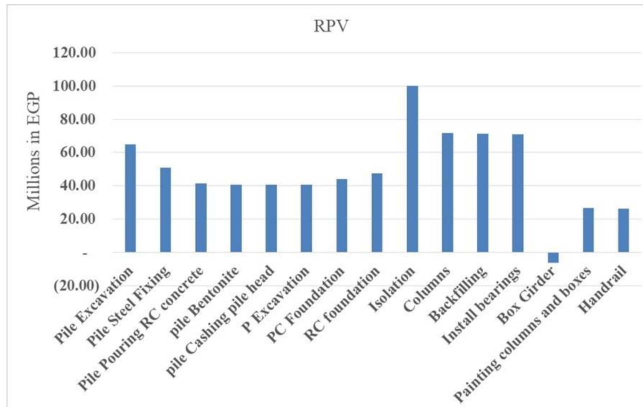

FIGURE 2: COMPARISONS OF DIFFERENT ACTIVITIES WITH RESPECT TO RISK-BASED PROJECT VALUE

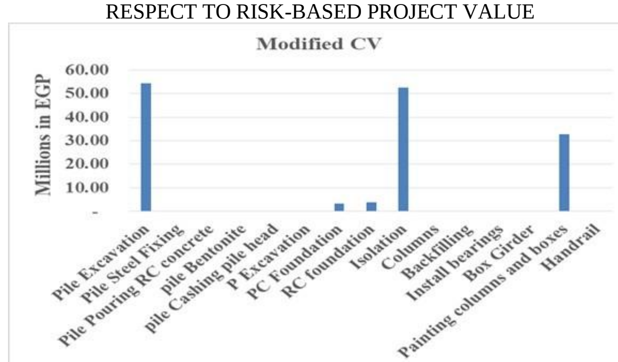

FIGURE 3: COMPARISONS OF DIFFERENT PROJECT ACTIVITIES WITH RESPECT TO CONTRIBUTION VALUE

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