

## Title

Construction and Infrastructure Projects : Cost Management Index

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## The Abstract

This research delves deep into the cost overruns in construction and infrastructure projects, exploring the reasons behind the discrepancies between planned expenses and actual costs. Our ultimate goal? To uncover effective strategies for monitoring and controlling project costs while establishing key performance indicators throughout the project lifecycle.

To achieve this, the research tackled four pivotal questions that shine a light on the complexities of cost estimation related to risks in construction projects. We examined how these estimations fit within the broader context of project management knowledge and scrutinized existing methods used by construction organizations. Our mission is to develop a robust project cost management framework that seamlessly integrates with all project knowledge areas, enhancing monitoring and control procedures.

Our research employs a dynamic mixed-methods approach that combines both qualitative and quantitative techniques. We gathered insights from a survey of 373 respondents, complemented by in-depth interviews with 95 project managers. This dual approach allows us to paint a comprehensive picture of the issues at hand, revealing rich perspectives and nuanced answers.

From our thorough literature review, we formulated three key hypotheses, each of which we rigorously tested during our analysis. The findings were promising:

Hypothesis 1: A well-managed project risk plan—encompassing the identification, analysis, and control of risks—can significantly mitigate cost overruns.

Hypothesis 2: Diligently studying project costs at the outset paves the way for better budget adherence down the line.

Hypothesis 3: Implementing Earned Value Management (EVM) throughout the project lifecycle offers powerful indicators that aid in monitoring and controlling cost overruns.

**Key Words:** Project Management, Cost Index, Risk Managemenet

## **Chapter 1 Introduction and Research Objectives**

### **1.1. Research Topic**

"Cost control and Cost Management Index: Construction and Infrastructure Projects."

### **1.2. Statement of the Problem & Research Importance**

The infrastructure and construction projects evolve rapidly regarding their diversity, size and financial budget, and to keep up with that development needs to adapt to contemporary changes, e.g. (dynamic project performance, flexible to change, quality assurance, human resource performance). The impact of this development illustrated in project processes from initiation to close. Therefore it should be used dynamic project management tools to analyse the cost elements for these projects.

The importance of this research is to study and analyse the reasons for exceeding the actual cost of construction and infrastructure projects comparing with the planned cost, and then find adequate procedures capable of control the costs of projects within the specified framework and without cost overrun, and measure the performance of these costs throughout the project lifecycle, and to reveal gaps and deviations from the planned cost. According to Vrijling & Redeker (1993), there are many projects where actual costs exceed planned costs, especially infrastructure projects.

### **1.3. The primary objectives of the research will address that**

- Cost estimation of risk for construction and infrastructure project as an integral part of project knowledge areas, which aims to comply with the actual project cost with the planned project budget.
- Developing project cost management as an integrated part of all project knowledge areas, e.g. (Schedule, Resource, Risk, and Procurement) which endeavours to control project cost elements and making rational decisions effectively.
- Develop and Improve monitoring procedures and control project cost management.

**The research will discuss and answer four questions to illustrate the research aim in-depth, which are:**

1. What is the effect of estimated costs of risk on project budget cost and their relation to a cost overrun?
2. What is the effect of cost estimates a rough order of magnitude (ROM) during the initial process of project management life-cycle on project budget cost?
3. Does the allocation of resources during project planning process effect on project budget cost?
4. How to monitor and measure the performance of project costs and early detection the cost overruns during all project processes?

#### **1.4.The Research Literature**

Project cost management is the backbone of project completion within the scope of the contract, where the project cost management aims to estimate the financial resources required for the project, aggregating those cost estimates and working on monitoring and controlling the budget of the project. Therefore, estimating project costs requires proper planning which contributes to estimating the cost of each activity in the project accurately, specifying the control thresholds for the variables that occur in the project cost management and the permitted flexibility limits associated with the variables e.g.(construction risk, cost reserve) that take place in the project during the different stages of the work.

Accordingly, the researchers have been studied the impact of independent and dependent factors and diversity variables on the project cost management; The research will review a number of the literature of these researchers and studies as follows.

**Olawale & Sun (2010)** conducted research based on positivism epistemology; the research was mixed of the interviews, and questionnaire, the research was carried on 250 construction projects organisations in the United Kingdom. The research reveals the major five inhibiting factors on cost overrun, these factors are uncertainties, design changes, inaccurate estimation of project duration, complexities, and non-performance of subcontractors. The weaknesses of the research undertaken by Olawale & Sun (2010) were the focus only on the analysis of design errors without study and analysis other critical variables that related to cost overrun such as schedule or resources.

**Love et al., (2010)** conducted research based on the positivist epistemology, the result of their research was that the most critical reason for cost overrun in construction projects is the re-work. According to Love et al., (2002a) the cons of the research approach which did not include different

management cultures, inflation, and market volatility factors were not considered, as well the pros was an Experimental study of the theory, which ensures confirmation of the hypotheses.

**Flyvbjerg et al., (2002)** conducted research based on epistemology method; they were concluded that decision making, tender, and the contract should be accurately studied during the planning process, while **Olawale & Sun (2010)** focused on an indispensable component, which is the project schedule by complying with the project budget cost, which had a definite impact on the research results, but their research has weakness to take other elements that also related to the project schedule, and cause cost overruns such as risks, and resources.

**Zwikael & Sadeh (2007)** conducted research based on constructionist epistemology method; they have studied project risk management and indicated that the risk process takes place throughout the project life cycle and direct impact to the productivity of the work, and weakness of project risk study leads to increased project costs. Therefore, One of the research weaknesses is that did not address how to estimate risk costs.

**Other studies**, for instance, "Planning project management" by Dinsmore, P. C. (1985); "Seven excuses for resisting schedule management" by Plaza, T. J. (2000); "Cost/schedule control systems criteria under inflation" by Farid, F. et al.,(1988); "Forecasting the final cost and schedule results" by Fleming, Q. W. et al., (1996) , " Grow your own cost tracking system" by Jones, M. (2002).

Most of the above researchers were based on the study of the influence of the independent, and dependent factors among different project elements such as performance rates, schedule, resources, and without focusing on some other critical factors such as risks and human resources. According to Love et al., (2002a) research, weak planning negatively affects project deliverables and leads to increasing actual costs than planned.

## **1.5. Conclusion**

From the literature review, it can be concluded that there is much research was based on a quantitative approach, which analysed the reasons for cost overrun in construction projects, where the quantitative approach is more structured, stable and predefined to ensure precision in measurement and verify reliability and validity and provide sufficient details to answer the research questions.

However, most of these studies which were based on literature review did not clarify the methods of measuring and estimate the cost of risk, as well the accuracy of project budget cost accounting at the initiation process and how resources are allocated during the project lifecycle. There is an inaccuracy in the study of the project cost during the initiation process, which is the backbone of the project.

The literature review concluded that most of the reasons for the increase in project costs were due to delayed schedule, weak analysis project costs elements, and failure to estimate project risk costs within final budget costs. Therefore, it is convenient to combine both quantitative and descriptive methods to obtain more in-depth results associated with inferences (Easterby-Smith et al., 2012). Also, The use of positivist epistemology suitable for studying and analysing the gap between the planned costs and the actual costs and the relationship of project costs with other variables.

## **1.6. The Research Questions**

The research aims to study the causes for increasing the planned cost compare with the actual costs for construction and infrastructure projects. The research will discuss the following questions:

### **1-What is the effect of estimated costs of risk on project budget cost and their relation to a cost overrun?**

Georgas, P. G., (1986) indicated that there is a direct link between the project risk process and the other project knowledge areas, which act as a homogeneous weave to obtain project deliverables as planned, but most of the previous research has not been identified and estimation project risks as an embedded of project management.

### **2-What is the effect of cost estimates a rough order of magnitude (ROM) during the initial process of project management life-cycle on project budget cost?**

Most of the construction organisations, whether profitable or non-profit, have conditions for purchase, which is the value of spending and a degree of sophistication, both of which have a different influence on the type and quality of the product or service.

A contemporary issue that required tackling, it is the precise identification of project requirements that are required to be obtained. These requirements come from the competitive nature of the procurement process to be done professionally.

"The project management team's is entirely responsible that all procurements must meet the specific project requirements within the procurement regulations within the organisation " (Project Management Institute, 2013, p.357).

### **3-Does the allocation of resources during project planning process can affect project budget cost?**

Project resources are the turning point for the success of construction and infrastructure projects. Therefore, proper planning for project resource allocation by identifying the quantities and types required and according to the project schedule will contribute efficiently to doing the project on the right track, and according to Olawale & Sun (2010) indicated that the lack of project resources provided align with the project schedule leads to project cost overrun.

### **4-How to monitor and measure the performance of project costs and early detection the cost overruns by the method of (EVM) during all project processes?**

In the infrastructure and construction projects, the purpose of monitoring and control is to achieve the project aim based on the project schedule, this aim can be obtained by focusing on the use of effective measuring and monitoring tools such as EVM (Earned Value Management), which is crucial tool to measuring project indicators such as costs and time during all the different project processes, thus contributing to the diagnosis of the project performance along their life cycle (Project Management Institute, 2013, p.217).

## **1.7. Research Design and Approach**

The chapter will discuss the methodology and design of the research, which needed to obtain the research sample and data analysis, as well the research methods used in data collection. Furthermore, ethical problems, bias, and reliability and their impact on data collection. According to Easterby-Smith et al., (2012, p.19) "the essential research concept was based on internal realism ontology, where the reality exists but can only be obtained through indirect methods". This research based on the positivist epistemology, where positivism involves to "real knowledge" including reliable measurement (Crowther & Lancaster, 2008).

The research will combine the qualitative and quantitative methods by the mixed method to obtain data from various perspectives and in-depth (Creswell & Plano Clark, 2007, p.5). This method expresses the integration of statistical data and logical explanations to obtain data from the research sample, according to Easterby-Smith et al., (2012, p.26) "the researcher needs to collect various perspectives by a mixture of quantitative and qualitative approaches, This approach is sometimes described as triangulation". Cameron et al., (2015) indicated the mixed method provides innovative way rather than traditional procedures. Also, mixed methods promote the use of triangulation to explains results more clearly and validate research.

Regarding the advantages of the research methodology, one of the essential pros is the measurement of the characteristics of the work environment, rather than theoretical abstraction. Concerning the use of quantitative methods, which are an integral part of the mixed research approach, the data will be collected through the survey questionnaire and then analysed using statistical tools to obtain the results. Kothari, C. R. (2004), indicated that quantitative approach is concerned with the measurement and study effect of an issue by measurable results, the advantage of this methods:

- The researcher can control all research variables which are related to the dependent variable.
- Quantitative research aims to explore statistical results that are objectively explained.
- The data will be presented by using the statistical programs such as (SPSS, Excel Sheets).

The research will use reputable secondary sources such as, local and global articles and studies that related to the research subject.



## **1.8.Sampling Data**

The research community includes the competent project management organisations and the large construction organisations in development disciplines.

The research study will include 5 of leading construction and infrastructure organisations in the Arabian Gulf, and the Middle East, each of these organisations has been covering at least 3,000 engineers and technicians, they are a specialist in the construction and infrastructure industry.

The research will use a mixed approach, "It can be good ways of collecting data about the opinions and behaviour of a vast number of people, as long as they are done well" (Easterby-Smith et al., 2012, p. 230).

## **1.9.Data Gathering Tools and Techniques**

The research will be based on quantitative, qualitative approach. For the collecting qualitative data, the researcher will design interviews at least three interviews per organisation will be conducted with total 15 interviews with project managers and relevant stakeholders, and for conducting quantitative approach the most common methods are closed-ended questionnaires, which lead to the accomplishment of the research purpose.

The questionnaires will be distributed to about 70-80 participants from five different leading construction organisations. The questionnaires will be made available to project managers and project management team members and regarding their relationship with the stakeholders that may have an adverse impact on the project planning process, and then delayed implementation. The questionnaires will be distributed randomly to prevent biased of respondents.

The results of quantitative methods will be provided to forecast Construction Cost Indexes (CCI), which will estimate by analysing and predicting work package costs that are proportional to schedule, e.g. market price, employee level, work permits, and financial flow.

Trustworthy sources will be used to collect statistical data, e.g. Global articles, reports published by the global organisations, and the governmental bodies accredited.

## Chapter 2 Literature Review

### 2.1.Introduction

Annually, many of infrastructure and construction projects are being constructed around the world. The statistics results indicate that the actual cost of these projects is predominantly higher than the planned cost. Flyvbjerg et al., (2002) refers to infrastructure projects (e.g., roads, bridges, and rail) are reported to have an 86% probability of outrunning their set cost targets due to inadequate planning, where the planning process is an embedded of project management.

Project cost management is a set of tools, skills, and knowledge, which are integrated for contributing to planning, monitor performance, and implementation of project deliverables, according to Project Management Institute (2013, p.47) "Project management is the understanding and application of each of the tools, skills, and knowledge required for each of the resources and activities of the project within its specified requirements". Also, contemporary project management provides procedures to monitor and control workflow, which guides project managers before the flaw occurred to ensure success.

Based on above, the research literature concludes that knowledge of project cost management has a significant role in achieving the objectives with the desired level of quality performance.

### 2.2.Literature Review

The research will review the literature of the following researchers:

**Love et al., (2010)** conducted research entitled "Rework in Civil Infrastructure Projects" was based on a survey of the causes that contributed to increasing the costs of infrastructure projects. A questionnaire survey of a sample of 115 infrastructure projects was used, and the survey results indicate that a critical factor that increases the cost of infrastructure projects, is the re-work factor. The results were analysed by statistical equations, e.g., regression analysis model; which results indicate that the percentage of cost increases up to 10% of project contract value.

The cause of that cost overrun as explained by Love et al., (2010) was due to five significant predictive factors which lead to increased costs; they are as follows:

- Lack of defined working procedure.
- Changes made at the request of the customer.
- The inefficient use of information technology.
- Lack of transparent contractor procedures to improve quality.

- Effective Participation of stakeholders in the project.

The study suggests that there is an essential relation between re-work and both of costs and schedule, which directly affect costs. Also, the study suggested that organisations involved in the infrastructure industry may need to improve the design verification process, as well improve and develop the planning and documentation process.

The research by **Lopez et al., (2012)** entitled "Design Error Costs in Construction Projects" which was based on a sample survey of 20 engineering consulting organisations supervising on 139 projects in the design of construction projects. The sample was divided into 45% architects and 55% engineers (civil, electrical, mechanical, structural, and hydraulic). The following hypotheses were formulated and studied:

- There is a significant relationship between the design errors costs and the types of procurement method.
- There is an essential relationship between the costs of design errors and types of construction and engineering projects.

The total cost of design errors was estimated from the total direct and indirect costs which provided by the respondents. The results as shown in Figure 2.1 below, show the mean (M) and the standard deviation (SD) of the total design error costs of contract value.

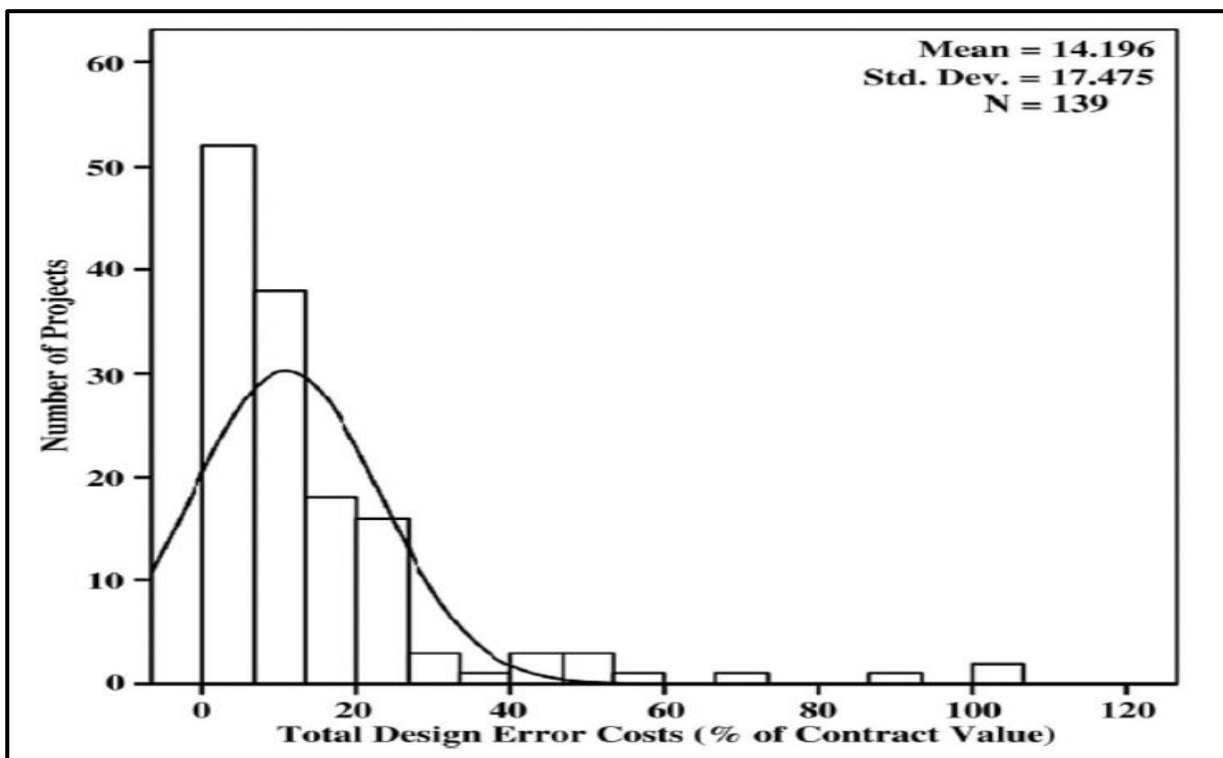


Figure 2.1 Total Design Error Costs as Percent of Contract Value

Robert Lopez et al. (2012, p.589)

The survey question for the selected sample of the construction projects 139 was "What is the relationship between the design errors costs and the methods of procurement?".

The research results were indicated that the mean and standard of deviation percentage of design errors according to the research hypothesis was ( $M = 14.2\%$ ,  $SD = 17.47\%$ ) of the total direct and indirect costs, and that was due to the use of traditional methods of procurement. Also, some architects indicated that clients developed unrealistic schedule plans for preparation of project documents, which contributes to design errors and increases project costs.

The final results of the study indicate that there is no significant relationship between the types of projects and procurement methods.

The research by **Flyvbjerg et al., (2002)**, entitled "Cost Underestimation in Public Works Projects" was based on a research sample of 258 transportation infrastructure projects. The research study was to interpret the effect of four factors on the increase of costs; these factors analysed were; technical, economic, psychological, and political. The research objective to answer the questions "What is the difference between the planned costs and the nominal costs of transport infrastructure projects? Are there any significant differences or errors? Are these errors, if any, random? What is the impact of policies on the development of transport infrastructure projects?"

The statistical conclusions made by Flyvbjerg and his research team, as shown in Figure 2.2 below:

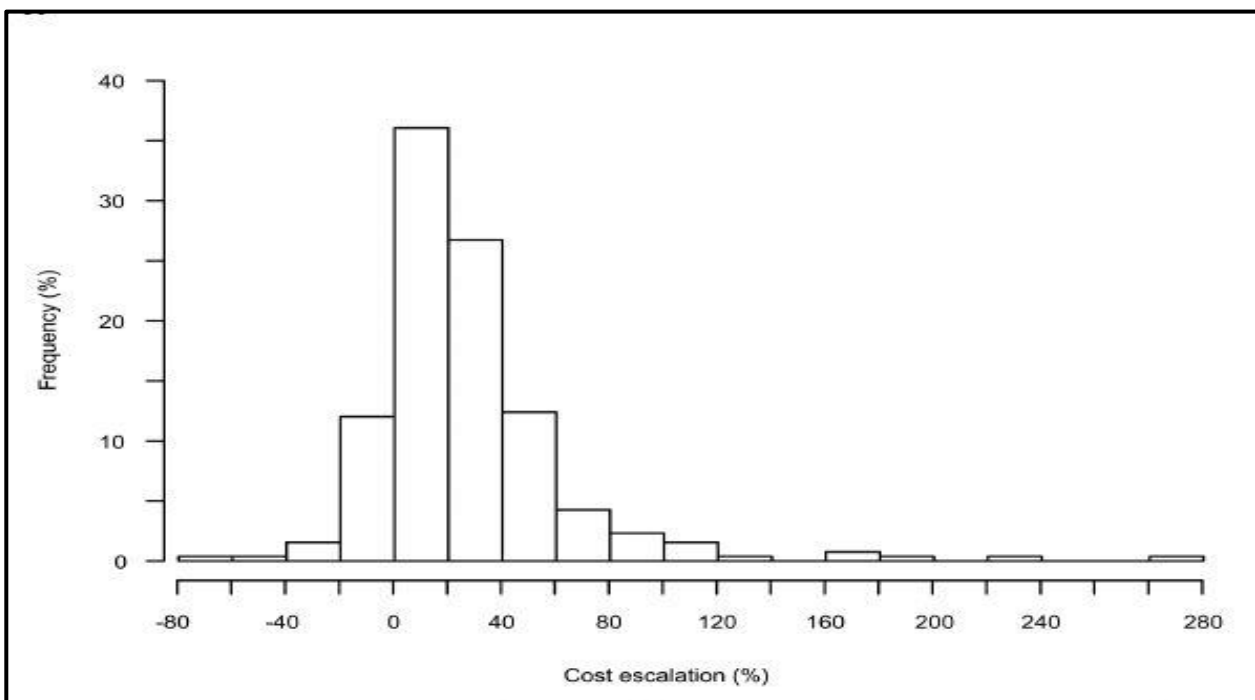


Figure 2.2 The inaccuracy of cost estimates in 258 transportation infrastructure projects (fixed prices)  
Flyvbjerg et al., (2012, p.36)

The histogram above showed the relation between the cost of escalation percentage and the frequency percentage, where the frequency means the number of times the event "cost increasing" which occurred in the sample of research.

Table 2-1 below, showed the results of inaccuracy of transportation project cost estimates by type of project.

Table 2-1 Inaccuracy of transportation project cost estimate  
Flyvbjerg et al., (2012, p.39)

Type of project	Number of cases (N)	Average Cost escalation (%)	Standard deviation	Level of significance, (p)
Rail	58	44.7	38.4	<0.001
Fixed links	33	33.8	62.4	<0.004
Roads	167	20.4	29.9	<0.001
All Projects	258	27.6	38.7	<0.001

Based on the above histogram Figure 2.2 and statistical Table 2-1, the results of the research can be summarised as follows:

- The error in estimating costs at initial phase is much more than the error in overstating costs during the implementation phase.
- The cost estimate for the initial phase of the project is the basis for the final cost estimate.
- The average difference between actual and planned costs is substantial. Also, there is an essential difference between the geographical distribution of projects and cost estimates.
- For all project types, actual costs exceed planned costs by 28%.
- There is a significant impact of regulations and policies on estimating the final costs of transport infrastructure projects.

**Olawale & Sun (2010)** conducted research entitled "Cost and Time Control of Construction Projects" based on a combination of quantitative and qualitative methods. The researcher's data collection tools were a questionnaire, and semi-structured interviews, with 250 construction project organisations in the UK. From the research perspective, five significant factors contribute to increasing the costs of construction and infrastructure projects; these factors are the cost of design changes, an inaccurate estimate of the project schedule, uncertainties, complexities, and weak of production rates of subcontractors.

The research questions were based on two phases: first, the questionnaire phase, where the researcher used 22 multiple-choice questions for the research sample, 250 organisations, and 150 for construction organisations and 100 for construction consultant's organisations. The questionnaire survey purpose was to identify the procedures and tools used to control the time and cost of construction projects, as well the factors that may inhibit it.

The second phase consisted of 15 interviews from 15 companies with an average age of 26.8 years. The objective of the interviews was to explore in greater depth the issues that were carried out by the questionnaire survey results. The research questions were about the importance of the use of monitor and control tools for both time and cost.

The sample results found that 84% of construction and infrastructure projects used cost control tools. Also, 16% of the respondents indicated that sometimes the cost control tools are applied to the projects. The researchers pointed to the use of diverse tools to control costs, including project cost value reconciliation, Project Costing System (PCS), and Program Evaluation and Review Technique (PERT/COST), other tools and their usage ratios, as shown in Table 2-2 below:

Table 2-2 Techniques used for project cost control  
Olawale & Sun (2010, pp.509 – 526)

Cost Control Techniques	Contractors	Consultants
Project Cost-Value Reconciliation	22%	20%
Overall profit or Loss	15%	16%
Profit or loss on each contract at valuation dates	1700%	10%
Labor/Plant/Material (actual versus forecast reconciliation)	18%	11%
Unit Costing	8%	13%
Standard Costing	6%	14%
Earned Value Analysis	7%	11%
Program Evaluation and Review	7%	4%
Technique (PERT/COST) Leading Parameter Method	0%	1%

Table 2-3 below, showed the percentage of use of the software package used for cost control of both contractors and consultant’s organisations.

Table 2-3 Software packages used for project cost control  
 Olawale & Sun (2010, pp.509 – 526)

Software Package	Contractors	Consultants
Bespoke/in-house Systems	29%	38%
Microsoft Project	20%	32%
Project Costing System (PCS)	15%	11%
Asta Power Project	15%	5%
Primavera Sure Trak	8%	5%
Microsoft Excel	7%	3%
COINS	5%	3%
WinQS	0%	3%

Despite the use of cost control tools and time control as shown in Table 2-3 above, Nevertheless, the research indicated that there is an issue of overrun both costs and time than the planned value in construction projects, as shown in Table 2-4 below:

Table 2-4 Proportion of projects that encounter cost and time overruns  
 Olawale & Sun (2010, pp.509-526)

Proportion of Projects	Time Overrun	Cost Overrun
> 90%	2.9%	4.4%
60 - 90 %	1.5%	7.4%
40 - 60 %	8.8%	11.8%
10 - 40 %	48.5%	35.3%
< 10 %	38.2%	41.2%

According to Olawale & Sun (2010), the questionnaire was looked for the most critical factors hindering the control of construction projects. The research results showed that more than 60 factors that affect the cost control and time of construction projects. The respondents were asked to rank these factors according to priority and their impact on their projects, and the results were as shown in Table 2-5 below:

Table 2-5 Software packages used for project cost control  
 Olawale & Sun (2010, pp.509-526)

Time control inhibiting factors	Rank	Relative importance index (RII)
Design changes	1	0.94
Inaccurate evaluation of projects time/duration	2	0.94
Complexity of works	3	0.86
Risk and uncertainty associated with projects	4	0.85
Non-performance of subcontractors and nominated suppliers	5	0.85
Lack of proper training and experience of PM	6	0.78
Discrepancies in contract documentation	7	0.77
Low-skilled manpower	8	0.74
Conflict between project parties	9	0.74
Unpredictable weather conditions	10	0.74
Financing and payment for completed works	11	0.73
Contract and specification interpretation disagreement	12	0.71
Dependency on imported materials	13	0.66
Lack of appropriate software	14	0.61
Inflation of prices	15	0.58
Weak regulation and control	16	0.55
Project fraud and corruption	17	0.5
Unstable government policies	18	0.47
Unstable interest rate	19	0.46
Fluctuation of currency/exchange rate	20	0.45

The study results concluded that there is a close relationship between the factors that hinder time and cost control. The research results in 90 factors mitigated measures to address these problems and can be classified into three categories as preventive, predictive, and corrective.

Olawale & Sun (2010) pointed to the need for future research to detect more factors inhibiting costs and time during the control process, as well the need to measure the effectiveness of methods of mitigating measures to address the project problems for cost and time overrun.



**Fleming & Koppelman (1996)** conducted research entitled "Forecasting the final cost and schedule results" which was based on a statistical study of construction projects in the United States. One of the unique characteristics of this sample was the US Defense Department. The research aims to study the importance of using the methods of forecasting the final costs and the schedule of construction projects by using two methods; the first was estimating the project cost from the bottom-up, and second, measuring the actual performance of the project compared to planned performance.

Fleming et al., (1996) concluded essential points based on his study, as followed:

- Three critical variable factors affect the use of tools to measure the project performance (Actual Performance Versus the Plan, Management Determination, and Quality of the Project Plan)
- It is necessary to use the measurement tools of the actual project performance against the planned performance.
- The precision evaluation of the critical path, in addition to the completion of the planned work package, support project managers to complete the project deliverables at the estimated cost and time.

The result of the research was that two tools could be used to measure the project's performance time and cost critical path method (CPM), and Earned Value despite the limited use of the Earned Value.

The research by **Doloi H. (2012)** entitled "Cost Overruns and Failure in Project Management" was based on constructionism epistemology, the research method was used survey and case study which aimed to determine the factors affecting cost performance from consultants, contractors, and clients. The research focused on studying the elements of increasing costs from three points of view, namely the (contractor, consultant, and owner), and highlighted the initial planning stage to study the state of the expected costs.

The research found that both of the delays in the periodic payments of contractors' and the inefficient performance of contractors lead to increased costs of projects (Flyvbjerg et al., 2004).

**The research by Doloi (2012) concluded the following results:**

- The need to control cost overruns for construction projects; some research indicates that both contractor and owner are causing these cost overruns.
- Consultants and contractors have an essential responsibility to control project costs.
- Communication between the project management team and key stakeholders should be activated to reduce cost overruns.

- It should be set cost baseline among project parties to monitoring project budget costs (Iyer et al., 2005).
- Construction design and work breakdown structure (WBS) should be evident in the planning process of the project.

**Reilly & Brown (2004)** conducted research entitled "Management and Control of Cost and Risk for Tunnelling and Infrastructure Projects" were studied the formulation of a method for estimating project risks within a structured methodology to eventually become an integral part of the project costs, this methodology has been employed to infrastructure projects in US, which valued at approximately \$ 25 billion.

Reilly et al., (2004) suggest that there are expected variables that are likely to affect overall project costs. Accordingly, Reilly et al., (2004) referred to a new approach which is Cost Estimate Validation Process (CEVP). This approach (CEVP) provides to the project management team to identify risks and to develop strategic risk management plans.

Although this approach noted the critical role of risks costs in infrastructure projects, this approach did not illustrate how to use risk analysis and assessment in other construction projects.

The results of the research urged the need to develop accurate methods to define and measure risk methodology and develop strategic plans to deal with it, as well to develop methods of measuring the risk limits, which would have to be rejected or accepted to increase the costs within the permissible limits. Also, measurement indicators should be created to measure cost baseline. Accordingly, risk should be studied as one of the most critical variables.

### **2.3.Literature Review Summary**

By reviewing the literature and based on the previous researchers, it was found that the reasons for exceeding the costs of construction projects and infrastructure due to the gap between practice and theory. For instance, Lopez et al., (2012) research show weaknesses were focused on design errors, which are the critical element of increasing project costs, although the project design is the most crucial project documents which project implementation is based. Nevertheless, Lopez et al., (2012) didn't regard with another knowledge area, such as resources, and schedule that directly depends on the design of the project. While, Flyvbjerg et al., (2002) relied entirely on the study of project cost overrun about the planned value during the implementation phase without considering the cost estimation in the initiation process. Olawale & Sun (2010) pointed out to there was limited research does not explore other variables, such as risk, quality, and resource was not considered.

**Also, some of the gaps that will be answered by the research which can be illustrated in the next points:**

- Lack of precision costs estimation, due to the failure to study and analyse all elements of the project work package accurately during the initiation phase, and therefore most of the design and technical errors during the progress of the project are occurring, which leads to increased costs.
- There was a deficiency in some studies that were researched the relationship between other project knowledge areas, e.g., scope, resources, risk and their relation to cost overrun.
- Most of the cost estimation studies did not consider the resource allocation and project risks as crucial elements in cost estimation.
- Project risks and project cost estimation during the initiation phase were not the subject of intensive study by researchers during literature review.

According to Iyer et al., (2005), the indicators of the project can be monitored during its implementation, through the uses of convenient monitoring and control tools.

## 2.4. Research Hypotheses

According to Black & Champion (1976, p.126), "a hypothesis is a temporary conclusion that is proposed at the beginning of the research to explain a phenomenon or problem". From analysis the literature review, the research hypotheses were formed based on the above research questions, as follows:

### 2.4.1. Development of Hypothesis 1

According to Vrijling & Redeker (1993) pointed out that many projects, especially infrastructure, have been exceeded their costs because of "unforeseen events", these unforeseen events or risks lie in construction, design and infrastructure projects (ITA 1992). Reilly & Thompson (2001) have conducted a survey, in which 1,400 projects were selected worldwide. This number was then selected to 40 projects representing different types, and categories of projects. The results of the study indicate that 30-50% of deficient management and cost overrun in the project due to a lack of identification and control project risk.

The final cost of any project is subject to some variables that significantly affect the expected cost and from these essential variables the potential project risks (Grasso et al., 2002).

The above review of literature allowed to formulate the following hypothesis:

**H1: Managing the project risk plan, e.g., (identify, analysis, and control risks) of each project will contribute positively to controlling cost overruns.**

### 2.4.2. Development of Hypothesis 2

Akinsola et al., (1997) conducted analysis in the U.K on 46 completed projects to study Factors that cause excess of costs in construction projects, and the results of the research are many, and the most important was percentage of design completed before tender, and adequacy of information provided, which affect project estimates when studied and that reasons lead to project cost overrun than planned. Also, Peter et al., (1997) conducted research to study factors that cause cost overruns for construction projects, one of the necessary research results were inaccurate estimates during project study.

Recent studies have been conducted to analyse the reasons for increasing costs in construction and infrastructure projects. Mansfield et al., (1994) surveyed 50 contractors, consultants, and clients. The research results for increased costs were design changes, shortage resources, inaccurate project estimates at the initial process.

Based on above studies and according to Baloi & Price (2003), the cost estimation process intended to forecast expenditures, and for the success of this process, it should be the integration of accurate information and control of project implementation and resource allocation.

The above review of literature allowed to formulate the following hypothesis:

**H2: Study of project costs accurately during the initial process will contribute positively to controlling cost overruns.**

### **2.4.3. Development of Hypothesis 3**

Salvucci (2003) and Flyvbjerg (2002) indicated that the cost overrun of infrastructure projects mainly due to the lack of cost control during the project life cycle. Also, Iyer et al., (2005) pointed to the importance of the role of consultant and contractor equally to the monitor and control of project cost and therefore was an urgent need to find ways to control the project costs during the implementation process. According to Project Management Institute (2011), the project control process maintains the regular performance of the work within the permitted scope to ensure the implementation of the project.

Earned Value Management (EVM) is one of the contemporary tools of project management, which has the ability to early warning of the indicators of the project time or cost, whether progress or delay, and used by comparing the planned baseline of the project to actual performance and the difference between them is the performance indicator of the project, which shows increased costs for planned costs, Or contains the actual costs within the scope of the project.

According to the definition of Project Management Institute (2013, p.217) "(EVM) it is the combination of project scope, resources and time, which support the project management team to evaluate the project's progress".

The above review of literature allowed to formulate the following hypothesis:

**H3: Using Earned value management (EVM) method during the project lifecycle will provide strong indicators that contributed to monitor and control project cost overruns.**

## Chapter 3 Research Design and Methodology

### 3.1.Introduction

This chapter discusses the literature review of a research method. From the literature review, it was found that most of the researchers have been using descriptive or quantitative approaches separately, and only a few of this researchers have been using the mixed method. For instance:

Research conducted by Love et al., (2010); Flyvbjerg et al., (2002); Fleming et al., (1996); and Doloi H. (2012), was based on quantitative approach, where the cons of that method, when used separately, is that error in the assumptions during the estimation of statistics leads to a flaw in the results that negatively affect the method of research.

Therefore, the researcher's had to look deeply at the different views to verify the research hypotheses. Some researchers, whose has been studied increasing the costs for construction projects and infrastructure that used mixed approaches as illustrated in the next paragraphs. For instance:

Olawale & Sun (2010) and Robert Lopez et al., (2012) used research based on the mixed approach that has succeeded in addressing these researchers genuinely within their hypotheses.

However, the researchers lacked to study other essential factors that affect the cost of projects directly or indirectly, such as studying project risks; estimating project costs accurately during the initial process; loading project resources during the planning process, and cost monitoring and control procedures.

Accordingly, this research adopts the use of mixed approaches. On the one hand, it uses the descriptive approach, where the primary objective is to understand and interpret the present to guide the future. It also involves predicting the future of phenomena and events that it studies by explaining the change in a previous phenomenon to allow people to plan for aspects of the future. According to Yin, R. K. (2011) "Qualitative approach can explain the answers to questions through a variety of perspectives; the descriptive approach is based on the study of the phenomenon as it exists. It is concerned with a precise description and is expressed as useful and clarifies characteristics".

On the other hand, a quantitative approach is based on statistical and estimates processes. Therefore, it is concerned with the variables that include the measurement of the characteristics. A quantitative approach aims to test and validate hypotheses; this is performed by defining the hypotheses that already exists in the previous literature, where the relations between the variables are assumed, and the data are collected and analysed statistically, and based on the results obtained, the hypotheses are accepted or rejected. According to Kothari, C. R. (2004) who indicated that the quantitative approach seeks to obtain the causes and facts and the relationships between variables so that these variables can explain cause-and-effect relationships, and it becomes possible to arrive at accurate predictions about phenomena under study.

### **3.2.Mixed Approach**

A mixed approach was used, which is often a good idea to use a subsequent study to interpret the results appropriately and to confirm the results of the study to respond the research questions and to obtain sufficient understanding of the research problem, according to Easterby-Smith et al., (2012) Mixed methods defined as the integration of the quantitative and descriptive approach, where it shows that the weaknesses of each can be complemented by another, for example, descriptive approach cannot be generalized, as well the quantitative approach cannot explain the reasons for the results obtained, so the integration of the two approaches lead to the maximum benefit from their strengths. According to Cameron et al., (2015) "the mixed research approach promotes the use of unconventional strategies, furthermore, the use of triangulation to add an in-depth explanation of search results".

Some of the results of the quantitative study need further explanation to understand the meaning of the results, and some of these results are not enough to reach explanations in depth from individuals or units of research to serve the problem of research. While quantitative results can illustrate the relationships between different elements or factors in general, To get a real and clear understanding of the results of statistical tests or their impact, that is often not possible. Therefore, data and qualitative results can help to obtain-on this in-depth understanding (Easterby-Smith et al., 2012). Based on the above, it can be argued that integrated research, in this case, helps us to reach a better understanding and more than one perspective, especially if such an in-depth and comprehensive knowledge is needed.

### **3.3. Advantages of Mixed Approach**

#### **a- The need to generalise the results of an exploratory study.**

When studying the problem of research, and in some cases it sometimes happens that the researcher does not have enough information to help interpret the research questions, so it is often preferred to perform an exploratory study to get a more in-depth understanding of the research questions, as well factors and theories that are relevant to the research questions. After the exploratory study, quantitative research can be performed and try to generalise the results.

#### **b-The need to improve the outcomes of a study using an additional research method.**

In this case, the researcher uses an additional secondary research method in the study to obtain a better knowledge of some parts of the study before the essential study.

#### **c-The need to understand the goal of the research objectives through more than one research stage.**

In large and complex projects, which may last for years and influenced by a researcher, the research project or scientific study is often complex and involves many aspects, objectives, and objects that the team seeks to study scientifically. In such cases, team members often need to undertake some studies and then attempt to link them to a research objective or to understand better or exceed a stage of the study.

### **3.4. Disadvantages of Mixed Approach**

According to Easterby-Smith et al., (2012, p.63), the disadvantages of mixed methods are the following:

- The design of the research must match the research questions.
- It needs some resources, unlike other individual methods.
- The difficulty of repetition.
- Researcher skills are required to use both qualitative and quantitative research methods.

### **3.5. Population and Sample Size**

The research focuses on the reasons for exceeding the actual cost of construction and infrastructure projects comparing with the planned cost. It also the research units of analysis were selected to be five of construction and infrastructure organizations whose geographic span includes two regions, which are the Arabian Gulf and North of Africa, each of them has at least 3,000 engineers and technicians working in construction and infrastructure projects, as well the research population includes both of privately and government organizations, which trading on the stock exchanges.



### 3.6.Data Collection Methods

The research uses the concurrent triangulation strategy, which depends on quantitative and qualitative data collection at a single stage, followed by the stage of comparing qualitative results with quantity and whether quantitative results are consistent with qualitative results.

According to Easterby-Smith et al., (2012, p.26) "The researchers' needs to collect various aspects of a mix of qualitative and quantitative methods, this approach is sometimes described as triangulation".

Questionnaire method will be employed to collect quantitative data, and interview method to collect qualitative data.

According to Easterby-Smith et al., (2012) t the principal references for the research method will be collected by (Questionnaire, and Structured Interview method), which will be discussed in detail in the following lines, and as shown in Figure 3.1.

To collect qualitative data, the research used 15-20 interviews open-ended questions.

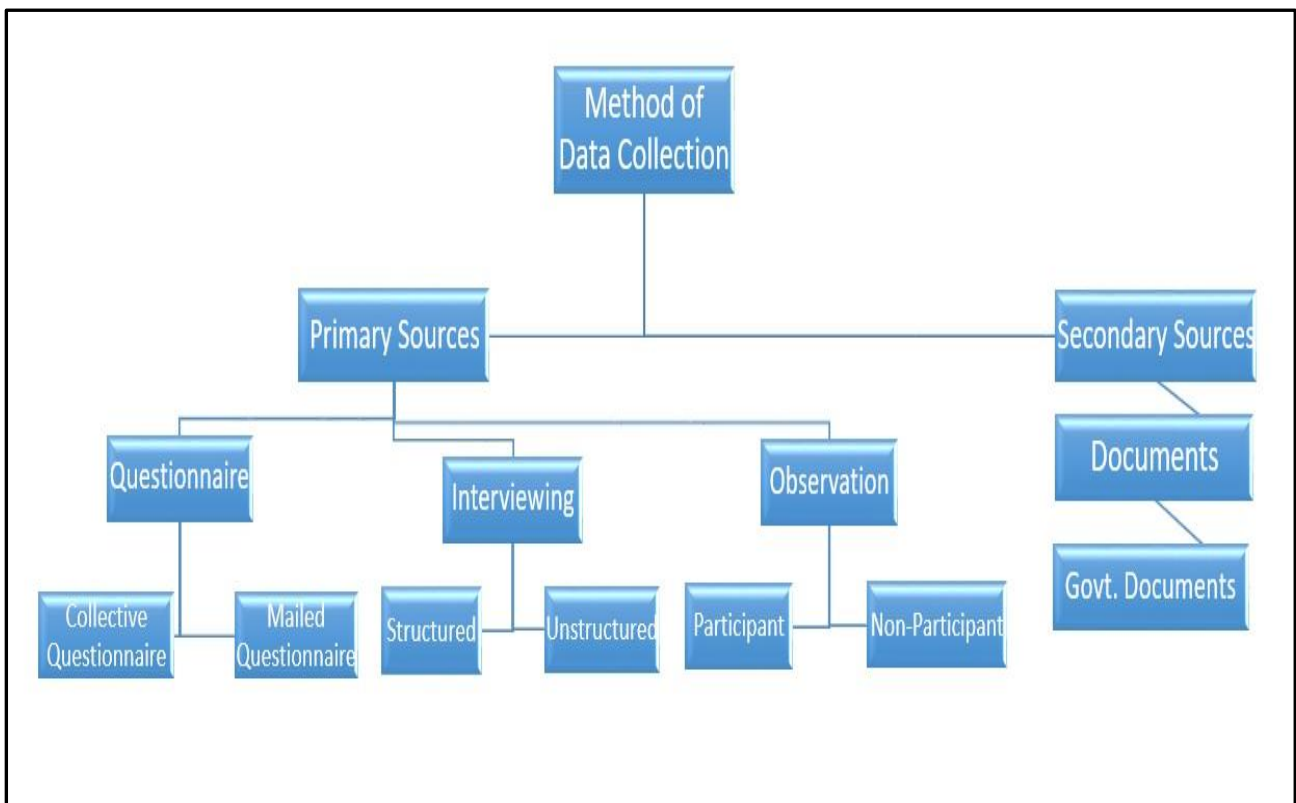


Figure 3.1 Method of data collection

Kumar R. (2011)

### **3.6.1. Interview Method**

Ghuri & Gronhaug (2002) argue that the qualitative research results based on in-depth, where interviews are essential because respondents get a more and accurate perception. According to Burns (1997, p.329), "an interview is an oral interchange, in which an interviewer attempts to obtain information, or opinions of another person". The interviews were based on project managers and effective stakeholders of construction and infrastructure organisations, because both of project managers and effective stakeholders can make decisions, therefore they have an integrated vision of the factors affecting the performance of projects knowledge areas. The interviews were conducted face to face, where limits misinterpretation of questions and provide interviewers in the flow of information.

The advantage of structured interview method is that provides standardised information, which ensures the possibility of comparison of information and does not require this particular method skill. It is also suitable for in-depth information extraction. It is also available to explain questions and can be used in different populations such as diversity of ages and roles (Easterby-Smith et al., 2012).

There is a disadvantage, where the quality of the information depends on the quality of the interviewers, as well consuming time and effort. The interview questions aim to answer in depth the questions of the research through different perspectives, and then analyse questions results and match them with research hypotheses.

Based on the explanation above of the interview objectives, the research interview questions developed a list of (6) structured questions, which is attached to the Appendix at the end of the research. The research interview sample will be between 15 - 20 interviewer of project managers and stakeholders.

### **3.6.2. Questionnaire Method**

The questionnaire is a list of questions relevant to the research questions, which the respondents record the responses, the difference between questionnaire and the interview, which are interviews is conducted to respondents in which the dialogue and explanation of the questions, but in the questionnaire, the answers are written by the respondents themselves (Kumar, R., 2011).

Also, the sequence of questions came up from the easy to the hardest, so that the purpose of the questionnaire for the respondents was smooth and understood, Questionnaire advantages are saving time, effort and inexpensive.

The research sample will be between 70 - 80 respondents who are involved in project management; the questionnaire will be distributed randomly to prevent bias.

The research questionnaire was divided into four sections, which are (Personal information, Job role, Educational Qualification, and questionnaire questions)

The research questionnaire questions are contained (7) questions will evaluate by frequency scale which is divided to (0=Never, 1=rarely, 2=sometimes, 3=often, and 4=always). One of the most advantage to the frequency scale is collected data on behaviours instead of attitudes or preferences, which will be attached to the appendices at the end of the research.

### **3.7. Reliability of Questionnaire**

To obtain a reliable and valid questionnaire, it should avoid using the "leading questions." This reliability and validation can be done by the following points, and according to Lydeard (1991), to use the questionnaire as an influential tool:

- Identify the scope of research by discussing and analysis relevant literature.
- Formulate research questions after reviewing the literature.
- Select the research sample and motivate them to pay attention to the response.
- Lead the research test for validity and reliability.
- Access to sources of errors if any.

### **3.8. The relation between research theoretical framework aim and research survey**

Tables 3-1 and Table 3-2 respectively illustrate the relationship between research questions; questionnaire, and interview questions.

Table 3-1

Relation between Research Questions and Research Questionnaire

Research Questions		Q1	Q2	Q3	Q4
Research questionnaire		What is the effect of estimated costs of risk on project budget cost and their relation to a cost overrun?	What is the effect of cost estimates a rough order of magnitude (ROM) during the initial process of project management life-cycle on project budget cost?	Does the allocation of resources during project planning process effect on project budget cost?	How to monitor and measure the performance of project costs and early detection the cost overruns by the method of (EVM) during all project processes?
Questionnaire	1	Is there a competent contract administration to study project costs budget during the initiation process?		Relevant	
	2	Are the WBS (Work Breakdown Structure) create during the planning process?		Relevant	
	3	Does the Procurement plan be submitted and approved before implementation begins?		Relevant	Relevant
	4	Does the Risk Plan be submitted and approved before implementation process?	Relevant		
	5	Are all project resources allocated to planned costs for project activities?			Relevant
	6	Are there contingency reserve to work package cost estimations?	Relevant	Relevant	
	7	Is the EVM (Earned value management)* system applicable?			

Table 3-2

Relation between Research Questions and Research Interview Questions

Research Questions		Q1	Q2	Q3	Q4
Research questions Interview		What is the effect of estimated costs of risk on project budget cost and their relation to a cost overrun?	What is the effect of cost estimates a rough order of magnitude (ROM) during the initial process of project management life-cycle on project budget cost?	Does the allocation of resources during project planning process effect on project budget cost?	How to monitor and measure the performance of project costs and early detection the cost overruns by the method of (EVM) during all project processes?
Interview	Q1	During the project initiation process, is the project cost accurately estimated along the project lifecycle?		Relevant	
	Q2	Are the actual resources allocated to the project and according to the project schedule based on the project lifecycle?			Relevant
	Q3	Are project risk register identified, and why?	Relevant		
	Q4	Are Qualitative and quantitative risk analysis performed during the planning process?	Relevant		
	Q5	Are there a plan for monitoring and controlling cost management?			Relevant
	Q6	Are there a cost control procedures within the project cost limits?			Relevant

## **Chapter 4 : Results, Analysis and Evaluation of Findings**

The research data collection methods consist of two parts: a survey questionnaire based on the quantitative approach, and interview questions based on the descriptive approach.

### **4.1. Interview Questions**

The research interview questions are contained (6) questions. The researcher conducted interviews with 15 project managers and relevant stakeholders based on a qualitative approach to obtain in-depth results of research questions.

### **4.2. Questionnaire Questions**

The research questionnaire questions are contained (7) questions which evaluated by frequency scale and divided to (0=Never, 1=rarely, 2=sometimes, 3=often, and 4=always).

The research sample included 73 respondents of different Job roles and experiences whose have a direct impact on decision-making in the construction industry and infrastructure.

### **4.3.Descriptive Statistics**

Standard deviation, mean, median, mode, Std. The error of Mean, as well as variance, are presented in Table 4-13 in Appendix 2. The skewness and kurtosis values of all variables were below 1.0, suggesting normal distribution.

#### **4.3.1. Validity**

According to definition by Campbell, D. T. & Stanley, J. C. (1963) Validity is the ability of tools used in research to measure the proposed measure. Cho and Trent (2006) identify two distinct approaches to validity, which are transactional, and transformational, these approaches are based on mutual interactive between the researcher and the subject of research using the tools dedicated such as triangulation. Therefore, the interview method was used to enhance the credibility of the data further and to validate the accuracy of information obtained.

#### **4.3.2. Reliability Analysis**

To measure reliability and, according to the Cronbach, L. J. (1951). The Cronbach alpha is used to measure the homogeneity of the responses of the individuals in the research sample; the reliability analysis was used to get information to help us make a decision.

There is no doubt that validity and reliability should be taken into consideration when evaluating the quality of a measuring tool, where reliability refers to the degree to which the measuring tool

can provide information relevant to the decision to be constructed so that the reliability coefficients give us an idea of the degree of consistency.

Reliability is also defined as the degree of consistency between data collected by re-applying the same measures to the same individuals or phenomena, under the same conditions or similar conditions to the most considerable extent possible.

According to Carmines & Zeller (1991) reliability is the ability of the tools to give the same results if the same measurement was repeated several times in the same conditions. The statistical reliability is the ratio of real variation to total variance, or square of the correlation coefficient between real and virtual signs. Since we never know the real signs, stability cannot be estimated in this way, and all we have are the virtual signs, i.e., obtaining a statistical index to judge the accuracy of the measurement and this indicator is called (Reliability Coefficient).

Based on the results of the questionnaire analysis, the reliability was as shown in Table 4-1 below:

Table 4-1  
Reliability Statistics

Cronbach's Alpha	Cronbach's Alpha Based on Standardized Items	N of Items
0.885	0.904	7

Based on Table 4-1 above, Cronbach's Alpha has an overall raw alpha of 0.904 (rounded from 0.885 from the top of the table). According to Nunnally (1978, p.245), 0.70 is an acceptable reliability coefficient. Consequently, the result of the alpha coefficient is excellent considering that 0.70 is the cut-off value for being acceptable.

#### 4.4. Analysis Sample Size Personal Information

After obtaining the results of questionnaires, the data was analysed through the SPSS. Table 4-2 shows the classification of the research sample according to their job role. The results analysis shows that project managers made up the most proportion of sample 45.21% then project planners 20.55%, project engineers 19.18%, and finally procurement management 15.07%.

It can be explained that the most proportion of sample is from project managers, where the project managers are directly responsible for the use of procedures affecting in the execution, monitoring, and control of the scope of work.

Table 4-2  
Job Role

Job Role	Frequency	Percent %	Cumulative %
Project Manager	33	45.21%	45.21%
Project Engineer	14	19.18%	64.38%
Project Planner	15	20.55%	84.93%
Procurement Management	11	15.07%	100.00%
Total	73	100.00%	

Table 4-3 below, shows the frequency, percentage and cumulative percentage of the data sample based on their ages (See Appendix 2).

Table 4-3  
Age of Respondent

Age (Year)	Frequency	Percent %	Cumulative %
22-39	29	39.73%	39.73%
30-39	31	42.47%	82.19%
>39	13	17.81%	100.00%
Total	73	100.00%	

Table 4-4, shows the frequency, percentage and cumulative percentage of the data sample based on their education and certification.

Table 4-4  
Education & Certification

Certification	Frequency	Percent %	Cumulative %
Bachelor's degree BSc.	67	91.78%	91.78%
Bachelor's degree + Master's Degree	1	1.37%	93.15%
bachelor's degree + Project management professional(PMP)	5	6.85%	100.00%
Total	73	100.00%	

Table 4-5 below, shows the frequency, percentage and cumulative percentage of the data sample based on their experiences.



Table 4-5  
Years of Working Experiences

Years of Experiences	Frequency	Percent %	Cumulative %
0-5	5	6.85%	6.85%
6-10	32	43.84%	50.68%
11-15	18	24.66%	75.34%
>15	18	24.66%	100.00%
Total	73	100.00%	

#### 4.5. Analysis of Quantitative and Qualitative Research Results

In the following lines, the research will review the results of quantitative and qualitative analysis of the research questions based on the results of the interviews, as well the questionnaire survey, and the three research hypotheses discussed in the literature review chapter will be verified.

##### 4.5.1. Research Question (1)

Referring to the research question number 1, "What is the effect of estimated costs of risk on project budget cost and their relation to a cost overrun?", Research question number 1 was related to the questionnaire questions number 4 and number 6, as shown in Table 3-1 in Appendix 2. The quantitative data analysis results were obtained, as shown in Table 4-6 and Table 4-7 below:

Table 4-6  
Q.4) Does the Risk plan be submitted and approved  
before implementation process?

Index	Frequency	Percent	Cumulative Percent
No	0	0.0	0.0
Rarely	7	9.6%	9.6%
Sometimes	37	50.70%	60.30%
Often	26	35.60%	95.90%
Always	3	4.10%	100.00%
Total	73	100.0%	

Table 4-7  
Q.6) Are there (contingency reserves) allocated to  
work package cost estimation?

Index	Frequency	Percent	Cumulative Percent
No	5	6.8%	6.8%
Rarely	1	1.4%	8.2%
Sometimes	9	12.3%	20.5%
Often	35	47.9%	68.5%
Always	23	31.5%	100.0%
Total	73	100.0%	

#### 4.5.1.1. Statistical Results

Referring to Table 4-6 above, the results of the study shows that 50.70 % of the participants agree that the risk plan "sometimes" is submitted and approved before the implementation begins, while 35.60% of the sample indicated that risk plan is "often" submitted and approved before the implementation, and only 4.10 % of the participants indicated that risk plan is "always" submitted and approved before the implementation.

Referring to Table 4-7 above, the results of the study shows that 12.30 % of the participants agree that contingency reserves are "sometimes" allocated to work package cost estimation, while 47.90% of the sample indicated that contingency reserves are "often" add to work package cost estimation, and 31.50 % of the participants indicated that "always" add contingency reserves to work package cost estimation.

#### 4.5.1.2. Quantitative Analysis

Referring to the results above, find that the vast majority of the sample indicated that "sometimes" the risk plan is submitted and approved before implementation, and 47.90% of the sample stated that contingency reserves are "often" add to work package cost estimation.

Based on the statistical results above, concluding that the procurement and contracts department of the organization tends to take into account the addition of contingency reserves, which representing a percentage of the contract value, due to the likelihood that project risk plan may not be evaluated and approved prior to implementation, which will lead to increased costs if not accurately estimated.

### 4.5.1.3. Qualitative Analysis

To study the statistical results in a more in-depth method, the research question number 1 which related to the interview questions number 3 and number 4, as shown in Table 3-1 in Appendix 2. Consequently, the interview was conducted with the project managers as they had the primary responsibility for the project. The results, as shown in Figure 4.5 below, indicates that 60% of project managers answered that risk register is not identified, where according to answer project manager interview number 3, who said that "The risk register identified does not identify, because of the risk management plan is not submitted and approved during the planning process", and According to answer project manager interview number 5, who said that "Not", because the organisation management does not have clear risk procedures, I think non-definition of risk contributes to increased both of project budget cost and project schedule". as shown in Appendix 3. The project's managers justified that for reasons including:

- The risk management plan is not submitted and approved during the planning process.
- The organisation's procedures do not often concern the importance of creating a risk management plan.
- The organisation does not assign risk manager to projects to define and manage risks.

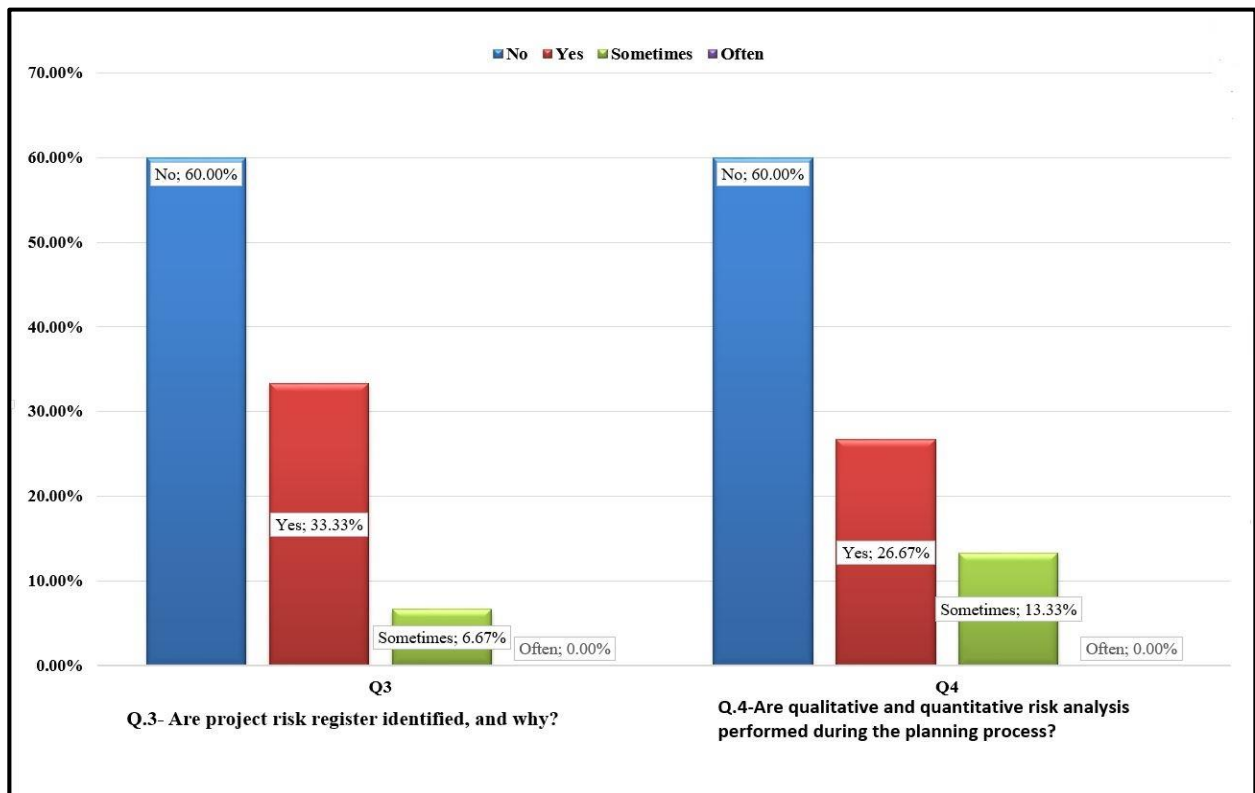


Figure 4.5  
Percentage of responses to research question 1

#### 4.5.1.4.Hypothesis Verification (H1)

Referring to Figure 4.5 above, shows that 40% of the project managers responded that the project risk plan is defined during the project planning process, and thus the risk qualitative and quantitative analysis is estimated, which is included in the procedures of calculating the project budget cost and therefore can control the cost overruns, where one of the primary objectives of the research is to estimate the costs of risk within the total project costs.

Reilly et al., (2004) identified that risk reduction related to cost control through risk definition, analysis, and contingency planning if necessary, is an essential management activity.

Consequently, non-definition of risks contributes to increased both of project budget cost and project schedule, that is illustrated by the addition of resources to project activities to compensate for the lost time periods, and hence cost overrun is occurred.

Accordingly, and based on the research question number 1, **the research hypothesis (H1) has been verified positively**, which is "Managing the project risk plan, e.g., (identify, analysis, and control risks) of each project will contribute positively to controlling cost overruns".

#### 4.5.2. Research Question (2)

Referring to the research question number 2, "What is the effect of cost estimates a rough order of magnitude (ROM) during the initial process of project management life-cycle on project budget cost?", Research question number 2 was related to the questionnaire questions number 1, number 3, and number 6, as shown in Table 3-1 in Appendix 2. The quantitative data analysis results were obtained, as shown in Table 4-7, Table 4-8 and Table 4-9, respectively below:

Table 4-7  
Q.6) Are there (contingency reserves) allocated to work package cost estimation?

Index	Frequency	Percent	Cumulative Percent
No	5	6.8%	6.8%
Rarely	1	1.4%	8.2%
Sometimes	9	12.3%	20.5%
Often	35	47.9%	68.5%
Always	23	31.5%	100.0%
Total	73	100.0%	

Table 4-8

Q.1) Is there a competent contract administration to study project costs budget during the initiation process?

Index	Frequency	Percent	Cumulative Percent
No	0	0.00%	0.00%
Rarely	0	0.00%	0.00%
Sometimes	7	9.59%	9.59%
Often	19	26.03%	35.62%
Always	47	64.38%	100.00%
Total	73	100.0%	

Table 4-9

Q.3) Does the Procurement plan be submitted and approved before implementation begins?

Index	Frequency	Percent	Cumulative Percent
No	0	0.00%	0.00%
Rarely	1	1.37%	1.37%
Sometimes	25	34.25%	35.62%
Often	39	53.42%	89.04%
Always	8	10.96%	100.00%
Total	73	100.00%	

#### 4.5.2.1. Statistical Results

Referring to Table 4-8 above, the results of the study shows that 64.38 % of the participants agree that contract costs "Always" are studied during the initiation process by a competent department, while 26.03% of the sample indicate that "often" contract costs are analyzed, and only 9.59 % of the participants indicate that "sometimes" contract costs are studied during the initiation process.

Referring to Table 4-9 above, the results of the study shows that 53.42 % of the participants agree that the procurement plan "often" is submitted and approved before the implementation begins, while 34.25% of the sample indicate that "sometimes" the procurement plan is submitted and approved, and only 10.96 % of the participants indicates that "always" the procurement plan is submitted and approved before the implementation. Refer to results of Table 4-7, which was explained above earlier.

#### **4.5.2.2.Quantitative Analysis**

Based on the statistical results, as shown in Table 4-8 above, concluded that vast majority of the sample with 64.38% indicating that there is a specific contract department "always" to study the costs of contracts during the initiation process. Also, referring to Table 4-9, the most proportion of the research sample with 53.42% indicates that the procurement plan "often" is submitted and approved before implementation begins, and compared to 34.24 % of the sample indicate that "sometimes" the procurement plan is submitted and approved before implementation, as well and referring to Table 4-7 above, the vast majority of the sample with 47.90% indicating that the contract administration “often” add contingency reserves to work package cost estimation.

Based on the statistical results, concluded that the contract and procurement administration of the project studies the project budget costs by developing the project requirements of resources during the initiation process and then participate in preparing the project procurement plan with the project managers and submitted it for approval.

However, and should take into account that 47.90% of the sample, indicates that the contract administration “often” add contingency reserves to work package cost estimates. The results mean that the contract administration tends to add approximate percentage value of the total contract value to be combined with the total project budget costs, and therefore the project costs not estimated accurately, and that could increase potential costs.

#### **4.5.2.3.Qualitative Analysis**

According to the statistical results above, and to understand the statistical data in a more explanatory and according to the descriptive approach, interviews were conducted with the project managers, refer to Table 3.2 in Appendix 2, which was related to the interview question number 1. The results, as shown in Figure 4.6 below, indicate that the percentage responses for the interviewees were almost identical between "Yes" 26.67%; "No" 26.67 %; "often" 13.33%, and "Sometimes" 33.33%. In accordance with the response of the project manager to interview number 7, who said that "Not quite accurately along the project life cycle, because of the some external factors, and are not taken into account such as inflation and increase prices", and according to the response of the project manager to interview number 1, who said that "Often, not done in an accurate manner for most of the project processes", as shown in Appendix 3. The project's managers were justified that to some factors, such as:

- Project budget cost estimated roughly according to the value of the contract sometimes between " $\pm 5\%$ " and others " $\pm 10\%$ ", which do not give the actual amount of the costs.
- External factors, which are not taken into account such as inflation and increase market prices.
- Often the project site is not received clearly and accurately, on which project cost estimation are based, such as the nature of the site soil, roads and transport, services, and employment residence, which have a direct impact on project budget costs.

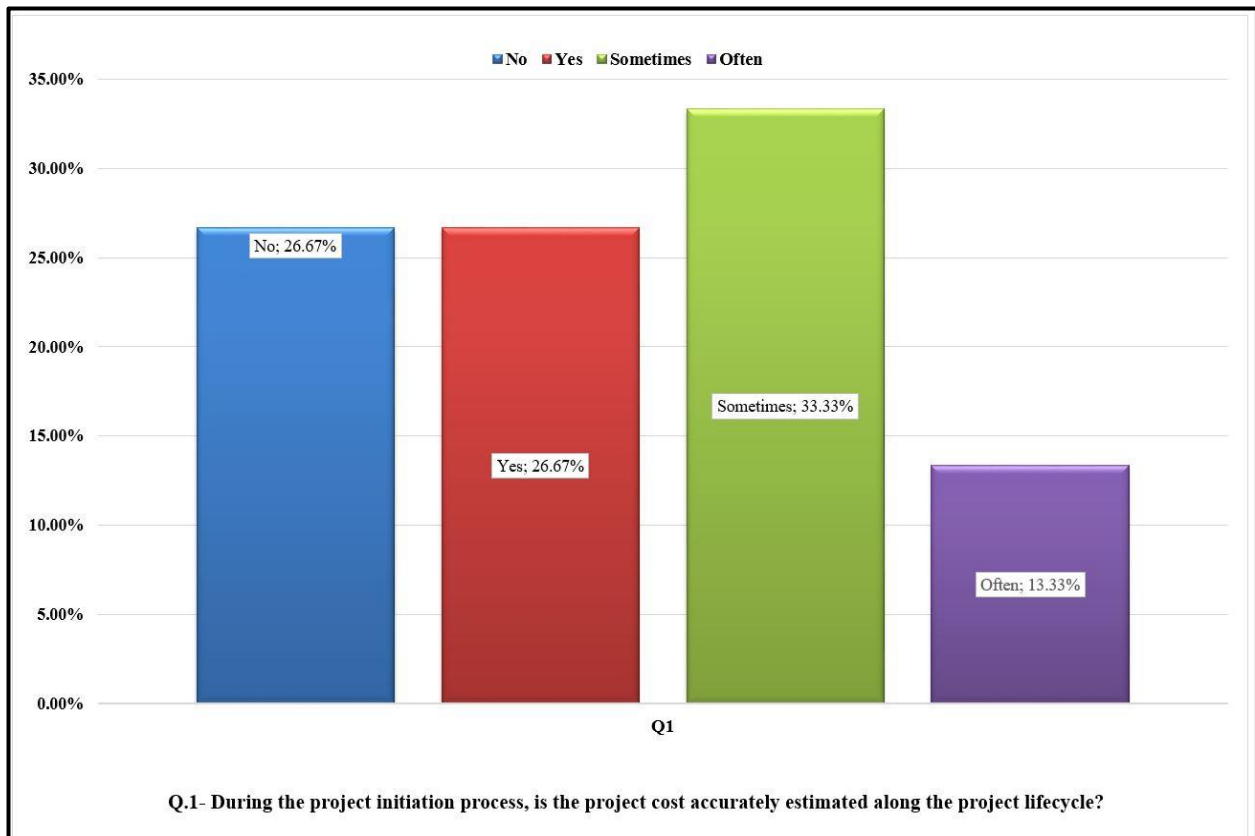


Figure 4.6  
Percentage of responses to research question 2

The result confirms what has been described according to project research question number 2, that a rough order magnitude (ROM) is estimated for the project contract during the initial process and not in a precise method, which affects on increased costs of the project than planned.

Peter et al., (1997) conducted research entitled "Factors influencing construction time and cost overruns on high-rise projects in Indonesia," The results of the study concluded that cost overrun is due to inaccurate estimates during the initial project phase.

#### 4.5.3. Research Question (3)

Referring to the research question number 3, "Does the allocation of resources during project planning process effect on project budget cost?", Research question number 3 was related to the

questionnaire questions number 2, number 3, and number 5, as shown in Table 3-1 in Appendix 2. The quantitative data analysis results were obtained, as shown in Table 4-9, Table 4-10 and Table 4-11 below:

Table 4-9  
Q.3) Does the Procurement plan be submitted and approved before implementation begins?

Index	Frequency	Percent	Cumulative Percent
No	0	0.00%	0.00%
Rarely	1	1.37%	1.37%
Sometimes	25	34.25%	35.62%
Often	39	53.42%	89.04%
Always	8	10.96%	100.00%
Total	73	100.00%	

Table 4-10  
Q.2) Are the WBS (Work Breakdown Structure) create during the planning process?

Index	Frequency	Percent	Cumulative Percent
No	3	4.11%	4.11%
Rarely	0	0.00%	4.11%
Sometimes	11	15.07%	19.18%
Often	48	65.75%	84.93%
Always	11	15.07%	100.00%
Total	73	100.00%	

Table 4-11  
Q.5) Are all project resources allocated to planned costs for project activities?

Index	Frequency	Percent	Cumulative Percent
No	5	6.85%	6.85%
Rarely	1	1.37%	8.22%
Sometimes	40	54.79%	63.01%
Often	24	32.88%	95.89%
Always	3	4.11%	100.00%
Total	73	100.00%	



#### **4.5.3.1. Statistical Results**

Referring to Table 4-10 above, the results of the study shows that 65.75 % of the participants agree that the WBS (Work Breakdown Structure) "Often" is created during the planning process, while that 15.07% of the sample indicate that "sometimes" the WBS (Work Breakdown Structure) is created, and the same percent to answer "Always" with 15.07%, and only 4.01 % of the participants are indicated that "No" the WBS (Work Breakdown Structure) is created during the planning process.

Based on the results of the study, according to Table 4-11 above, show that 54.79 % of the participants agree that all project resources are "sometimes" allocated to project activities and according to planned costs, while 32.88% of the sample indicate that "often" project resources are allocated to project activities, and 6.85 % of the participants indicated that "No" allocated to project activities and according to planned costs. Refer to results of Table 4-9, which was explained above earlier.

#### **4.5.3.2. Quantitative Analysis**

Based on the statistical results above, the resulting sample means that decomposition of the total scope of work, and project deliverables subdivided into smaller, more manageable components, and these are the first steps on the right track to determining costs accurately. However, through the above results, the resources required for the project activities are not allocated as planned, Thus increasing actual costs compared with planned cost.

#### **4.5.3.3. Qualitative Analysis**

To study the quantitative results in more depth as part of triangulation method, refer to Table 3-2 in Appendix 2, and refer to the interviews results analysis, which was related to the interview questions number 2. The results, as shown in Figure 4.7 below, indicate that 40% of interviewees confirmed that actual resources are not allocated to the project compliance with the project schedule during the project lifecycle, and causing cost overruns. In accordance with the response of the project manager to interview number 2, who said that "Actual resources are not allocated accurately throughout the project life-cycle and according to the project schedule because the schedule depends on the ideal cases, while in fact there are many obstacles", and according to the response of the project manager to interview number 10, who said that "Resources are not allocated according to the project schedule because of other external factors, such as transport, variable raw

materials prices and natural factors (torrents) which prevent implementation on time", as shown in Appendix 3. The project's managers were justified that to several factors, for instance:

- The project schedule depends on the ideal cases, while in reality there are many obstacles factors beyond control prevent access to resources on time.
- The approved procurement project plan and due to delayed supply.
- Approved project schedule baseline.
- External factors, such as transport, variable raw materials prices, and natural disaster factors, e.g. (torrents) which prevent implementation on time.

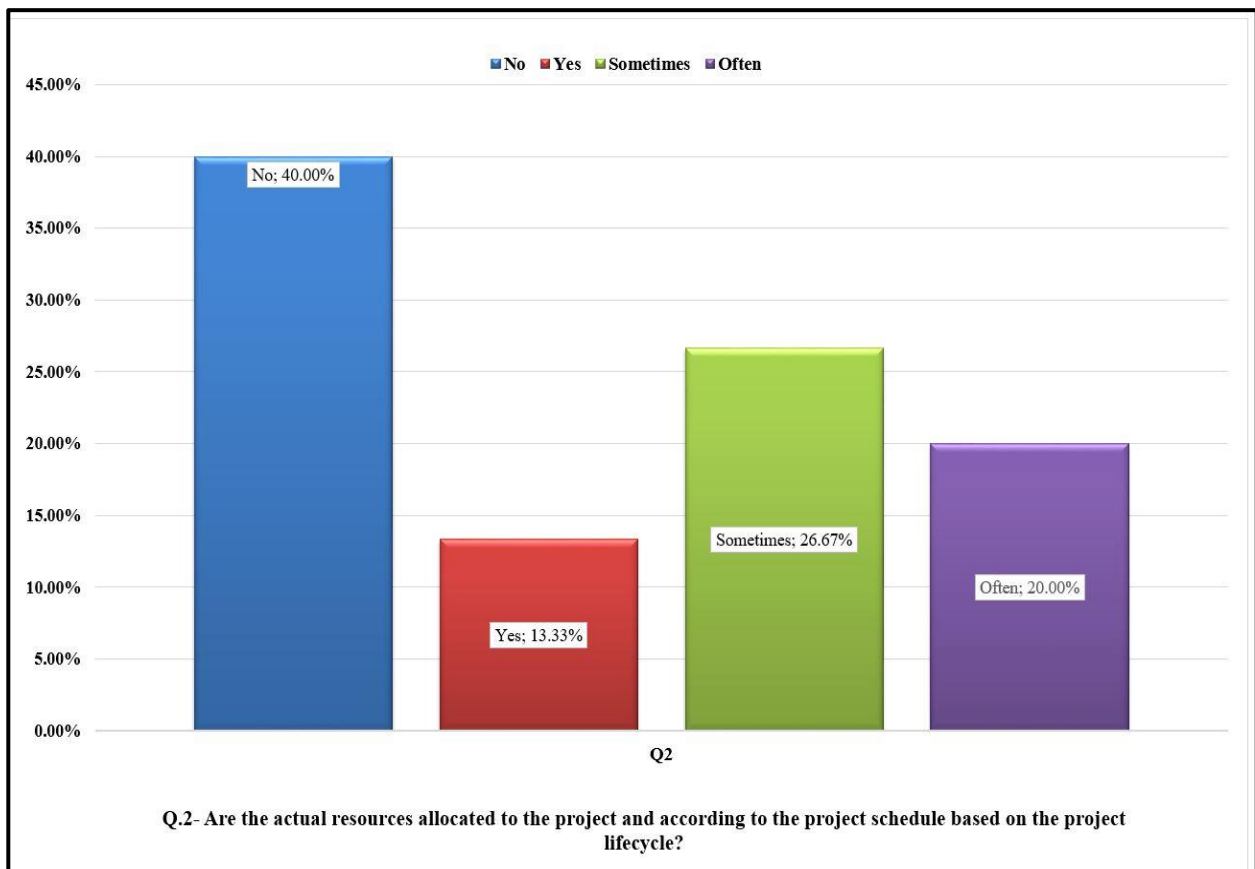


Figure 4.7  
Percentage of responses to question 3

#### 4.5.3.4.Hypothesis Verification (H2)

According to Figure 4.7 above, concluded that 13.33% of project managers agree that the actual resources are allocated to the project activities and according to the project schedule, while 20% of research sample indicate that "often" the actual resources are allocated to the project activities, and 26.67% of project managers referring to "sometimes" actual resources are allocated to the project schedule.

The project managers are asserted that the allocation of actual project resources, such as raw materials and equipment during the planning process leads to controlling the project cost overrun. The reasons, which it should be taken into account to avoid cost overruns, including:

- Change in the exchange rate, which includes inflation and high prices of raw materials.
- The status of the market and increasing prices of raw materials and equipment.
- The potential shortage of resources from the market.
- Add fees and additional taxes that change over time, e.g. VAT (Value Add Tax).

Deficiencies in project resource allocation result in increased project costs than planned (Love et al., 2005).

Doloi H. (2012) has justified that the inability of construction contractors to understand the scope of the project at the initiation, and planning process, leading to misallocation of resources and thus increase the project costs. Consequently, the interview responses are consistent with the questionnaire and support the research question number 3, where allocating the actual resources during the planning process affects control project budget costs.

Accordingly, and based on the research questions number 2 and number 3, **the second research hypothesis (H2)** has been verified positively, which is " Study of project costs accurately during the initial process will contribute positively to controlling cost overruns".

#### 4.5.4. Research Question (4)

Referring to the research question number 4, "How to monitor and measure the performance of project costs and early detection the cost overruns by the method of (EVM) during all project processes?", Research question number 3 was related to the questionnaire questions number 7, as shown in Table 3.1 in Appendix 2. The quantitative data analysis results were obtained, as shown in Table 4-12 below:

Table 4-12  
Q.7) Is the EVM (Earned value management) method applicable?

Index	Frequency	Percent	Cumulative Percent
No	36	49.32%	49.32%
Rarely	4	5.48%	54.79%
Sometimes	14	19.18%	73.97%
Often	15	20.55%	94.52%
Always	4	5.48%	100.00%
Total	73	100.00%	

#### **4.5.4.1. Statistical Results**

Referring to Table 4-12 above, the results of the study shows that 49.32 % of the participants convince that "No" used to EVM (Earned value management) method, while 20.55% of the sample indicate that "often" used to EVM method, and 19.18% "sometimes" used to EVM method, and only 5.48 % of the participants indicate that "Always" used to EVM (Earned value management) method.

#### **4.5.4.2. Quantitative Analysis**

Based on the statistical results above, the method of EVM (Earned value management) is sometimes used as a tool and indicator to monitor and control project costs, where the majority of the sample responses with 49.32 % indicate that the EVM is not used, and the lowest proportion of the research sample with 5.48% indicates that the EVM method is already used in their projects.

#### **4.5.4.3. Qualitative Analysis**

To study the statistical results in more details by the qualitative approach, refer to Table 3-2 in Appendix 2, and refer to the interviews results analysis, which was related to the interview questions number 5 and number 6. The results, as shown in Figure 4.8 below, which indicate that 60 % of interviewees confirmed that there is no specific monitoring and control plan, and 40% of interviewees agree that there are not a cost control procedures within the project cost limits. In accordance with the response of the project manager to interview number 6, who said that "There is no monitor plan and cost control", and according to the response of the project manager to interview number 13, who said that "There are no cost control procedures, and that because of the cost control plan is based on skills and vision of the project manager and it must be supposed to be managed by the organisation", as shown in Appendix 3.

The project managers sample explained the reasons for the inability to used monitoring and control costs procedures, for instance:

- The diversity of performance rates along the project life-cycle makes it difficult to control costs.
- Lack of proper study of the project during initiation process leads to difficult of monitor and control cost.
- Predominantly, cost control plan is based on skills and vision of the project manager, and it must be supposed to be managed by the organisation.

Consequently, lack of monitor and control of project budget costs result to cost overruns because of the lack of proper control tools.

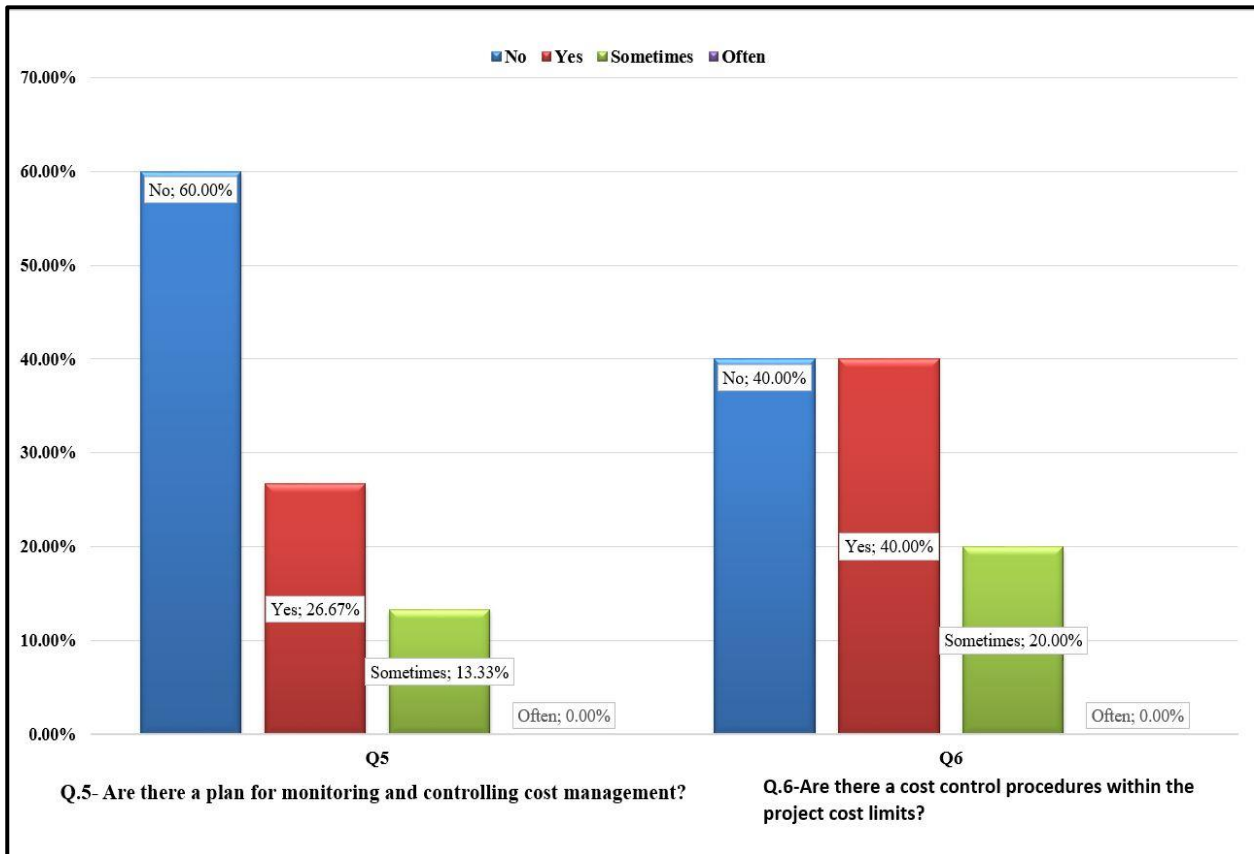


Figure 4.8  
Percentage of responses to research question 4

#### 4.5.4.4.Hypothesis Verification (H3)

Referring to Figure 4.8 above, the results of the study show that 40% of experienced project managers whose have mature years from 12 to 23 years agree that there are monitor and control cost plan, as well using to Earned value management (EVM).

The project manager has also justified the use of the EVM method, for the following reasons:

- The EVM method is one of the contemporary core practical project management tools.
- The EVM method represents the early warning to project status, whether positively or negatively indicator for cost and schedule.
- The EVM method is used to "compare the performance management baseline with what has been accomplished, to find out the project status and to predict what could be in the future, where are organised in control accounts" (Project Management Institute, 2011, p.11).

The project managers confirm that the EVM method is supported monitor the project indicators, whether negatively or positively throughout the project life-cycle, and that leads to control both of costs and project schedule.

Accordingly, and based on the research question number 4, **the third research hypothesis (H3)** has been verified positively, which is " Using Earned value management (EVM) method during the project lifecycle will provide strong indicators that contributed to monitor and control project cost overruns".

#### **4.6. Comparison between Findings and the Literature Review**

The vast majority of the previous studies point out to Procurement, schedule, design errors, quality, and resources, which are the core reasons for the cost overrun in the construction and infrastructure projects that have been addressed in many types of research. Most of these studies focused on the study of theoretical aspects without looking at the practical aspects. For example, some of these studies indicate that cost overrun in the project is due mainly to design errors (Lopez et al., 2012). Research show weaknesses were focused solely on design errors, while it is possible that the design is ideal, but the implementation of the design has the problem, which leads to cost overruns. While Flyvbjerg et al., (2002) refers to procurement, decision making, and do not take into account another essentials variables, like risk, resources, which could impact cost overrun.

Zwikael & Sadeh (2007) point out to the importance of the risks, which affect the performance of the project. While one of the research weaknesses is that did not address how to estimate risk costs. Previous studies, by Fleming, Q. W. et al., (1996); Plaza, T. J. (2000); Jones, M. (2002); Farid, F. et al. (1988), all of these studies were based primarily on the study of costs and their relation to the project schedule regard to changing the performance rates throughout the project lifecycle, While these studies did not deal with detailing and analysing other essential factors that would affect project costs, including risks, quality, and human resources performance.

Most of these researchers discussed increasing the costs based on the variable of the production rates of resources without taking into account the estimate risk and study costs during the initiation process, and what are the appropriate tools for monitor and control costs. The literature review found that many reasons for cost overruns, but that researcher failed to identify the proper tools for monitoring and cost control throughout the project lifecycle.

On the other hand, the empirical research findings which have been studied and analysed in this chapter are based on a mixed approach, to study the reasons for cost overruns in a more in-depth method to interpret the results of quantitative approach appropriately to confirm the results of the study. Also, the research finding has revealed the weaknesses that lead to cost overruns in

construction and infrastructure projects, which have not been discussed in the previous studies before, For instance:

- The impact of estimated costs of risk on project budget cost, where 40% of the sample project managers agreed that if the risk plan is defined during the planning process, this leads to an estimate of unforeseen costs which may lead to cost overruns.
- The impact of cost estimation a rough order of magnitude (ROM) during the initial process, and the impact of the allocation of resources during project planning process, where 47.90% of the research sample refers to add approximate percentage rate “5% to 10%” from the contract value to be embedded of the project budget cost, and used as a contingency reserve and thus leads to cost overruns.
- Monitor and measure the performance indicators of project costs during all project processes, 40% of the sample experienced project managers pointed out that the method of using (Earned Value Management) for monitoring and control cost leads to the reduction of cost overruns. "EVM used to compare the performance management baseline with what has been accomplished, to find out the project status" (Project Management Institute, 2011, p.11).

## Chapter 5 Conclusions and Recommendations

### 5.1 Introduction

This chapter will explore the research objectives, limitations and future research study, conclusions and recommendations for future research.

### 5.2 Reviewed and addressed research objectives

In the first chapter, the research problem statement was reviewed, which is a cost overrun in infrastructure projects and construction compared to planned costs, which may lead to negative impact on the completion of projects.

The research objectives were involved in analysing and monitoring the reasons for cost overruns for construction and infrastructure projects with the focus on the knowledge areas that affect the projects cost management; The following points can summarise this:

- Estimating the cost of the project risks as an integral part of the project budget costs.
- Accurately estimating the project budget cost during the initiation process and during the project lifecycle by the allocation of resources required for projects and according to the project schedule.
- The development of procedures, tools and methods for measuring cost indicators during the project's lifecycle

The research addressed and answered four questions to clarify the aim of the study, which are:

1. What is the effect of estimated costs of risk on project budget cost and their relation to a cost overrun?
2. What is the effect of cost estimates a rough order of magnitude (ROM) during the initial process of project management life-cycle on project budget cost?
3. Does the allocation of resources during project planning process effect on project budget cost?
4. How to monitor and measure the performance of project costs and early detection the cost overruns during all project processes?

Based on the research questions above, and from literature review, the three research hypotheses were deduced, which are:

**H1:** Managing the project risk plan, e.g., (identify, analysis, and control risks) of each project will contribute positively to controlling cost overruns.

**H2:** Study of project costs accurately during the initial process will contribute positively to controlling cost overruns.



**H3:** Using Earned value management (EVM) method during the project lifecycle will provide strong indicators that contributed to monitor and control project cost overruns.

### **5.3 Summarise Conclusions**

The research questions were asked of the respondents by using the mixed approach. The data collection tools used were a questionnaire and interview method, and the results were analysed and discussed, where the results indicated that the vast majority of project managers agree that project risks should be defined within the project plans, where it contributes positively or negatively to the project cost budget. Also, the project budget should not be estimated approximately during the initiation process, but it should be done on an accurate basis.

Also, the results indicated the use of monitoring tools and control of costs, and of these essential tools the earned value management EVM, which contribute positively to measuring project performance indicators over project lifecycle.

Eventually, the research objectives were achieved, and the research hypotheses are positively validated.

Based on all of the above, should be taken into account the cost management as an integral part of project management, where its impact directly contributes to the success or failure of any project.

### **5.4 Limitations and Future Research**

The research was restricted by the sample size, which was selected within construction organisations, where the contractor's perspective was used in-depth, because the contractors play a crucial role in influencing project costs direct or indirect, and the consultant's view was not taken into account more widely.

Also, because of the difficulty of researching many diverse countries, the research was conducted within the Arabian Gulf region and the Middle East, as the diversity of cultures among countries may lead to the emergence of new reasons for cost overrun in the project.

The descriptive approach was conducted by interviews on a limited sample of project managers due to lack of time.

#### **Future study areas related to this research are:**

- Study the aspects of the influence of stakeholders, especially the owner, on increasing the cost of projects.
- Study the impact of human behaviour on project cost management within the scope of the project.

## 5.5 Recommendations

Based on the research results, the following recommendations are made, which directly effect on controlling the project costs and their impact on project management:

- The contracting companies should delegate the authority to the competent authorities to distribute and allocate the resources for work package, and the planning department of the company should allow the experienced employees to participate in the development of the plans.
- The laws, regulations, and circulars that affect the cost planning and control process for construction and infrastructure projects should be studied, and identifying the procedures to be applied to control costs
- The terms of the contract must be reviewed and audit. Also, the executive regulations of the procurement procedures should be considered, because of its binding clauses for the contractor.
- Familiarity with the prices of raw materials used according to the approval of the owner to procurement plan, taking into consideration the difference in prices of raw materials from one area to another.
- The price of the project items should be determined according to the specified profit margin, taking into consideration the nature of the project, size and location, so that the profit margin is realised in all the items in a balanced manner.
- The project risk plan should take importance regarding project risk identification in advance and then estimate the costs of these risks within the overall project costs.
- Monitoring and control of project costs should be determined from the initiation process for the project and during the project life cycle, and use of appropriate measurement indicators to monitor and measure the cost plan.

## **References**

- Akinsola, A. & Potts, K. & Ndekugri, I. & Harris, F. (1997). Identification and evaluation of factors influencing variations on building projects, *International Journal of Project Management*, 15 (4), 263-267
- Ahiaga, D. D. & Love, P.E.D. & Smith, S. & Ackermann, F. (2017). Toward a Systemic View to Cost Overrun Causation in Infrastructure Projects. *Project Management Journal*, 48(2), 88–98
- Black, J., A. & Champion, D. J. (1976). *Methods and Issues in Social Research*. New York, Wiley.
- Blaikie, Norman, 2007, *Approaches to Social Enquiry*, Second Edition, Cambridge, Polity Press
- Burns, Robert B. (1997). *Introduction to Research Methods*. Second edition, Melbourne, Longman Cheshire
- Baloi, D. & Price, A. D. F. (2003). Modelling global risk factors affecting construction cost performance. *International Journal of Project Management*, 21(4), 261–269
- Cronbach, L. J. (1951). Coefficient alpha and the internal structure of tests- *Psychometrika*, 16 (3), 16-297. <https://doi.org/10.1007/BF02310555>
- Campbell, D. T. & Stanley, J. C. (1963). *Experimental and quasi-experimental designs for research*. Chicago, IL: Rand McNally, 171–246
- Carmines, E. G. & Zeller, R.A. (1991). *Reliability and validity assessment*. Newbury Park: Sage Publications.
- Kothari, C. R. (2004). *Research Methodology: Methods and Techniques*, second. Revised .Ed., New Age International Limited, Publishers
- Cho, J. & Trent, A. (2006). The validity of Qualitative Research Revisited. *Qualitative Research* 6(3), 319-340
- Creswell, J., & Plano Clark, V. (2007). *Designing and Conducting Mixed Methods Research*. Thousand Oaks, CA: Sage
- Crowther, D. & Lancaster, G. (2008). *Research Methods: A Concise Introduction to Research in Management and Business Consultancy*. Butterworth-Heinemann
- Cameron, R. & Sankaran, S. & Scales J. (2015). Mixed Methods Use in Project Management Research. *Project Management Journal*, 46(2), 90–104
- Dinsmore, P. C. (1985). Planning project management: sizing up the barriers. *Project Management Journal*, 16(4), 82–87
- Drouin, N. & Müller, R. & Sankaran, S. (2013). *Novel Approaches to Organizational Project Management Research*. Copenhagen Business School Press, 383-401

- Doloi, H. (2012). Cost Overruns and Failure in Project Management- Understanding the Roles of Key Stakeholders in Construction Projects. *Journal of construction engineering and management*, 139(3), 267-279
- Easterby-Smith, M. & Thorpe, R. & Jackson, P. (2012). *Management Research*, four<sup>th</sup>. Edition, London: SAGE Publications
- Farid, F. & Karshenas, S. (1988). Cost/schedule control systems criteria under inflation. *Project Management Journal*, 19(5), 23–29
- Fleming, Q. W. & Koppelman, J. M. (1996). Forecasting the final cost and schedule results. *PM Network*, 10(1), 13–18
- Flyvbjerg, B., Holm, M. K. S., and Buhl, S. R. L. (2002). Underestimating Costs in Public Works Projects: Error or Lie?, *Journal of the American Planning Association*, 68(3), 279-295
- Flyvbjerg, B., Holm, M. K. S., and Buhl, S. R. L. (2004). What causes cost overrun in transport infrastructure projects?. *Trans. Rev.*, 24(1), 3-18
- Georgas, P. G. & Vallance, G. V. (1986). Cost management. *Project Management Journal*, 17(3), 47–54
- Grasso, P. & Mahtab M. & Kalamaras, G. & Einstein, H.H. (2002). On the Development of a Risk Management Plan for Tunneling. *Proc. AITES-ITA Down under 2002, World Tunnel Congress, Sydney*
- Ghauri, P. & Gronhaug, K. (2002). *Research methods in business studies – a practical guide*, 2nd ed. Harlow: Prentice-Hall
- ITA. (1992). *Recommendations on the contractual sharing of risks*. Second edition, International Tunneling Association, published by the Norwegian Tunneling Society
- Iyer, K.C. & Jha, K. N. (2005). Factors affecting cost performance. Evidence from Indian construction projects. *Int. J. Proj. Manage.* 23(4), 283–295
- Jones, M. (2002). Grow your own cost tracking system. Paper presented at Project Management Institute Annual Seminars & Symposium, San Antonio, TX. Newtown Square, PA: Project Management Institute
- Kumar, R. (2011). *Research Methodology*, Third Edition, London: SAGE Publications
- Lydeard, S. (1991). The questionnaire as a research tool. *Oxford Journal press*, 8(1), 84-91  
Available at: <http://fampra.oxfordjournals.org/content/8/1/84.full.pdf+html> (Accessed 15 November 2017)
- Lopez, R. & Love, P.E.D. (2012). Design Error Costs in Construction Projects. *Journal of construction engineering and management. J. Constr. Eng. Manage.*, 138(5), 585-593

- Mansfield, N.; Ugwu, O., and Doran, T. (1994). Causes of delay and cost overrun in Nigerian construction projects, *International Journal of Project Management*, 12 (4), 254-260
- Nunnally, J. C. (1978). *Psychometric theory*, Second Edition, New York: McGraw-Hill
- Olawale, Y. & Sun, M. (2010). Cost and time control of construction projects-Inhibiting factors and mitigating measures in practice. *Construction Management and Economics*, 28 (5), 509 – 526
- Peter, F. K. & Paul, O. O. & Gary, D. H. & Frank, C. H. (1997). Factors influencing construction time and cost overrun on high-rise projects in Indonesia, *Construction Management and Economics*, 15(1)
- Plaza, T. J. (2000). Seven excuses for resisting schedule management. *PM Network*, 14(3), 56–60
- Love P.E.D. (2002a). Influence of project type and procurement methods on rework costs in building construction projects. *J. Constr. Eng. Manag.*, 128(1), 18-29
- Love, P. E. D & Tse, R. Y. C. & Edwards, D. J. (2005). Time-cost relationships in Australian building construction projects, *J. Constr. Eng. Manage.*, 131(2), 187–194
- Love, P. E. D & Edwards, D. J. & Watson, H. & Davis P. (2010). Rework in Civil Infrastructure Projects-Determination of Cost Predictors. *Journal of Construction Engineering and Management*, 136 (3), 275-282
- Project Management Institute (2011). *Practice Standard for Earned Value Management*. 2nd. Edition, Newtown Square, PA: Project Management Institute
- Project Management Institute (2013). *PMBOK® Guide, Fifth Edition*, Newtown Square, PA: Project Management Institute
- Reilly, J.J.& Thompson, R. (2001). *The International survey. 1400 projects'*, internal report.
- Reilly, J.J. & Brown, J. (2004). *Management and Control of Costs and Risk for Tunneling and Infrastructure Projects*, Proceedings, World Tunneling Conference, International Tunneling Association, Singapore, 1-11
- Vrijling, J.K. & Redeker. (1993). *The risks involved in major infrastructure projects. Options for Tunneling*. Ed H Burger ISBN 0-444-899359 (Elsevier Science)
- Yin, R. K. (2011). *Qualitative Research from Start to Finish*. New York: The Guilford Press
- Zwikael, O. & Sadeh, A. (2007). Planning effort as effective risk management tool. *Journal of Operations Management*, 25 (4), 755-767

# Appendix 1



## PARTICIPANT CONSENT FORM

**Title of Research Project: "Cost control and Cost Management Index: Construction and Infrastructure Projects."**

**Brief Description of Research Project, and What Participation Involves:**

The research proposal is to study and analyze the reasons for exceeding the actual cost of construction and infrastructure projects comparing with the planned cost, and then find adequate procedures capable of control the costs of projects within the specified framework and without cost overrun.

The questionnaires will be distributed to about 50 participants from five different leading construction organizations, as well 20 interviews with project managers.

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**Consent Statement:**

I agree to take part in this research and am aware that I am free to withdraw at any point without giving a reason, although if I do, so I understand that my data might still be used in a collated form. I understand that the information I provide will be treated in confidence by the investigator and that my identity will be protected in the publication of any findings, and that data will be collected and processed in accordance with the Data Protection Act 1998 and with the University's Data Protection Policy.

Name .....

Signature .....

Date .....

Please note: if you have a concern about any aspect of your participation or any other queries, please raise this with the investigator (or if the researcher is a student you can also contact the Director of Studies.) However, if you would like to contact an independent party please contact the Head of Department.

**Programme Director Contact Details:**

Name  
Email  
Telephone

## Survey Questionnaire

### Personal information

Age of respondent: 22 – 29 years , 30 – 39 years , above 39 years

Years of working experience: 0-5 years , 6-10 years , 11-15 years , above 15 years

### Job role & Education in organization:

Project Manager/Director , Project Engineer , Procurement Contract Administrator , Project Planning & Control , others (specify)...

### Educational Qualification:

B.Sc. , M.Sc. , PMP, PgMP , others (specify)...

### Survey Questions

Kindly check (☒) the appropriate box with the extent of your decision with rationale factors and processes that may impact on budget cost for infrastructure and construction projects.  
The five-point scale ranges as follows: 0 = No, 1 = rarely, 2 = sometimes, 3 = often, 4 = always.

No.	Questions	Index				
		0	1	2	3	4
1	Is there a competent contract administration to study project costs budget during the initiation process <sup>†</sup>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
2	Are the WBS (Work Breakdown Structure) create during the planning process?	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
3	Does the Procurement plan be submitted and approved before implementation begins?	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
4	Does the Risk plan be submitted and approved before implementation process?	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
5	Are all project resources allocated to planned costs for project activities <sup>†</sup>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
6	Are there (contingency reserves)* allocated to work package cost estimations?	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
7	Is the EVM (Earned value management)* method applicable <sup>†</sup>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

\* Contingency reserves are the budget within the cost baseline that is allocated for identified risks, and cost uncertainty, which are accepted, it may be a percentage of the estimated cost, or a fixed number. (PMBOK Guide, 2013, p.206)

\*\* Earned value management (EVM) is a methodology that combines scope, schedule, and resource measurements to assess project performance and progress. (PMBOK Guide, 2013, p.217)



## Interview Questions

### Personal Information

**Name:**

**Job Title:**

**Experiences Years:**

### Questions:

Q1) During the project initiation process, is the project cost accurately estimated along the project lifecycle?

Q2) Are the actual resources allocated to the project and according to the project schedule based on the project lifecycle?

Q3) Are project risk register identified, and why?

Q4) Are Qualitative and quantitative risk analysis performed during the planning process?

Q5) Are there a plan for monitoring and controlling cost management?

Q6) Are there a cost control procedures within the project cost limits?



## Appendix 2

### Results of Statistical Analysis

Table 4-2  
Job Role

Job Role	Frequency	Percent %	Cumulative %
Project Manager	33	45.21%	45.21%
Project Engineer	14	19.18%	64.38%
Project Planner	15	20.55%	84.93%
Procurement Management	11	15.07%	100.00%
Total	73	100.00%	

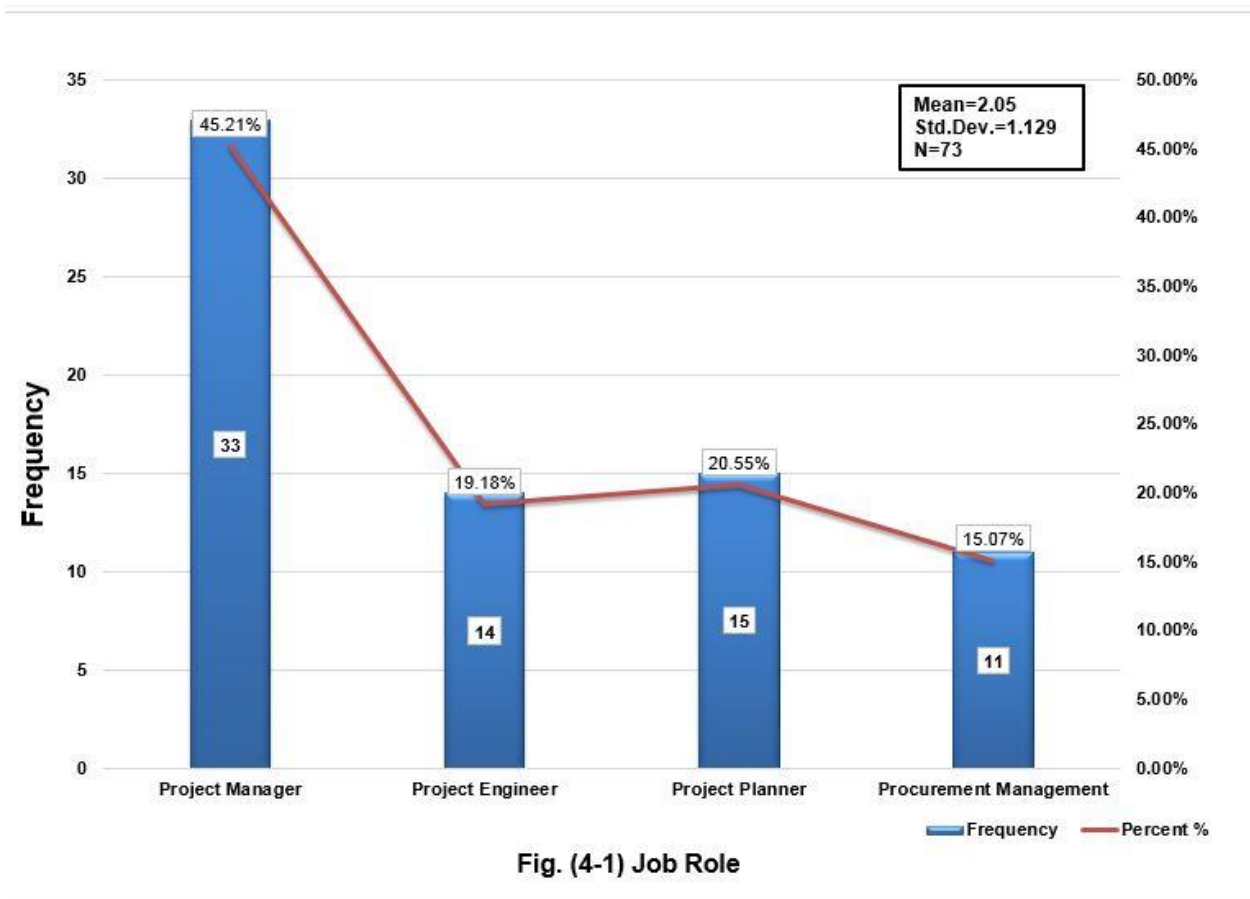


Table 4-3  
Age of Respondent

Age (Year)	Frequency	Percent %	Cumulative %
22-39	29	39.73%	39.73%
30-39	31	42.47%	82.19%
>39	13	17.81%	100.00%
Total	73	100.00%	

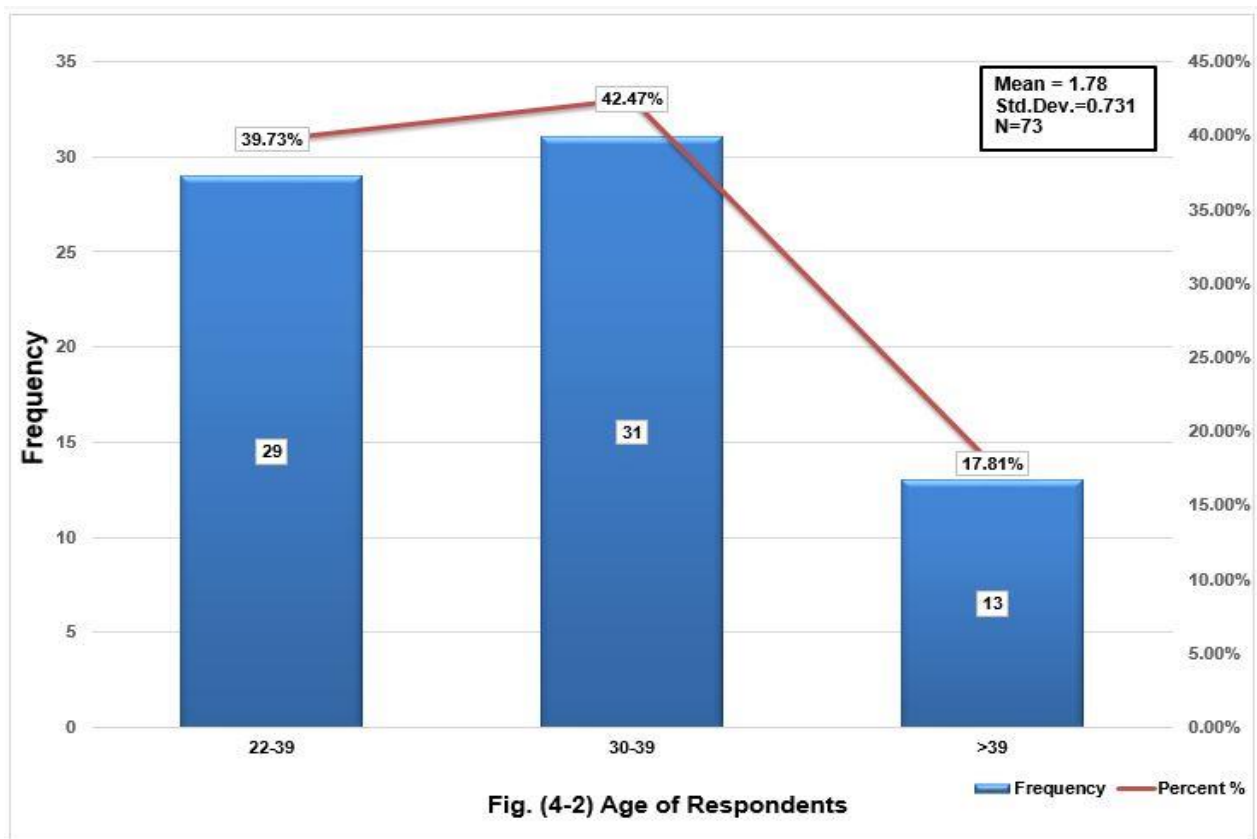


Table 4-4  
Education & Certification

Certification	Frequency	Percent %	Cumulative %
Bachelor's degree BSc.	67	91.78%	91.78%
Bachelor's degree + Master's Degree	1	1.37%	93.15%
bachelor's degree + Project management professional(PMP)	5	6.85%	100.00%
Total	73	100.00%	

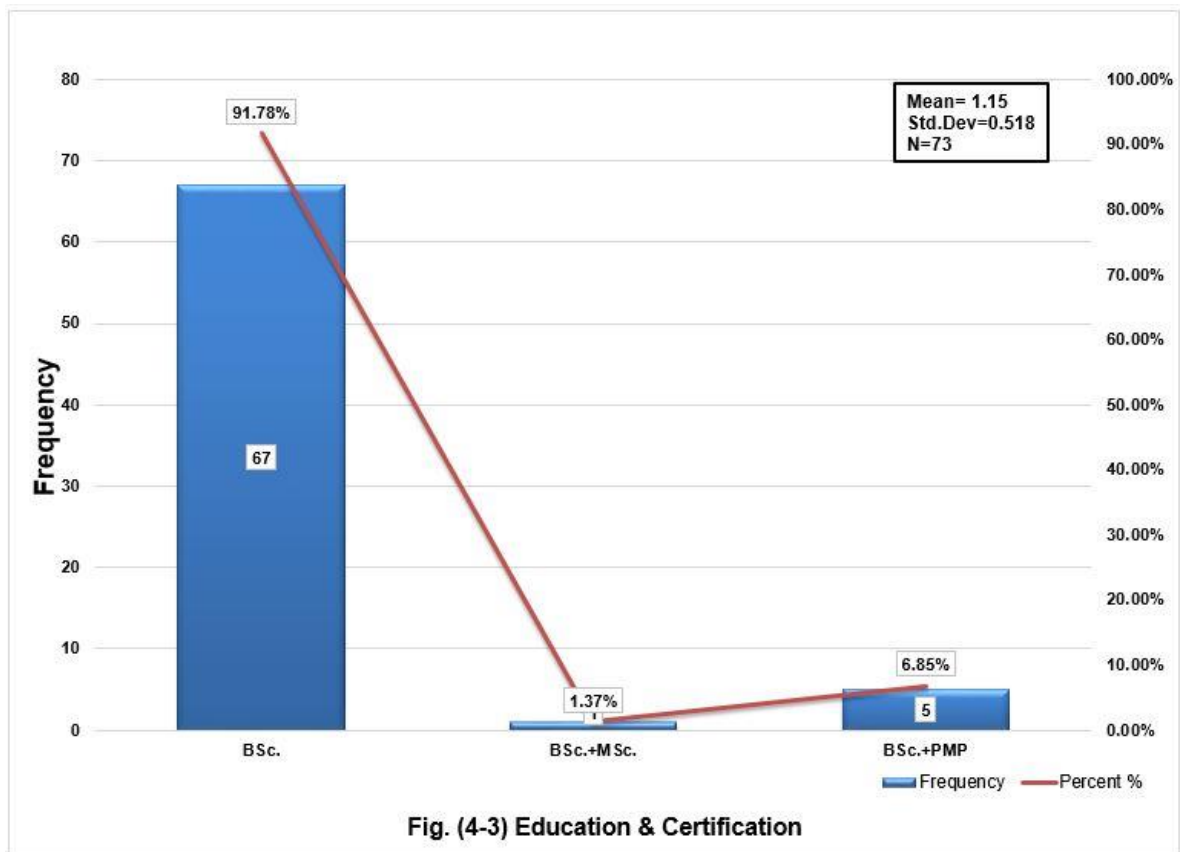


Table 4-5  
Years of Working Experiences

Years of Experiences	Frequency	Percent %	Cumulative %
0-5	5	6.85%	6.85%
6-10	32	43.84%	50.68%
11-15	18	24.66%	75.34%
>15	18	24.66%	100.00%
Total	73	100.00%	

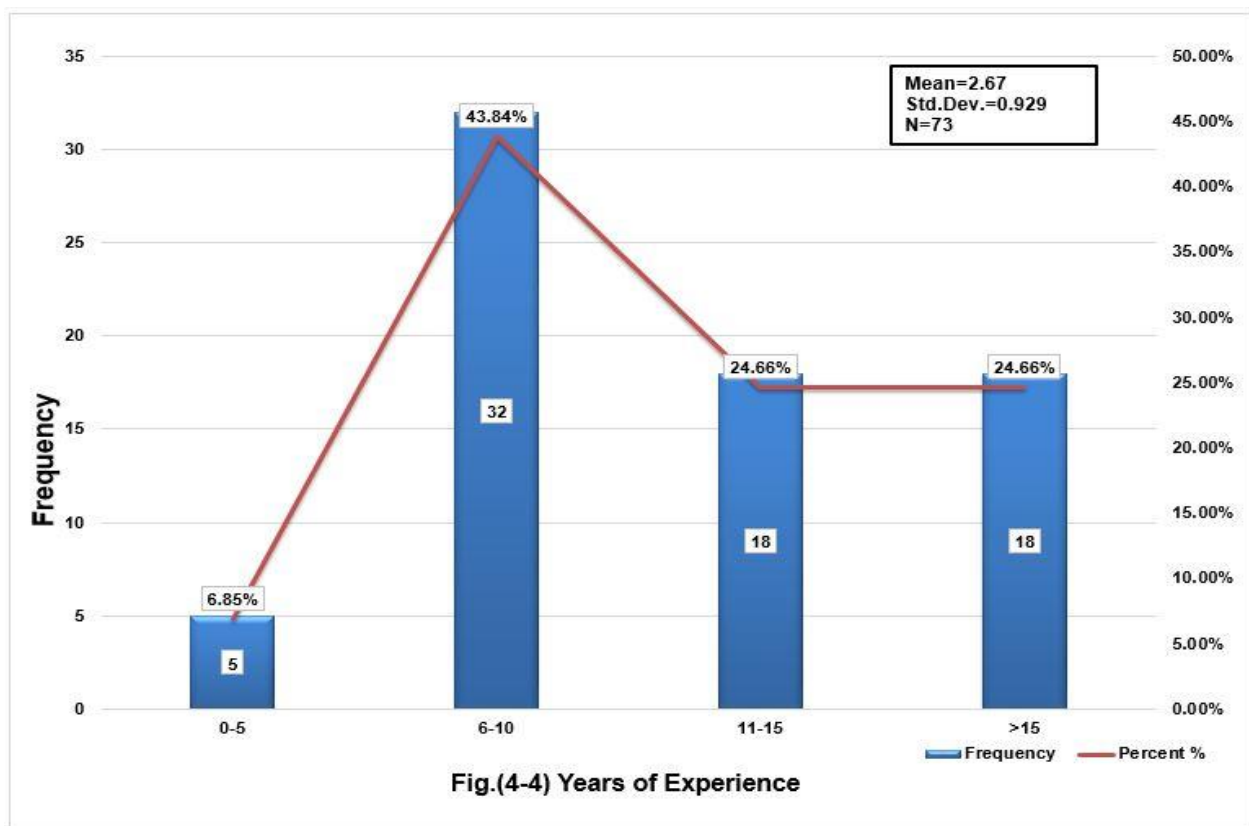


Table 4-6  
Q.4) Does the Risk plan be submitted and approved before implementation process?

Index	Frequency	Percent	Cumulative Percent
No	0	0.0	0.0
Rarely	7	9.6%	9.6%
Sometimes	37	50.70%	60.30%
Often	26	35.60%	95.90%
Always	3	4.10%	100.00%
Total	73	100.0%	

Table 4-7  
Q.6) Are there (contingency reserves) allocated to work package cost estimation?

Index	Frequency	Percent	Cumulative Percent
No	5	6.8%	6.8%
Rarely	1	1.4%	8.2%
Sometimes	9	12.3%	20.5%
Often	35	47.9%	68.5%
Always	23	31.5%	100.0%
Total	73	100.0%	

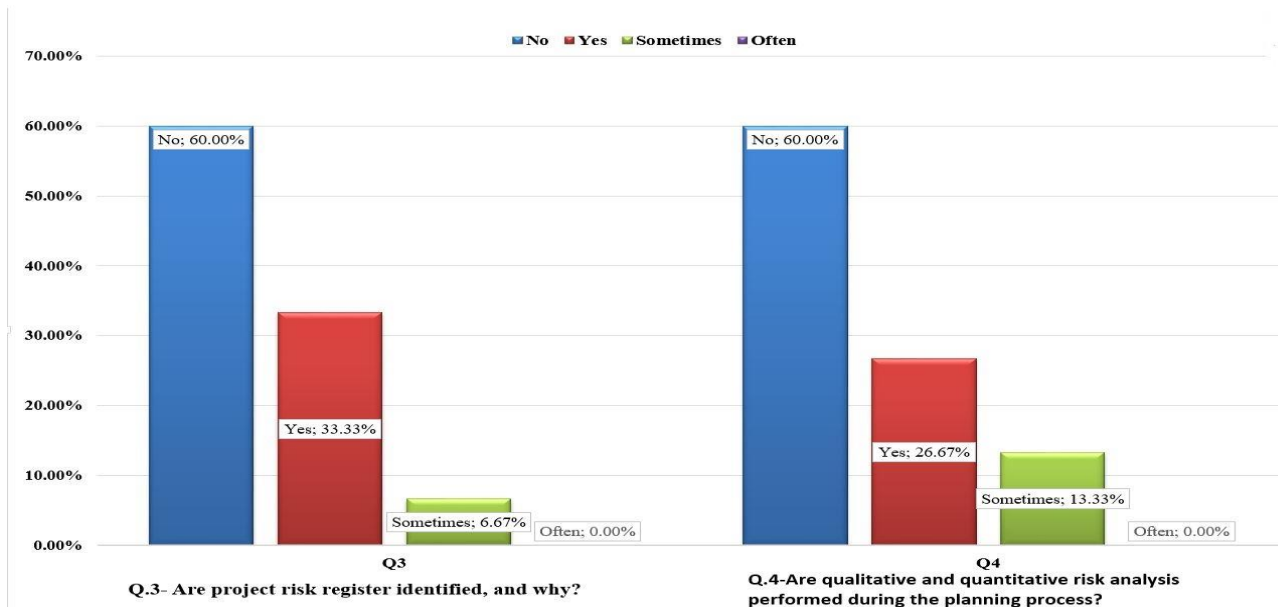


Figure 4.5

Table 4-7  
Q.6) Are there (contingency reserves) allocated to  
work package cost estimation?

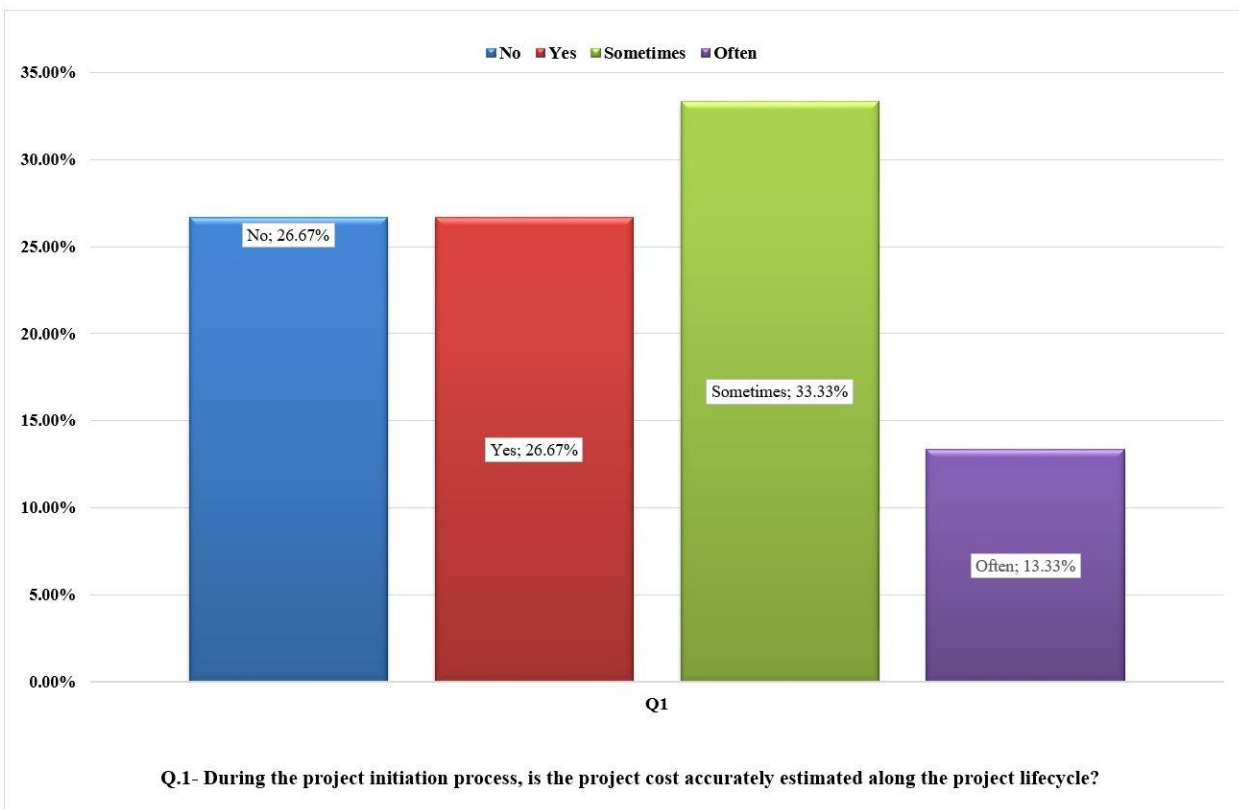
Index	Frequency	Percent	Cumulative Percent
No	5	6.8%	6.8%
Rarely	1	1.4%	8.2%
Sometimes	9	12.3%	20.5%
Often	35	47.9%	68.5%
Always	23	31.5%	100.0%
Total	73	100.0%	

Table 4-8  
Q.1) Is there a competent contract administration to study  
project costs budget during the initiation process?

Index	Frequency	Percent	Cumulative Percent
No	0	0.00%	0.00%
Rarely	0	0.00%	0.00%
Sometimes	7	9.59%	9.59%
Often	19	26.03%	35.62%
Always	47	64.38%	100.00%
Total	73	100.0%	

Table 4-9  
Q.3) Does the Procurement plan be submitted and  
approved before implementation begins?

Index	Frequency	Percent	Cumulative Percent
No	0	0.00%	0.00%
Rarely	1	1.37%	1.37%
Sometimes	25	34.25%	35.62%
Often	39	53.42%	89.04%
Always	8	10.96%	100.00%
Total	73	100.00%	



**Figure 4.6**

Table 4-9  
Q.3) Does the Procurement plan be submitted and approved before implementation begins?

Index	Frequency	Percent	Cumulative Percent
No	0	0.00%	0.00%
Rarely	1	1.37%	1.37%
Sometimes	25	34.25%	35.62%
Often	39	53.42%	89.04%
Always	8	10.96%	100.00%
Total	73	100.00%	

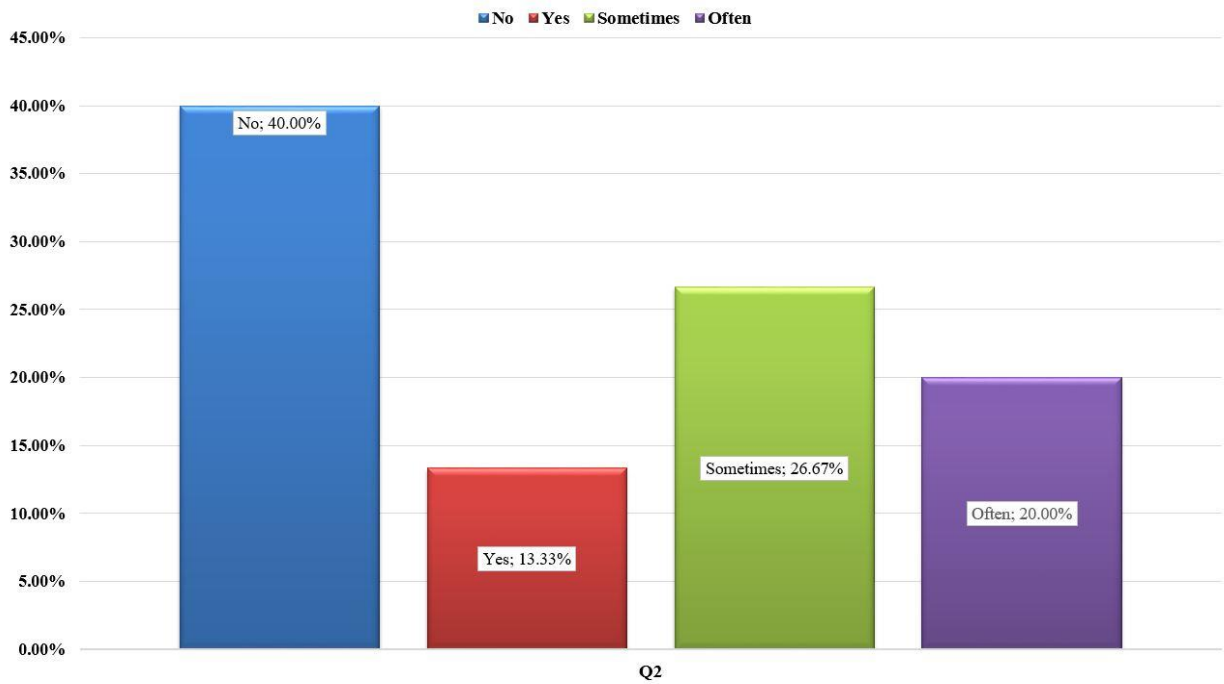
Table 4-10  
Q.2) Are the WBS (Work Breakdown Structure)  
create during the planning process?

Index	Frequency	Percent	Cumulative Percent
No	3	4.11%	4.11%
Rarely	0	0.00%	4.11%
Sometimes	11	15.07%	19.18%
Often	48	65.75%	84.93%
Always	11	15.07%	100.00%
Total	73	100.00%	

Table 4-11  
Q.5) Are all project resources allocated to  
planned costs for project activities?

Index	Frequency	Percent	Cumulative Percent
No	5	6.85%	6.85%
Rarely	1	1.37%	8.22%
Sometimes	40	54.79%	63.01%
Often	24	32.88%	95.89%
Always	3	4.11%	100.00%
Total	73	100.00%	





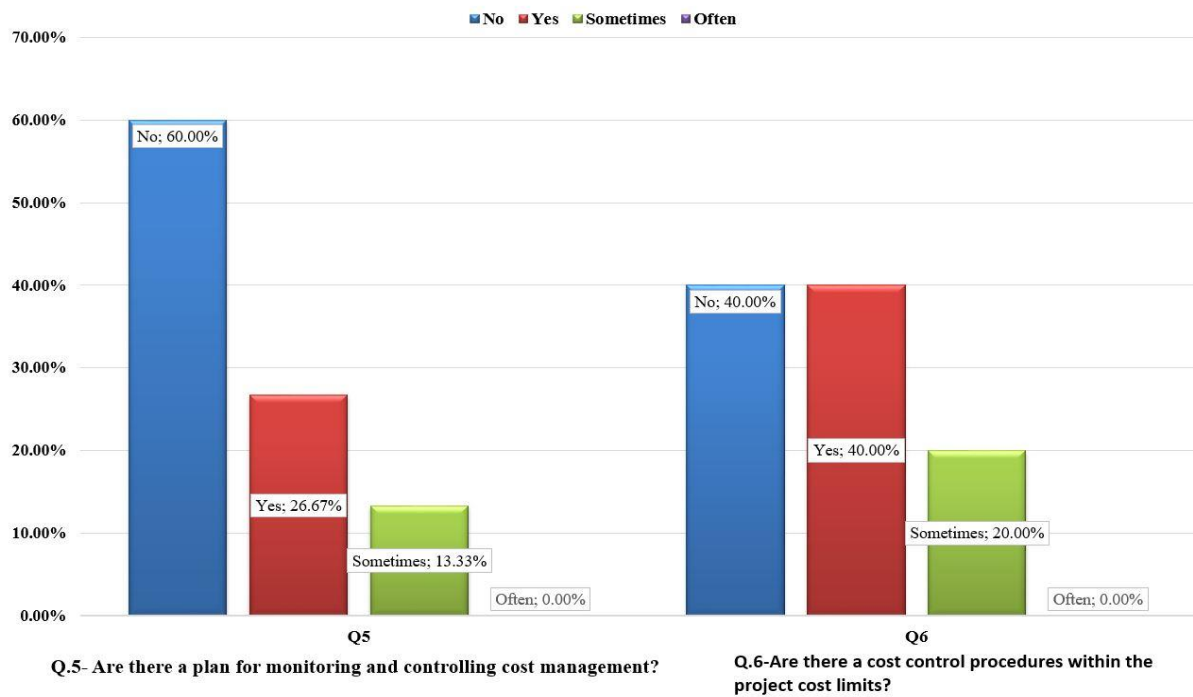
**Q.2- Are the actual resources allocated to the project and according to the project schedule based on the project lifecycle?**

**Figure 4.7**

**Table 4-12**

**Q.7) Is the EVM (Earned value management) method applicable?**

Index	Frequency	Percent	Cumulative Percent
No	36	49.32%	49.32%
Rarely	4	5.48%	54.79%
Sometimes	14	19.18%	73.97%
Often	15	20.55%	94.52%
Always	4	5.48%	100.00%
Total	73	100.00%	



**Figure 4.8**

**Table 4-13**  
Sample Statistics

		Age of respondent	Education & Certification	Job Role	Years of working experience
N	Valid	73	73	73	73
	Missing	0	0	0	0
Mean		1.78	1.15	2.05	2.67
Std. Error of Mean		.086	.061	.132	.109
Median		2.00	1.00	2.00	2.00
Mode		2	1	1	2
Std. Deviation		.731	.518	1.129	.929
Variance		.535	.269	1.275	.863
Range		2	2	3	3
Minimum		1	1	1	1
Maximum		3	3	4	4
Sum		130	84	150	195

Table 4-14  
Responses Statistics

	Is there a competent contract administration to study project costs budget during the initiation process?	Are the WBS (Work Breakdown Structure) create during the planning process?	Does the Procurement plan be submitted and approved before implementation begins?	Does the Risk plan be submitted and approved before implementation process?	Are all project resources allocated to planned costs for project activities?	Are there (contingency reserves) allocated to work package cost estimates?	Is the EVM (Earned value management) method applicable?
N Valid	73	73	73	73	73	73	73
Missing	0	0	0	0	0	0	0
Mean	3.55	2.88	2.74	2.34	2.26	2.96	1.27
Std. Error of Mean	.078	.095	.078	.083	.100	.124	.164
Median	4.00	3.00	3.00	2.00	2.00	3.00	1.00
Mode	.668	.816	.667	.711	.850	1.060	1.397
Std. Deviation	.446	.665	.445	.506	.723	1.123	1.952
Variance	2	4	3	3	4	4	4
Skewness	2	0	1	1	0	0	0
Std. Error of Skewness	4	4	4	4	4	4	4
Kurtosis	259	210	200	171	165	216	93

Table 3-1

## Relation between Research Questions and Research Questionnaire

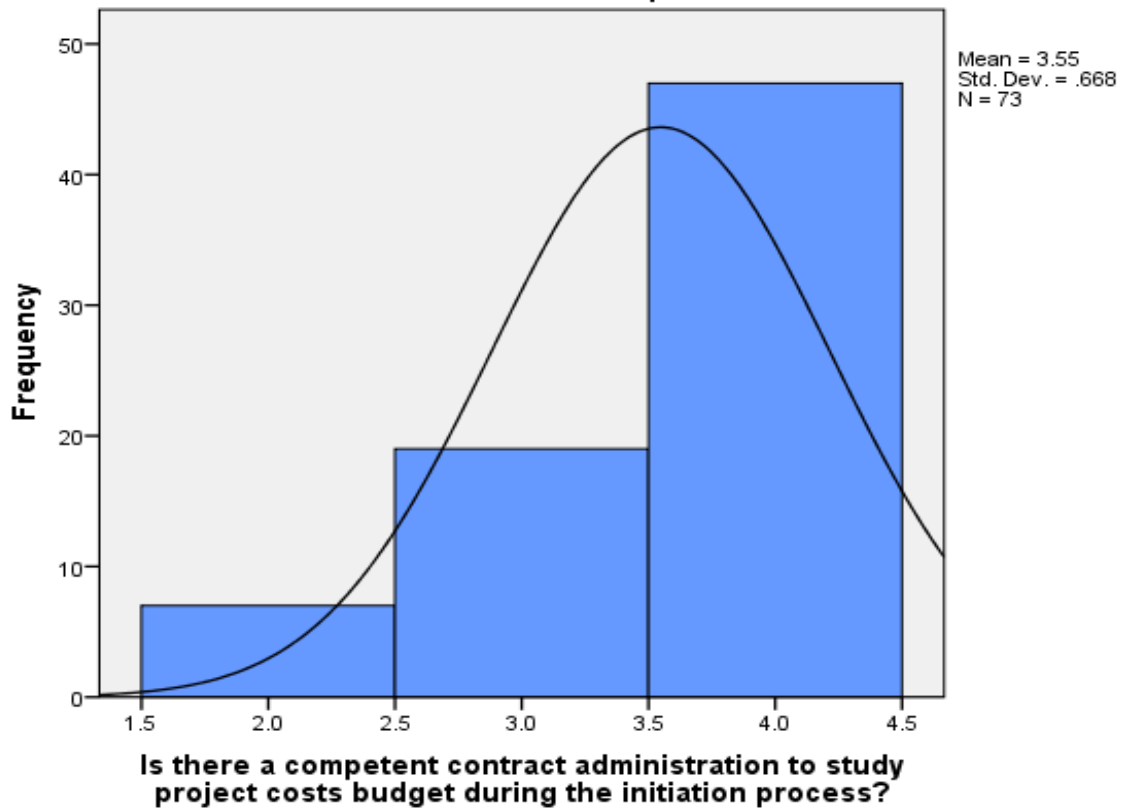
Research Questions		Q1	Q2	Q3	Q4
Research questionnaire		What is the effect of estimated costs of risk on project budget cost and their relation to a cost overrun?	What is the effect of cost estimates a rough order of magnitude (ROM) during the initial process of project management life-cycle on project budget cost?	Does the allocation of resources during project planning process effect on project budget cost?	How to monitor and measure the performance of project costs and early detection the cost overruns by the method of (EVM) during all project processes?
Questionnaire	1	Is there a competent contract administration to study project costs budget during the initiation process?	Relevant		
	2	Are the WBS (Work Breakdown Structure) create during the planning process?		Relevant	
	3	Does the Procurement plan be submitted and approved before implementation begins?	Relevant	Relevant	
	4	Does the Risk Plan be submitted and approved before implementation process?	Relevant		
	5	Are all project resources allocated to planned costs for project activities?		Relevant	
	6	Are there contingency reserve to work package cost estimations?	Relevant	Relevant	
	7	Is the EVM (Earned value management)* system applicable?			Relevant

Table 3-2

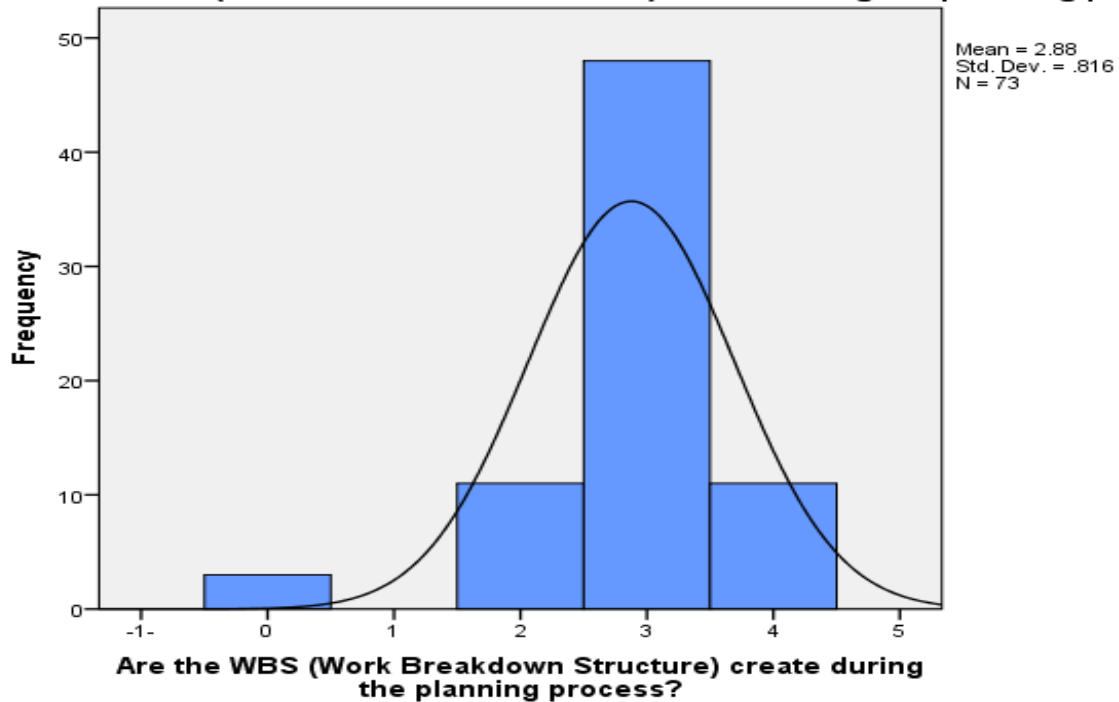
Relation between Research Questions and Research Interview Questions

Research Questions		Q1	Q2	Q3	Q4	
Research questions Interview		What is the effect of estimated costs of risk on project budget cost and their relation to a cost overrun?	What is the effect of cost estimates a rough order of magnitude (ROM) during the initial process of project management life-cycle on project budget cost?	Does the allocation of resources during project planning process effect on project budget cost?	How to monitor and measure the performance of project costs and early detection the cost overruns by the method of (EVM) during all project processes?	
Interview	Q1	During the project initiation process, is the project cost accurately estimated along the project lifecycle?		Relevant		
	Q2	Are the actual resources allocated to the project and according to the project schedule based on the project lifecycle?			Relevant	
	Q3	Are project risk register identified, and why?	Relevant			
	Q4	Are Qualitative and quantitative risk analysis performed during the planning process?	Relevant			
	Q5	Are there a plan for monitoring and controlling cost management?				Relevant
	Q6	Are there a cost control procedures within the project cost limits?				Relevant

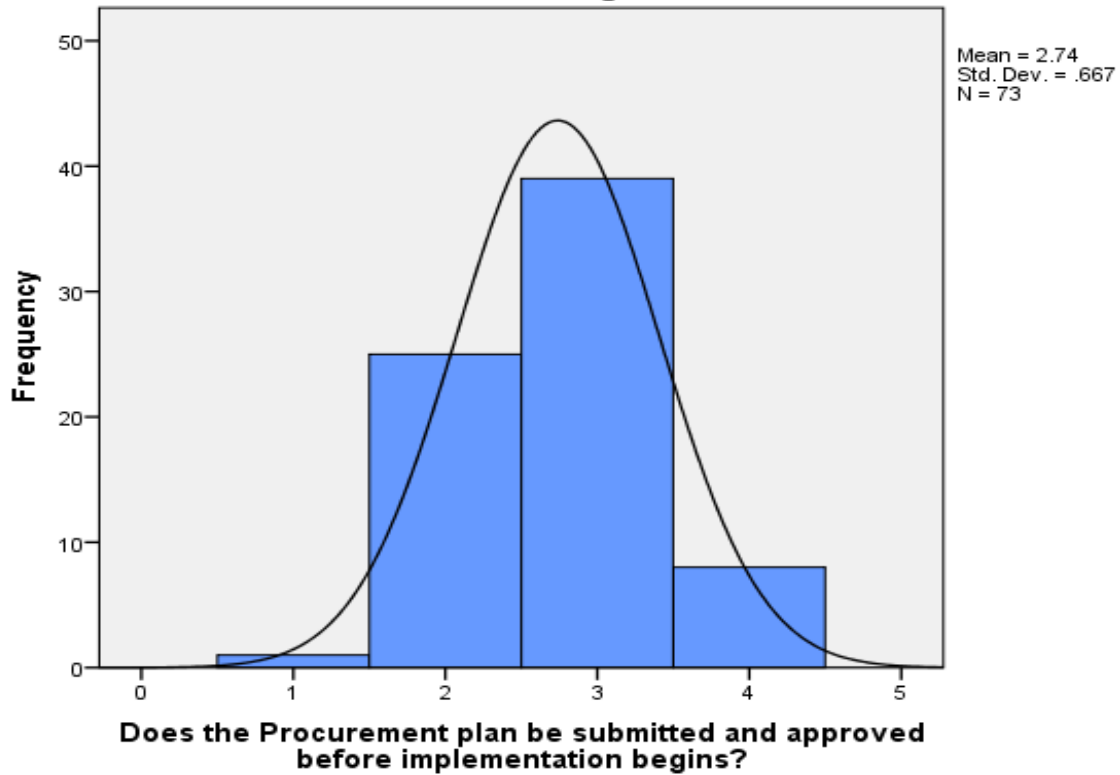
**Is there a competent contract administration to study project costs budget during the initiation process?**



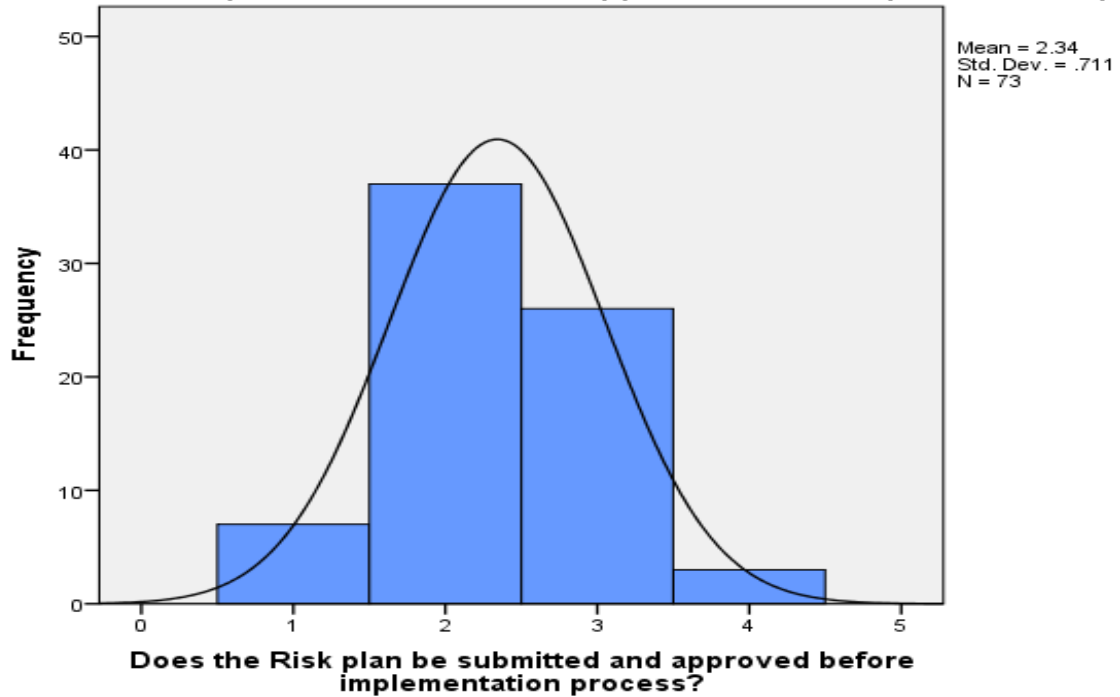
**Are the WBS (Work Breakdown Structure) create during the planning process?**



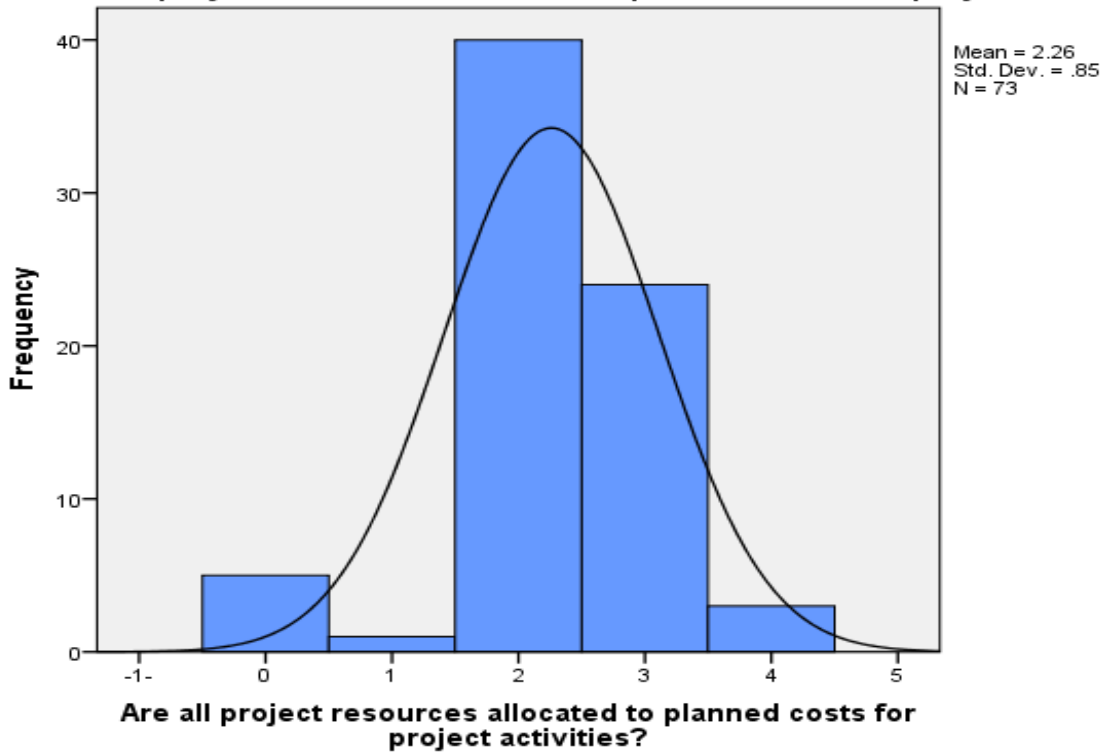
**Does the Procurement plan be submitted and approved before implementation begins?**



**Does the Risk plan be submitted and approved before implementation process?**



**Are all project resources allocated to planned costs for project activities?**



**Are there (contingency reserves) allocated to work package cost estimates?**

