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FACULTY OF ARCHITECTURE AND PLANNING

DEPARTMENT OF BUILDING TECHNOLOGY

Cost Overruns in the Delivery of Highway Construction Projects in Ghana

BY

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DECLARATION

I hereby declare that this submission is my own work towards the MSC degree in Construction Management and that, to the best of my knowledge, it contains no material previously published by another person nor material which has been accepted for the award of any other degree of the university, except where due acknowledgement has been made in the text.

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This work is dedicated to my lovely wife Mrs Lilian Ofosu Appiah, and our four lovely children, Evelyn, Nyarkoa, Josiah Atta and Joseph Atta Jnr.

ABSTRACT

Infrastructure development, and for that matter the construction of roads, serve as inputs for other sectors of a country's economy and are therefore used to stimulate growth and development in a nation. Infrastructure development therefore plays a vital role in the economic growth of a country. This role of infrastructure development in ensuring economic growth is however being defeated by increasing cost overruns in project delivery across the world. The phenomenon of project cost overruns is very widespread in developing countries (Mahamid and Dmaidi 2013), Ghana not being an exception. The effects of construction project cost overruns are a source of friction especially between government owners, consultants, and contractors in terms of project cost variation subsequent to the owner's decision to build (Creedy et al. 2010). Highway construction projects are particularly affected by cost overruns, with actual costs on average being 28% higher than estimated (Flyvbjerg et al. 2003). There have been several researches in countries the world over to identify the factors that lead to cost overruns in infrastructure projects and to look for ways to reduce the incidents of the problem. However, as a result of differences in the socio-economic and political maturity levels, the causative factors and therefore the remedies differ from country to country.

The research sought to identify and assess the critical risk factors leading to highway construction cost overruns in Ghana from the points of view of the owner. The five top ranked critical risk factors identified are; use of line diagrams for highway construction projects, lack of adequate designs before contract award, underestimation of quantities in Bills of Quantities (BOQ), delay in payment for certified work done, inadequate contingency allowance in BOQ . A common theme amongst the critical risk factors identified is that most of them are client-related. This means that they can be better controlled or managed by the client or owner.

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CHAPTER ONE

INTRODUCTION

1.0 BACKGROUND OF THE STUDY

All too often, construction projects make the national headlines for being financial disasters rather than significant engineering achievements that contribute to the improvement of our built environment. The construction industry, as a prime indicator of economic activity, is often utilised by governments not only to stimulate growth but also to assist economic recoveries from recessions. Considering the large capital outlays associated with highway construction projects, the performance in terms of cost and time are closely monitored, especially as tax payers' money is involved. The third measurement criterion for project performance, namely 'quality' is a more subjective unit of measure. The quantitative results from measuring against original project duration estimates and approved budgets remain popular yardsticks for assessing overall project performance.

In Ghana empirical studies on the subject of cost overruns in highway construction are either non-existent or are kept away from the tax payers' who have the right to know about how efficiently their monies are utilised by officials whilst making provisions of public goods and services. Highway construction involves huge outlay of capital which could otherwise be used to develop other sectors of the economy. Giving the current economic situation within the country, it is imperative that monies allocated for highway infrastructure developments are used judiciously.

1.1 STATEMENT OF THE PROBLEM

The problem of cost overrun, especially in the construction industry, is a worldwide phenomenon (Creedy et al. 2010). A project in the construction is considered successful if it is completed on time, within budget and to specification or quality standard. The achievement of this objective however is a major problem in the construction industry especially in developing countries, Ghana not being an exception. The reason for this is that the nature of construction activities makes the industry susceptible to high degree of risk. Identifying and mitigating project risk is therefore at the core of the duties of a construction project manager (Wysocki, 2009).

Highway construction requires high outlay of capital, yet in Ghana very little is known of their successful implementation. The tax payer whose money is used in developing these highways is thus left in the dark as to whether or not the taxes are being judiciously used and that he is getting value for money. Several completed highway construction projects in Ghana exceeded their original cost estimates.

Highway constructions have the potential to bring about the development of a country's economy and to open up a country for domestic as well as foreign direct investments to all parts of the economy. Governments therefore give highway construction a priority in the sharing of the national cake. If therefore the sector is not getting value for money, other critical sectors of the economy could be deprived of much needed funds.

1.2 IMPORTANCE OF THE PROBLEM

Cost overruns in highway construction have significant implications from economic as well as political point of view. According to Morris (1990) cost overruns in construction projects lead to an increase in the capital-output for the entire economy. Cost overruns reduce the efficiency of available economic resources and limit the growth potential of the entire economy. Cost overrun of highway projects affects program budgeting from the view of the owner (Creedy et al. 2010). The planning and budgeting of future highway construction projects are essential responsibility of highway organizations. Any deviations from budgeted contract sums are likely to incur the displeasure of the public, the press and politicians.

To mitigate the risk of cost overruns, owners usually include a percentage of the estimated cost as contingency in the determination of project budget. If the contingency is too high, it might encourage poor cost management, or deprive other projects of much needed funds (Dey et al. 1996). On the other hand, if the contingency is too low, it might lead to unsatisfactory performance or low value for money. There has been little or no research undertaken that relates owner risks in highway construction to the factors that lead to cost overrun of construction projects in Ghana as this research seeks to do.

1.3 AIM AND OBJECTIVES

The aim of the research is to assess the critical risk factors leading to cost overruns of highway construction projects in Ghana.

The objectives of the research are;

- To identify and analyse the risk factors leading to cost overruns in highway construction from the points of view of the owner.
- To evaluate the risk factors by prioritizing them on the basis of their impact on cost overruns from the points of view of the owner.

1.4 RESEARCH APPROACH AND METHODOLOGY

In order to provide adequate answers to the research objectives listed above, the following five research stages would be adopted:

- To identify the risk factors that lead to cost overruns of highway construction projects through detailed literature review.
- To validate the identified risk factors through personal interviews with experienced professionals involved in highway construction in Ghana
- To undertake a questionnaire survey to solicit the opinion of the owner represented by Engineers and Quantity Surveyors employed by GHA on the risk factors that lead to cost overruns by classifying the identified factors according to their degree of severity and frequency of occurrence.
- To analyse and rank the critical risk factors identified by the above stakeholders in order of importance using the importance index.
- To perform Statistical analyses of the responses to the identified risk factors from the point of view of the owner.

1.5 SCOPE AND LIMITATION

The scope of the research is limited to:

- The pre contract and post contract phases of highway construction project life cycle.
- Owner budget overrun and not the contractor cost overrun.
- The identification of the risk factors that lead to cost overruns in the delivery of highway construction projects from the point of view of the owner represented by engineers and quantity surveyors employed by Ghana Highway Authority (GHA).
- Analysis of the risk factors that lead to cost overruns from the points of view of the owner represented by engineers and quantity surveyors employed by GHA.
- Computation of the importance index for the identified risk factors in order to determine the critical ones among them.
- Statistical analyses of the responses to the identified risk factors from the point of view of the owner.

CHAPTER TWO

LITERATURE REVIEW

2.1 INTRODUCTION

The construction industry has a reputation for delivering projects over budget. One of the criterion by which a construction project is considered successful is that it must be completed within budget. The achievement of this objective however is a major problem in the construction industry especially in developing countries, Ghana not being an exception. The reason for this is that the nature of construction activities makes the industry susceptible to high degree of risk. Identifying and mitigating project risk is therefore at the core of the duties of a construction project manager (Wysocki, 2009). Highway construction involves huge outlay of capital which could be invested in other sectors of the economy. It is therefore imperative that funds invested in highway construction are used judiciously and that the ordinary tax payer whose taxes are used for these project get value for money.

This chapter examines in detail the literature on the key words in the research title, namely: risk management and cost overruns under the following sub headings:

- Project Risk Management
- Cost Overrun in the Global Construction Industry

2.1 PROJECT RISK MANAGEMENT

2.1.1 Introduction

A "risk" is an event that has the potential to cause an undesirable change in a project. Risk associated with project management refers to some future event that happens with some probability and results in a change, either positive or negative, to the project (Wysocki, 2009). A risk is defined as follows:

- A definable event
- With a probability of occurrence; and
- With a consequence or impact if it occurs.

A measure of the severity of risk is:

- Severity = Probability x Impact

In the management of risk, one needs to have a 'mitigation plan' which either lowers the probability and/or the impact to reduce the severity to an acceptable level (Abdulaal, 2009).

Risk is inherent in all activities of any construction project. For a construction project to be successful, a risk management process is needed such that risk can be continually evaluated and managed in order to minimize the consequences of adverse events. According to Abdulaal (2009), the final goal of risk management is to increase the probability of project and activity success by focussing attention on problematic areas early and reducing the amount of costly modifications in the future.

According to the PMBOK guide (fifth edition) Project Risk Management involves the processes of conducting risk management planning, identification, analysis, response planning, and controlling risk on a project. The objectives of project risk management are to increase the likelihood and impact of positive events, and decrease the likelihood and impact of negative events in the project. Before describing the risk management process, it is important to review the literature on construction risk and to define certain terms associated with risk management.

2.2.2 Research into Construction Risk

The intricate nature of construction projects, local conditions of the project area, type of contract, familiarity with work and inadequate communication are some of the leading contributors to risk in construction projects (Creedy et al. 2010). According to Thompson and Perry (1992) research on projects the world over indicates that project risk are not being adequately addressed. Research has shown that the construction industry focuses almost entirely on the reduction of financial risk and less on managing technical risk. A lot of researches have been undertaken in the field of risk management in the construction industry in the past. The important outcomes of a few are narrated as follows.

Hastak and Shaked (2000) undertook a study in which they identified three broad categories of construction risks; project, market, and country level risks. Country risks are related to macroeconomic stability of the country and are associated with the monetary and fiscal policy of the country. Market level risks result from foreign risks, and include technical advantage of the firm over local competitors, availability of construction related resources and government support at both local and foreign level towards the construction industry. Project level risks are specific to the project activities, and they include improper project design, safety measures on construction sites, constraints of logistics, improper control of quality and environmental protection. Uher (1994) identified thirty-four individual risks and categorised them into a single model, referring to some as "activity" risks that may affect individual activities, while others were "global" that were common to all activities. Dey (1999) used Delphi techniques to identify risk factors.

In highway construction, high levels of risks have been associated with unforeseen ground conditions. This has led to recurring and high frequency of claims. A study in Hong Kong by Kumaraswamy (1997), found that unforeseen ground conditions were ranked fourth in the "top ten" common categories of construction claims as perceived by contractors, owners, and consultants.

2.2.3 Basic Terminologies/Definitions

- **Risk** is the potential/likelihood of an activity to lead to a loss (undesirable outcome)
- **ISO 31000** (Risk Management Standard) defines risk as the 'effect of uncertainty of objectives'
- **Uncertainty** is the lack of complete certainty. That is, the existence of more than one possibility.
- **Risk Event** is a discrete occurrence that may affect the project for bad
- **Measurement of risk** is assigning quantified probability to possibilities.
- **Risk Probability** describes the potential for the risk occurring and ranges anywhere between 0% and 100%
- **Risk Impact** describes the effects or consequences of the occurrence of a risk

- **Project Risk** is an uncertain event or condition that, if it occurs has a positive or negative effect on at least one project objective, such as time, cost, scope, or quality.
- **Risk Management** is a systematic method of identifying, analysing, evaluating, treating, and monitoring the risks involved in any activity or process
- **Project Risk Management** is a process that assists project managers in setting priorities, allocating resources and implementing actions that reduce the risk of the project not achieving its objectives (Abdulaal, 2009).

2.2.4 Risk Management Process

Every project is subject to risks. Some can be identified and plans can be put in place if they occur; others cannot and must be dealt with as they occur (Wysocki, 2009). This section focuses on events that could compromise the successful completion of the project. No one knows when they will occur, but they will occur with some likelihood and cause some damage to the project. Project risk management is dynamic and not static. This means risk change throughout the project life cycle and therefore has to be monitored and appropriate control measures put in place to mitigate its effects.

Risk can be managed, minimized, shared, transferred, or accepted, but it cannot be ignored (Latham, 1994). This section list and explains the four key parts of the risk management process namely; Risk identification, Risk assessment, Risk mitigation, Risk monitoring.

2.2.4.1 Risk Identification

To establish the risk management for the project, the project manager and project team must go through several processes. The first is identifying risk. In this part of the process, the entire team is brought together to discuss and identify the risks that are specific to the project on hand. The focus of the team should be solely on risk in order to emphasize the importance of risk management and to avoid missing any potential risk event.

Developing a risk management plan is a significant part of the project planning process. The more complex and uncertain the project, the more important it is to have a dynamic and maintained risk management plan. Risk identification can start with the source of problems, or with the problem itself. Risk categorization and risk breakdown structure helps to comprehensively identify all risk. Brainstorming can be employed to help in identify all the risk. After the risk drivers have been identified and documented, the project team can move to the second step of classifying the risk drivers into four categories (Wysocki, 2009).

2.2.4.1.1 Candidate Risk Drivers

The first step in the Risk Management Process is to identify the risk drivers that may be operative on a given project. These are conditions or situations that may unfavourably affect project success. As an example, Figure 2-1 shows a candidate list from which the list of risk drivers that are appropriate for a given project can be chosen.

- Too conservative a budget	- Inadequate skilled personnel
- Schedule is too aggressive	- Continuous requirement changes
- New/unfamiliar technology	- Unsuitable organizational structure
- Poorly defined requirements	- Poor technology support
- Frequent change request	- Loss of critical team member
- Misunderstood contract terms	- Lack of political support for project

Figure 0.1: List of candidate risk drivers

2.2.4.1.2 Risk Categories

Risk can be classified into four categories. The categories together with its potential risks are listed below;

- **Technical Risks (Internal risks)**
  - Unproven or complex technology
  - Unrealistic performance goals
  - Changes to technology
- **Project Management Risks (Internal risks)**
  - Poor allocation of resources, cost, time etc.
  - Inadequate quality of plan
  - Poor use of project management disciplines
- **Organizational Risks (Internal risks)**

- Inadequate prioritization of projects
- Inadequate/interrupted funding
- Conflicts with other competing projects

- **External Risks**
  - Legal or regulatory requirements
  - Economic collapse or industrial strikes
  - Supplier and contractor risks

2.2.4.2 Risk Assessment

There are two major factors in assessing risks after they have been identified. The first one is the probability that the risk event will occur. The second part of risk assessment is the impact the risk will have on the project. To assign a numerical score to a risk event, you simply multiply the probability of the risk occurring and the impact that the event's occurrence would have. The probability of an event occurring is subjective to a great extent, as is the impact of the event.

According to Adinyira (2014) risk assessment involves two processes namely; risk analysis and risk evaluation. These two processes are now discussed.

2.2.4.2.1 Risk Analysis

After risks have been identified, there is the need for the risks to be analysed. This involves the determination of the consequence (impact) and likelihood (frequency) of each risk. . Frequency and impact are the two primary characteristics used to filter risks and separate them into minor risks that do not require further management attention and significant risks that require management attention and possibly quantitative analysis. Various methods have been developed to assist in classifying risks according to their seriousness. One common method is to develop a two-dimensioned matrix that classifies risks into three categories based on the combined effects of their frequency and impact. Figure 2-2 shows the classification of risks into one of five states of likelihood (remote through almost certain) and into five states of consequence (insignificant through catastrophic). The prioritization of risk brings in the concept of risk evaluation

Consequences		**Likelihood**	
Level	Descriptor	Level	Descriptor
1	Insignificant	A	Almost certain
2	Minor	B	Likely
3	Moderate	C	Possible
4	Major	D	Unlikely
5	Catastrophic	E	Remote

Figure 0.2: Risk classification matrix

2.2.4.2.2 Risk Evaluation

This involves ranking of the analysed risk to some management priority such as effect on project scope, time, cost etc. The evaluation of risk yields a five-by-five matrix that prioritises a risk as either "high" (red), "moderate" (yellow), or "low" (green) as shown in Figure 2-3.

Likelihood	**Consequences**				
	Insignificant 1	Minor 2	Moderate 3	Major 4	Catastrophic 5
A – almost certain	M	M	H	H	H
B - likely	L	M	M	H	H
C - possible	L	L	M	M	H
D - unlikely	L	L	L	M	M
E - remote	L	L	L	L	M

Figure 0.3: Risk prioritization matrix

L - **Low-Risk Events**

Risks that are characterized as low can usually be disregarded and eliminated from further assessment. As risk is periodically reassessed in the future, these low risks may have to be closed, retained, or elevated to a higher risk category.

M - Moderate-Risk Events

Moderate-risk events are either high-likelihood, low consequence events or low-likelihood, high-consequence events. An individual high-likelihood, low-consequence event by itself would have little impact on project cost or schedule outcomes. However, most projects contain a combination of such risks (material prices fluctuations, poor workmanship, payment delays, etc.); the combined effect of several high-likelihood, low consequence risks can significantly alter project outcomes. Commonly, risk management procedures control this high-likelihood, low-consequence risks by determining their combined effect and developing cost and/or schedule contingency allowances to mitigate their impact. Low-likelihood, high-consequence events, on the other hand, usually requires unique attention and management. At the least, low-likelihood, high-consequence events should be periodically monitored for changes either in their probability of occurrence or in their severity of impacts. Some events with very large, albeit unlikely, impacts may be actively managed to mitigate the negative consequences should the unlikely event occur.

H - High-Risk Events

High-risk events are so classified either because they have a high likelihood of occurrence coupled with at least a moderate impact or they have a high impact with at least moderate likelihood. In either case, specific focused management action is warranted to reduce the probability of occurrence or the risk's negative impact.

In prioritizing risk there is the need to define a probability and impact scale based on the effect the risk event has on the chosen management objectives. A typical scale adopted from Adinyira (2014) is shown in Fig 2-4 below.

Defined conditions for impact scales of a Risk on Major Project Objectives					
Project Objectives	Very low/0.05	Low/0.10	Moderate/0.20	High/0.40	Very High/0.80
Cost	Insignificant cost increase	<10% cost increase	10 – 20% cost increase	20 – 40% cost increase	>40% cost increase
Time	Insignificant time increase	<5% time increase	5 – 10% time increase	10 – 20% time increase	>20% time increase

Figure 0.4: Risk probability and impact scale

2.2.4.3 Risk Mitigation

The next step in risk management is to plan, as much as possible, the responses that will be used in the event that the identified risks occur. For instance a client may want to include a clause in a construction contract with a contractor that should he fail to complete the project by a certain date, then he will be liable to pay a penalty. This penalty gives the contractor an incentive to analyse and mitigate the risks involved in late completion of the project.

The objectives of risk mitigation and planning are to identify risk response strategies for the high risk items identified in the qualitative and quantitative risk assessment. The process identifies and assigns parties to take responsibility for each risk response. It ensures that each risk requiring a response has an owner. The owner of the risk could be a project manager, engineer, or construction manager, depending on the point in project development, or it could be a contractor, depending on the contracting method and risk allocation.

The Caltrans Project Risk Management Handbook states that the project management team must identify which strategy is suitable for each risk and then design specific actions to implement that strategy. The strategies and actions in the handbook include the following:

- Avoidance-The team alters the project plan in order to remove the risk or to protect the project objectives from its impact. The team might achieve this by changing scope, increasing time, or increasing contingency allowance (thus relaxing the so-called triple constraint).
- Transference-The team transfers the financial impact of risk by contracting out some aspect of the work. Transference reduces the risk only if the contractor is more capable of taking steps to reduce the risk and does so.
- Mitigation-The team seeks to reduce the probability or impact of a risk event to an acceptable level. It achieves this via many different means that are specific to the project and the risk. Mitigation steps, although costly and time consuming, may still be preferable to going forward with the unmitigated risk.
- Acceptance-The project manager and team decide to accept certain risks. They do not change the project plan to deal with a risk or identify any response strategy other than agreeing to address the risk if it occurs.

2.2.4.3.1 Risk allocation

The contract is the means for risk allocation. Whether the contract is for construction, design, design-build, or some other aspect of highway construction management, it defines the roles and responsibilities for risks. Risk allocation in any contract affects cost, time, quality, and the potential for disputes, delays, and claims. In fact, research has shown that contractual misallocation of risk is the leading cause of construction disputes the world over.

The objectives of risk allocation can vary depending on individual project goals, but four fundamental tenets of sound risk allocation should always be followed:

1. Allocate risks to the party in the best position to manage them - A fundamental tenet of risk management is to allocate the risks to the party best able to manage them. The party assuming the risk should be able to best evaluate, control, bear the cost of, and benefit from its assumption. For example, the risk of an inadequate labour force, a breakdown in equipment, or a specific construction technique is best borne by the contractor, while a risk of securing of project funds or project site availability is best borne by the client or owner.

   Following this principle of allocating the risks to the party best able to manage them will ultimately result in the lowest overall price because contractors will not be pushed to include contingencies in their rate build-up for possible financial losses or take gambles in an extremely competitive bidding environment. Inappropriate risk shifting from the client to the contractor can result in misaligned incentives, mistrust, and an increase in contractual disputes.

2. Allocate the risk in conformity with project goals - Risks should be allocated in a manner that maximizes the likelihood of project success. The definition of a clear and unambiguous set of project objectives is essential to project success and these objectives must be understood to properly allocate project risks. For instance, if the public needs a project completed sooner than would be achievable under traditional contracting and risk allocation methods, the owner may be forced to ask the contractor to assume more risk for timely or expedited completion and it must be willing to compensate the contractor for assuming this risk.

   Allocating risks in alignment with project objectives begins with a clear understanding of the project objectives by the project manager and a clear communication of these objectives to the contracting, consulting, or design party. While this idea seems simple, in practice it is often difficult to identify and prioritize concise objectives because of the complex nature of highway construction projects.

3. Share risk when appropriate to achieve project goals - The term "risk sharing" can be somewhat misleading. In reality, no risk is truly shared; instead, exposure to the risk is split among the parties. Risk sharing is clearly defining the point at which the risk is transferred from one party to the other. These transfer points should be scrutinized for appropriateness and then explicitly

and clearly addressed in the contract. For example, a risk that is commonly shared is unusually severe weather. A contract provision for unusually severe weather may grant the contractor a right to an extension of contract period while not providing for additional compensation of costs. In this situation, the owner is allocated the risk of delay while the contractor is allocated the risk of additional costs.

4. Ultimately seek to allocate risks to promote team alignment with customer-oriented performance goals - The ultimate goal of risk allocation should be to help align the project team with customer-oriented performance goals. After all one of the criterion for project success is to meet customer expectations and goals.

2.2.4.3.2 Risk contingency considerations

A Contingency can be defined as a reserve amount of money or time needed above the estimate to reduce the risk of overruns of project objectives to a level acceptable to the organization. Not all risks can be avoided or fully mitigated. If an owner accepts a risk, it is prudent to maintain a contingency in case the risk occurs. Likewise, the contractor reserves a contingency for risks that have been allocated to its organization in the contract. In the case of a shared contingency pool, the contingency is known to both parties and there are incentives for completing the project without spending the entire contingency.

Any party assuming a risk must be prepared for the financial responsibility associated with that risk. Prudent contractors and owners use the quantitative risk assessment techniques to estimate the contingency necessary to complete a project. Proper risk allocation will allow for the minimization of this contingency for both parties.

When an owner requires a contractor to assume a risk in a fixed price contract, that contractor must include a contingency. This will obviously cost the owner money, but it may achieve a required project goal. An option that is not often exercised in highway construction projects but has been successful in the private sector in the developed world is establishment of a shared contingency pool, a sum of money set aside by the owner for an uncertainty in the project. The contractor can spend the contingency pool at its standard unit rates, but if the contractor can avoid spending the contingency pool, it can receive an incentive payment of 50% of the remaining money in the contingency pool. In this way, the owner and the contractor truly share the risk and rewards for managing the project uncertainty in construction.

2.2.4.4 Risk Monitoring and Control

After risks have been identified, and the probability and impact of the risk have been assessed, the Project Manager and his team have to plan what to do if the risk event occurs. When the project implementation starts the Construction Manager (CM) then has to monitor and control the project risks. According to Wysocki (2009) writing down the risks and assessing them gives everyone on the project team an awareness of their existence. To accommodate the monitoring and control phase of the risk management life cycle, the CM should maintain a risk log. This document lists all risks that one wants to manage and describes what the risks is, who is supposed to manage the risk, and what has been done to manage the risk event.

The objectives of risk monitoring and updating are to:

1. systematically track the identified risks
2. identify any new risks
3. effectively manage the contingency reserve
4. capture lessons learned for future risk assessment and allocation efforts

The risk monitoring and updating process occurs after the risk mitigation, planning, and allocation processes. It must continue for the life of the project because risks are dynamic. The list of risks and associated risk management strategies will likely change as the project matures and new risks develop or anticipated risks disappear.

Periodic project risk reviews repeat the tasks of identification, assessment, analysis, mitigation, planning, and allocation. Regularly scheduled project risk reviews can be used to ensure that project risk is an agenda item at all project development and construction management meetings. If unanticipated risks emerge or a risk's impact is greater than expected, the planned response or risk allocation may not be adequate. At this point, the project team must perform additional response planning to control the risk.

2.3 COST OVERRUN IN THE GLOBAL CONSTRUCTION INDUSTRY

2.3.1 Introduction

Cost overrun is simply defined as the difference between the final actual cost of a construction project at completion and the initial contract sum agreed between the owner and the contractor at the contract signing stage. Risk and uncertainty exist in situations where the actual outcome of a particular event or activity is likely to deviate from the estimate or forecast value (Creedy et al. 2010).

Construction projects cost overruns in the global economy are a well-researched topic. These studies have shown that cost overruns in the construction industry are a global phenomenon. The reasons for this situation are that all construction projects are by their very nature economically risky undertakings and projects awarded on the basis of competitive bids can add to such risks (Mahamid and Dmaidi 2013). Most highway infrastructure projects in most countries including Ghana adopt a common project delivery method known as the "traditional model" or design-bid-build (DBB). In this model, the design/engineering services are first produced and then another procurement contract is tendered for the actual construction based on the design (Creedy et al. 2010). The main criticisms of the traditional DBB method are lack of innovation, delayed completion periods, and cost overruns. The owner of a construction project bears most of the risks of both the design and construction phases. It is therefore necessary to put in measures that would ensure that the owner's needs are being fulfilled and that quicker project completion times and cost effective solutions are provided.

A study of 47 "megaprojects" conducted by Merrow et al. (1988) in the construction environment as cited by Baloyi and Bekker (2011) revealed that only four were on budget with an average cost overrun of 88%. A study undertaken by the International Program in the Management of Engineering and Construction (IMEC) in 2000 revealed that 18% of 60 large engineering and construction projects, with an average capital value of one billion dollars undertaken between 1980 and 2000, incurred extensive cost overruns (Miller and Lessard 2000). The relatively poor performance of construction projects has led researchers to investigate and identify the factors that cause cost overruns. In the following section the results of related literature is summarized with regards to the identification of the most important and dominant factors.

2.3.2 Factors causing cost overruns

For over two decades now, there have been several studies to investigate the causes for project cost overruns on construction projects. For example according to Ganuza (2007) cost overrun is attributable to imperfect estimation techniques and lack of data. In other words cost overruns are due to 'genuine' mistakes on the part of government officials. However, if cost overruns are only due to imperfect estimation techniques, then negative cost overrun should have equal chance of occurring as positive cost overrun on a construction project. Research has shown that negative cost overrun is more frequent on construction projects as compared to positive cost overrun. Flyvbjerg et al (2002, 2004) attributes cost overrun to political factors. That is politicians understate cost and exaggerate benefits in order to make projects saleable.

Kaming et al. (1997) studied 31 construction projects in Indonesia and identified that from contractors' perspective, the main causes of cost overruns are; inaccuracy of material take-off, increase in material costs, and increase in cost due to environmental restrictions. In a study of cost overruns and delays on groundwater projects in Ghana, Frimpong et al. (2003) found that from the point of view of contractors, late payments of certified work done by clients was the single most important factor leading to cost overrun and time delays. However from the point of view of clients, poor contractor performance was the most important cost and time overrun factor.

In yet another research on construction projects in Nigeria, Okpala and Aniekwu (1988) established that architects, consultants and clients agreed that 'shortage of materials', 'finance and payment of completed works', and poor contract management' were the most important causes of cost overruns. Mansfield et al. (1994) investigated the performance of transportation infrastructure projects in Nigeria and came to the conclusion that 'material price fluctuations', 'inaccurate estimates', 'project delays', and additional work', were the significant factors leading to cost overruns. Elinwa and Buba (1994) undertook a study on construction projects in Nigeria and found out that 'cost of materials', 'fraudulent practices', and 'fluctuations in materials prices' had the most significant impact on project costs. In a research on construction project performance in developed counties, Morris and Hough (1987) as well as Flyvbjerg et al. (2003) identified 'fluctuations in material cost' and 'additional work' as the most significant contributors of cost overruns.

In concluding it can be argued that the factors that lead to cost overruns do not stand alone but are interrelated. For instance, additional work requested by a client can result in delay in ordering material which might itself be subjected to price increases or shortages. The factors that lead to cost overruns might be different from the points of view of the three main stakeholders involved in construction, namely; clients, contractors and consultants even though there might be points of convergence.

2.3.3 Assessment of factors causing cost overruns

Construction projects involve business engagement between two main parties, namely the client or owner of the project and the contracting parties. The client is usually an individual or an institutional body such as a governmental department, a corporate institution, financial institution, or non-governmental institution. Contracting companies could be main contractors, subcontractors or suppliers. The business engagements between the two parties occur in an economic, socio-economic and environmentally delicate business environment. This environment consists of many external factors that have the potential to affect the progress and success of the project. These external factors together with the client-related and contractor-related factors should be considered when investigating the causes of cost overruns in construction projects. In view of this, the following basic categories developed by Antill and Woodhead (1990) as referenced by Baloyi and Bekker (2011) would be adopted in assessing the risk factors leading to cost overruns in the delivery of highway construction projects.

- Client-related factors;
- Contractor and supplier related factors, and

- External factors

2.3.3.1 Client related factors

These are cost overrun factors that originate from the actions or inactions of the client and or his representatives. For such risks the client ultimately bears the consequences. Client-related factors include: late payments, approval delays, changes to work and design, poor technical definition, design delays, decision making and internal skills shortages, inadequate designs, inadequate estimates etc.

2.3.3.2 Contractor related factors

These are cost overrun factors that originate from the actions or inactions of the contractor, his agents, subcontractors or suppliers. For such risks the contractor ultimately bears the consequences. Contractor-related factors include: Poor project supervision, Low productivity, Poor project planning, poor financial control, disputes on site etc.

2.3.3.3 External factors

External risks are items that are generally imposed on the project from establishments beyond the limits of the project. Interactions with citizens groups or regulators are typical external risks. Funding constraints and restrictions, shortage of material, inflationary trends are other common external risks. External risks tend to refer to items that are inherently unpredictable but generally foreseeable.

CHAPTER THREE

RESEARCH METHODOLOGY

3.1 INTRODUCTION

The overall objective of this research is to identify the critical risk factors leading to cost overruns in highway construction projects from the perspective of the owner. Construction projects entail the business engagement between two parties; namely the client or owner of the project and the contracting parties. This business engagement between the two parties occurs in an economic, socio-economic and environmentally sensitive business environment. This global environment consists of many external factors that could influence the progress and success of the project.

In view of this, 55 factors that might affect cost overrun in highway construction projects were defined through detailed literature review and divided into 3 groups; client-related, contractor-related and external factors. The factors were tabulated into a questionnaire form. The draft questionnaire was discussed with some construction professionals involved in highway construction to evaluate the content of the questionnaire. Modifications and changes were then made to produce a final questionnaire.

3.2 QUESTIONNAIRE DESIGN

In order to conduct the survey, a detailed questionnaire was developed. The main purpose of the questionnaire was to assess the perception of respondents regarding the risk factors that lead to cost overruns in highway construction projects. The questionnaire is divided into two main parts. Part I is related to general information about the respondents. The owner (represented by engineers and quantity surveyors working with Ghana Highway Authority) were asked questions pertaining to their experience in highway construction projects in Ghana and their opinions about the percentage average cost overrun in highway construction projects they have experienced.

Part II includes the list of the identified risk factors leading to cost overrun in highway construction projects. For each factor, two questions were asked: what is the frequency of this factor? And what is the degree of severity of this factor on cost overrun in highway construction. Both frequency and severity were categorized on a five-point scale as follows: very high, high, moderate, low, very low (on 5 to 1 point scale).

3.3 SAMPLING METHOD

The population size of the owner represented by civil engineers and quantity surveyors distributed across the country and obtained from the human resource department of Ghana Highway Authority (GHA) is 179 as at June 2013. A total of 60 questionnaires were distributed to the owner asking their opinion in assessing the 55 risk factors in terms of severity and frequency using an ordinal scale. This sample size was adopted from a similar study conducted by Baloyi and Bekker (2011).

The sampling method used for this research is commonly referred to as convenience or snowball sampling. This type of sampling falls under the category of non-probability techniques and, as the name implies, sample elements are identified by convenience (friends, colleagues and professional contacts) and referral networks. This sampling method was adopted as a result of the difficulty in obtaining a detailed list and contact addresses of all the Engineers and Quantity Surveyors in the current employment of GHA.

CHAPTER FOUR

DATA ANALYSIS

4.1 INTRODUCTION

The 55 risk factors identified through the literature review and personal interviews were classified in the form of a questionnaire into 3 sections namely, client-related factors, contractor related-factors and external factors. The client-related factors considered were 22. The contractor-related and external factors considered were 17 and 16 respectively. The respondents who are Engineers and Quantity Surveyors employed by GHA were asked to classify the factors according to a chosen scale adopted from Mahamid and Dmaidi (2013) in terms of their frequency of occurrence and severity of impact. The scale is as shown below:

Table 4.1: Index scale for frequency of occurrence and severity of impact

Index Value (Scale)	Frequency of occurrence	Severity of impact
<20 %	very low (1)	very low (1)
20 - 40 %	low (2)	low (2)
40 - 60 %	moderate (3)	moderate (3)
60 - 80 %	high (4)	high (4)
80 - 100 %	very high (5)	very high (5)

The above scale (Table 4.1) together with the risk map shown in Figure 4.1 was used to analyse and to determine the level of risk for each factor. The map is 5x5 matrixes with severity ranging from VL to VH on the horizontal axis and frequency (with the same range) on the vertical axis. Three zones are presented in the map: green, yellow and red. The zones have the following characteristics:

Green zone – risks in this zone are low level and can be ignored

Yellow zone – risks in this zone are of moderate importance, if these risks occur, they can be managed. However if their frequency and severity are moderate, they should be controlled and reduced and a contingency plans put in place just in case they happen.

Red zone – risks in this zone are of critical importance. These are the top priority risks and therefore require close attention.

Severity/ Frequency	**VL**	**L**	**M**	**H**	**VH**
VL	green	green	green	yellow	red
L	green	green	yellow	red	red
M	green	green	yellow	red	red
H	green	yellow	red	red	red
VH	green	yellow	red	red	red

Figure 4.1: 5x5 Risk Matrix

4.2 RESPONSE RATE AND PATTERN

Of the 60 questionnaires distributed, 39 (65%) responses were received. Of the 39 responses received 15(38%) were from Civil Engineers and 24(62%) were from Quantity Surveyor in the current employment of GHA. Details of response pattern is shown in Table 4.2 and illustrated in Figure 4.2.

Table 4.2: Response rate and pattern

RESPONDENTS	POPULATION	SAMPLE SIZE	NO OF QUESTIONNAIRES ISSUED	NO OF QUESTIONNAIRES RETURNED	PERCENTAGE OF VALID RESPONSES
CIVIL ENGINEERS	110	30	30	15	38.46%
QUANTITY SURVEYORS	69	30	30	24	61.54%
TOTAL	179	60	60	39	100.00%

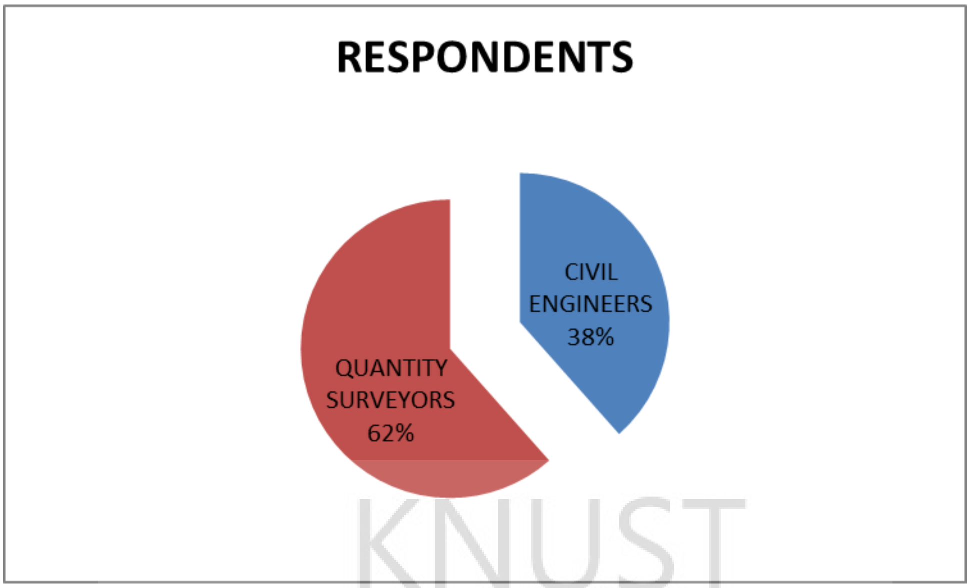

Figure 4.2: Response rate and pattern

General Characteristics of Respondents

Of the 39 respondents 26 (67%) were males and 13(33%) were females as illustrated in Table 4.3 and Figure 4.3. 15 Civil Engineers and 24 Quantity Surveyors in the current employment of GHA representing 32% and 68% respectively responded to the questionnaire. This is illustrated in Table 4.4 and Figure 4.4. 35 respondents representing 90% have first degrees as shown in Table 4.5 and Figure 4.5. Most of the respondents 72% are aged between 41-50 years, and have over 20 years' experience in the construction industry as illustrated in Table 4.6 and 4.6 respectively.

Worthy of note is the respondents' perception about the average cost overrun in highway construction projects in Ghana. 30 out of the 39 respondents representing 77% indicated that the average cost overrun they have experienced is above 40%. This is shown in Table 4.8 and Figure 4.8.

Table 4.3: Respondents Gender

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	MALE	26	66.7	66.7	66.7
	FEMALE	13	33.3	33.3	100.0
	Total	39	100.0	100.0	

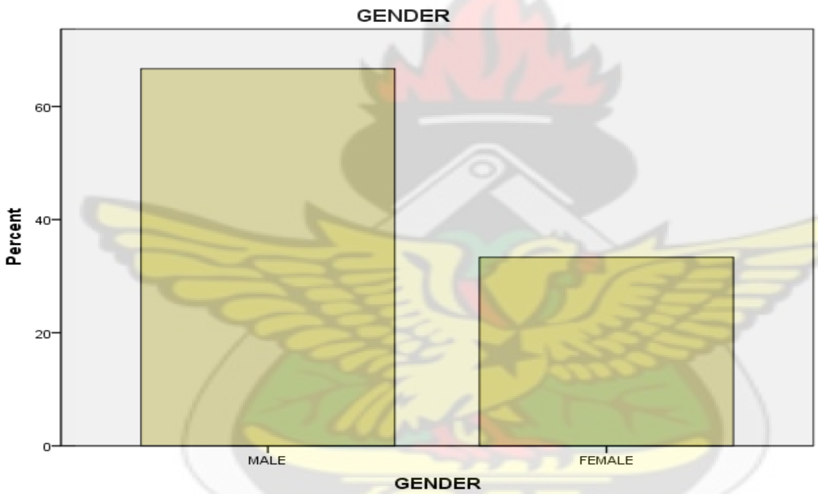

Figure 4.3: Respondents Gender

Table 4.4: Respondents Job Description

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	CIVIL ENGINEER	15	38.46	38.46	38.46
	QUANTITY SURVEYOR	24	61.54	61.54	100.0
	Total	39	100.0	100.0	

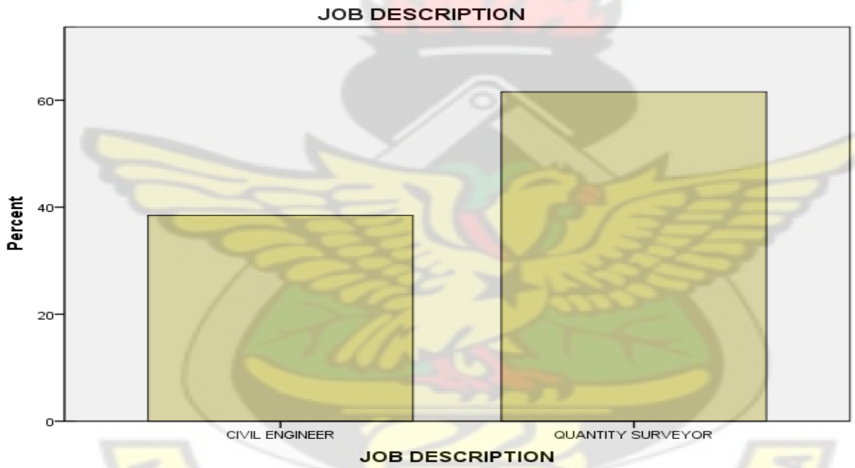

Figure 4.4: Respondents Job Description

Table 4.5: Respondents level of education

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	POST GRADUATE	3	7.7	7.7	7.7
	FIRST DEGREE	35	89.7	89.7	97.4
	HND/DIPLOMA	1	2.6	2.6	100.0
	Total	39	100.0	100.0	

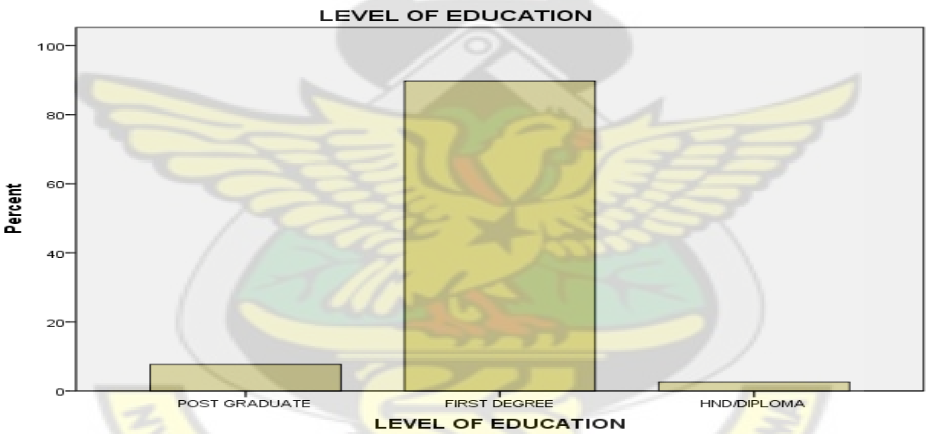

Figure 4.5: Respondents level of education

Table 4.6: Respondents experience in the construction industry

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	6-10	8	20.5	20.5	20.5
	11-15	13	33.3	33.3	53.8
	16-20	2	5.1	5.1	59.0
	ABOVE 20	16	41.0	41.0	100.0
	Total	39	100.0	100.0	

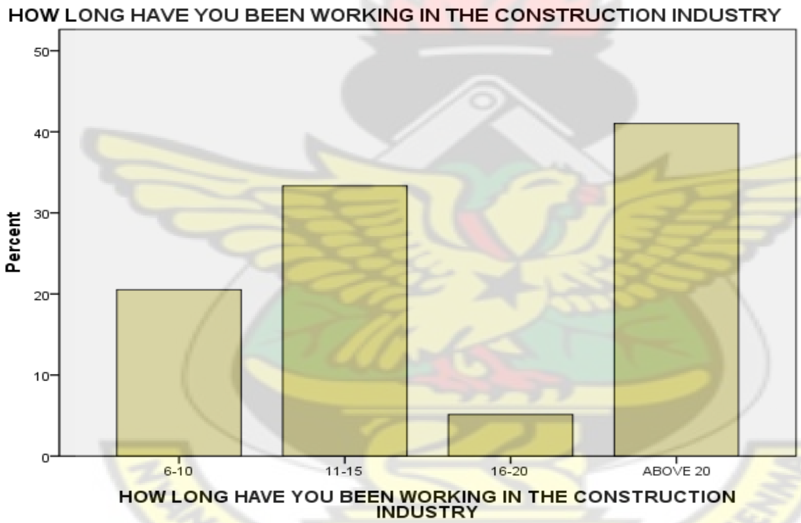

Figure 4.6: Respondents experience in the construction industry

Table 4.7: Respondents age group

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	31-40	11	28.2	28.2	28.2
	41-50	28	71.8	71.8	100.0
	Total	39	100.0	100.0	

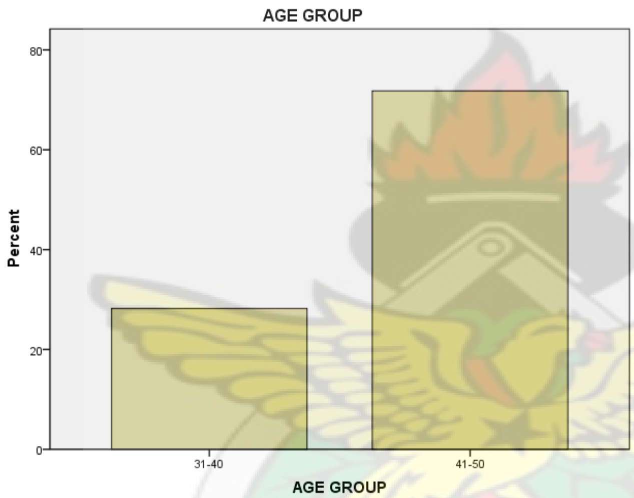

Figure 4.7: Respondents age group

Table 4.8: Respondents perception on average cost overrun

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	>20%				
	20% - 40%	9	23.1	23.1	23.1
	40% - 60%	30	76.9	76.9	100.0
	60% - 80%				
	80%-100%				

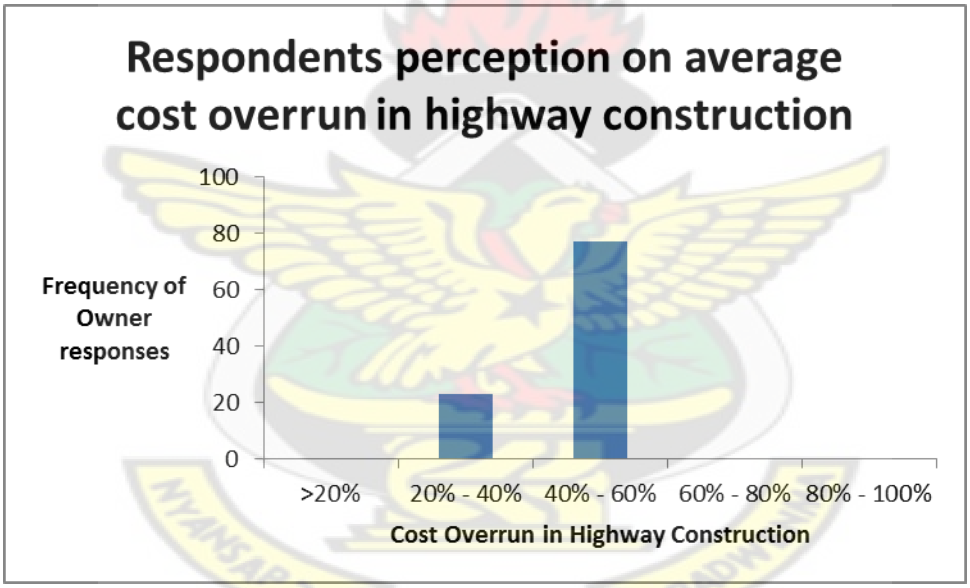

Figure 4.8: Respondents perception on average cost overrun

4.3 RISK ANALYSIS OF FACTORS

The data collected were stored and analyse using Microsoft Excel and SPSS version 18. In computing the Frequency Index (F.I.) and the Severity Index (S.I.), the formula shown in equation1 was used.

(F.I/ S.I) Index (%) = (∑ (a*(n/N))*100/5): Equation 1

Where:

a = the constant expressing weighting given to each response (ranges from 1 for very low up to 5 for very high)

n = the frequency of the responses

N = total number of responses

Tables 4.9 to 4.11 show the Frequency Index (F.I.) and the Severity Index (S.I.) for all the factors classified into the 3 categories namely: client-related factors, contractor-related factors and external factors.

Table 4.9: Frequency index and severity index for client-related factors

	FACTORS	FREQUENCY OF OCCURRENCE WEIGHTINGS					F.I. (%)	SEVERITY OF IMPACT WEIGHTINGS					S.I. (%)
A	**CLIENT-RELATED FACTORS**	**1**	**2**	**3**	**4**	**5**		**1**	**2**	**3**	**4**	**5**	
1	Delay in payment				3	36	98.46				17	22	91.28
2	Delay in giving approvals		23	16			48.21			25	13	1	67.69
3	Design/ Project scope change			33	6		63.08			12	21	6	76.92
4	Ommision of neccesary works in BOQ				35	4	82.05			1	15	23	91.28
5	Lack of detail designs before contract award				3	36	98.46			1	2	36	97.95
6	Increased measure of Additional works			2	36	1	79.49			1	33	5	82.05
7	Contract tender price higher than original estimate		24	4	11		53.33		19	7	13		56.92
8	Underestimation of quantities in BOQ				8	31	95.90				12	27	93.85
9	Use of line diagrams for highway projects				1	38	99.49				1	38	99.49
10	Latent Condition - Remove and replace unsuitable material			25	14		67.18			3	35	1	78.97
11	Latent Condition - Rock encounted			28	11		65.64			4	34	1	78.46
12	Latent Condition - Additional stabilization			35	4		62.05			14	23	2	73.85
13	Fradulent practices and kickbacks	26	13				26.67	2	35	1		1	41.03
14	Inadequate contigency allowance in BOQ			10	1	28	89.23			12	4	23	85.64
15	Inadequate project supervision/ monitoring by ER and team		27	11	1		46.67		7	27	4	1	59.49
16	Project administration cost increase	2	35	2			40.00	8	29	1	1		37.44
17	Project acceleration requirement	38	1				20.51	18	17	3	1		33.33
18	Delay in evaluating and awarding contracts			5	34		77.44		2	20	16	1	68.21
19	Contract failure-New contract establishment cost		39				40.00		20	12	6	1	53.85
20	Contract tender price lower than original estimate	2	37				38.97	15	22	1		1	34.36
21	Lack of adequate manpower for project supervision	24	4	11			33.33		20	17	2		50.77
22	Unrealistic construction periods	1	28	10			44.62	17	8	13		1	39.49

Table 4.10: Frequency index and severity index for contractor related factors

	FACTORS	FREQUENCY OF OCCURRENCE WEIGHTINGS					F.I. (%)	SEVERITY OF IMPACT WEIGHTINGS					S.I. (%)
B	**CONTRACTOR-RELATED FACTORS**	**1**	**2**	**3**	**4**	**5**		**1**	**2**	**3**	**4**	**5**	
1	Underpricing of tender due to competition	10	1	28			49.23	19	19		1		31.28
2	Delay in project completion			12	27		73.85			25	14		67.18
3	Poor project planning		2	33	4		61.03		3	35		1	59.49
4	Fradulent practices and kickbacks	27	12				26.15	9	29			1	36.92
5	Overmeasurement of work done			2	15	22	90.26			1	30	8	83.59
6	Inaccurate contract time estimates	1	38				39.49	11	25	3			35.90
7	Inadequate resources for project execution		15	24			52.31	2	32	4	1		42.05
8	over reliance on claims to recover lost profits	4	25	10			43.08	6	11	19	2	1	50.26
9	abondonment of projects	21	8	10			34.36		9	25	5		57.95
10	Lack of skilled work force	18	21				30.77	23	13	3			29.74
11	wrong estimation method	21	16	2			30.26	17	20	1	1		32.82
12	Stopages due to labor agitations	4	22	12	1		45.13	10	13	15	1		43.59
13	Poor labor productivity		15	24			52.31	2	22	14		1	47.69
14	Improper control and storage of materials		12	27			53.85	10	28		1		35.90
15	Disputes on site		27	2			30.77	11	23	4		1	37.95
16	Poor financial control on site	10	2	25	2		49.74	15	11	11	2		40.00
17	Poor sub contractors and suppliers management	34	2	3			24.10	15	20	4			34.36

Table 4.11: frequency index and severity index for external factors

	FACTORS	FREQUENCY OF OCCURRENCE WEIGHTINGS					F.I. (%)	SEVERITY OF IMPACT WEIGHTINGS					S.I. (%)
C	EXTERNAL FACTORS	1	2	3	4	5		1	2	3	4	5	
1	Delay in obtaining funding			39			60.00	5	17	17			46.15
2	Escalation and inflation in material prices				37	2	81.03		1	1	18	19	88.21
3	Shortages of materials		39				40.00		6	25	6	2	62.05
4	Unpredictable site conditions	28	5	6			28.72	1	21	14	2	1	50.26
5	Delay in obtaining statutory approvals	4	29	6			41.03	4	19	15	1		46.67
6	Economic instability	29	10				25.13	16	17	2	4		36.92
7	Effect of high level of competition on pricing	1	32	6			42.56	5	25	9			42.05
8	Absence of construction cost data	27	12				26.15	4	33	2			38.97
9	Monopoly by suppliers	12	27				33.85	20	15	4			31.79
10	High interest rate by banks	6	31	2			37.95	11	2	24	1	1	49.23
11	High cost of machinary		6	5	28		71.28		15	15	8	1	57.44
12	Currency exchange rate		1	35	3		61.03	1	6	26	5	1	59.49
13	Project location	27	10	2			27.18	22	16	1			29.23
14	Political climate and interferance	8	31				35.90	12	22	4	1		36.92
15	Service relocation cost	29	9	1			25.64	1	23	8	7		50.77
16	High cost associated with right-of-way acquisitions	10	28	1			35.38	23	9	7			31.79

The factor's frequency and severity levels were calculated and its location in the risk map was identified in accordance with Table 4.1 and Figure 4.1. The various factors classified into the 3 categories together with their locations in the risk map are shown in Tables 4.12 to 4.14.

Table 4.12: Risk map for client related factors

	FACTORS	F.I. (%)	Frequency level	S.I. (%)	Severity level	Map zone
A	**CLIENT-RELATED FACTORS**					
1	Delay in payment	98.46	VH	91.28	VH	red
2	Delay in giving approvals	48.21	M	67.69	H	red
3	Design/ Project scope change	63.08	H	76.92	H	red
4	Ommision of neccesary works in BOQ	82.05	VH	91.28	VH	red
5	Lack of detail designs before contract award	98.46	VH	97.95	VH	red
6	Increased measure of Additional works	79.49	H	82.05	VH	red
7	Contract tender price higher than original estimate	53.33	M	56.92	M	yellow
8	Underestimation of quantities in BOQ	95.90	VH	93.85	VH	red
9	Use of line diagrams for highway projects	99.49	VH	99.49	VH	red
10	Latent Condition - Remove and replace unsuitable material	67.18	H	78.97	H	red
11	Latent Condition - Rock encounted	65.64	H	78.46	H	red
12	Latent Condition - Additional stabilization	62.05	H	73.85	H	red
13	Fradulent practices and kickbacks	26.67	L	41.03	M	yellow
14	Inadequate contigency allowance in BOQ	89.23	VH	85.64	VH	red
15	Inadequate project supervision/ monitoring by ER and team	46.67	M	59.49	M	yellow
16	Project administration cost increase	40.00	L	37.44	L	green
17	Project acceleration requirement	20.51	L	33.33	L	green
18	Delay in evaluating and awarding contracts	77.44	H	68.21	H	red
19	Contract failure-New contract establishment cost	40.00	L	53.85	H	red
20	Contract tender price lower than original estimate	38.97	L	34.359	L	green
21	Lack of adequate manpower for project supervision	33.333	L	50.769	M	yellow
22	Unrealistic construction periods	44.615	M	39.487	L	green

Table 4.13: Risk map for contractor related factors

	FACTORS	F.I. (%)	Frequency level	S.I. (%)	Severity level	Map zone
B	**CONTRACTOR-RELATED FACTORS**					
1	Underpricing of tender due to competition	49.23	M	31.28	L	green
2	Delay in project completion	73.85	H	67.18	H	red
3	Poor project planning	61.03	H	59.49	M	red
4	Fradulent practices and kickbacks	26.15	L	36.92	L	green
5	Overmeasurement of work done	90.26	VH	83.59	VH	red
6	Inaccurate contract time estimates	39.49	L	35.90	L	green
7	Inadequate resources for project execution	52.31	M	42.05	M	yellow
8	over reliance on claims to recover lost profits	43.08	M	50.26	M	yellow
9	abondonment of projects	34.36	L	57.95	M	yellow
10	Lack of skilled work force	30.77	L	29.74	L	green
11	wrong estimation method	30.26	L	32.82	L	green
12	Stopages due to labor agitations	45.13	M	43.59	M	yellow
13	Poor labor productivity	52.31	M	47.69	M	yellow
14	Improper control and storage of materials	53.85	M	35.90	L	green
15	Disputes on site	30.77	L	37.95	L	green
16	Poor financial control on site	49.74	M	40.00	L	green
17	Poor sub contractors and suppliers management	24.10	L	34.36	L	green

Table 4.14: Risk map for external factors

	FACTORS	F.I. (%)	Frequency level	S.I. (%)	Severity level	Map zone
C	EXTERNAL FACTORS					
1	Delay in obtaining funding	60.00	M	46.15	M	yellow
2	Escalation and inflation in material prices	81.03	VH	88.21	VH	red
3	Shortages of materials	40.00	L	62.05	H	red
4	Unpredictable site conditions	28.72	L	50.26	M	yellow
5	Delay in obtaining statutory approvals	41.03	M	46.67	M	yellow
6	Economic instability	25.13	L	36.92	L	green
7	Effect of high level of competition on pricing	42.56	M	42.05	M	yellow
8	Absence of construction cost data	26.15	L	38.97	L	green
9	Monopoly by suppliers	33.85	L	31.79	L	green
10	High interest rate by banks	37.95	L	49.23	M	yellow
11	High cost of machinary	71.28	H	57.44	M	red
12	Currency exchange rate	61.03	H	59.49	M	red
13	Project location	27.18	L	29.23	L	green
14	Political climate and interferance	35.90	L	36.92	L	green
15	Service relocation cost	25.64	L	50.77	M	yellow
16	High cost associated with right-of-way acquisitions	35.38	L	31.79	L	green

Risk Map for Client-Related Factors

Table 4.12 and Figure 4.9 illustrate the risk map for client related factors. 22 factors are considered under this group. The results indicate that 14 factors are located in the red zone, 4 factors are located in the yellow zone and 3 factors are located in the green zone.

GREEN ZONE	YELLOW ZONE	RED ZONE
- Project administration cost increases - Contract tender price lower than original estimates - Unrealistic construction periods	- Contract tender price higher than original estimates - Fraudulent practices and kickbacks - Inadequate project supervision by ER and team - Lack of adequate manpower for project supervision	- Delay in payment - Delay in giving approvals - Design/Project scope change - Omission of necessary works in BOQ - Lack of detailed design before contract award - Increased measure of additional works - Underestimation of quantities in BOQ - Use of line diagrams for highway projects - Latent Conditions-remove and replace unsuitable materials - Latent Conditions-Rock encountered - Latent Conditions-Additional stabilization - Inadequate contingency allowance in BOQ - Delay in evaluating and awarding contracts - Contract failure-New contract establishment cost

Figure 4.9: Risk map for client related factors

Risk Map for Contractor-Related Factors

Table 4.13 and Figure 4.10 illustrate the risk map for contractor-related factors. 17 factors are identified under this group. The results indicate that 3 factors are located in the red zone, 5 factors are located in the yellow zone, and 9 factors are located in the green zone.

GREEN ZONE	YELLOW ZONE	RED ZONE
- Under-pricing of tenders due to competition - Fraudulent practices and kickbacks - Inaccurate contract time estimates - Lack of skilled workforce - Wrong estimation method - Improper control and storage of materials - Disputes on site - Poor financial control on site - Poor Subcontractors and suppliers management	- Inadequate resources for project execution - Over reliance on claims to recover lost profit - Abandonment of projects - Stoppages due to labour agitations - Poor labour productivity	- Delay in project completion - Poor project planning - Over measurement of work done

Figure 4.10: Risk map for contractor related factors

Risk Map for External Factors

Table 4.14 and Figure 4.11 illustrate the risk map for external factors. 16 factors are considered under this group. The results indicate that 4 factors are located in the red zone, 6 factors are located in the yellow zone and 6 factors are located in the green zone.

GREEN ZONE	YELLOW ZONE	RED ZONE
- Economic instability - Absence of construction cost data - Monopoly of suppliers - Project location - Political climate and interference - High cost associated with right of way acquisition	- Delay in obtaining funding - Unpredictable site conditions - Delay in obtaining statutory approvals - Effect of high level of competition on pricing - High interest rates by banks - Service relocation cost	- Escalation and inflation in material prices - Shortages of materials - High cost of machinery - Currency exchange rate depreciations

Figure 4.11: Risk map for external factors

4.4 RISK EVALUATION OF FACTORS

In the risk evaluation of the factors, only those factors located in the red zone were considered. These factors located in the red zone of the risk map are of critical importance. They are the top priorities so far as cost overrun in highway construction is concerned. These risk factors need to be closely monitored and mitigated. In order to rank these critical risk factors according to their degree of importance from the owners' perspective, the importance index for each factor is calculated as a function of frequency and severity indexes, as follows:

Importance Index (IMP.I) = [(F.I)(%) x (S.I)(%)] / 100: Equation 2

Table 4-8 shows the top priority factors leading to cost overrun in highway construction projects and their related groups in descending order. All of these factors are located in the red zone of the risk map.

Table 4.15: Importance index for the critical factors

	FACTORS	F.I. (%)	Freq. level	S.I. (%)	Severity level	IMP.I	Related group
	CRITICAL RISK FACTORS						
1	Use of line diagrams for highway projects	99.49	VH	99.49	VH	98.98	client
2	Lack of detail designs before contract award	98.46	VH	97.95	VH	96.44	client
3	Underestimation of quantities in BOQ	95.90	VH	93.85	VH	90.00	client
4	Delay in payment	98.46	VH	91.28	VH	89.88	client
5	Inadequate contingency allowance in BOQ	89.23	VH	85.64	VH	76.42	client
6	Overmeasurement of work done	90.26	VH	83.59	VH	75.45	contractor
7	Ommision of neccesary works in BOQ	82.05	VH	91.28	VH	74.90	client
8	Escalation and inflation in material prices	81.03	VH	88.21	VH	71.47	external
9	Increased measure of Additional works	79.49	H	82.05	VH	65.22	client
10	Latent Condition - Remove and replace unsuitable material	67.18	H	78.97	H	53.05	client
11	Delay in evaluating and awarding contracts	77.44	H	68.21	H	52.82	client
12	Latent Condition - Rock encounted	65.64	H	78.46	H	51.50	client
13	Delay in project completion	73.85	H	67.18	H	49.61	contractor
14	Design/ Project scope change	63.08	H	76.92	H	48.52	client
15	Latent Condition - Additional stabilization	62.05	H	73.85	H	45.82	client
16	High cost of machinary	71.28	H	57.44	M	40.94	external
17	Currency exchange rate	61.03	H	59.49	M	36.30	external
18	Poor project planning	61.03	H	59.49	M	36.30	contractor
19	Delay in giving approvals	48.21	M	67.69	H	32.63	client
20	Shortages of materials	40.00	L	62.05	H	24.82	external
21	Contract failure-New contract establishment cost	40.00	L	53.85	H	21.54	client

The results in Table 4.15 indicate that there are 21 factors located in the critical zone of the risk map. Their distribution among the groups is as follows:

- 14 factors are related to the client or owner
- 3 factors are related to the contractor
- 4 factors are related to external conditions

4.5 STATISTICAL ANALYSES OF RESPONSES

The weighted mean, standard deviation and coefficient of variation are calculated for all the 55 factors under the 3 categories as shown in Tables 4.16 to 4.21. These statistical analyses are done for both severity and frequency responses of cost overrun factors in highway construction projects as assessed by the owner. These statistics are used to interpret the dispersion, compactness, and the degree of homogeneity of the collected data.

Excel was used in calculating the weighted average, standard deviation and coefficient of variation (CV). By way of illustrating how this was done on a Likert scale using Excel, assuming A1:A5 has the raw values and B1:B5 has the respective scores (1 to 5 in this research), the formulas used are as follows:

Weighted Average Score (C1) is =SUMPRODUCT(A1:A5,B1:B5)/(SUM(A1:A5))

The Variance (C2) of the score is

=SUMPRODUCT(A1:A5,(B1:B5-C1)^2)/(SUM(A1:A5)-1)

The Standard Deviation is the square root of the variance =SQRT(C2)

The Coefficient of Variation (CV) = (standard deviation/weighted average) x 100%

Table 4.16: Statistical analysis for frequency responses (client related factors)

	FACTORS	FREQUENCY OF OCCURRENCE WEIGHTINGS					WEIGHTED MEAN	STANDARD DEVIATION	COEFFICIENT OF VARIATION
A	**CLIENT-RELATED FACTORS**	**1**	**2**	**3**	**4**	**5**			
1	Delay in payment				3	36	4.92	0.27	5.48%
2	Delay in giving approvals		23	16			2.41	0.50	20.67%
3	Design/ Project scope change			33	6		3.15	0.37	11.59%
4	Ommision of neccesary works in BOQ				35	4	4.10	0.31	7.49%
5	Lack of detail designs before contract award				3	36	4.92	0.27	5.48%
6	Increased measure of Additional works			2	36	1	3.97	0.28	7.04%
7	Contract tender price higher than original estimate		24	4	11		2.67	0.90	33.69%
8	Underestimation of quantities in BOQ				8	31	4.79	0.41	8.53%
9	Use of line diagrams for highway projects				1	38	4.97	0.16	3.22%
10	Latent Condition - Remove and replace unsuitable material			25	14		3.36	0.49	14.47%
11	Latent Condition - Rock encounted			28	11		3.28	0.46	13.89%
12	Latent Condition - Additional stabilization			35	4		3.10	0.31	9.91%
13	Fradulent practices and kickbacks	26	13				1.33	0.48	35.82%
14	Inadequate contigency allowance in BOQ			10	1	28	4.46	0.88	19.81%
15	Inadequate project supervision/ monitoring by ER and team		27	11	1		2.33	0.53	22.71%
16	Project administration cost increase	2	35	2			2.00	0.32	16.22%
17	Project acceleration requirement	38	1				1.03	0.16	15.61%
18	Delay in evaluating and awarding contracts			5	34		3.87	0.34	8.75%
19	Contract failure-New contract establishment cost		39				2.00	0.00	0.00%
20	Contract tender price lower than original estimate	2	37				1.95	0.22	11.47%
21	Lack of adequate manpower for project supervision	24	4	11			1.67	0.90	53.90%
22	Unrealistic construction periods	1	28	10			2.23	0.48	21.72%

Table 4.17: Statistical analysis for frequency responses (contractor-related factors)

	FACTORS	FREQUENCY OF OCCURRENCE WEIGHTINGS					WEIGHTED MEAN	STANDARD DEVIATION	COEFFICIENT OF VARIATION
B	**CONTRACTOR-RELATED FACTORS**	**1**	**2**	**3**	**4**	**5**			
1	Underpricing of tender due to competition	10	1	28			2.46	0.88	35.91%
2	Delay in project completion			12	27		3.69	0.47	12.66%
3	Poor project planning		2	33	4		3.05	0.39	12.91%
4	Fradulent practices and kickbacks	27	12				1.31	0.47	35.76%
5	Overmeasurement of work done			2	15	22	4.51	0.60	13.33%
6	Inaccurate contract time estimates	1	38				1.97	0.16	8.11%
7	Inadequate resources for project execution		15	24			2.62	0.49	18.84%
8	over reliance on claims to recover lost profits	4	25	10			2.15	0.59	27.24%
9	abondonment of projects	21	8	10			1.72	0.86	49.87%
10	Lack of skilled work force	18	21				1.54	0.51	32.83%
11	wrong estimation method	21	16	2			1.51	0.60	39.75%
12	Stopages due to labor agitations	4	22	12	1		2.26	0.68	30.02%
13	Poor labor productivity		15	24			2.62	0.49	18.84%
14	Improper control and storage of materials		12	27			2.69	0.47	17.37%
15	Disputes on site		27	2			2.07	0.26	12.46%
16	Poor financial control on site	10	2	25	2		2.49	0.94	37.89%
17	Poor sub contractors and suppliers management	34	2	3			1.21	0.57	47.32%

Table 4.18: Statistical analysis for frequency responses (external factors)

	FACTORS	FREQUENCY OF OCCURRENCE WEIGHTINGS					WEIGHTED MEAN	STANDARD DEVIATION	COEFFICIENT OF VARIATION
C	EXTERNAL FACTORS	1	2	3	4	5			
1	Delay in obtaining funding			39			3.00	0.00	0.00%
2	Escalation and inflation in material prices				37	2	4.05	0.22	5.52%
3	Shortages of materials		39				2.00	0.00	0.00%
4	Unpredictable site conditions	28	5	6			1.44	0.75	52.49%
5	Delay in obtaining statutory approvals	4	29	6			2.05	0.51	24.88%
6	Economic instability	29	10				1.26	0.44	35.21%
7	Effect of high level of competition on pricing	1	32	6			2.13	0.41	19.22%
8	Absence of construction cost data	27	12				1.31	0.47	35.76%
9	Monopoly by suppliers	12	27				1.69	0.47	27.63%
10	High interest rate by banks	6	31	2			1.90	0.45	23.55%
11	High cost of machinary		6	5	28		3.56	0.75	21.15%
12	Currency exchange rate		1	35	3		3.05	0.32	10.50%
13	Project location	27	10	2			1.36	0.58	43.00%
14	Political climate and interferance	8	31				1.79	0.41	22.79%
15	Service relocation cost	29	9	1			1.28	0.51	39.81%
16	High cost associated with right-of-way acquisitions	10	28	1			1.77	0.48	27.39%

Table 4.19: Statistical analysis for severity responses (client related factors)

	FACTORS	SEVERITY OF IMPACT WEIGHTINGS					WEIGHTED MEAN	STANDARD DEVIATION	COEFFICIENT OF VARIATION
A	**CLIENT-RELATED FACTORS**	**1**	**2**	**3**	**4**	**5**			
1	Delay in payment				17	22	4.56	0.25	5.53%
2	Delay in giving approvals			25	13	1	3.38	0.30	8.73%
3	Design/ Project scope change			12	21	6	3.85	0.45	11.68%
4	Ommision of neccesary works in BOQ			1	15	23	4.56	0.30	6.68%
5	Lack of detail designs before contract award			1	2	36	4.90	0.15	3.00%
6	Increased measure of Additional works			1	33	5	4.10	0.15	3.59%
7	Contract tender price higher than original estimate		19	7	13		2.85	0.82	28.73%
8	Underestimation of quantities in BOQ				12	27	4.69	0.22	4.66%
9	Use of line diagrams for highway projects				1	38	4.97	0.03	0.52%
10	Latent Condition - Remove and replace unsuitable material			3	35	1	3.95	0.10	2.60%
11	Latent Condition - Rock encounted			4	34	1	3.92	0.13	3.20%
12	Latent Condition - Additional stabilization			14	23	2	3.69	0.32	8.77%
13	Fradulent practices and kickbacks	2	35	1		1	2.05	0.31	15.26%
14	Inadequate contigency allowance in BOQ			12	4	23	4.28	0.84	19.60%
15	Inadequate project supervision/ monitoring by ER and team		7	27	4	1	2.97	0.39	13.25%
16	Project administration cost increase	8	29	1	1		1.87	0.33	17.38%
17	Project acceleration requirement	18	17	3	1		1.67	0.54	32.63%
18	Delay in evaluating and awarding contracts		2	20	16	1	3.41	0.41	11.91%
19	Contract failure-New contract establishment cost		20	12	6	1	2.69	0.69	25.71%
20	Contract tender price lower than original estimate	15	22	1		1	1.72	0.58	33.54%
21	Lack of adequate manpower for project supervision		20	17	2		2.54	0.36	14.19%
22	Unrealistic construction periods	17	8	13		1	1.97	1.03	51.95%

Table 4.20: Statistical analysis for severity responses (contractor- related factors)

	FACTORS	SEVERITY OF IMPACT WEIGHTINGS					WEIGHTED MEAN	STANDARD DEVIATION	COEFFICIENT OF VARIATION
B	**CONTRACTOR-RELATED FACTORS**	**1**	**2**	**3**	**4**	**5**			
1	Underpricing of tender due to competition	19	19		1		1.56	0.41	26.23%
2	Delay in project completion			25	14		3.36	0.24	7.03%
3	Poor project planning		3	35		1	2.97	0.18	6.17%
4	Fradulent practices and kickbacks	9	29			1	1.85	0.45	24.34%
5	Overmeasurement of work done			1	30	8	4.18	0.20	4.88%
6	Inaccurate contract time estimates	11	25	3			1.79	0.33	18.12%
7	Inadequate resources for project execution	2	32	4	1		2.10	0.25	12.00%
8	over reliance on claims to recover lost profits	6	11	19	2	1	2.51	0.84	33.24%
9	abondonment of projects		9	25	5		2.90	0.36	12.34%
10	Lack of skilled work force	23	13	3			1.49	0.41	27.86%
11	wrong estimation method	17	20	1	1		1.64	0.45	27.22%
12	Stopages due to labor agitations	10	13	15	1		2.18	0.73	33.50%
13	Poor labor productivity	2	22	14		1	2.38	0.51	21.22%
14	Improper control and storage of materials	10	28		1		1.79	0.33	18.12%
15	Disputes on site	11	23	4		1	1.90	0.62	32.72%
16	Poor financial control on site	15	11	11	2		2.00	0.89	44.74%
17	Poor sub contractors and suppliers management	15	20	4			1.72	0.42	24.35%

Table 4.21: Statistical analysis for severity responses (external factors)

FACTORS		SEVERITY OF IMPACT WEIGHTINGS					WEIGHTED MEAN	STANDARD DEVIATION	COEFFICIENT OF VARIATION
C	EXTERNAL FACTORS	1	2	3	4	5			
1	Delay in obtaining funding	5	17	17			2.31	0.48	20.88%
2	Escalation and inflation in material prices		1	1	18	19	4.41	0.46	10.40%
3	Shortages of materials		6	25	6	2	3.10	0.52	16.62%
4	Unpredictable site conditions	1	21	14	2	1	2.51	0.57	22.77%
5	Delay in obtaining statutory approvals	4	19	15	1		2.33	0.49	21.05%
6	Economic instability	16	17	2	4		1.85	0.87	47.15%
7	Effect of high level of competition on pricing	5	25	9			2.10	0.36	17.01%
8	Absence of construction cost data	4	33	2			1.95	0.16	7.96%
9	Monopoly by suppliers	20	15	4			1.59	0.46	28.86%
10	High interest rate by banks	11	2	24	1	1	2.46	1.04	42.43%
11	High cost of machinary		15	15	8	1	2.87	0.69	24.15%
12	Currency exchange rate	1	6	26	5	1	2.97	0.50	16.79%
13	Project location	22	16	1			1.46	0.31	21.05%
14	Political climate and interferance	12	22	4	1		1.85	0.50	27.19%
15	Service relocation cost	1	23	8	7		2.54	0.68	26.63%
16	High cost associated with right-of-way acquisitions	23	9	7			1.59	0.62	38.79%

Table 4.16-4.18 and Table 4.19-4.21 above show that the standard deviations of the cost overrun factors for frequency and severity responses range from 0.00 to 0.94 and 0.03 to 1.04, respectively. A visual indication obtained from the scatter diagram shown in Figure 4.12 and Figure 4.13 shows that the data has good compactness, indicating that there is good data consistency and agreement among Civil Engineers and Quantity Surveyors employed by GHA on the severity and frequency of the identified risk factors.

Table 4.16-4.18 and Table 4.19-4.21 also shows that as the factors weighted mean increase, the coefficient of variation decrease, meaning that the respondents are highly in agreement on the impact of the top risk factors.

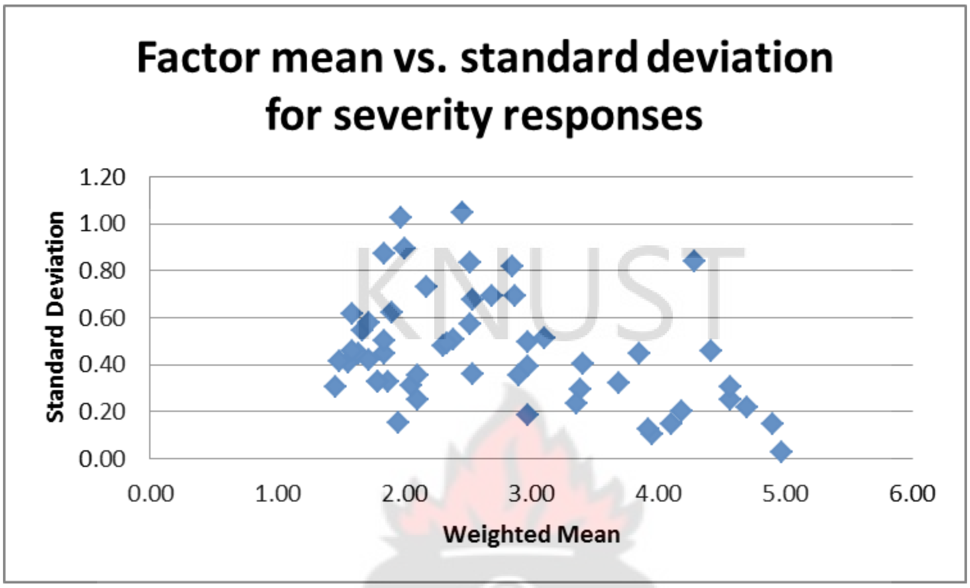

Figure 4.12: Scatter diagram of factor mean and standard deviation for severity responses

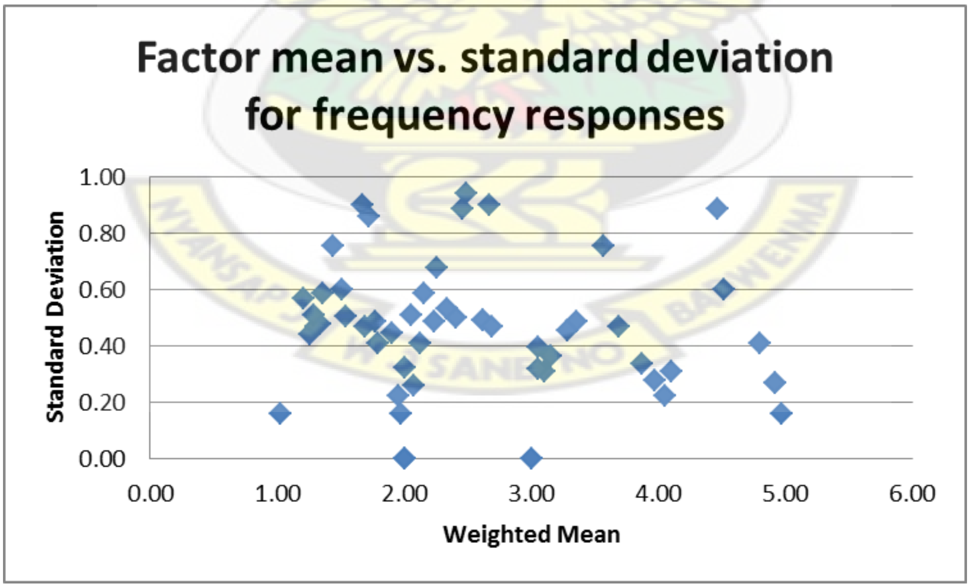

Figure 4.13: Scatter diagram of factor mean and standard deviation for frequency responses

CHAPTER FIVE

CONCLUSION AND RECOMMENDATIONS

5.1 INTRODUCTION

This research was conducted to investigate and identify the critical risk factors leading to cost overrun in the delivery of highway construction projects in Ghana from the perspective of the owner represented by Civil Engineers and Quantity Surveyors working with GHA. The analysis of the participants' responses indicates that cost overrun in highway construction projects is a major problem. 77% of the respondents indicated that average cost overrun in highway construction projects they have experienced is between 40% and 60% of the project's original estimated cost. Only 23% of the respondents indicated the cost overruns in highway construction they have experienced to be between 20% and 40%.

Giving the economic circumstances of the country, these cost overruns levels in highway construction projects are rather too high. Several sectors of the country's economy compete for a share of the limited national cake. The highway sub-sector is of prime importance as it tends to open up the whole country for both domestic as well as foreign direct investments. This however, requires that the ordinary tax payer whose money is used for highway infrastructure projects gets value for money. Highway construction projects involves huge investment of capital and therefore monies allocated for highway construction projects have to be utilized judiciously in order not to deprive other critical sectors of the economy much needed funds.

5.2 CONCLUSION

The research identified the risk map for 55 cost overrun factors. 21 factors were concluded as critical factors (Table 4.15). Responses from the owner of highway projects represented by Civil Engineers and Quantity Surveyors in GHA revealed that the top five factors leading to cost overrun in highway construction projects in Ghana are: use of line diagram for highway construction projects, lack of adequate designs before contract award, underestimation of quantities in BOQ, delay in payment, and inadequate contingency allowance in BOQ.

These five critical factors leading to cost overruns of highway construction projects are now discussed;

- Use of line diagrams – In most cases in Ghana, highway construction projects cost are estimated from line diagrams a copy of which is shown in appendix A. What usually happens is that before a highway contract is packaged, a team of Civil Engineers undertake a recognisance survey on the road to be developed and determine all the works that are needed to be done. The team comes out with a line diagram based upon which the Quantity Surveyor prepares the Bill of quantities. A contractor who wins the job is given a copy of the line diagram as part of the contract documents for the project. These line diagrams are not detailed enough as they don't capture the nature of the sub-grade which is the foundation upon which the pavement is laid. Earthworks form a significant proportion of the cost of highway projects. Lack of thorough sub-grade investigation at the pre-contract stage can lead to cost overruns during the construction stage when rocks are encountered, or unsuitable materials have to be removed and replaced with specified good imported material.

- Lack of adequate designs before contract award – Most highway construction projects are awarded without adequate designs. The astute contractor who wants to maximize his profit usually insists on designing the road upon wining the contract. The contractor is usually giving the permission to design the road and submit the designs to GHA for approval. The design invariably increases the contract price and leads to cost overrun. The approvals for the designs by the agency sometimes delays and entitles the contractor to a claim for ideal equipment and labour.

- Underestimation of quantities in BOQ – Lack of adequate designs and use of line diagrams in the estimation of quantities for various work items in highway projects lead to inadequate quantities in BOQ's. An astute contractor conversant with the project area may price high those items whose quantities have been underestimated. During construction as it becomes necessary to approve additional works, the quantities increase and the contractor gets a windfall. This invariably leads to the project cost exceeding the original budget.

- Delay in payment – The owner usually delays in paying contractors for certified work done. When this happens the contractor cites this default on the part of the owner as part of the reasons for his inability to achieve his planned schedules. This invariably leads to a claim for extension of contract period. As the project delays the owner incurs more cost by way of fluctuation claims. When the contractor is eventually paid, he again claims for delay in payment for certified work done. All these eventually lead to cost overruns on the project.

- Inadequate contingency allowance in BOQ – A contingency is reserve money used to mitigate the risk of cost overrun. This reserve is very essential, especially in economies with high inflation such as in Ghana. The contingency allowed for in most highway contracts is 25% of the cost of the works less provisional sums. This percentage covers both physical contingency (10%) and price contingency (15%). Research undertaken by the quantity surveying section of GHA has revealed that this figure is woefully inadequate. On the average price fluctuations on highway projects is about 20% per year. Since majority of highway construction projects last for about 3 years, 60% price contingency is what is required for most highway construction projects in Ghana. A low contingency allowance will eventually lead to cost overruns.

5.3 RECOMMENDATIONS

The focus of this research is on owners' exposure to cost overruns. Based on the research findings, the following recommendations are suggested in order to mitigate the incident of cost overrun in the delivery of highway construction projects in Ghana.

- Highway construction projects should be designed in detail before costing and contract award. The design should incorporate comprehensive hydrological investigations as well as geotechnical investigations in order to ascertain drainage requirements and the nature of the sub-grade material respectively.

- Thorough reconnaissance survey should be undertaking prior to the packaging of contracts. The survey should ensure that as much as possible, all items of work needed to be done on the project in order to obtain value for money are captured and put into the design. This will enable the Quantity Surveyor estimate reasonably firm quantities for the preparation of the Bill of Quantities.

- In the evaluation of tenders, the team of evaluators must pay particular attention to balanced pricing of the prospective bidders. This will help in avoiding a situation whereby a contractor gains excessively to the detriment of the owner, when variation orders are given.

- Funding for highway construction contracts should be secured well in advance of commencement in order to avoid the situation of payment delays for certified work done. Also an application for extension of time by a contractor should be scrutinize to determine whether the extension can be granted without cost to the client.

- The introduction of a more realistic contingency allowance across highway construction projects will go a long way to minimizing cost overruns. The situation whereby an arbitrary contingency percentage is applied to highway construction contracts to accommodate project risk can lead to those projects incurring substantial cost overruns.

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APPENDIX A

Questionnaire Administered

KWAME NKRUMAH UNIVERSITY OF SCIENCE AND TECHNOLOGY

(KNUST) KUMASI

COST OVERRUNS IN THE DELIVERY OF HIGHWAY CONSTRUCTION

PROJECTS IN GHANA

The researcher is a post-graduate student at the Kwame Nkrumah University of Science and Technology studying for a Master of Science degree in Construction Management. The researcher is conducting a research into cost overruns in the delivery of highway construction projects in Ghana. The aim of the research is to assess the risk factors leading to cost overruns of highway construction projects in Ghana.

The researcher wishes to solicit your assistance in answering the questions in this questionnaire to the best of your ability. Please rest assured that your responses to this questionnaire would be confidential and used exclusively for academic purposes.

SECTION A: (SOCIO-DEMOGRAPHIC CHARACTERISTICS OF RESPONDENTS)

Please tick ☑ where appropriate

1. Gender

Male ☐ Female ☐

2. Job description

Civil Engineer ☐ Quantity Surveyor ☐

Others (specify)…………………..

3. What is your level of education¬?

Post graduate ☐ First Degree ☐ HND/Diploma Others ☐ (specify)………………

4. How long have you been working in the construction industry?

≤ 5 yrs. ☐ 6 – 10 yrs. ☐ 11 – 15 yrs. ☐

16 – 20 yrs. ☐ Above 20 yrs. ☐

5. What is your age group?

20 – 30 yrs. ☐ 31 – 40 yrs. ☐ 41 – 50 yrs. ☐

51 – 60 yrs. ☐ Above 60 yrs. ☐

6. What in your opinion is the percentage average cost overrun in highway construction projects in Ghana?

< 20 % ☐ 20 – 40 % ☐ 40 – 60 % ☐

60 – 80 % ☐ 80 - 100% ☐

SECTION B:

Please tick where appropriate ☒

Please use the following scale to rate the listed risk factors in terms of their frequency of occurrence and their severity of impact on highway construction project cost overrun in Ghana

Index Value (Scale)	**Frequency of occurrence**	**Severity of impact**
< 20 %	very low (1)	very low (1)
20 - 40 %	low (2)	low (2)
40 - 60 %	moderate (3)	moderate (3)
60 - 80 %	high (4)	high (4)
80 - 100 %	very high (5)	very high (5)

RISK FACTORS LEADING TO COST OVERRUNS IN THE DELIVERY OF HIGHWAY	**FREQUENCY OF OCCURRENCE**					**SEVERITY OF IMPACT**				
	1	**2**	**3**	**4**	**5**	**1**	**2**	**3**	**4**	**5**

CONSTRUCTION PROJECTS IN GHANA											
CLIENT - RELATED FACTORS											
1	Delay in payment	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
2	Delay in giving approvals	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
3	Design/ Project scope change	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
4	Omission of necessary works in BOQ	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
5	Lack of detail designs before contract award	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
6	Increased measure of Additional works	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
7	Contract tender price higher than original estimate	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
8	Underestimation of quantities in BOQ	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
9	Use of line diagrams for highway projects	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
10	Latent Condition - Remove and replace unsuitable material	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
11	Latent Condition - Rock encountered	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
12	Latent Condition - Additional stabilization	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
13	Fraudulent practices and kickbacks	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐

14	Inadequate contingency allowance in BOQ	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
15	Inadequate project supervision/ monitoring by ER and team	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
16	Project administration cost increase	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
17	Project acceleration requirement	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
18	Delay in evaluating and awarding contracts	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
19	Contract failure-New contract establishment cost	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
20	Contract tender price lower than original estimate	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
21	Lack of adequate manpower for project supervision	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
22	Unrealistic construction periods	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
CONTRACTOR - RELATED FACTORS											
23	Underpricing of tenders due to competition	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
24	Delay in project completion	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
25	Poor project planning	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
26	Fraudulent practices and kickbacks	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐

27	Over measurement of work done	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
28	Inaccurate contract time estimates	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
29	Inadequate resources for project execution	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
30	over reliance on claims to recover lost profits	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
31	abandonment of projects	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
32	Lack of skilled work force	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
33	wrong estimation method	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
34	Stoppages due to labor agitations	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
35	Poor labor productivity	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
36	Improper control and storage of materials	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
37	Disputes on site	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
38	Poor financial control on site	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
39	Poor sub-contractors and suppliers management	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
EXTERNAL FACTORS											
40	Delay in obtaining funding	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
41	Escalation and inflation in material prices	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
42	Shortages of materials	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
43	Unpredictable site conditions	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐

44	Delay in obtaining statutory approvals	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
45	Economic instability	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
46	Effect of high level of competition on pricing	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
47	Absence of construction cost data	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
48	Monopoly by suppliers	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
49	High interest rate by banks	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
50	High cost of machinery	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
51	Currency exchange rate	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
52	Project location	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
53	Political climate and interference	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
54	Service relocation cost	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
55	High cost associated with right-of-way acquisitions	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
		☐	☐	☐	☐	☐	☐	☐	☐	☐	☐

APPENDIX B

[redacted]GHA[redacted]HIGHWAY AUTHORITY

LINE DIAGRAM

[redacted]PROJ[redacted] Re[redacted]itat[redacted]Ofoase-Gyadem-Asokwa Road

DIRECTION: *Antoa - Tikrom Missing Link (3.71km)*

FROM Antoa *TO Tikrom*

Route No:

Sheet 1 of 5

CHAINAGE	KM / METRES	0.0 — 100, 200, 300, 400, 500 (Antoa), 600, 700, 800, 900 — 1.0
EXISTING CARRIAGEWAY		GS w=9m; Gravel Surface Av. w = 3m
VEGETATION CONTROL	CLEAR BUSH, GRASS ETC.	Clear Bush w = 6.5m ES
DRAINAGE WORKS	CONSTRUCT NEW CULVERTS	(Note 4); (Note 4)
	V-SHAPED EARTH DITCH	
	CONSTUCT LINED DRAINS	Note 5; Construct 600mm UD on BS
EARTHWORKS	REMOVE TOP SOIL	th = 0.15m, w = 6.5m ES
	SCARIFY EXISTING SURFACE	GS w=9m
	EXCAVATE TO WIDEN ROAD	
	FILL TO WIDEN ROAD	w=3m
	FILL TO FORMATION	Av. w = 12m, Av. h = 1.0m
PAVEMENT WORKS	SUB-BASE (200mm Thick)	Av. w = 12.0m
	BASE (200mm Thick)	Av. w = 12.0m
BITUMINOUS SURFACING WORKS	PRIMERSEAL (10mm Aggregates)	w=12.0m
	SEAL (14mm Aggregates)	w=12.0m
MISCELLANEOUS		Note 6

NOTES

1. All locations to be confirmed by ER

2. Line Diagrams to be read in conjuction with other Drawings and Technical Specifications

3. Maximum length of turnouts & culvert inlet and outlet channels is 20m, unless otherwise directed by ER.

4. Construct 1/900mm diameter PCs at the following locations:

km 0.150: L = 13m

km 0.325: L = 13m

km 0.500: L = 13m

km 0.600: L = 13m

km 0.850: L = 13m

km 0.950: L = 13m

5. Maintain existing U-Drains between km 0.00 and 0.030

6. Provide Access Cover Slabs: L=6m - 6No.; L=2m - 10No.

LEGEND:

ES - Each Side	*Av - Average*	*PC - Pipe Culvert*
BS - Both Sides	*w - Width*	*AC - Access Culvert*
LHS - Left Hand Side	*h - Height*	*BC - Box Culvert*
RHS - Right Hand Side	*th - Thickness*	*UD - Concrete U-Drain*
GS - Gravel Surface	*L - Length*	*TP - Trapezoidal Drain*

LINE DIAGRAM

GHANA HIGHWAY AUTHORITY	PROJECT: Rehabilitation [illegible]gu-Ofoase-Gyadem-Asokwa Road *Antoa - Tikrom Missing Link (3.71km)*	Route No:
	DIRECTION: FROM Antoa TO Tikrom	Sheet 2 of 5

CHAINAGE	KM	1.0 ... 2.0
	METRES	100, 200, 300, 400, 500, 600, 700, 800, 900
EXISTING CARRIAGEWAY		GS Av. w = 2m (1.0 – 1.7); GS w=0.5m (1.7 – 2.0)
VEGETATION CONTROL	CLEAR BUSH, GRASS ETC.	Clear Bush w = 7m ES (1.0 – 1.7); w=8m ES (1.7 – 2.0)
DRAINAGE WORKS	CONSTRUCT NEW CULVERTS	(Note 4); Note 5
	V-SHAPED EARTH DITCH	
	CONSTUCT LINED DRAINS	Construct 600mm UD on BS (1.0 – 1.2)
EARTHWORKS	REMOVE TOP SOIL	th = 0.15m, w = 7m ES
	SCARIFY EXISTING SURFACE	
	EXCAVATE TO WIDEN ROAD	
	FILL TO WIDEN ROAD	
	FILL TO FORMATION	Av. w = 14m, Av. h = 1.0m (1.0 – 1.7); w=14m, Av. h=1.8m (1.7 – 2.0)
PAVEMENT WORKS	SUB-BASE (200mm Thick)	Av. w = 12.0m
	BASE (200mm Thick)	Av. w = 11.5m
BITUMINOUS SURFACING WORKS	PRIMERSEAL (10mm Aggregates)	w=11.3m
	SEAL (14mm Aggregates)	w=11.3m
MISCELLANEOUS		

NOTES

1. All locations to be confirmed by ER
2. Line Diagrams to be read in conjuction with other Drawings and Technical Specifications
3. Maximum length of turnouts & culvert inlet and outlet channels is 20m, unless otherwise directed by ER.
4. Construct 1/1200mm diameter PCs at the following location:
   km 1.450: L = 14m
5. Construct 3/2.0m x 2.0m BC at km 1.875; L = 14m

LEGEND:

ES - Each Side	Av - Average	PC - Pipe Culvert
BS - Both Sides	w - Width	AC - Access Culvert
LHS - Left Hand Side	h - Height	BC - Box Culvert
RHS - Right Hand Side	th - Thickness	UD - Concrete U-Drain
GS - Gravel Surface	L - Length	TP - Trapezoidal Drain

LINE DIAGRAM

GHANA HIGHWAY AUTHORITY	PROJECT: Rehabilitation o[...]gu-Ofoase-Gyadem-Asokwa Road Antoa - Tikrom Missing Link (3.71km) DIRECTION: FROM Antoa TO Tikrom	Route No: Sheet 3 of 5

CHAINAGE	KM / METRES	2.0 – 100	100 – 200	200 – 300	300 – 400	400 – 500	500 – 600	600 – 700	700 – 800	800 – 900	900 – 3.0
EXISTING CARRIAGEWAY		GS w=0.5m			GS Av. w = 4m				GS w=0.5m		
VEGETATION CONTROL	CLEAR BUSH, GRASS ETC.	w=8m ES			Clear Bush w = 7m ES					w=8m ES	
DRAINAGE WORKS	CONSTRUCT NEW CULVERTS			(Note 4)							
	V-SHAPED EARTH DITCH										
	CONSTUCT LINED DRAINS										
EARTHWORKS	REMOVE TOP SOIL				th = 0.15m, w = 7m ES						
	SCARIFY EXISTING SURFACE										
	EXCAVATE TO WIDEN ROAD										
	FILL TO WIDEN ROAD										
	FILL TO FORMATION				Av. w = 14m, Av. h = 1.0m				w=14m, Av. h=0.8m		
PAVEMENT WORKS	SUB-BASE (200mm Thick)					Av. w = 12.0m					
	BASE (200mm Thick)					Av. w = 11.5m					
BITUMINOUS SURFACING WORKS	PRIMERSEAL (10mm Aggregates)					w=11.3m					
	SEAL (14mm Aggregates)					w=11.3m					
MISCELLANEOUS											

NOTES

1. All locations to be confirmed by ER
2. Line Diagrams to be read in conjuction with other Drawings and Technical Specifications
3. Maximum length of turnouts & culvert inlet and outlet channels is 20m, unless otherwise directed by ER.
4. Construct 1/1200mm diameter PCs at the following locations:
   - km 2.325: L = 14m
   - km 2.450: L = 14m
   - km 2.925: L = 14m

LEGEND:

ES - Each Side	Av - Average	PC - Pipe Culvert
BS - Both Sides	w - Width	AC - Access Culvert
LHS - Left Hand Side	h - Height	BC - Box Culvert
RHS - Right Hand Side	th - Thickness	UD - Concrete U-Drain
GS - Gravel Surface	L - Length	TP - Trapezoidal Drain

GHANA HIGHWAY AUTHORITY	PROJECT: Rehabilitation …gu-Ofoase-Gyadem-Asokwa Road Antoa - Tikrom Missing Link (3.71km) DIRECTION: FROM Antoa TO Tikrom	Route No: Sheet 4 of 5

CHAINAGE	KM / METRES	3.0 – 100	200	300 (Tikrom)	400	500	600	700	800	900	4.0
EXISTING CARRIAGEWAY				GS w = 5m							
VEGETATION CONTROL	CLEAR BUSH, GRASS ETC.	w=4m ES									
DRAINAGE WORKS	CONSTRUCT NEW CULVERTS		(Note 4)	↕		↕					
	V-SHAPED EARTH DITCH										
	CONSTUCT LINED DRAINS		600mm UD L=510m ES								
EARTHWORKS	REMOVE TOP SOIL	w=4m ES									
	SCARIFY EXISTING SURFACE										
	EXCAVATE TO WIDEN ROAD										
	FILL TO WIDEN ROAD		w=3.5m, h=0.6m ES								
	FILL TO FORMATION		Av. w = 12m, Av. h = 0.8m								
PAVEMENT WORKS	SUB-BASE (200mm Thick)			w=12m	L=510m						
	BASE (200mm Thick)			w=12m	L=510m						
BITUMINOUS SURFACING WORKS	PRIMERSEAL (10mm Aggregates)			w=12m	L=510m						
	SEAL (14mm Aggregates)			w=12m	L=510m						
MISCELLANEOUS				Note 5							

NOTES

1. All locations to be confirmed by ER
2. Line Diagrams to be read in conjuction with other Drawings and Technical Specifications
3. Maximum length of turnouts & culvert inlet and outlet channels is 20m, unless otherwise directed by ER.
4. Construct 1/900mm diameter PCs at the following locations:
   km 3.225: L = 13m
   km 3.425: L = 13m
5. Provide Access Cover Slabs: L=6m - 4No.; L=2m - 8No.

LEGEND:

ES - Each Side	Av - Average	PC - Pipe Culvert	
BS - Both Sides	w - Width	AC - Access Culvert	
LHS - Left Hand Side	h - Height	BC - Box Culvert	
RHS - Right Hand Side	th - Thickness	UD - Concrete U-Drain	
GS - Gravel Surface	L - Length	TP - Trapezoidal Drain	

LINE DIAGRAM

GHANA HIGHWAY AUTHORITY

PROJECT: Rehabilitation ...gyu-Ofoase-Gyadem-Asokwa Road

(Access Roads in Tikrom - 200m)

DIRECTION: *FROM* *Antoa* *TO* *Tikrom*

Route No:

Sheet 5 of 5

CHAINAGE	KM	0.0 *Tikrom*									1.0
	METRES	100	200	300	400	500	600	700	800	900	
EXISTING CARRIAGEWAY		GS w=5m (0–200)									
VEGETATION CONTROL	CLEAR BUSH, GRASS ETC.	w=4m ES (0–200)									
DRAINAGE WORKS	CONSTRUCT NEW CULVERTS										
	V-SHAPED EARTH DITCH										
	CONSTUCT LINED DRAINS	600mm UD, L=200m ES (0–200)									
EARTHWORKS	REMOVE TOP SOIL	w=4m ES (0–200)									
	SCARIFY EXISTING SURFACE										
	EXCAVATE TO WIDEN ROAD										
	FILL TO WIDEN ROAD	w=3.5m, h=0.6m ES (0–200)									
	FILL TO FORMATION	w = 12m, h = 0.3m (0–200)									
PAVEMENT WORKS	SUB-BASE (200mm Thick)	w=12m (0–200)									
	BASE (200mm Thick)	w=12m (0–200)									
BITUMINOUS SURFACING WORKS	PRIMERSEAL (10mm Aggregates)	w=12m (0–200)									
	SEAL (14mm Aggregates)	w=12m (0–200)									
MISCELLANEOUS											

NOTES

1. All locations to be confirmed by ER
2. Line Diagrams to be read in conjuction with other Drawings and Technical Specifications
3. Maximum length of turnouts & culvert inlet and outlet channels is 20m, unless otherwise directed by ER.

LEGEND:

ES - Each Side	*Av - Average*	*PC - Pipe Culvert*
BS - Both Sides	*w - Width*	*AC - Access Culvert*
LHS - Left Hand Side	*h - Height*	*BC - Box Culvert*
RHS - Right Hand Side	*th - Thickness*	*UD - Concrete U-Drain*
GS - Gravel Surface	*L - Length*	*TP - Trapezoidal Drain*