

COST ESCALATION, SCHEDULE OVERRUNS AND QUALITY SHORTFALLS ON CONSTRUCTION PROJECTS

By

Chabota Kaliba

A dissertation submitted to the University of Zambia in fulfilment of the requirements
for the Degree of Master of Engineering in Construction Management

THE UNIVERSITY OF ZAMBIA
LUSAKA

2010

Copyright declaration

I hereby declare that the work presented in this thesis is the result of my research work and that it has not previously been submitted for a degree, diploma or other qualification at this or another University.

Signature

Date

Certificate of Approval

(Insert Certificate of Approval)

Abstract

COST ESCALATION, SCHEDULE OVERRUNS AND QUALITY SHORTFALLS ON CONSTRUCTION PROJECTS

Chabota Kaliba

The construction industry plays a central role in the creation of any nation's wealth. For developing economies, it forms the backbone of most industries. Cost escalation, schedule overruns and quality shortfalls in construction projects often offset the intended contribution of the industry to the economy.

The aim of the study reported in this dissertation was to establish significant causes of cost escalation, schedule overruns and quality shortfalls and propose mechanisms that could be used to systematically address the causal factors.

Using a detailed literature review, structured interviews and questionnaire surveys, the results of the study confirmed the prevalence of cost escalation and schedule delays on construction projects in Zambia. The study identified: insufficient initial analysis of costs; change orders; inflation; and schedule overruns to be the most significant causal factors of cost escalation. Financial difficulties on the part of contractors; change orders; poor sub-contractor performance; and changes in drawings or specifications were found to be the major causes of schedule overruns. On the other hand, the most significant causal factors for quality shortfalls were identified to be: inadequate and inconsistent release of funds by clients; poor financial management by contractors; long lapse between feasibility study and implementation of projects; inadequate supervision; and incompetence or lack of capacity by contractors. The study also identified a knowledge gap in project managers in construction management.

It was established that the Client Satisfaction Enhancement Flowchart Model (CSEFM) that was developed during the study could be used to improve project delivery and satisfaction enhancement factors in terms of their relative importance. Appropriate project management practices and training for successful execution of construction projects have been recommended, especially in developing economies like Zambia.

Keywords: construction projects, cost escalation, schedule overruns, quality shortfalls, Zambia

Acknowledgements

First and foremost, I wish to thank the almighty God for enabling me to undertake the study and for giving me good health. Without him, I would be nothing.

I would also want to extend my gratitude to Dr. Muya for his patience and guidance during the course of study. I'm greatly inspired by his works and knowledge.

Further gratitude goes to my parents and family members for being there whenever I needed them.

I would be failing if I did not acknowledge the contributions from participants that took time off to attend to the questionnaires, interviews, AHP pre-test and Data collection using the CSEFM during my study. I would also like to thank my workmates at Pöyry Environment GmbH and UWP Consulting Engineers for the encouragement rendered throughout the study period.

Table of Contents

CHAPTER 1 : INTRODUCTION	1
1.1 BACKGROUND	1
1.2 RATIONALE	2
1.3 OBJECTIVES.....	6
1.3.1 Main objective	6
1.3.2 Specific objectives	7
1.3.3 Study achievements.....	7
1.4 ORGANISATION OF THE DISSERTATION	8
CHAPTER 2 : LITERATURE REVIEW	9
2.1 INTRODUCTION.....	9
2.2 PREVIOUS STUDIES ON COST ESCALATION, SCHEDULE OVERRUNS AND QUALITY SHORTFALLS IN CONSTRUCTION PROJECTS	10
2.2.1 Cost escalation	10
2.2.2 Schedule overruns	13
2.2.3 Quality shortfalls.....	15
2.3 SUMMARY	25
CHAPTER 3 : METHODOLOGY	26
3.1 INTRODUCTION.....	26
3.2 RESEARCH METHODS	26
3.2.1 Primary technique	26
3.2.2 Secondary technique.....	30
3.3 RESEARCH DESIGN	30
3.3.1 Literature review.....	31
3.3.2 Data Collection	34
3.4 METHODS OF ANALYSIS	37
3.4.1 Model development.....	40
3.5 SUMMARY	40
CHAPTER 4 : ANALYSIS AND DISCUSION OF SURVEY RESULTS	42
4.1 INTRODUCTION.....	42
4.2 INTERVIEW DATA AND ANALYSIS	42
4.2.1 Profiles of interviewees and their firms.....	42
4.2.2 Prevalence of cost escalation, schedule overruns and quality shortfalls.....	43
4.2.3 Causal factors	43

4.2.4	<i>Availability of strategies and policies</i>	46
4.2.5	<i>Contractual methods that can best address cost escalation, schedule overruns and quality shortfalls.....</i>	47
4.2.6	<i>Contractual provisions and their adequacy</i>	47
4.2.7	<i>Party most responsible for cost escalation, schedule overrun and quality shortfalls.....</i>	48
4.2.8	<i>How cost escalation, schedule overruns and quality shortfalls can be addressed.....</i>	48
4.3	QUESTIONNAIRE SURVEY	49
4.3.1	<i>Profile of respondents</i>	49
4.3.2	<i>Contractual arrangements</i>	51
4.3.3	<i>Causal factors</i>	52
4.3.4	<i>Project success factors</i>	65
4.3.5	<i>Recommended project success and client satisfaction enhancement factors</i>	71
4.4	SUMMARY	72
CHAPTER 5 : BACKGROUND OF THE ANALYTIC HIERARCHY PROCESS.....		73
5.1	INTRODUCTION.....	73
5.2	MULTIPLE CRITERIA DECISION MAKING.....	73
5.3	THE ANALYTIC HIERARCHY PROCESS	74
5.3.1	<i>Advantages of AHP</i>	75
5.3.2	<i>Structuring the hierarchy</i>	76
5.3.3	<i>Pairwise comparison.....</i>	78
5.3.4	<i>Synthesis for overall priorities ranking.....</i>	80
5.3.5	<i>Consistency.....</i>	80
5.4	SUMMARY	80
CHAPTER 6 : THE CLIENT SATISFACTION ENHANCEMENT FLOWCHART MODEL...		81
6.1	INTRODUCTION.....	81
6.2	THE CLIENT SATISFACTION ENHANCEMENT MODEL DEVELOPMENT.....	81
6.2.1	<i>Development of the CSEFM.....</i>	81
6.2.2	<i>Structuring of the CSEFM Model.....</i>	85
6.2.3	<i>Pre-testing of the CSEFM</i>	88
6.2.4	<i>Data collection and project success factor prioritisation using the CSEFM Model.....</i>	88
6.2.5	<i>Results of AHP analysis using the CSEFM Model.....</i>	88
6.3	SUMMARY	90

CHAPTER 7 : CONCLUSIONS, STUDY LIMITATIONS AND RECOMMENDATIONS	91
7.1 INTRODUCTION.....	91
7.2 CONCLUSIONS	91
7.3 LIMITATIONS	92
7.4 RECOMMENDATIONS	92
7.4.1 <i>General recommendations</i>	92
7.4.2 <i>Specific recommendations</i>	94

List of figures

<i>Figure 1-1: Relationship Diagram.....</i>	<i>3</i>
<i>Figure 1-2: Growth Trends for contributors to GDP</i>	<i>4</i>
<i>Figure 2-1: Cost -Time - Quality Relationship</i>	<i>9</i>
<i>Figure 4-1: Ranking of factors that cause cost escalation.....</i>	<i>44</i>
<i>Figure 4-2: Ranking of schedule overruns causal factors</i>	<i>45</i>
<i>Figure 4-3: Ranking of causal factors for quality shortfalls</i>	<i>46</i>
<i>Figure 4-4: Percentage of respondents.....</i>	<i>49</i>
<i>Figure 4-5: Number of respondents by sector type.....</i>	<i>50</i>
<i>Figure 4-6: Respondents' experience in construction projects</i>	<i>50</i>
<i>Figure 4-7: Percentage of respondents based on the size of projects undertaken.....</i>	<i>51</i>
<i>Figure 4-8: Frequency of respondents based on contractual arrangements.....</i>	<i>51</i>
<i>Figure 4-9: Respondent's rating of contractual arrangement best suited to deal with cost escalation, schedule overruns and quality shortfalls in construction.....</i>	<i>52</i>
<i>Figure 4-10: Ranking of cost escalation causal factors by frequency.....</i>	<i>54</i>
<i>Figure 4-11: Ranking of cost escalation causal factors by severity</i>	<i>55</i>
<i>Figure 4-12: Ranking of causal factors for cost escalation based on their significance.....</i>	<i>56</i>
<i>Figure 4-13: Ranking of schedule overrun factors by frequency.....</i>	<i>58</i>
<i>Figure 4-14: Ranking of schedule overrun causal factors by severity.....</i>	<i>59</i>
<i>Figure 4-15: Ranking of schedule overrun causal factors based on the FII</i>	<i>60</i>
<i>Figure 4-16: Ranking of quality shortfall causal factors by frequency</i>	<i>62</i>
<i>Figure 4-17: Ranking of quality shortfall causal factors by severity.....</i>	<i>63</i>
<i>Figure 4-18: Rating of quality shortfalls causal factors based on the FII.....</i>	<i>64</i>
<i>Figure 4-19: Rating of project success factors with respect to cost</i>	<i>66</i>
<i>Figure 4-20: Rating of project success factors with respect to schedule.....</i>	<i>68</i>
<i>Figure 4-21: Rating of project success factors with respect to quality.....</i>	<i>70</i>
<i>Figure 5-1: Standard Hierarchical Structure</i>	<i>78</i>
<i>Figure 6-1: The Client Satisfaction Enhancement Flowchart Model.....</i>	<i>82</i>
<i>Figure 6-2: Schematic drawing of the AHP based CSEFM.....</i>	<i>87</i>

List of tables

<i>Table 1-1: Performance of Selected Projects</i>	<i>5</i>
<i>Table 2-1: Content analysis of literature reviewed.....</i>	<i>18</i>
<i>Table 3-1: Frequency and severity weighting.....</i>	<i>37</i>
<i>Table 3-2: Frequency-Severity Matrix.....</i>	<i>38</i>
<i>Table 3-3: Weighted Frequency-Severity Matrix.....</i>	<i>39</i>
<i>Table 4-1: Ranking of project success enhancement factors</i>	<i>71</i>
<i>Table 6-1: CSEFM acronyms and their definitions</i>	<i>85</i>
<i>Table 6-2: Overall synthesis results by different respondents</i>	<i>89</i>

List of Equations

Equation 3-1: Frequency Index 37

Equation 3-2: Severity Index..... 37

Equation 3-3: Factor Importance Index 39

Equation 3-4: Weighted average 39

List of Appendices

<i>APPENDIX 1: Publications from the dissertation.....</i>	<i>100</i>
<i>APPENDIX 2: Structured Interview Questions</i>	<i>101</i>
<i>APPENDIX 3: Cover letter to the questionnaire</i>	<i>104</i>
<i>APPENDIX 4: Questionnaire</i>	<i>105</i>
<i>APPENDIX 5: Snapshots from Expert Choice on the CSEFM</i>	<i>112</i>

List of acronyms

AHP	Analytic Hierarchy Process
CSEFM	Client Satisfaction Enhancement Flowchart Model
CSO	Central Statistics Office
CSPR	Civil Society for poverty Reduction
EC	Expert Choice
FI	Frequency Index
FII	Factor Importance Index
GDP	Gross Domestic Product
ICE	Institution of Civil Engineers
IPC	Interim Payment Certificate
MCDM	Multiple Criteria Decision Making
MoFNP	Ministry of Finance and National Planning
NAP	National Academic Press
NCC	National Council for Construction
NEC	New Engineering Contract
RDA	Road Development Agency
SI	Severity Index

CHAPTER 1 : INTRODUCTION

1.1 Background

The construction industry is a conglomeration of diverse fields and participants that have been loosely lumped together as a sector of the economy (Hendrickson and Au, 2003). The industry plays a central role in national welfare, including the development of housing, office buildings, educational, health and transport infrastructure and industrial plants, and the restoration of the nation's infrastructure and other public facilities. The importance of the industry lies in the function of its products, which provide the foundation for industrial production, and its impacts on the national economy cannot be measured by the value of its output or the number of persons employed in its activities alone (Hendrickson and Au, 2003).

Construction refers to all types of activities usually associated with the erection and repair of immobile facilities. Contract construction consists of a large number of firms that perform construction work for others, and is estimated to be approximately 85 percent of all construction activities. The remaining 15 percent is performed by owners of the facilities, and is referred to as force-account construction (Hendrickson & Au, 2003). This study takes into account contract construction only.

Several factors, however, are particularly noteworthy because of their significant impacts on the quality, cost and time of construction. It is axiomatic of construction management that a project may be regarded as successful if it is completed on time, within budget, and is of the desired quality (Falqi, 2004). Cost escalation, schedule overruns and quality shortfalls can occur due to a wide range of causes on various types of projects. If project costs or schedules exceed their planned targets, client satisfaction would be compromised. The funding profile would no longer match the budget requirement and further slippage in schedule could result. On the other hand, if the project quality does not meet design standards, the client's satisfaction would be compromised, thus cost escalation and schedule overruns would result in an effort to improve the situation. The resulting effects would be detrimental, especially in the case of developing countries, whose wealth measure is greatly dependant on their performance in infrastructure provision through the construction industry. Figure 1-1

illustrates the relationship that exists amongst the major contributors to national development and how cost escalation, schedule overruns and quality shortfalls could affect a national development agenda.

According to Ahmed *et al.* (2002), delays on construction projects are a universal phenomenon. They are usually accompanied by cost and time overruns. These have a debilitating effect on parties to a contract such as owners, contractors and consultants in terms of growth in adversarial relationships, mistrust, litigation, arbitration, cash-flow problems and a general feeling of trepidation towards each other (Ahmed *et al.*, 2002).

Many, if not most, construction projects in Zambia have experienced cost escalation, time overruns as well as quality shortfalls. The public and various stakeholders have bemoaned the delayed handover of projects and prevalent quality shortfalls on construction projects. Time and again, the blame has been apportioned to contractors (The Post, 10/01/2008). The study reported in this dissertation endeavoured to establish the causes and effects of cost escalation, schedule overruns and quality shortfalls on construction projects and proposes mitigation mechanisms.

1.2 Rationale

Construction is a major industry with a significant contribution to the gross domestic product and the development strategy, especially of developing countries (Muya *et al.*, 2006). The construction industry in Zambia has been one of the fastest growing industries in the recent past and has been estimated to have a contribution of about 10.4% of the GDP at constant 1994 prices as of the year 2007 as illustrated in **Figure I-2** (CSO, 2008). The estimates of growth presented in national budgets also indicate that there has been positive growth in the industry such as 20.5% in 2004; 19.9% in 2005; 14.4% in 2006; and 13.3% in 2007 (MoFNP 2006, 2008).

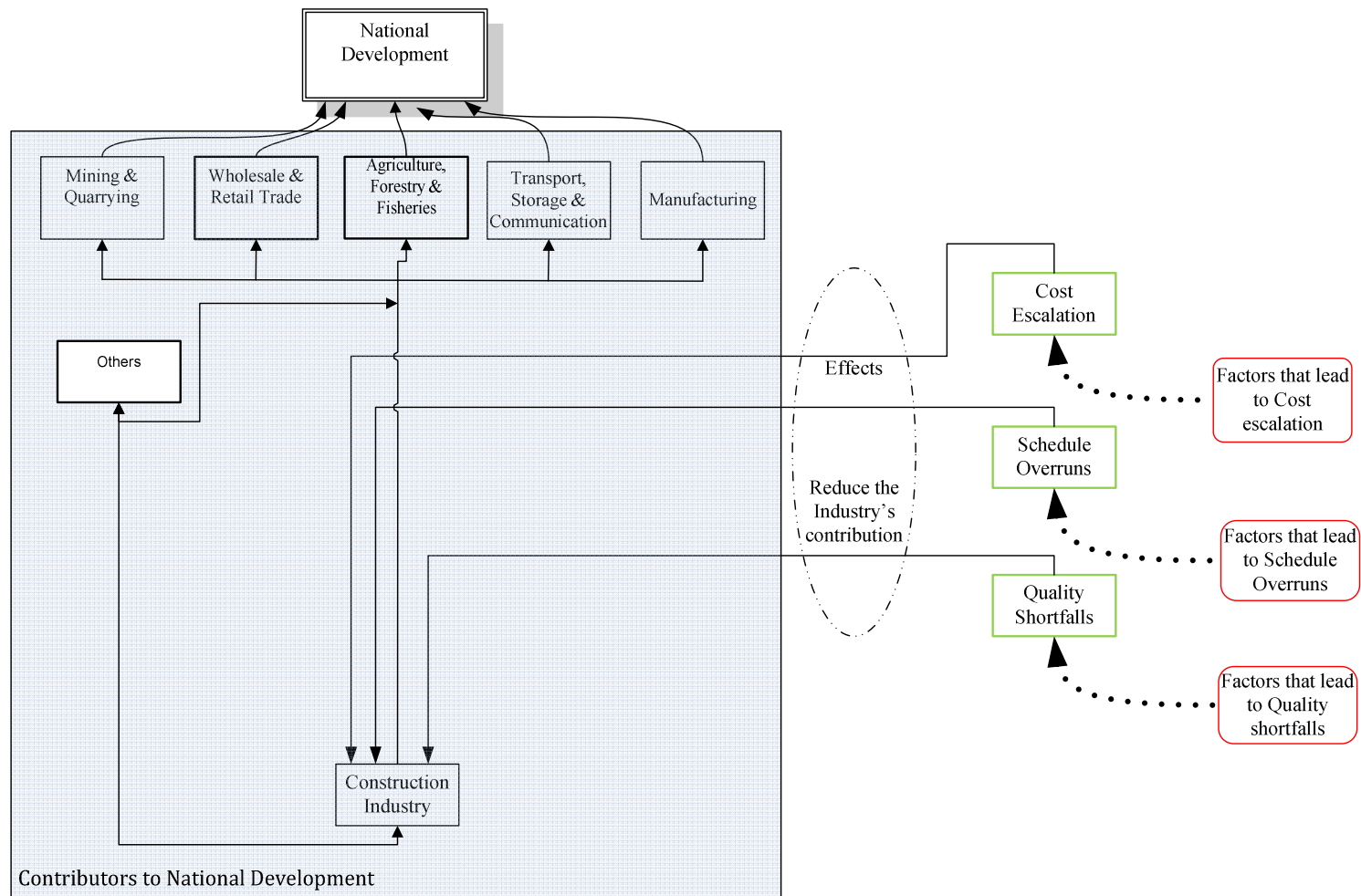


Figure 1-1: Relationship Diagram

Despite this being the case, the growth rate of the construction industry has been decreasing every year since 2004 as can be seen in **Figure 1-2**. This indicates that there are factors that are hindering further flourishing of the industry. Further investigations into the trends in some sectors of the construction industry indicate that there has been a consistent pattern of projects costing more than planned, taking longer than planned or even being terminated before commencement or during implementation as shown in Table 1-1.

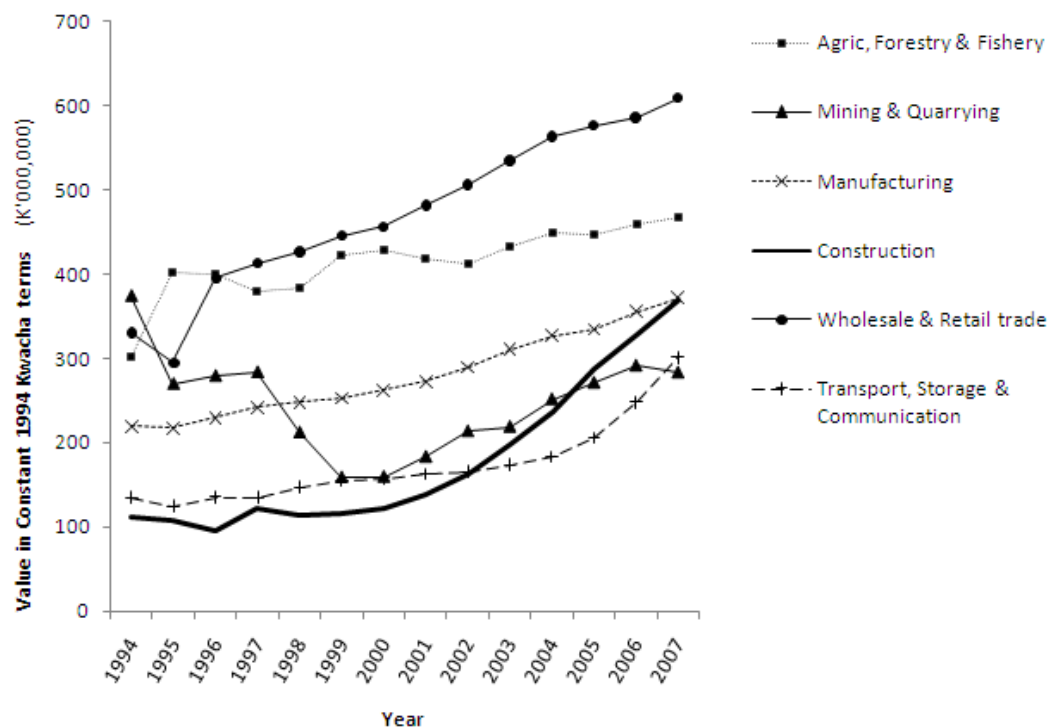


Figure 1-2: Growth Trends for contributors to GDP

Source: The Monthly (CSO, 2008)

Table 1-1: Performance of Selected Projects

	Name of Project	Start Date	Original Finish Date	Revised Finish Date	Original Contract Sum (US\$' Million)	Final Contract Sum (US\$' Million)	Remarks
1	Nyimba-Katete	Oct 2003	Oct 2004	Jul 2005	4.90	5.88	Beyond budget, beyond schedule
2	Kasama-Luwingu	Oct 2001	Nov 2003	Nil	35.00		Beyond schedule
3	Kashikishi-Lunchinda	Jun 2001	Jan 2003	Nil	37.50		Incomplete work
4	Mpika-Kasama	Jun 2001	Dec 2002	Nil	2.38		Beyond schedule
5	Mpika-Muwele	Jun 2001	Dec 2001	Nil	1.30		Failure to commence
6	Chambeshi-Chinkobo	Jan 2001	Aug 2001	Nil	1.35		Failure to commence
7	Isoka-Muyombe	Dec 2000	Mar 2002	Aug 2002	4.00	5.50	Beyond budget, beyond schedule
8	Mpika-Chinsali	May 1999	Mar 2000	Nov 2000	1.95	1.95	Beyond schedule
9	Chinsali-Nakonde	Apr 1999	Jul 2000	Nov 2000	2.00	2.00	Beyond schedule
10	Mutanda-Kasempa	Feb 1997	Feb 1999	Dec 2000	3.85	6.45	Beyond budget, beyond schedule
11	Luanshya-Mpongwe	Nov 1994	Jan 1997	Dec 2001	2.53	3.63	Beyond budget, beyond schedule
12	Choma-Namwala	Nov 1994	Feb 1998	Nil	2.50	8.60	Beyond budget, incomplete work

Source: Projects Progress Report (Roads Department, 2002) and Projects Progress Report (RDA, 2005)

Quality shortfalls in the construction industry have also been of great public concern (Post, 17/04/2007; 23/09/2007). In a bid to solve this problem, in 2008, the government blacklisted 42 contractors allegedly for shoddy works (Daily Mail 09/03/2008). Some contracts were terminated. Some of the blacklisted contractors claimed compensation, citing wrongful termination of contracts. The civil society has also argued that the Government would continue to put taxpayers' money in a 'bottomless pit' if there was no proper management of construction projects (CSPR, 2006).

The trend shown in Table 1-1 raises questions as to what extent the problem proliferates in the construction industry in general. It is worth noting that the projects in Table 1-1 all used standard contract documents which have provisions for cost, schedule and quality control. Not only do the clauses in the contract documents provide for what should be done to prevent time and cost overruns and how to ensure that quality is adhered to, but they also provide for what should be done in the event the provisions are not followed. In most cases, the contracts are administered by professional engineers

who are qualified and have the ‘necessary’ experience in the construction industry. In spite of this, it would appear that either the clauses provided therein are inadequate or the contract administrators are not doing what is required of them. This situation necessitates an in-depth study of the performance in construction projects delivery so as to find solutions that would alleviate or minimise cost escalation, schedule overruns and quality shortfalls. The resultant poor performance in the delivery of construction projects in terms of cost, time and quality has far reaching effects on the economy which, if left unchecked, could retard national development.

In spite of the plethora of public complaints and the extent to which cost escalation, schedule overruns and quality shortfalls have affected the industry, not much has been done to systematically address the problem. Implementing agencies and contractors all do not seem to have established methodologies for addressing the causes and effects of cost escalation, schedule overruns and quality shortfalls on construction projects. Improved management of construction projects would only be demonstrated when projects of desired quality are delivered within their scheduled period and costs. The successful execution of construction projects within estimated cost and prescribed schedules depend on a methodology that requires sound engineering judgment (Hancher and Rowings, 1981). Therefore, the aim of the research presented in this dissertation was to systematically address the causes and effects of cost escalation, schedule overruns and quality shortfalls in construction projects in Zambia. The study was also aimed at providing a model that could be used to deal with cost escalation, schedule overruns and quality shortfalls on construction projects. The resulting model was expected to provide professionals involved in management of construction projects with a structured and efficient tool for identifying factors that would contribute to project success and aid in successful decision making process to keep cost escalation, schedule overruns and quality shortfalls to a minimum.

1.3 Objectives

1.3.1 Main objective

The main aim of this study was to identify the causes of cost escalation, schedule overruns and quality shortfalls and develop a project management model that could be

used to systematically enhance project cost, schedule and quality performance monitoring and control processes.

1.3.2 Specific objectives

To achieve the main objective, specific objectives for the study were to:

- establish the factors that lead to cost escalation, schedule overruns and quality shortfalls in construction projects;
- analyse how the identified factors relate to overall project performance and their impacts on projects; and
- evaluate the possible options for alleviating or reducing cost escalation, schedule overruns and quality shortfalls on construction projects.

1.3.3 Study achievements

Cost escalation, schedule overruns and quality shortfalls were confirmed to be serious problems on construction projects. The study established that: insufficient initial analysis of costs; change orders or scope changes; inflation; and schedule delay or overrun were the most significant causal factors for cost escalation. Financial difficulties on the part of contractors; change orders or scope changes; poor sub-contractor performance; and changes in drawings and specifications were the most significant causal factors for schedule overruns while those for quality shortfalls included: inadequate and/or inconsistent release of project funds by clients; poor financial management by contractors; long time lapse between feasibility study and implementation of projects; inadequate supervision; and incompetence and lack of capacity by contractors to execute works.

The Client Satisfaction Enhancement Flowchart Model (CSEFM) was developed. Using the model, the project delivery and satisfaction enhancement factors were optimised and ranked. It was established that consultants' and contractors' competence and experience were the most significant factors in successful project delivery. Therefore, cost escalation, schedule overruns and quality shortfalls can be addressed using tools such as the CSEFM.

1.4 Organisation of the dissertation

The report is organized in seven chapters.

Chapter 1 outlines the background, rationale, aim and objectives of the study. It also presents the achievements recorded in the study.

Chapter 2 lays a foundation of the study through the review of literature relevant to cost escalation, schedule overruns and quality shortfalls.

In *Chapter 3*, highlights of the various research methodologies and the justification for the method adopted for the study is presented.

Chapter 4 presents the results of the research survey. The analysis of the results is also presented and discussed. The chapter further recommends the necessary project success enhancement factors that could be adopted in model development.

Since the model is based on multi-criteria decision making, Chapter 5 presents a discussion on the subject. The background information on the multi-criteria decision making (MCDM) and the Analytic Hierarchy Process (AHP) is presented.

The Client Satisfaction Enhancement Flowchart Model (CSEFM) is presented in *Chapter 6*. The development steps and its use in data collection and manipulation is also presented. The dissertation ends with *Chapter 7* which presents the conclusions, limitations and recommendations of the study.

CHAPTER 2 : LITERATURE REVIEW

2.1 Introduction

The previous chapter presented an overview of cost escalation, schedule overruns and quality shortfalls in construction projects. The rationale and objectives of the study were also presented. This chapter presents a review of available literature on the subject of cost escalation, schedule overruns and quality shortfalls.

Over the past 50 years, cost, time and quality have become inextricably linked to the measurement of the success of project management. This is perhaps not surprising, since over the same period these criteria have usually been included in the description of project management (Atkinson 1999). The three factors remain in constant tension. As can be seen in Figure 2-1, optimization is imperative so as to have a successful project.

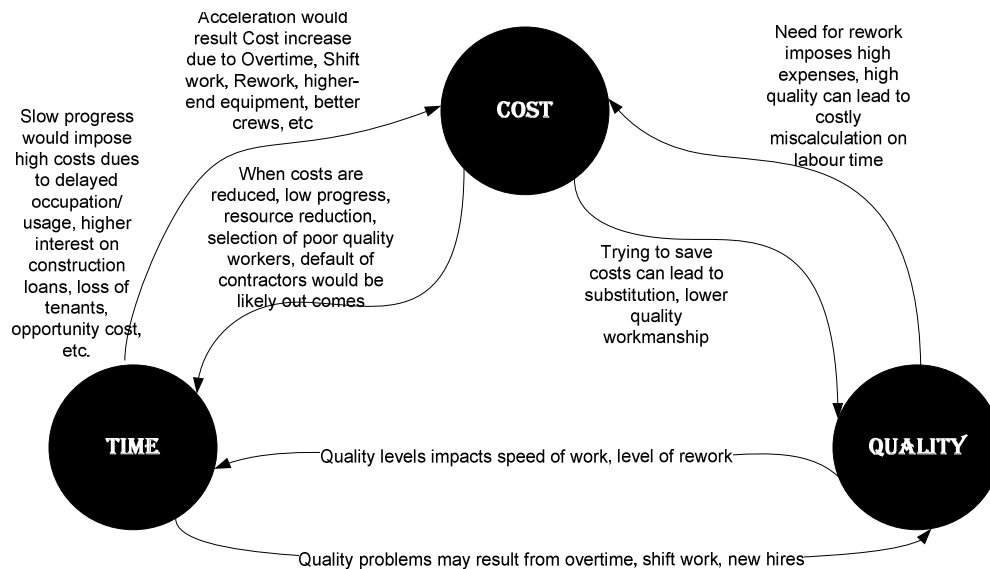


Figure 2-1: Cost -Time - Quality Relationship

(Adapted from MIT Project Management Lecture Notes, 2007)

In the project life cycle, the most influential factors affecting the outcome of a project often reside at the early stages. At this point, decisions should be based on competent economic evaluation with due consideration for adequate financing, prevalent social and regulatory environment, and technological considerations (Hendrickson and Au, 2003).

As noted by Cross (1952), it is customary to think of engineering as part of a trilogy: pure science; applied science; and engineering. It needs emphasis that this trilogy is only one of a triad of trilogies into which engineering fits. The first is pure science, applied science and engineering; the second is economic theory, finance and engineering; and the third is social relations, industrial relations and engineering. Many engineering problems are as closely allied to social problems as they are to pure science. It is therefore important to understand these social challenges and find appropriate solutions that would minimise or where possible eliminate the problems associated with the management of construction projects.

Predicting and understanding the problems before they occur, careful planning to avoid any of them and adopting appropriate solutions when they actually come into existence is possible when fore-knowledge of which challenges are most likely to occur in construction projects is available. Such assessment could help in combating construction challenges with more preparedness even before they actually occur (Toor and Ogunlana, 2006).

There is a wide range of views for causes of quality shortfall, schedule delays and cost escalations in engineering and construction projects. Some are attributable to a single party, others can be ascribed to several quarters, and many relate more to systemic faults or deficiencies rather than to a group or groups of people. The successful execution of construction projects and keeping them within estimated cost and prescribed schedules depend on a methodology that requires sound engineering judgment (Hancher and Rowings 1981).

2.2 Previous studies on cost escalation, schedule overruns and quality shortfalls in construction projects

2.2.1 Cost escalation

No text specifically deal with the subject of cost escalation was accessed during this study. However, literature on construction cost estimation can be used to understand this subject. Cost escalation factors that lead to project cost growth have been documented in a large number of studies and matched to changes in cost estimates. Each factor

presents a challenge to any agency seeking to produce accurate project cost estimates (Schexnayder *et al.* 2007).

Cost escalation refers to the increase in the amount of money required to construct a project over and above the original budgeted amount. While this is a straightforward concept, the difference between "nominal" cost escalation and "real" cost escalation can lead to confusion. Nominal costs are dollar amounts without regard to time, whereas real costs are constant dollar amounts. Thus, nominal cost escalation includes inflation while real cost escalation does not (Leavitt *et al.*, 1993). Nominal cost escalation is used in this study in order to be consistent with the literature reviewed. The study also deals with cost escalation for the construction period only as seen by clients rather than contractors.

Datta in the India Infrastructure Report (2002) described cost escalation as a ubiquitous problem in government projects. Schexnayder *et al.* (2003) and Merewitz (1973) endeavoured to find some of the reasons that lead to cost escalation and categorized them into two broad groups: uncontrollable and controllable factors.

In a study to identify factors that cause inaccuracies in cost estimates of highway projects, the General Accounting Office (GAO/RCED, 1997) found that 77 percent of highway projects in the USA experienced cost escalation. Among the many factors identified, GAO/RCED (1997) specifically noted three:

- initial estimates were preliminary and not designed to be reliable predictors of project costs;
- initial estimates were modified to reflect more detailed plans and specifications as a project is designed; and
- a project's costs were affected by among other things, inflation and changes in scope to accommodate economic considerations that occur over time as a project is designed and built.

Other studies (Frimpong *et al.*, 2003, Schexnayder *et al.*, 2003; NAP, 2002; Datta, 2002; Mansfield *et al.*, 1994; Merrow, 1988; and Merewitz, 1973) identified cost escalation to be a result of problems such as poor contract management, poor technical performances, delay in land acquisition, unexpected problems in supply of raw

materials, illegal encroachment on land even during project implementation, or due to internal problems in government organizations. It has further been noted that delays between the planning stage and actual implementation, of especially large infrastructure projects, is a ubiquitous problem resulting in cost escalation and failure to meet the demands as the construction completion horizon is reached even before the completion of the project (Datta, 2002).

Factors that lead to cost escalation are said to include among others: the size of the project; project scope enlargement; inflation; length of time to complete the project; incompleteness of preliminary engineering and quantity surveys; engineering uncertainties; exogenous delays; complexities of administrative structures; and inexperience of administrative personnel (Merewitz, 1973). Cost escalation is further compounded by factors such as project location, project conditions, environmental mitigation costs, suspension of works, strikes, poor coordination on site, expiry of bid, local government pressures, political discontinuity and transportation problems (Schexnayder *et al.*, 2003 and NAP, 2002).

Studies by the Rand Corporation to address the question of what steps could be taken to minimize cost and schedule risks suggest that factors such as remote sites, failure to plan for adequate manpower, poor understanding of local labour practices, and changing or unclear labour regulations can lead to cost escalation (Morrow, 1988). These studies also indicated that poor management could cause cost escalation but stress that poor project execution caused by management deficiencies is usually not the primary driver of project cost escalation (Morrow, 1988). Mansfield *et al.* (1994) showed that the major factors that cause cost escalation were poor contract management, improper planning, inaccurate estimating, and overall price fluctuations.

i) Summary of factors that lead to cost escalation

Previous studies by other investigators have documented various factors that lead to cost escalation in construction projects. Literature reveals that cost escalation can be caused by: poor contract management, poor technical performance, real estate acquisition challenges; inclement weather (heavy rains and floods); changes or unclear regulatory requirements; complexity of administrative structures; disruption of management

continuity; disruption of political continuity; engineering uncertainties; environmental protection and mitigation costs; illegal encroachment on project sites; inexperienced administrative personnel; inflation; insufficient initial analysis of costs; lack of coordination on site; lack of organisational capacity or capabilities; local government pressures; new technology requirements; project conditions; project location; safety and health regulation; schedule overruns; scope changes; size of project; strikes; suspension of works; technical challenges; transformation of community expectation; unforeseen constructability issues; and unforeseen engineering complexities.

2.2.2 Schedule overruns

Schedule overruns refer to situations where the actual project duration exceeds the originally planned and agreed completion period. Time is an integral part of every plan a company develops for performing contract work. There is a relationship between the schedule, the scope of work, and project conditions. Changes to any one or more of the above three can affect the compensation level and time of completion (Ahmed *et al.*, 2002).

Construction projects frequently experience schedule overruns. Various factors affect completion periods of projects. It has been argued that it is necessary to create awareness of causes of project delays, their frequency, and the extent to which they can adversely affect project delivery (Falqi, 2004). According to Ahmed (2002), delays can be grouped in the following four broad categories depending on how they operate contractually:

- non-excusable delays;
- non-compensable excusable delays;
- compensable excusable delays; and
- concurrent delays.

Mansfield *et al.* (1994) showed that the most significant factors affecting construction schedules were financing and payment for completed works, poor contract management, changes in site conditions, shortage of materials, and improper planning. Ahmed *et al.* (2002), Al-Moumani (2000), Chan and Kumaraswami (1997) and Assaf *et al.* (1995) agreed on most of the causes of schedule overruns in the construction industry. They

concluded that the most significant causes of overruns included approval of working drawings, delays in payments to contractors and the resulting cash-flow problems during construction, design changes, conflicts in work schedules of subcontractors, slow decision making and executive bureaucracy in the clients' organizations, design errors, labour shortage and inadequate labour skills.

In a study of construction projects in Nigeria, Dlakwa and Culpin (1990) found that the major reasons for schedule overruns in public sector construction projects included: lack of prompt payment by agencies to contractors; and fluctuations in material, labour and plant costs. Project cost overruns were often said to derive from disruptions and delays to project progress. Frimpong *et al.* (2003) concluded that: poor contractor management; monthly payment difficulties from agencies; material procurement; poor technical performances; escalation of material prices according to their degree of influence; inclement weather; and unexpected natural events were possible causes of schedule overruns.

Ogunlana and Promkuntong (1996) concluded that the problems of the construction industry in developing economies could be nested in three layers:

- shortages or inadequacies in industry infrastructure, mainly supply of resources;
- problems caused by clients and consultants; and
- incompetence of contractors.

i) Summary of causes of schedule overruns

The literature reviewed highlighted that schedule overruns can be caused by: challenges in acquisition of real estate; change orders; changes in drawings; changes in laws and regulations; changes in specifications; construction mistakes; contract modification; damages to structures under construction; defective work; delayed payments; difficult or different site conditions; economic problems; environmental protection laws; equipment unavailability; financial processes and difficulties; floods; inadequate planning; inadequate reviews; inadequate scheduling; incomplete documents; labour disputes and strikes; labour injuries; lack of high technology; lack of qualified manpower; material fabrication delays; material procurement; poor coordination on site; poor managerial skills; poor sub-contractor performance; poor supervision; safety rules; schedule

mismanagement; staffing problems; subsurface soil conditions; suspensions; transportation delays; and underestimation of productivity.

2.2.3 *Quality shortfalls*

The term quality, particularly when applied to constructed facilities, has no single generally accepted meaning. For many people, it is a characteristic of an object. For others, it has something to do with actions taken to achieve an object with certain characteristics. Quality is a value-laden term that depends on one's point of view (NAP, 1991).

Within the limited context of the design and construction stage of a facility, quality can be more readily defined as conformance to adequately developed requirements. This definition indicates that a quality constructed facility will result provided that the following conditions are met (NAP, 1991):

- contract documents comprise a clear, complete, and accurate description of the facility to be constructed, correctly conveying the intent of the owner regarding the characteristics of a facility needed to serve his or her purposes;
- contract documents define a constructed facility considered acceptable under applicable regulatory codes and standards of professional practice, in terms of its reliability, the ease with which maintenance and repairs can be performed, the durability of its materials and operating systems, and the life safety afforded its users; and
- the facility is constructed in accordance with those documents.

The National Council for Construction (NCC) organised a workshop to carry out a post-mortem on why contractors executed shoddy works. The reasons identified for shoddy works included (NCC, 03/2006):

- long time lapse between assessment, procurement and implementation of the project;
- inadequate and/or inconsistent release of project funds by clients;
- poor financial management by contractors;
- inadequate supervision by contractors;
- corruption and demand for kick backs by consultants prior to certification of works;

- incompetence of some consultants especially with regards to initial project assessment;
- incompetence and lack of capacity by contractors to execute works; and
- departure from mission statements by some government ministries to venture into construction e.g. Ministries of Health and Education.

A year later, NCC published an article on shoddy works and wondered why this ‘problem’ was more prevalent in the public and not in the private sector despite both using the same contract documents, consultants and contractors. NCC wondered why politicians were in the forefront in complaining about quality shortfalls while consultants showed satisfaction of the works done by certifying the contractors’ claims (NCC, 03/2007). The article raised questions as to whether quality shortfalls existed in construction projects or it was mere politicking on the part of government.

Despite the many articles in the media about quality shortfalls, there has been no publication that has attempted to identify their causes. The effects of quality shortfalls, however, are well known throughout the construction and project management industry. Hendrickson and Au (2003) indicated that quality shortfalls in constructed facilities can result in very large costs. Even with minor defects, re-construction may be required and facility operations impaired. Increased costs and delays could result. In the worst case, failures may cause personal injuries or fatalities. Accidents during the construction process can similarly result in personal injuries and large costs. Indirect costs of insurance, inspection and regulation are increasing rapidly due to increased direct costs.

i) Summary of causes of quality shortfalls

The literature reviewed indicated that quality shortfalls result from: clients’ lack of relevant knowledge; corruption and demand for kick backs by consultants prior to certification of works; disruption of project management continuity; inadequate and/or inconsistent release of project funds by clients; inadequate inspections; inadequate project planning; inadequate supervision by contractors; inadequate or wrongly applied specifications; incompetence and lack of capacity by contractors to execute works in terms of human, plant or machinery and financial resources; incompetence of some consultants; lack of project coordination by the client, contractor and consultant; local

government pressures; time lapse between assessment, procurement and implementation of projects; poor financial management by contractors; poor sub-contractor performance; project location; and size of projects.

Table 2-1 provides a summary and critique of the literature reviewed.

Table 2-1: *Content analysis of literature reviewed*

S/N	Author	Objectives	Methodology	Conclusions	Comments, critique (if any)
1.	Schexnayder <i>et al.</i> , 2007	To provide clear and concise set of strategies that would result in improved cost estimates	Review of existing strategies aimed at improving cost estimation management	The paper showed that cost escalation deficiencies have been documented through a large number of studies. These shortcomings could be mitigated through strategies that focused on controlling their possible effects.	The paper, however, did not provide strategies for avoiding identified shortcomings but indicated that contingent funds should be allocated to mitigate the effects as and when they occur.
2.	NCC, 2006	To carry out a post-mortem on why contractors executed shoddy works	Workshop	The workshop cited: long time lapse between assessment, procurement and implementation of projects; inadequate and or inconsistent release of project funds by clients; poor financial management by contractors; inadequate supervision by contractors; corruption and demand for kick backs by consultants prior to certification of works; incompetence of some consultants especially as regards initial project assessment; incompetence and lack of capacity by contractors to execute works (human, plant or machinery and financial resources); and the departure from their mission statements by some government ministries to venture into construction e.g. Health and Education Ministries as some of the reasons for quality shortfalls in construction projects	Being outcomes of a workshop, the conclusion could have been biased depending on the participants. The findings were not based on any research as such they might not have been represented of the views of the industry. The information was, however, an important starting point for studies

S/N	Author	Objectives	Methodology	Conclusions	Comments, critique (if any)
3.	Toor and Ogunlana, 2006	To categorize several construction problems into groups and then find the significance of those challenges with respect to various construction participants	Literature review Interviews Questionnaire survey	The paper showed that challenges related to participant organizations were given higher ratings compared to those related to other issues like site and environment, finance and contract. Lack of competence in terms of staff's, foremen's, subcontractor's and contractor's experience was also highlighted in the top rated problems. The findings confirmed previous studies that most of the problems in construction projects were human and management related and not technical in nature.	
4.	Falqi, 2004	To identify the principal causes of delay in construction projects in Saudi Arabia and the United Kingdom	Literature review Questionnaire survey	The paper emphasised the need to create awareness of causes of project delays, their frequency, and the extent to which they could adversely affect project delivery. Contractors, consultants, and owners in each country were shown to be statistically agreed on the relative importance ranking of delay causes. However, the extent of suffering delay causes differed between Saudi Arabia and the United Kingdom. The performance of contractors was recognized as the most important delay category, followed by owner-related factors, while the consultants' delay factors were assigned as the least important	Well elaborated research work. However, lack of data on cost and quality in relation to construction projects made the research somehow incomplete.

S/N	Author	Objectives	Methodology	Conclusions	Comments, critique (if any)
5.	Frimpong <i>et al.</i> , 2003	To study and evaluate the factors that contributed to schedule delays and cost overruns in groundwater construction	Questionnaire Survey	The paper illustrated that ground water construction projects suffered cost and time overruns. Ranked results indicated that clients, consultants and contractors all felt that the major factors that could cause excessive groundwater project cost or schedule overruns in developing countries were poor contractor management, monthly payment difficulties from agencies, material procurement, poor technical performance (quality shortfalls), and escalation of material prices according to their degree of influence. Other factors that emerged clearly as not very important, but of interest, were bad weather and unexpected natural events. The results showed also that many of the problems in the groundwater construction projects originated from poor resources management (human, technical and material).	Study limited to groundwater projects. Also no data on causes and effects of quality shortfalls on construction projects.
6.	Schexnayder <i>et al.</i> , 2003	To examine the estimation practices that were in use by state Departments of Transport (DoT) in the United States of America (USA).	Use of historic data from all DoTs in USA Literature review	The report brought to light the fact that cost escalation was related to scope changes; inflation; new technologies; project duration; exogenous factors and project management.	The research was limited estimation practices for highway projects in a developed country i.e. USA.
7.	Ahmed <i>et al.</i> , 2002	The main objective of the study was to identify the major causes of delays in construction projects in the Florida Construction Industry through a survey.	Literature review Questionnaire survey	The primary aim of the study was to identify the perceptions of the different parties regarding causes of delays, the allocation of responsibilities and the types of delays. The paper concluded that building permits approval; change orders; changes in drawings; incomplete documents; inadequate inspections; changes in specifications; design development; and changes in laws and regulations as the most critical causes of delays in Florida construction projects	The study was limited to building projects only in Florida. The study also just looked at only one factor of the project triangle and did not make reference to the effects of cost and quality on a project.

S/N	Author	Objectives	Methodology	Conclusions	Comments, critique (if any)
8.	Datta, 2002	To highlight the factors that were crucial to Kanpur Development Authority (KDA) emerging as an efficient and economic provider of infrastructure services in Kanpur	Organisation setup review Organisation procedures review	Among the primary challenges that could be faced by KDA, cost escalation was described as the most ubiquitous problem. The paper however did not indicate how this challenge could be overcome	The paper did not consider schedule and quality issues on construction projects
9.	NAP, 2002	To examine factors that led to cost growth on the Central Artery/Tunnel Project in the USA	Project data review	The study attributed cost growth to: inflation; extended schedule; low initial estimates; efforts to maintain schedule; increased scope; unplanned expenses to mitigate projects effects on the environment and movement of traffic; unexpected technical complexities; and delays in making decisions.	
10.	Al-Moumani, 2000	Quantification of the amount of construction delays on projects	Literature review Study of 130 construction projects over a period of 7 years	The study presented regression models of the relationship between actual and planned project duration for different types of building facilities. The analysis also included the reported frequencies of time extensions for the different causes of delays. The researcher concluded that the main causes of delay in construction projects relate to designers, user changes, weather, site conditions, late deliveries, economic conditions, and increase in quantities	The study ably quantified the amount of construction delays but did not correlate any effects of cost and quality on construction projects
11.	Chan and Kumaraswami, 1997	To determine the causes of time overruns in the Hong Kong construction industry through comparative studies	Surveys Literature review	The paper established agreement among clients, consultants and contractors that the five most significant sources of schedule and cost overrun were site management and supervision, unforeseen ground conditions, low speed of decision making involving all project teams, client-initiated variations and necessary variations of works.	

S/N	Author	Objectives	Methodology	Conclusions	Comments, critique (if any)
12.	GAO/RCED, 1997	To examine cost growth on large dollar projects in the USA; determine if large dollar projects experienced cost growth; identify how Federal Highway Authorities (FHWA's) approved large dollar projects and agreed costs; and identify how FHWA's ensured project costs were controlled and federal funds were efficiently used.	Project review Interviews Discussions	Data to track cost growth was not readily available but that which was collected showed that 23 out of 30 projects had cost growth; out of the 23 projects, almost half had cost growth of 25% or more; project approval processes consisted of incremental actions as such there was no approval or agreement to cost at the outset of a project; initial estimates were not reliable; controlling costs of projects was not the primary objective of FHWA's but was more concerned with safety and quality. The paper showed that management of project costs was a challenge to most FHWA's and was essential in reducing cost escalation	
13.	Ogunlana and Promkuntong, 1996	To understand causes of delay in developing economies – Thailand as a case study	Case study of Thai construction industry	The paper concluded that the problems of the construction industry in developing economies could be nested in three layers: problem of shortages or inadequacies in industry infrastructure, mainly supply of resources; problems caused by clients and consultants; and problems caused by incompetence of contractors.	

S/N	Author	Objectives	Methodology	Conclusions	Comments, critique (if any)
14.	Assaf <i>et al.</i> , 1995	Identification of the main causes of delay in large building construction projects in Saudi Arabia	Literature Review Questionnaire Survey	The study identified 56 causes of delay in Saudi Arabian construction projects and concluded that contractors, consultants, and owners generally agree on the importance ranking of delay factors. Delay factors were categorised into nine groups, of which financing was unanimously ranked highest. The most important causes of delay included approval of shop drawings, delays in payments to contractors and the resulting cash-flow problems during construction, design changes, conflicts in work schedules of subcontractors, slow decision making and executive bureaucracy in the owners' organizations, design errors, labour shortage and inadequate labour skills	The study was limited to building construction and only focused on construction delays. There were, however, no tangible solutions that were proposed to systematically deal with construction delays
15.	Mansfield <i>et al.</i> , 1994	To identify the causes of delay and cost overruns in construction projects in Nigeria	Literature review Surveys	The results showed that the most significant causes of delay and cost overruns were financing and payment for completed works, poor contract management, changes in site conditions, shortage of materials, and improper planning.	
16.	Leavitt <i>et al.</i> , 1993	To re-evaluate the CalSpeed estimates	Review and examination of cost escalation on rail construction projects; and Systematic re-evaluation of the original estimates based on the findings.	The paper indicated that most of the changes in initial estimates were due to either inflation or changes in designs. Design estimates were most likely to be inaccurate in projects where engineers lacked previous experience with the type of project or technology. Like all articles on estimation, the paper focused on factors that affected initial cost estimates. The paper did not address how the identified factors could be enhanced or improved to ensure that project costs did not grow out of proportion.	

S/N	Author	Objectives	Methodology	Conclusions	Comments, critique (if any)
17.	Dlakwa and Culpin, 1990	To determine the major reasons for cost and schedule overruns in public sector construction projects	Literature review Surveys	The paper established that the major reasons for schedule and cost overruns were the lack of prompt payment by agencies to contractors and fluctuations in material, labour and plant costs. Project cost overruns often derived from disruptions and delays to project progress	
18.	Merrow 1988	To answer the following questions: Have mega projects generally met their goals in terms of cost, schedule, performance, etc?; What factors drives good and bad outcomes?; What steps can be taken to minimise cost, schedule and performance risks associated with mega projects?	Project review	Studies by the Rand Corporation to address the question of what steps could be taken to minimize cost and schedule risks suggested that factors such as remote sites, failure to plan for adequate manpower, poor understanding of local labour practices, and changing or unclear labour regulations could lead to cost escalation. These studies also indicated that poor management would cause cost escalation but stressed that poor project execution caused by management deficiencies was usually not the primary driver of project cost escalation	
19.	Merewitz, 1973	To present some findings on cost overruns in public works	Case studies Literature review	The paper established that cost overruns have been an issue of discussion since the 1960s. Factors such as: project size; scope enlargement; inflation; duration of the project; engineering uncertainties; complexity of administration structures; inexperienced administrative personnel; and exogenous delays were cited to be possible causes of cost escalation.	

2.3 Summary

This chapter presented a review literature on the subject of cost escalation schedule overruns and quality shortfalls on construction projects. The reviewed showed that there has been high interest in the subject of causes and effects of cost escalation and schedule overruns but little on quality shortfalls with regards to the construction industry world-wide. A Similar study conducted in Zambia was limited to road construction industry only (Kaliba *et al.*, 2009). That study examined cost and time aspects holding quality constant. It was from that perspective that the motivation to undertake this study on the causes, effects and solutions to cost escalation, schedule overruns and quality shortfalls in construction projects in Zambia was drawn from.

The next chapter discusses the research methods used in this study. The merits and demerits of the various research methods are also discussed and presented.

CHAPTER 3 : METHODOLOGY

3.1 Introduction

The previous chapter presented reviewed literature on cost escalation, schedule overruns and quality shortfalls in construction projects. This chapter presents the methodology used to carry out the research presented in this dissertation in order to address the defined study aim and objectives. The chapter highlights the various methodologies that can be adopted for research purposes. It further explains how the problem was investigated and describes the tools used to undertake the investigation. It also describes the characteristics of the research sample and the methods of data analysis employed.

3.2 Research methods

There are various research methods available in the world today. Different research types also have different data gathering methods. Data collection techniques can be broadly classified as:

- primary; and
- secondary.

3.2.1 Primary technique

This is the technique used to collect one's own data or information. The collector of such data is the first to ever embark on collecting it. This technique includes methods such as observations, interviews and administration of questionnaires (Nkhata 1997). Focus Group Discussion is also one of the primary techniques of data collection.

i) Observation

This is a method of data collection that requires a researcher to attain membership of some alien or exotic group or organisation being studied. Once the researcher joins the organisation, the aim would be to learn all their behaviour and habits. This involves total immersion in the group being studied (Achola and Bless 1988). Within the construction industry, the observer would join an organisation with the aim of studying the construction processes.

There are various types of observation approaches that a researcher can opt to use. These include (Nkhata 1997):

- complete observation, where the researcher hides his or her identity, objectives and hypothesis. The group being studied does not know that they are being observed since the researcher behaves in the same way as they do. This allows the researcher to obtain the exact picture of the group's behaviour. Special devices like tape recorders can be used. However, there can be adverse effects if the researchers' behaviour arouses suspicion; and
- participant observer, where the researcher's role is known. This mode minimises the risk of role pretending. The group is aware of the objectives of the study. This might induce an aspect of pretence among the observed, thereby reducing the validity of the study.

ii) Case study

Case studies are detailed and thorough investigation of a few real life situations. They provide a way of organising data and looking at the objects to be studied as a whole. All aspects are considered, which means that the development over time of the event constitutes an important dimension. Thus a case study offers advantages of acquiring detailed information about the subject through an in-depth study. On the other hand, the data obtained would be more or less reliable depending on the objectivity of the researcher (Achola and Bless 1988).

iii) Survey research

This is a method that involves the administration of questionnaires to a sample selected from a population. Interviews and questionnaires are the methods used. It is appropriate for both descriptive and explanatory researches (Bryman 2001).

a) Interviewing

This is a data collection method involving oral questions to either individuals or groups but more often individuals. It involves an inter-personal relationship between the interviewer and the interviewee. This method has, however, its own advantages and disadvantages (Bryman 2001).

Its advantages being that it:

- incorporates illiterate respondents;
- permits clarification of issues; and
- gives a higher response rate than written questionnaires.

Disadvantages of the method include:

- the presence of the interviewer may influence responses;
- reports of events may not be as complete as in the case of observation;
- personal interviews are costly in terms of time and money; and
- a danger of serious disparities is likely if more than one interviewer is used and this reduces comparability of responses.

b) Questionnaires

This method involves the use of written questions that are presented to the respondent. These are to be answered by the respondent in a written form. Two types of questionnaire surveys are available. These are (Achola and Bless 1988):

- self-administered questionnaire are posted to the respondent and returned completed; and
- an administered questionnaire is delivered by the interviewer.

This method has its merits and demerits when used in a survey (Nkhata 1997). Its advantages include:

- it can be less expensive than interviews i.e. when one takes self administered questionnaires, they are less expensive;
- it permits or allow for anonymity that can result in more honesty responses;
- it does not require research assistants; and
- questionnaires eliminate bias due to phrasing because questions are phrased and framed the same way for all respondents.

Disadvantages of the method include:

- self administered questionnaires cannot be used with illiterates;

- low response rates may result as some respondents may decide to put the questionnaire in the rubbish bins as opposed to completing it; and
- questions may be misunderstood in the absence of the interviewer.

There are two types of questions: (Achola and Bless 1988):

- open-ended; and
- closed-ended or structured questions.

(i) Open – ended questions

These are questions which permit free responses that should be reported in the respondents' own way i.e. the respondent is not given possible answers to choose from. This is important when the researcher wants to get information on opinions, attitude and reactions to sensitive questions (Achola and Bless 1988).

Advantages of open-ended questions include:

- issues that may not have been asked may be explored, thereby allowing the researcher to gain more information;
- information is given spontaneously and it is more likely to be true than answers which are limited to choice; and
- the information in the respondents' own way may be very useful as examples or illustrations that add interest to the final report.

Disadvantages include:

- Analysis of information based on open-ended questions can be time consuming and requires responses which are not numeric and it means going through all the questions and summarizing the relevant information.

(ii) Closed-ended or structured questions

This offers a list of options from which respondents must make a choice of what is most suitable. The options must be exhaustive and stiff (Achola and Bless 1988).

Advantages of closed-ended questions include:

- answers can be recorded quickly; and

- analysis of answers is very easy

Disadvantages include:

- they are not suitable for face to face interviews;
- respondents may choose options that they might otherwise not have thought of especially if the options are not exhaustive;
- information may be missed out through lapses; and
- the respondents may lose interest and suffer from boredom and fatigue.

3.2.2 *Secondary technique*

This technique involves the use of available information that was collected by somebody else. The researcher in this case is the secondary user of the information. An example of such a technique is literature review. This technique has some advantages and disadvantages as well (Bryman 2001).

Advantages include:

- it is inexpensive in that the data is already in existence and one just has to pick it; and
- it permits the analysis of trends such as traffic or population growth trends etc.

Disadvantages include:

- ethical issues of confidentiality for instance in the case of on-going government projects might make the information not to be availed to the researcher; and
- information may be incomplete and imprecise – this relates to issues of the methods employed.

3.3 Research design

This study was designed to address the problem identified in Section 1.2 and achieve the objectives outlined in Section 1.3. It was considered essential to obtain a full understanding of the study by setting out the various elements in a logical sequence, so as to avoid misunderstanding at any point in the research. The problem statement, aims and objectives of the research were therefore stated at the outset. In order to present

clear perspectives about the causes of cost escalation, schedule overruns and quality shortfalls in construction projects and to bring out the effects, it was decided to conduct the study in four phases. The first was comprehensive literature review. This phase overlapped all the other phases as it was important that even latest information on the research subject be incorporated. Data collection which was done through interviews and questionnaire surveys constituted the second phase. The triangulation of the various methods was done to enhance the confidence that can be placed on the research findings (Spector, 1981). The third phase was the analysis of the data collected. The information from the earlier stages was then used in the fourth phase as the input data. The fourth phase was the development of the conceptual project management model constructed meant to mitigate cost escalation, schedule overruns and quality shortfalls in construction projects.

3.3.1 Literature review

In getting a better understanding of the subject, it was decided to collect secondary data from what other researchers elsewhere have done. This method was used based on the fact that it is cheaper to lay the foundation of the research, and build it up on what has been established by others (Nkhata 1997).

The main objective throughout the review stage was to identify factors likely to be relevant in studying cost escalation, schedule overruns and quality shortfalls. In order to achieve the objectives, a systematic literature review was conducted. The objective was to (UCSC 2006 and Achola and Bless 1988):

- define and limit the research questions being worked on;
- place the study in a historical perspective;
- avoid unnecessary duplication;
- identify approaches to research design and methodology; and
- clarify the future direction for the study.

i) Literature sources

The source of information can be considered to be an important factor when checking the validity of the information obtained. Below is a brief discussion of the various sources of information (Languages Centre 2005).

Journal articles are good especially for up-to-date information. It should be born in mind, though, that it can take up to two years to publish articles. Journal articles are frequently used in literature reviews because they offer a relatively concise, up-to-date format for research and because all reputable journals are refereed.

Books tend to be less up-to-date as it takes longer for a book to be published than for a journal article. Text books are unlikely to be useful for literature review as they are intended for teaching, not for research, but they do offer a good starting point from which to find more detailed sources.

Conference proceedings can be useful in providing the latest research, or research that has not yet been published. They are also helpful in providing information on current research areas, and as such can be helpful in tracking down the work done by others.

Government and corporate reports - many government departments and corporations commission research projects. Their published findings can provide a useful source of information, depending on the field of study.

Newspapers are generally intended for a general and not specialized audience, the information they provide will be of very limited use for literature review. Often newspapers are more helpful as providers of information about recent trends, discoveries or changes, for example announcing changes in government policy, but one needs to then search for more detailed information in other sources.

Theses and dissertations can be useful sources of information. However there are disadvantages: they can be difficult to obtain since they are not published, but are generally only available from the library shelf or through inter-library loan; and the student who carried out the research may not be an experienced researcher and therefore

the subsequent researcher might have to treat their findings with more caution than published research.

The Internet is the fastest-growing source of information. It is impossible to characterize the information available but there are some hints about using electronic sources: it should be borne in mind that anyone can post information on the internet so the quality may not be reliable; the information found may be intended for a general audience and may not be suitable for inclusion in literature review as information for a general audience is usually less detailed; and more and more refereed electronic journals are appearing on the internet. If they are refereed, it means that there is an editorial board that evaluates the work before publishing it in their e-journal, so the quality should be more reliable depending on the reputation of the journal.

CD-ROMS - at the moment, few CD-ROMs provide the kind of specialized, detailed information about academic research that one needs for detailed scientific investigations since most are intended for a general audience. However, more and more bibliographies are being put onto CD-ROMs for use in academic libraries, so they can be a very valuable tool in searching for the information a researcher needs.

Magazines intended for a general audience are unlikely to be useful in providing the sort of information one needs. Specialized magazines may be of use, but usually magazines are not dependable sources for research except as a starting point by providing news or general information about new discoveries, policies, etc. that one can further research on in more specialized sources.

Based on the above appraisal of the various sources of information, literature review was conducted covering trade and academic journals, books, institutional and statutory publications, the internet, seminar and conference papers.

ii) How the literature review addressed the objective

The objectives identified in Section 1.3 were addressed by through the literature review as follows:

- presentation and discussion of the previous related studies; and

- identification and description of the classified list of cost escalation, schedule overruns and quality shortfall factors adopted in this study.

3.3.2 Data Collection

i) Interviews

Interviews were conducted prior to questionnaire surveys. The interviews were aimed at obtaining preliminary data that would enhance the questionnaire survey as such the sample did not exceed 20 participants. The participants were selected to ensure that various viewpoints of the main stakeholders in the construction industry were incorporated in the questionnaire survey as such the interviews were targeted at professionals working for clients, consulting firms and contractor organisations within the public construction sector in Zambia. The interviews were limited to participants within Lusaka, the capital city, due to the short time required to get preliminary data.

ii) Questionnaire Survey

The self-administered questionnaire survey was adopted as the main research instrument based on the advantages that a representative sample would be realised with little time or costs. The method allowed most stakeholders in the Zambian construction sector to make their contribution. The respondents were assured of anonymity which in turn helped them to be honest in their answers. Also bias due to personal characteristics of the interviewer was avoided, as no interview was used. This was critical in this study as the respondents might have tried to impress the interviewer if present, thereby portraying a picture that their organisation has never experienced cost escalation, schedule overruns or quality shortfalls in their construction projects. This method also allowed respondents to have adequate time to consult where they were not sure, thereby answering the questions more appropriately. These factors made this method more advantageous compared to the other methods available.

With the above advantages noted, the questionnaire was designed to meet the research aim and objectives. Firstly, the information presented in the previous chapters helped to widen the author's knowledge and create an awareness of other issues that might not otherwise have been taken into account. A provisional version of the questionnaire was

then developed to cover all aspects needed to accomplish the purpose of the research. However, it was also necessary to ensure that the questionnaire was reliable.

For this reason, a quality control process was undertaken, by ensuring that each objective had questions corresponding to it, passing through a pre-test in which three potential respondents were asked to fill in the questionnaire in order to examine the level of clarity, and ending with an approval procedure by the research supervisor.

The purpose of the questionnaire survey was to measure the frequency of occurrence, severity of impact, and significance of cost escalation, schedule overruns and quality shortfall factors in construction projects. The data collected was then used as input for the project management model.

In addition, it was expected that the respondents' knowledge and experiences would differ from one to another, and that this might have an impact on their answers, so attention was paid to addressing this point.

In order to present the questionnaire in a systematic way, it was decided to divide the questions into four sections:

- questions concerned with respondents' experience. This contained general questions about the profession, period of experience, sector and type of work specialty;
- questions concerning contractual arrangements that the respondents had been involved in;
- questions dealing with performance of the projects the respondents had been involved in; and
- questions dealing with factors that cause cost escalation, schedule overruns and quality shortfalls associated with construction projects. the questions had a scale range of 1 to 4 for the frequency and severity of each probable cause.

The questionnaire made provisions for capturing extreme cases by providing options that allowed for specifications to be made by the respondents.

a) Questionnaire writing, distribution and collection

The questionnaire was written in one format and distributed to professionals working for contractors, consultants, and government departments and agencies in Zambia.

Three points were considered in order to obtain a high response level by:

- providing a covering letter for:
- identifying the type of research, sponsoring organisation and the researcher's name;
- explaining the purpose and the benefits of the study;
- encouraging the participants to fill in the questionnaire in a solicitous language; and
- informing the participants that their name, department, or company name would not appear in the study documentation.
- structuring the questionnaire in a neat format; and
- keeping the questionnaire as short as possible, but comprehensive enough, so that it could be completed within 25 to 30 minutes.

It was decided to use appropriate distribution method for each respondent. For speed of response, some questionnaires were distributed personally and collected by hand. This method was effective as it ensured that the questionnaires reached the targeted organisations in good time and within budget. For the other respondents who could not be easily reached, the questionnaires were distributed and collected via the post.

Apart from the simple style and structure of the questionnaire, two points were considered in the design of the postal questionnaire to guarantee a fast and high response level:

- a reply envelope was provided inside each letter; and
- a stamp was affixed to each reply envelope.

b) The survey sample

The population sample of this research was composed of four strata: clients and their representatives, financiers, consulting engineers (project managers) and contractors working in the construction field in Zambia within the public sector. The

disproportionate stratified sampling technique was employed so as to allow any minority to be represented. Thirty participants in each stratum were targeted.

3.4 Methods of analysis

Data collected from the survey was analysed using descriptive statistical techniques. An advanced and accurate analysis method was needed to arrange the large body of data in a systematic, fast and reliable way. For this purpose the computer software Statistical Package for Social Science (SPSS) and Excel were chosen as the best options available. Questions in section four of the questionnaire survey asked the respondents to rate the causes cost escalation, schedule overruns and quality shortfalls with respect to their frequency and severity weight. The likert scales provided ranged from 1 to 4 as shown in Table 3-1. The quantitative measures of the frequency and the severity were obtained using the same scale that was assigned to them.

Table 3-1: Frequency and severity weighting

Scale	Frequency (F)	Weight	Severity (S)	Weight
1	Never	1	No effect	1
2	Occasionally	2	Fairly severe	2
3	Frequently	3	Severe	3
4	Always	4	Very severe	4

The use of weighted averages was employed to determine the Frequency Indices (FI) and Severity Indices (SI) of the causes of cost escalation, schedule overruns and quality shortfalls as shown in Equations 3-1 and 3-2 below, respectively.

$$FI = \frac{\sum_{h=1}^4 F_h P_h}{\sum_{h=1}^4 P_h} \dots\dots\dots \text{Equation 3-1: Frequency Index}$$

$$SI = \frac{\sum_{k=1}^4 S_k P_k}{\sum_{k=1}^4 P_k} \dots\dots\dots \text{Equation 3-2: Severity Index}$$

Where: F_h is the frequency weight assigned to option h
 P_h is the number of participants who responded to option h
 S_k is the severity weight assigned to option k
 P_k is the number of participants who responded to option k

The frequency indices or severity indices alone were not sufficient. The factors that contribute to cost escalation, schedule overruns or quality short falls on construction projects could be frequent but may not be severe and vice versa. It was then decided that an index that combines the two indices be developed so as to show the combined impact and frequency. The frequency index and severity index were therefore integrated to come up with the Factor Importance Index (FII).

The Factor Importance Index was generated in a two step operation. The first step was the generation of a matrix for frequency and severity as shown in Table 3-2

Table 3-2: Frequency-Severity Matrix

$\otimes$		Frequency			
		1	2	3	4
Severity	1	1	2	3	4
	2	2	4	6	8
	3	3	6	9	12
	4	4	8	12	16

The matrix indicates that out of the sixteen possible solutions for integrating frequency and severity, there are only nine possible scores that can be derived from this operation. It was then decided to adopt a scale of 1 to 9 in ascending order of the solutions, i.e. the lowest possible score given the weight of 1 while the highest possible score was given the weight of 9. Therefore the weighted matrix was arrived at as shown in Table 3-3.

Table 3-3: Weighted Frequency-Severity Matrix

$\otimes$		Frequency			
		1	2	3	4
Severity	1	1	2	3	4
	2	2	4	5	6
	3	3	5	7	8
	4	4	6	8	9

The Factor Importance Index for each factor was then calculated using **Equation 3-3** (Falqi, 2004)

$$FII = \frac{\sum_{i=1}^9 (F \otimes S)_i P_i}{\sum_{i=1}^9 P_i} \quad \dots\dots\dots \textbf{Equation 3-3: Factor Importance Index}$$

Where: $(F \otimes S)_i$ was the weight (1, 2, ..., or 9) of frequency-severity conjugation in Table 3-3 assigned to option i

P_i was the number of participants who responded to option i

The Factor Importance Index was important in identifying the major causes of cost escalation, schedule overruns and quality shortfalls in the construction industry.

Project enhancement factors were also analyzed to determine their relative importance with respect to cost, schedule and quality on a construction project. The calculation of the index was based on weighted averages using the formula (Kaliba *et al.*, 2009):

$$WA = \frac{1}{4} \times \frac{\sum_{i=1}^4 F_i R_i}{\sum_{i=1}^4 F_i} \times 100\% \quad \dots\dots\dots \textbf{Equation 3-4: Weighted average}$$

Where WA was the average weighted perceived significance; F_i the frequency or total number of respondents choosing response type i on the likert scale i ranging from 1 to 4; R_i the response type on the likert scale i ranging from 1 to 4 as earlier described. For each factor, three indices were calculated, i.e. Cost Importance Index (CII), Schedule Importance Index (SII) and Quality Importance Index (QII).

3.4.1 Model development

The construction industry is vast and dynamic as such each construction project is unique. This poses a challenge in developing a model that can solve the varying problems that affect construction projects. Despite this, appropriate methodologies can be assembled to come up with conceptual means of solving problems that cause cost escalation, schedule overruns and quality shortfalls on construction projects. Multiple Criteria Decision-Making (MCDM) approaches would prove to be beneficial in deriving clients' satisfaction on construction projects.

MCDM approaches are efficient tools for making critical decisions in many fields. They are utilized when decision-makers are faced with difficulties because of more than one objective or criteria that have to be satisfied (Al-Besha, 1998). The various kinds of MCDM available include: the Analytic Hierarchy Process (AHP); Concordance-Discordance Analysis; Regime Analysis; the Thurstone Model; and Multi Attribute Utility Theory (Muya, 1999).

The Analytic Hierarchy Process (AHP) was selected based on its advantages that are outlined in this section. AHP is a powerful decision-aiding tool that can deal with the intuitive, the rational, and the irrational when making decisions considering the suitability of a large number of factors and alternatives. It is an appropriate MCDM approach for conducting both deductive and inductive evaluation that allows the consideration of several criteria and alternatives at the same time, along with the benefit of a feedback mechanism and numerical tradeoffs (Al-Besha, 1999). Background information on AHP is provided in Chapter 5, whereas the details of how the model was developed are presented in Chapter 6.

3.5 Summary

This chapter presented the methodology used to carry out the research and address its aims and objectives. Highlights about the various methodologies that could be adopted for research purposes were also included in this chapter. The chapter further presented an explanation of how the problem was investigated and described the tools used to undertake the investigation. It also described the characteristics of the research sample and the method of analysis that was employed.

The next chapter discusses the data collected and analysed in the study.

CHAPTER 4 : ANALYSIS AND DISCUSION OF SURVEY RESULTS

4.1 Introduction

The previous chapter outlined the methodology for carrying out the research and the methods used to analyze the data collected. This chapter presents the research results and how they were analysed. Section 4.2 presents information pertaining to the interviews, while section 4.3 presents the results and analysis of the questionnaire survey.

4.2 Interview data and analysis

Structured interviews were conducted between July and August 2008. The interviews were preliminary in nature and targeted fifteen professionals working for contractors, consultants, clients or financiers of public construction projects. The interviewees were sampled based on the prominence of their organization as well as their experience in the construction industry. The purpose was to obtain an in-depth understanding of how the various stakeholders in Zambia view cost escalation, schedule overruns and quality shortfalls.

4.2.1 Profiles of interviewees and their firms

Eleven out of the targeted fifteen professionals participated in the interviews. The four professionals who could not participate expressed willingness but could not be available due to other commitments in their work places. Out of the eleven interviewees, nine had over eight years of experience in the construction sector and were in middle to top management. The other two interviewees had between four and eight years of management and were in middle management. Four of the interviewees worked for consultancy firms, four for contractors and three for clients. This provided an assurance of reasonable professional experience in management of construction projects. Most of the interviewees' firms had a long history of involvement in the construction industry. The firms' experience in construction ranged from nine to seventy-three years.

4.2.2 Prevalence of cost escalation, schedule overruns and quality shortfalls

There was a general agreement by all the interviewees that cost escalation, schedule overruns and quality shortfalls were prevalent on construction projects in Zambia. The interviewees also acknowledged that these shortcomings of the industry had adverse effects on the economy at large as clients end up paying more than anticipated. The cost in terms of delayed occupancy or use of facilities, interest rates on borrowed funds and rework have far reaching impacts on the nation's economy.

4.2.3 Causal factors

Questions aimed at obtaining the common casual factors that would lead to cost escalation, schedule overruns and quality shortfalls were posed. The interviewees had various responses that highlighted the casual factors.

i) Cost escalation

The interviewees highlighted a number of factors that would cause cost escalation. The factors were compared and analyzed to assess which ones would be said to be common as appraised by various interviewees. The factors highlighted included: delayed award of construction contracts; delayed honouring of Interim Payment Certificates (IPCs) to contractors; cost escalation and instability in prices of goods and materials due to market forces such as demand and supply; construction schedule overruns; poor planning and project management; underestimation of the budget; and corruption.

Figure 4-1 presents the ranking of the causal factors based on the number of interviewees that identified them as common instigators of cost escalation.

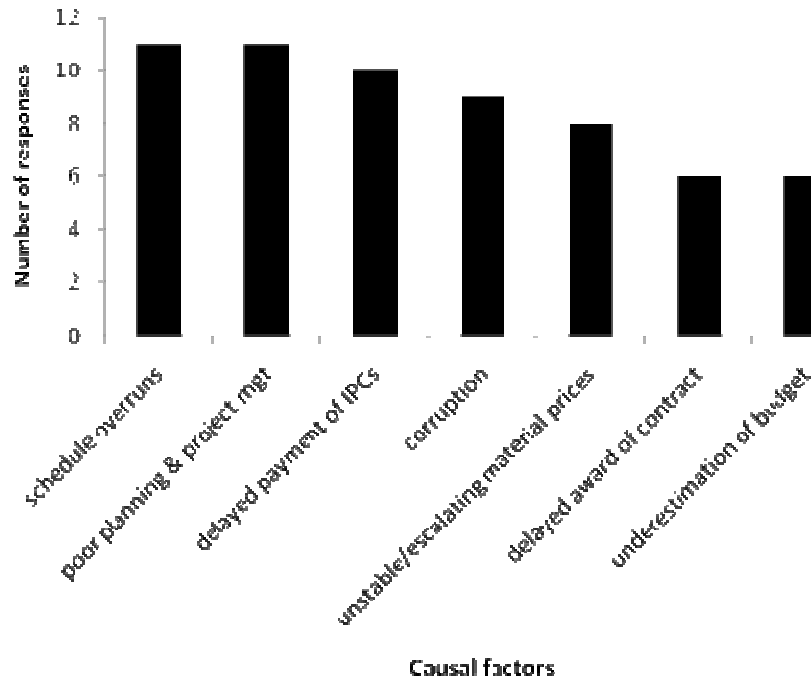


Figure 4-1: Ranking of factors that cause cost escalation

ii) Schedule overruns

Just like cost escalation, interviewees identified: lack of proper project management by contractors, consultants and clients; poor organization of project resources such as plant, human, financial and material resources; inadequate or improper planning of projects; shortages of some key materials such as bitumen and cement due to volatile market forces; inclement weather; late or non-payment of IPCs; unstable power supply; lack of adequate supervision; requirement for materials of higher specifications; and socio-economic setups of projects as the most prominent factors that they attributed to schedule overruns. The factors were ranked based on the number of interviewees that mentioned them. This information is presented in Figure 4-2.

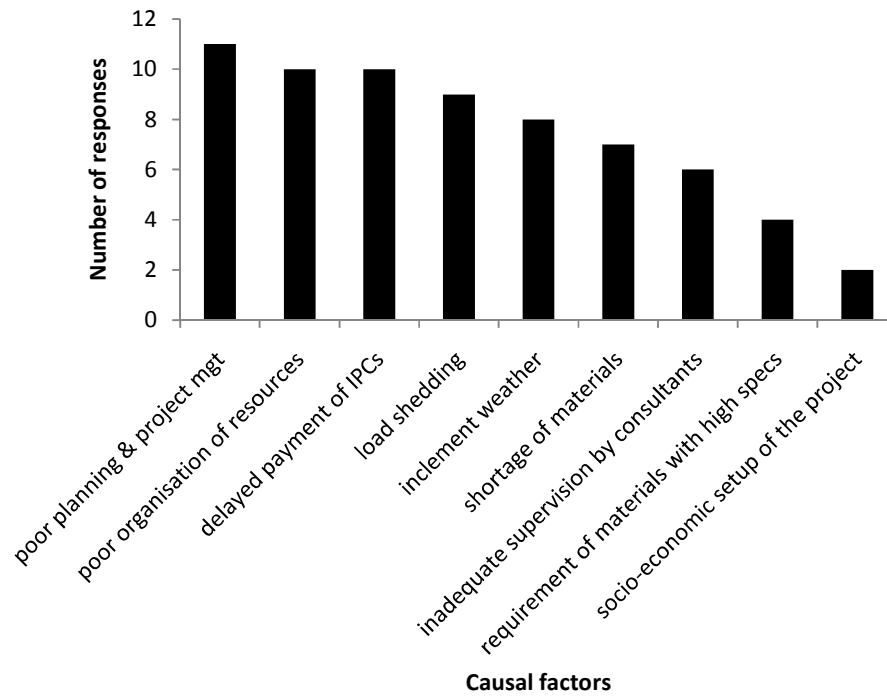


Figure 4-2: *Ranking of schedule overruns causal factors*

iii) Quality shortfalls

The main common causes of quality shortfalls in construction projects were identified to include: corruption; lack of qualified personnel on site; lack of motivation amongst site personnel; lack of reliable sources of materials; poor quality control; and lack of adequate supervision. Figure 4-3 shows the ranking of these causes based on the frequency of interviewees who mentioned them as critical casual factors for quality shortfalls on construction projects.

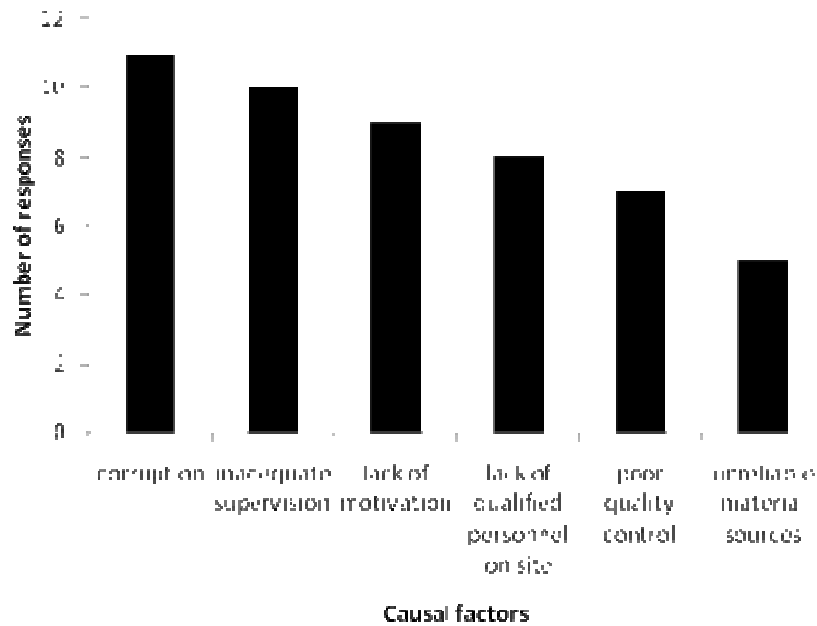


Figure 4-3: *Ranking of causal factors for quality shortfalls*

4.2.4 Availability of strategies and policies

Questions on the availability of strategies or policies on cost escalation, schedule overruns and quality shortfalls in particular and construction management in general indicated the knowledge gap available in Zambia's construction industry. All the interviewees indicated that there were no documented policies or strategies that could be used to address cost escalation, schedule overrun and/or quality shortfalls in Zambia. The personnel working in the industry were said to be using the rule of thumb in addressing these issues. This view was, however, not correct as there is wide literature, including academic and professional papers as well as books that have been published since the early 1960s on the subject (Schexnayder *et al.*, 2003). The training programmes that deal with construction management are also on offer at various learning institutions. The knowledge gap in the construction industry could be as a result of not regarding construction management as an important field of study in Zambia. However, the knowledge gap among the key professionals exacerbates the occurrence of cost escalation, schedule overruns and quality shortfalls in construction projects.

4.2.5 Contractual methods that can best address cost escalation, schedule overruns and quality shortfalls

The interviewees indicated that there was generally no specific contractual method that could be said to be the best for addressing cost escalation, schedule overruns and/or quality shortfalls. Most of the contractual methods available would be useful in addressing these problems provided competent personnel were assigned the responsibility of managing construction projects. Careful and systematic consultant and contractor selection methods could enhance the performance of construction projects. The selection procedures for contractors and consultants were often highly subjective and inconsistent (Al-Besha, 1998). Also in most cases, selection would be based on the price which may not guarantee performance. There was need, therefore, to have in-depth analysis of how best the existing contractual methods could be enhanced so as to employ competent consultants and contractors on construction projects.

4.2.6 Contractual provisions and their adequacy

While most of the interviewees agreed that the contracts in use had adequate clauses and needed competent project managers to run the projects, others argued that there was need to modify contracts to match the modern technological advancements and events. The interviewees that argued on the need to modify the contracts were not familiar with the New Engineering Contract (NEC) developed by the Institution of Civil Engineers (ICE). The NEC takes into account the modern technological advancement and could be used as some of contracts for construction projects with new technologies (McInnis, 2001). The argument should have been on there user friendliness as they were relatively new at the time of the study and most of the parties would not have been familiar with the clauses provided therein.

Regardless of which contractual provisions that would be in contract documents, it was noted that many problems occur in construction projects because the parties do not stick to the contracts they sign. The clauses provided would only work effectively if the human resource component of construction projects was competent. As long as there were knowledge gaps, these problems would continue to be major hindrances to enhanced performance of construction projects.

4.2.7 Party most responsible for cost escalation, schedule overrun and quality shortfalls

There was a general agreement that all parties were responsible for the prevalence of cost escalation, schedule overruns and quality shortfalls. Consultants generally felt that contractors were the first responsible party. Clients on the other hand blamed consultants for not ensuring that projects were executed within budgets, scheduled duration and prescribed quality, and as such termed them as the first responsible party. Contractors however, attributed cost escalation, schedule overruns and quality shortfalls to factors that were within the control of consultants and clients.

The triple-directional way of the blame indicated how adversarial relations could build up especially if cost escalation, schedule overruns and quality shortfalls are left unchecked on projects.

4.2.8 How cost escalation, schedule overruns and quality shortfalls can be addressed

Interviewees had difficulties in addressing this question. They indicated that there were no straight forward answers to the challenges. There was consensus, however, among interviewees that:

- parties need to adhere to contractual agreements and scope. For example, that there should be no unnecessary changes of scope and that designs should be ‘frozen’ as much as possible once a contract has been signed;
- clients should engage consultants and contractors who have the requisite technical and financial capacity;
- the fight against corruption should be vigorously carried out in the construction sector in order to improve the performance of the industry;
- a stable national economy would improve the stability and performance of the industry; and
- projects need to be carefully and proficiently planned in terms of time, cost and quality.

4.3 Questionnaire survey

The questionnaire survey was carried out over a period of three months between 3rd November 2008 and 31st January 2009. The questionnaires were sent to financiers, clients, consultants and contractors working in the construction industry in Zambia. A total of 70 questionnaires were distributed with a response rate of 75.7%. The questionnaire sought to establish indices for the causal factors identified from literature and interviews. The questionnaire also sought to establish importance indices for project enhancement factors.

4.3.1 Profile of respondents

i) Main business and sector type in construction

Respondents were from clients, consultants, contractors or financiers of construction projects in either the public or private sector of the construction industry.

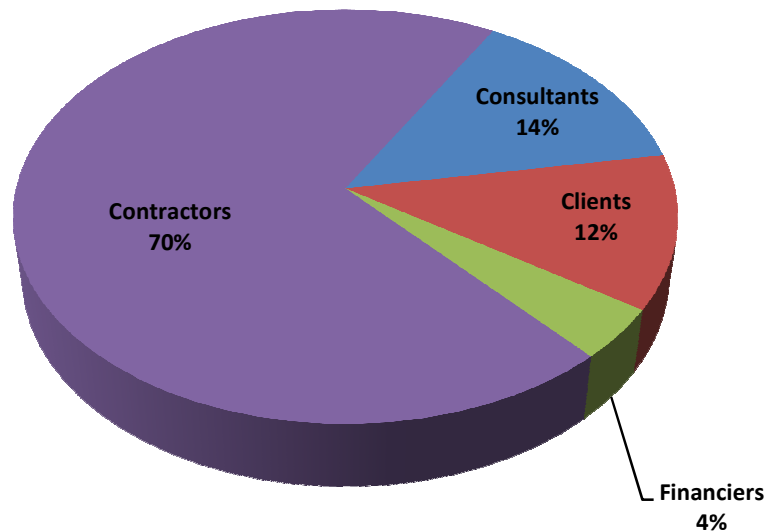


Figure 4-4: *Percentage of respondents*

As is indicated in Figure 4-4, 12% of the respondents worked for client organizations, 14% for consulting firms, 70% for contractors and 4% for financiers.

The respondents had experience in diverse sector types of the construction industry. Figure 4-5 shows that 7 respondents had worked on public sector projects only. The rest had worked on both public and private sector projects.

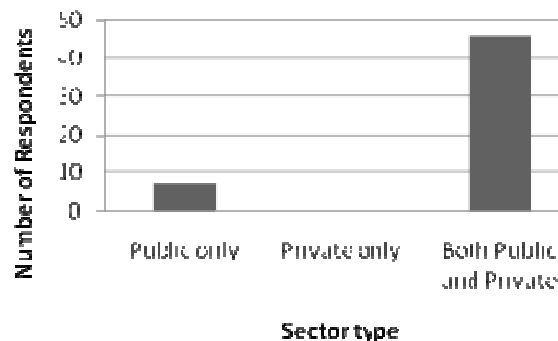


Figure 4-5: *Number of respondents by sector type*

ii) Experience in the construction industry

The respondents' years of experience in industry ranged from 5 to over 15 years with over 65% having more than 15 years of experience. Figure 4-6 presents the respondents' years of experience in the construction industry.

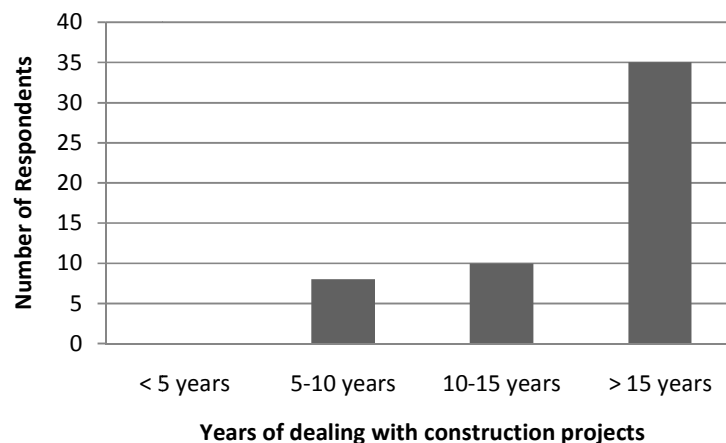


Figure 4-6: *Respondents' experience in construction projects*

iii) Size of projects

The respondents were asked to indicate the magnitude of projects they had worked on in terms their monetary. Figure 4-7 shows that 58 percent of the respondents had dealt with construction projects with values exceeding US\$10 million. Fourteen percent had worked on projects that cost less than US\$5 million. The remaining worked on projects of values exceeding US\$5 million but less than US\$10 million.

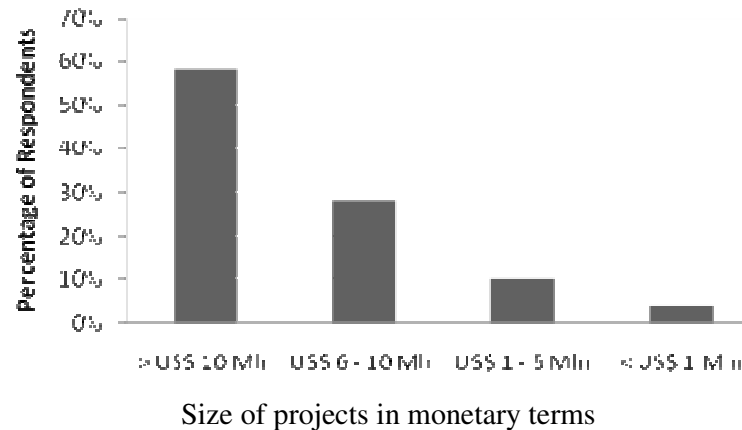


Figure 4-7: *Percentage of respondents based on the size of projects undertaken*

The level of experience exhibited by the respondents suggested a fairly high degree of reliability derived from their responses.

4.3.2 Contractual arrangements

Questions were also posed on the contractual arrangements the respondents had been involved. Figure 4-8 shows that 'traditional' contractual arrangements were very common in Zambia with all respondents having been involved in at least one project. The second most common arrangement was the 'design and build' method. Only ten respondents had undertaken projects under 'construction management' contractual arrangement while only four had experience in 'management contracting'.

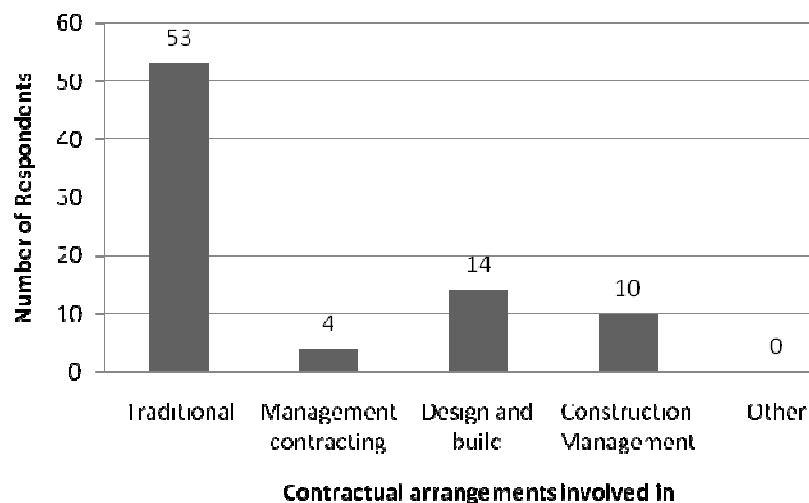


Figure 4-8: *Frequency of respondents based on contractual arrangements*

To determine which method the respondents would prefer in alleviating cost escalation, schedule overruns and quality shortfalls in construction, they were asked to choose the best contractual arrangements. The respondents indicated that ‘construction management’ contractual arrangement would be best in avoiding cost escalation, schedule overruns and quality shortfalls in construction project. ‘Design and build’ was the second most preferred method while the third was ‘traditional’ contractual arrangement. ‘Management contracting’ was the least preferred. This might be attributed to it being a less common contractual method in Zambia. The rating of the contractual arrangements is presented in Figure 4-9.

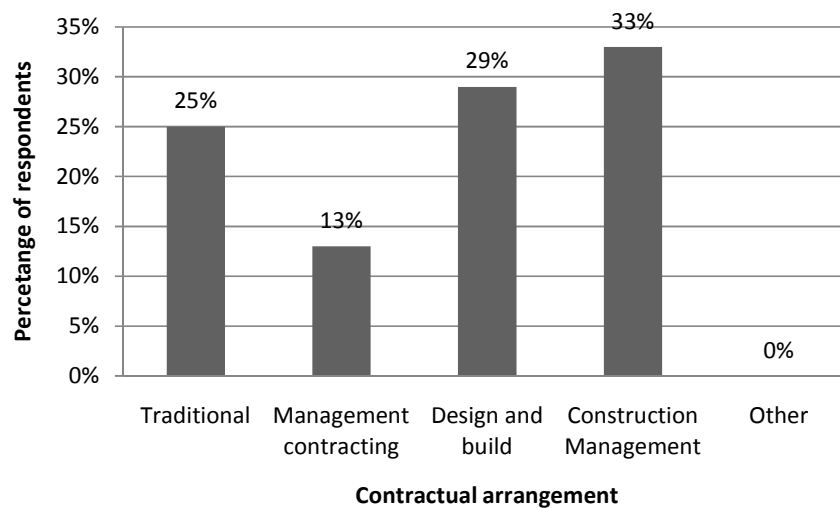


Figure 4-9: *Respondent’s rating of contractual arrangement best suited to deal with cost escalation, schedule overruns and quality shortfalls in construction*

4.3.3 Causal factors

Causal factors highlighted in literature and those established through the interviews were compiled and assessed through a questionnaire survey. A total of thirty one possible causal factors for cost escalation were assessed. Forty and seventeen possible causal factors for schedule overruns and quality shortfalls respectively were also assessed. The sections below provide the details of the findings.

i) Cost escalation

Thirty one possible casual factors of cost escalation were assessed in terms of their frequency, severity and significance. The responses from the respondents indicated that some factors, despite having higher frequency of occurrence, were not as severe and as such the resultant effects would not be significant.

a) Frequency indices

The causal factors for cost escalation were ranked in terms of their frequency on construction projects. The four most frequent causes of cost escalation were: inflation; insufficient initial analysis of project costs; change orders or scope changes; and schedule delays or overruns. The rating of all possible causal factors by frequency is presented in Figure 4-10 below.

b) Severity indices

The factors were also assessed in terms of their severity if they were to occur on a construction project. As illustrated in Figure 4-11, schedule overrun; corruption; inflation; and delayed payment of 'Interim Payment Certificates' (IPC) were found to be the most severe causal factors of cost escalation.

c) Factor Importance indices

The four most significant causes of cost escalation were found to be: insufficient initial analysis of project costs; change orders or scope changes; inflation; and schedule delays or overruns, all scoring FIIs above 70%. Figure 4-12 indicates the ranking of the various causal factors of cost escalation in terms of their Factor Importance Indices (FIIs).

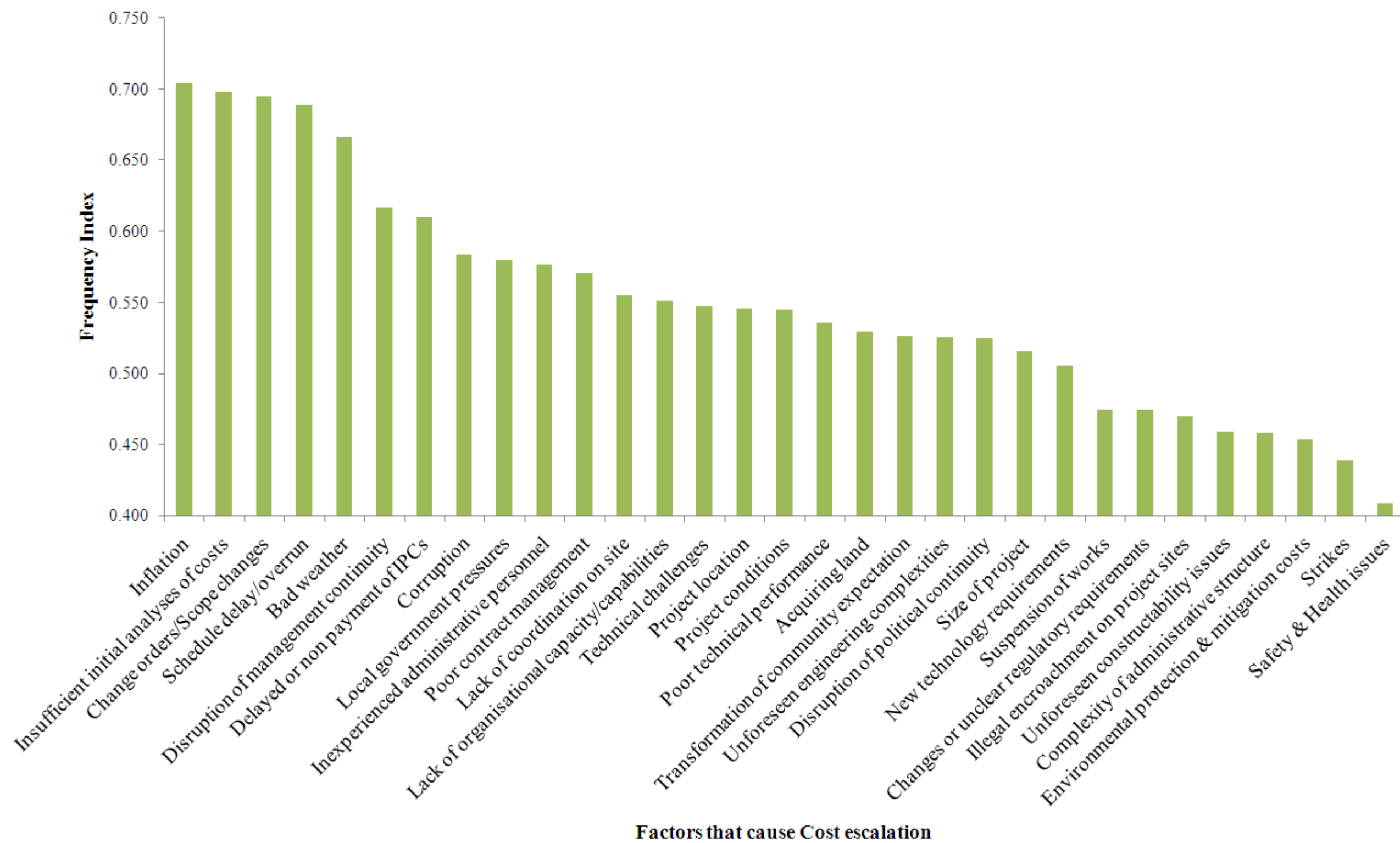


Figure 4-10: Ranking of cost escalation causal factors by frequency

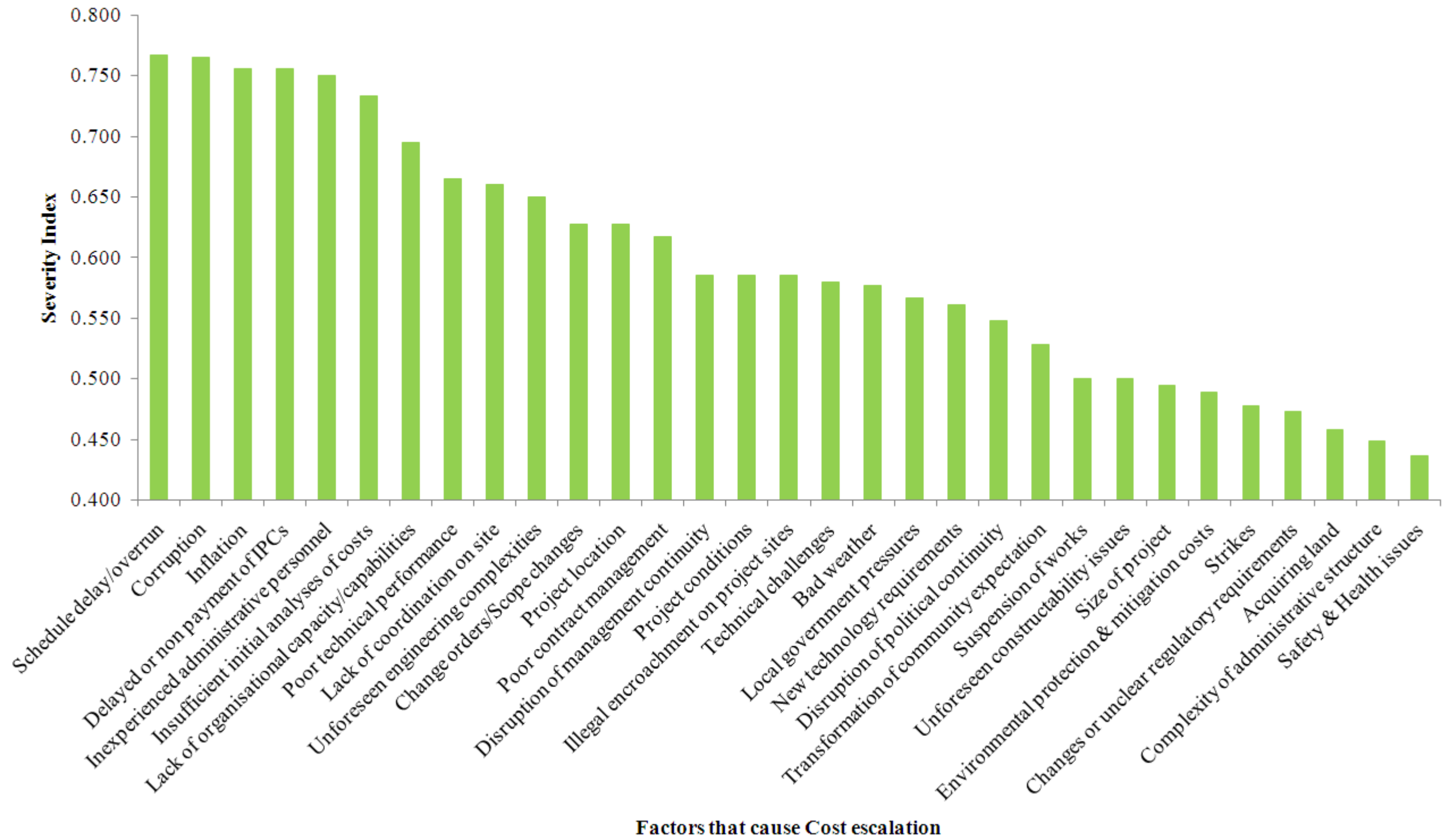


Figure 4-11: Ranking of cost escalation causal factors by severity

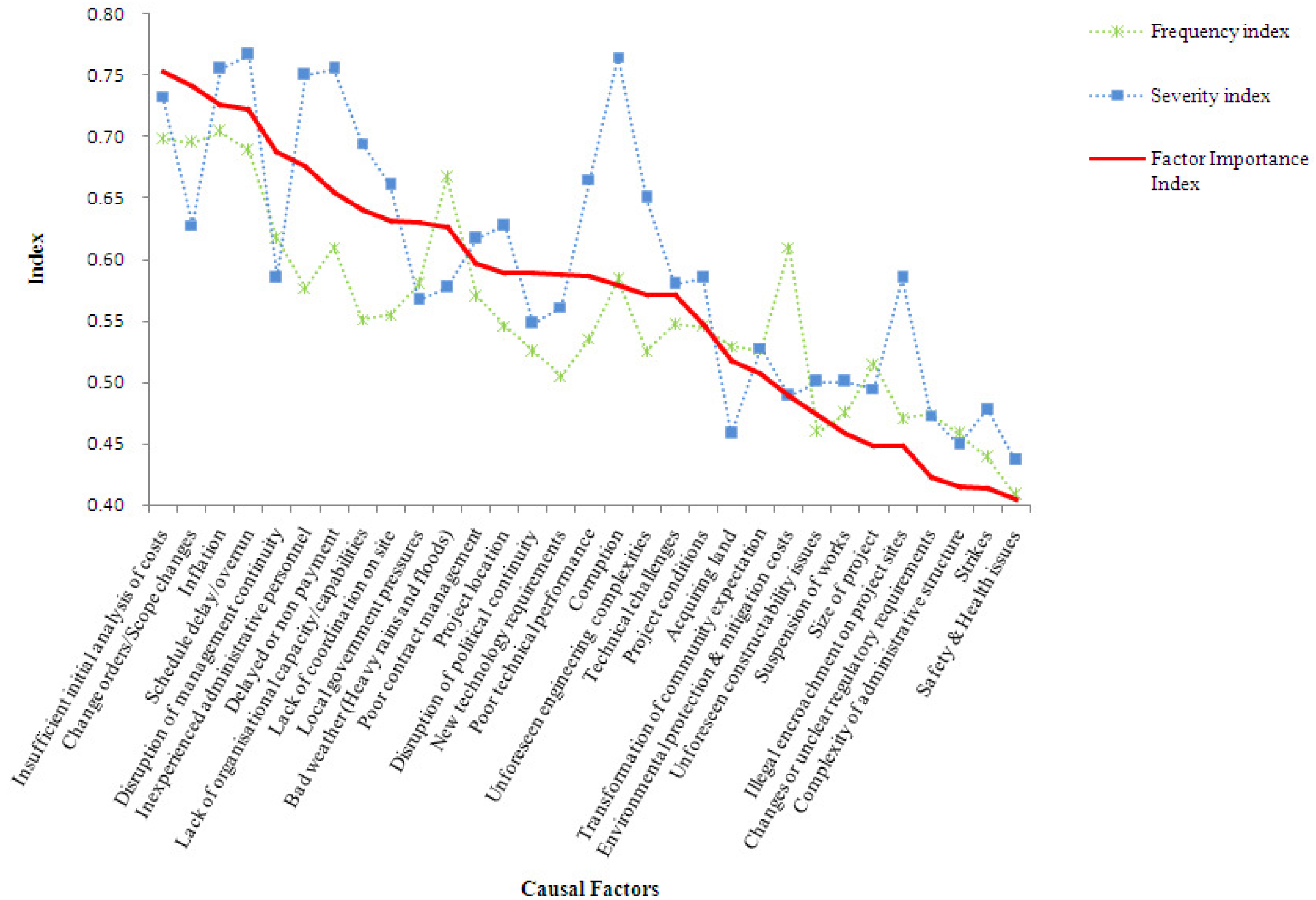


Figure 4-12: Ranking of causal factors for cost escalation based on their significance

ii) Schedule overruns

Forty possible casual factors for schedule overruns obtained from literature and interviews were assessed through the questionnaire survey in terms their frequency, severity and significance on construction projects.

a) Frequency indices

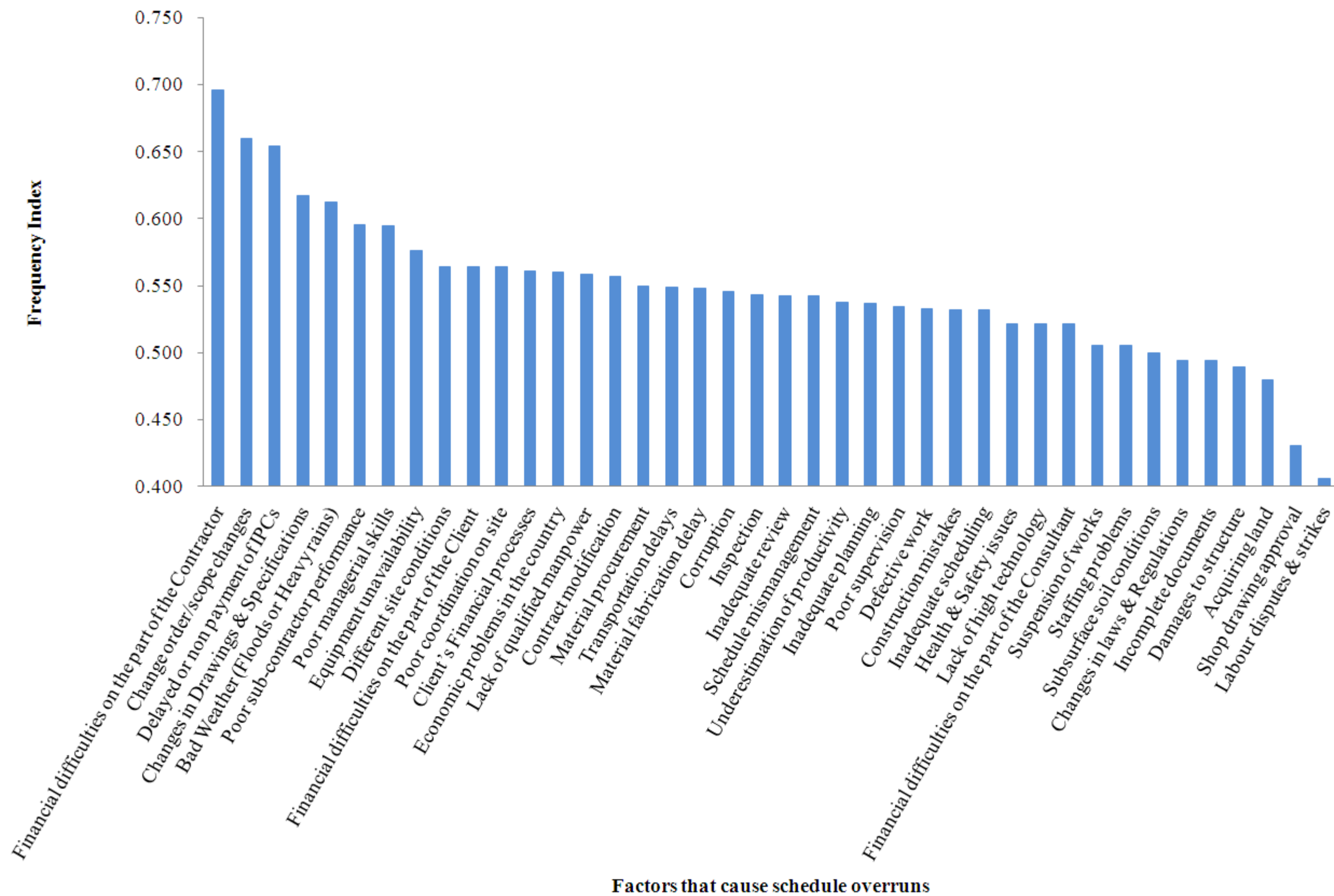
The four most frequent causes of schedule overruns were found to be: financial difficulties on the part of contractors; change orders or scope changes; delayed or non-payment of IPCs; and changes in drawings or specifications. The scores for each factor are presented in Figure 4-13.

b) Severity indices

The factors with very severe effects on construction projects with regards to schedule overruns were found to be: lack of qualified manpower; financial difficulties on the part of contractors; suspension of works; and delayed or non-payment of IPCs. The rating of the identified causal factors is presented in Figure 4-14.

c) Factor Importance Index

With regards to schedule overruns: financial difficulties on the part of contractors; change orders or scope changes; poor sub-contractor performance; and changes in drawings and specifications were found to be the four most significant causal factors. Figure 4-15 shows the rating of causal factors for schedule overruns.



d)

Figure 4-13: Ranking of schedule overrun factors by frequency

e)

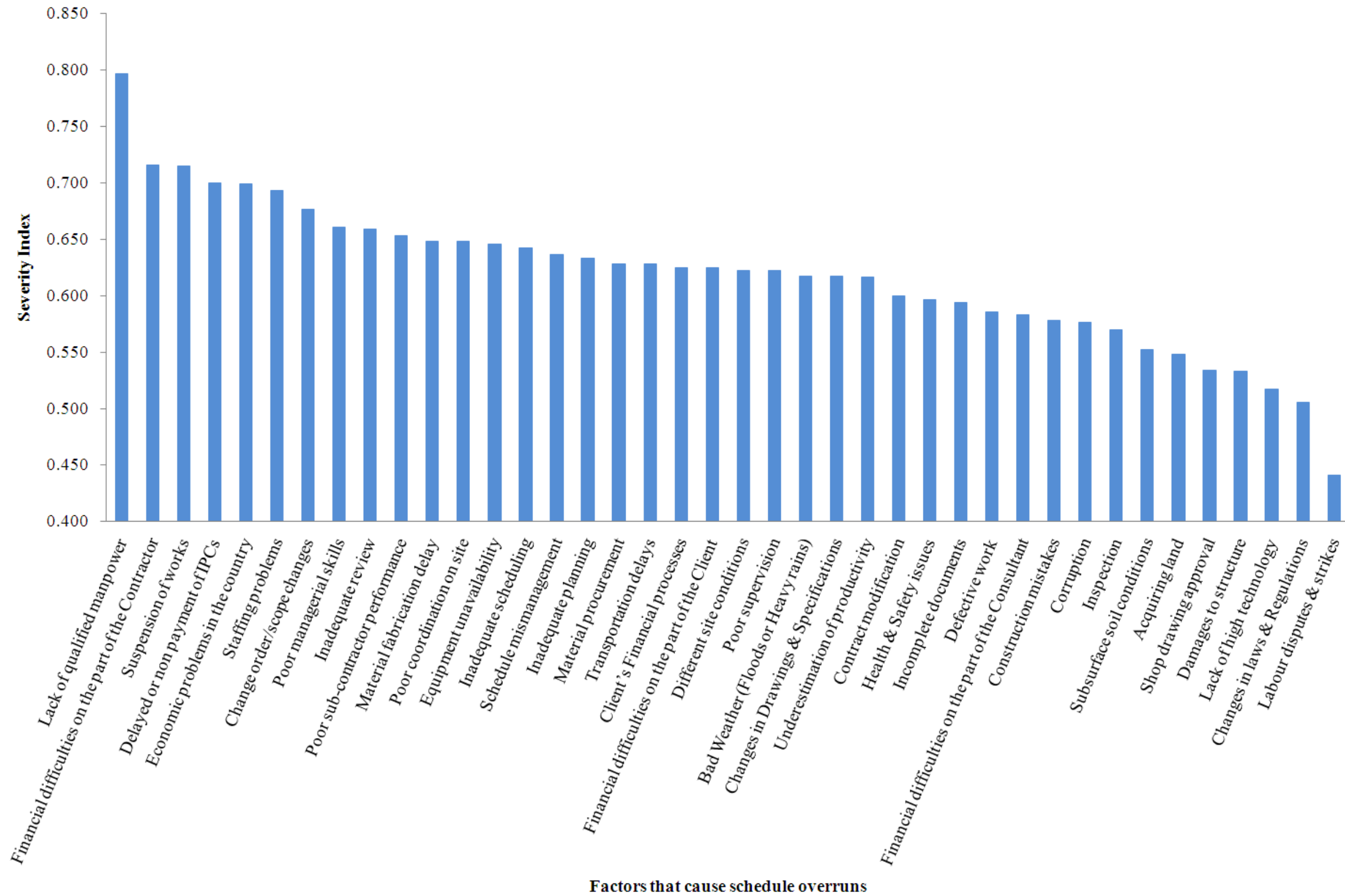


Figure 4-14: Ranking of schedule overrun causal factors by severity

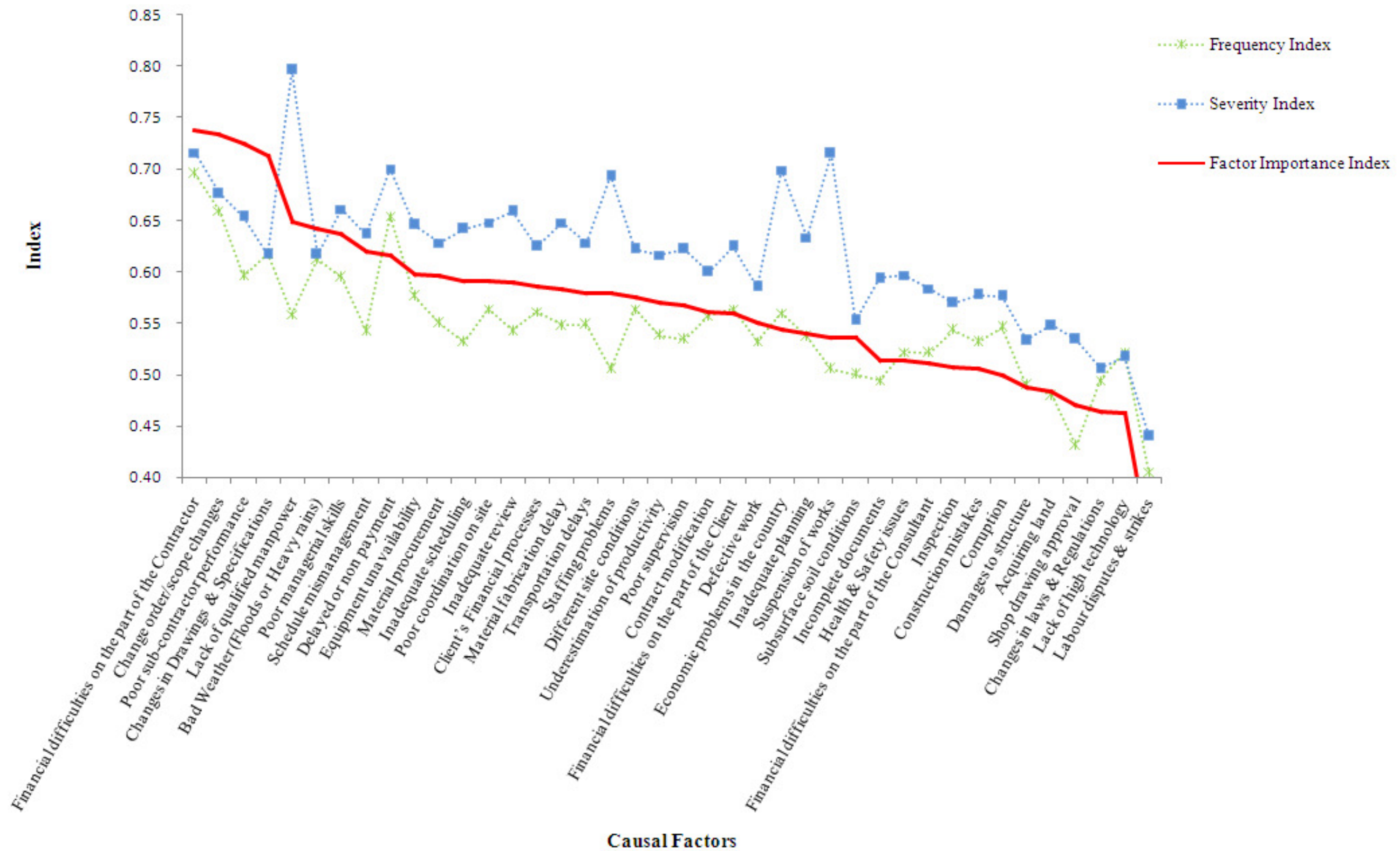


Figure 4-15: Ranking of schedule overrun causal factors based on the FII

iii) Quality shortfalls

Seventeen possible causal factors of quality shortfalls identified in literature and interviews were assessed in terms of their frequency and severity on construction projects. Their Factor Importance Indices were also computed based on responses from the respondents.

a) Frequency Indices

The four most frequent causes of quality shortfalls in construction projects were found to be: inadequate or inconsistent release of funds by clients; poor financial management by contractors; inadequate project planning; and long time lapse between assessment and implementation of the project. The scores for each factor are presented in Figure 4-16.

b) Severity Indices

The factors with severe effects on construction projects with regards to quality shortfalls were found to be: poor financial management by contractors; incompetence and lack of capacity by contractors; corruption and demand for kick-backs by consultants; and inadequate supervision of construction projects. The rating of all the possible causal factors is presented in Figure 4-17.

c) Factor Importance Indices

The five most significant causes of quality shortfalls in Zambia's construction industry with FIIs of 70% and above were found to be: inadequate and/or inconsistent release of project funds by clients; poor financial management by contractors; long time lapse between feasibility studies and implementation of projects; inadequate supervision; and incompetence and lack of capacity by contractors to execute works. All the factors are presented in Figure 4-18.

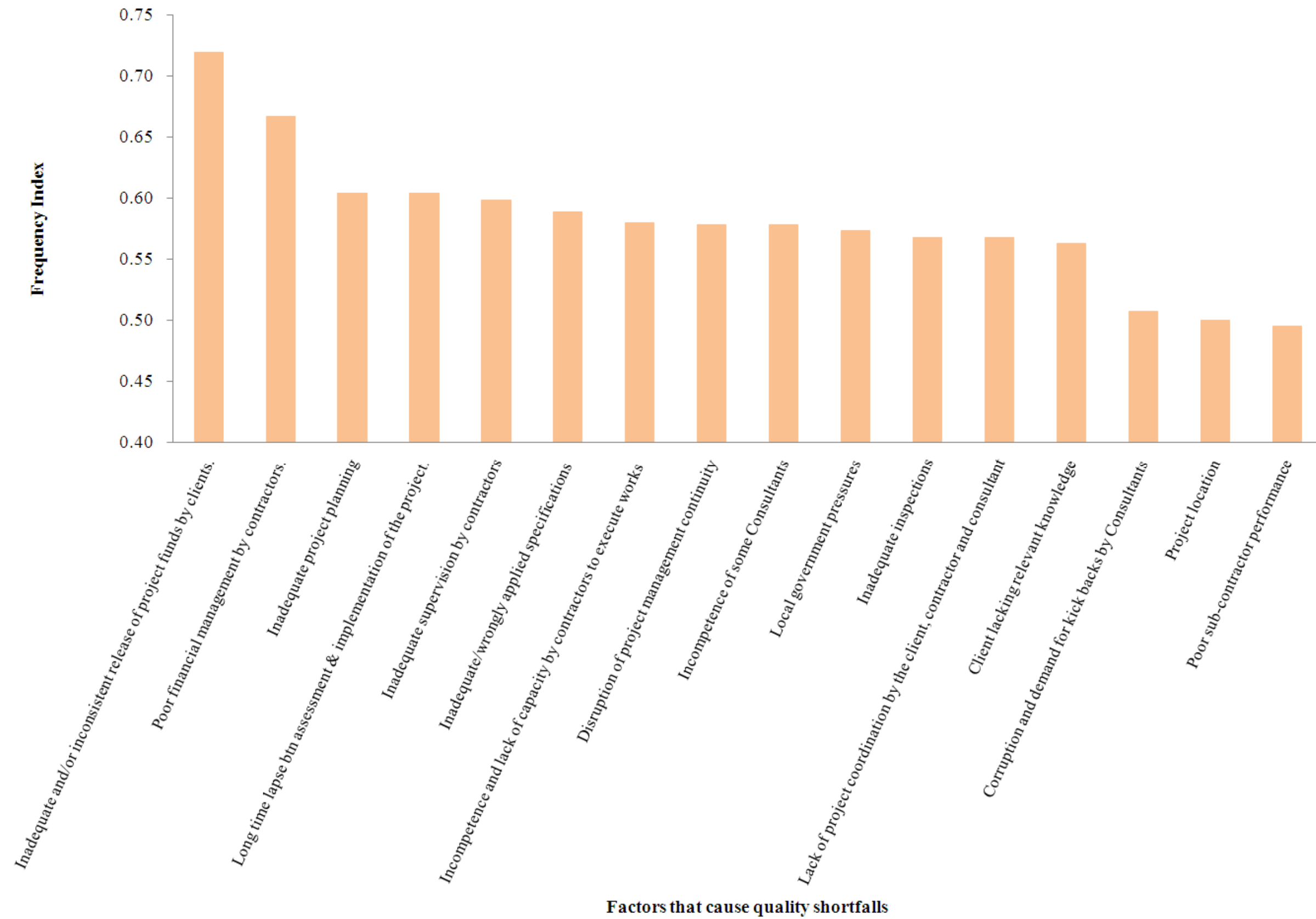


Figure 4-16: Ranking of quality shortfall causal factors by frequency

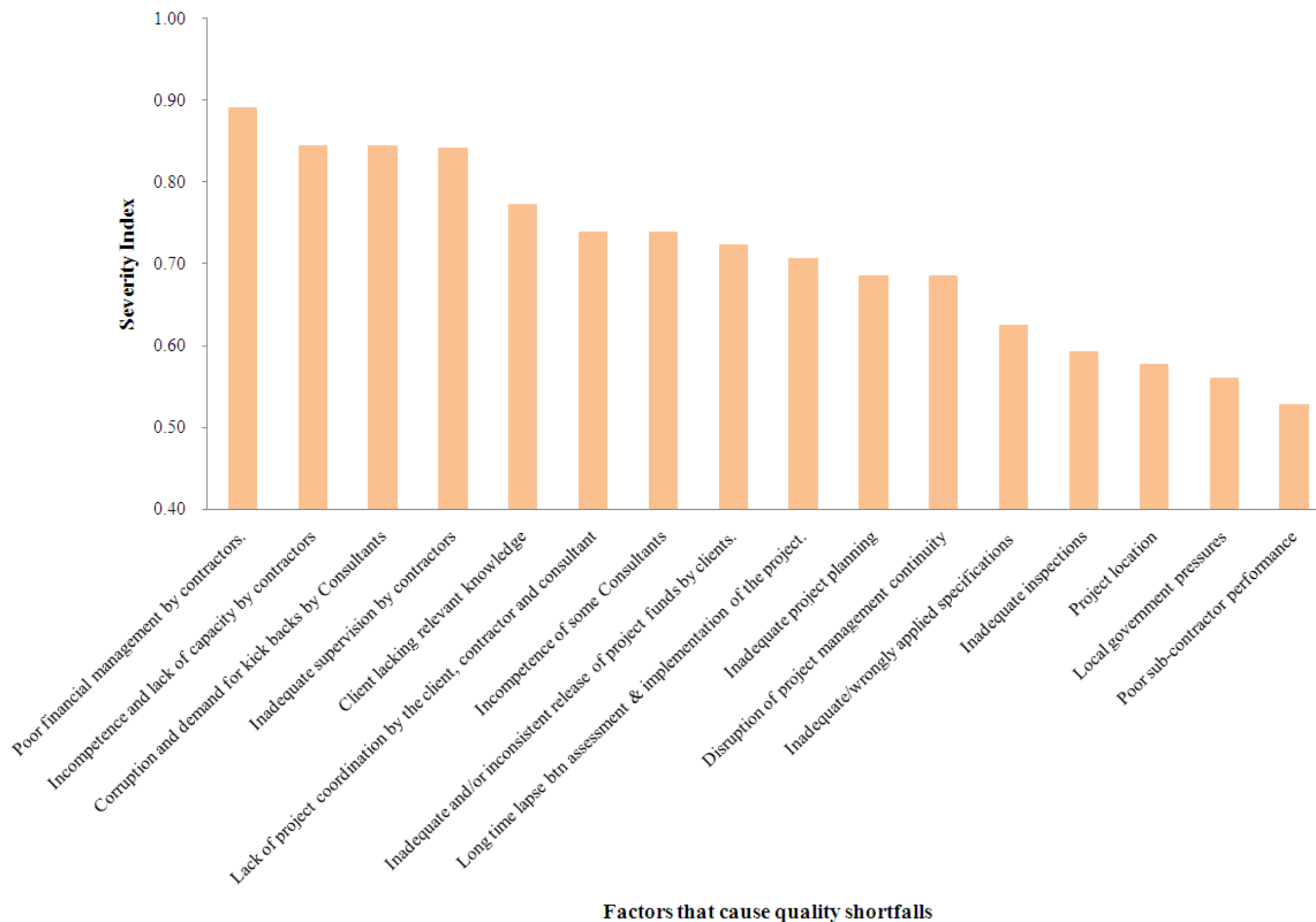


Figure 4-17: *Ranking of quality shortfall causal factors by severity*

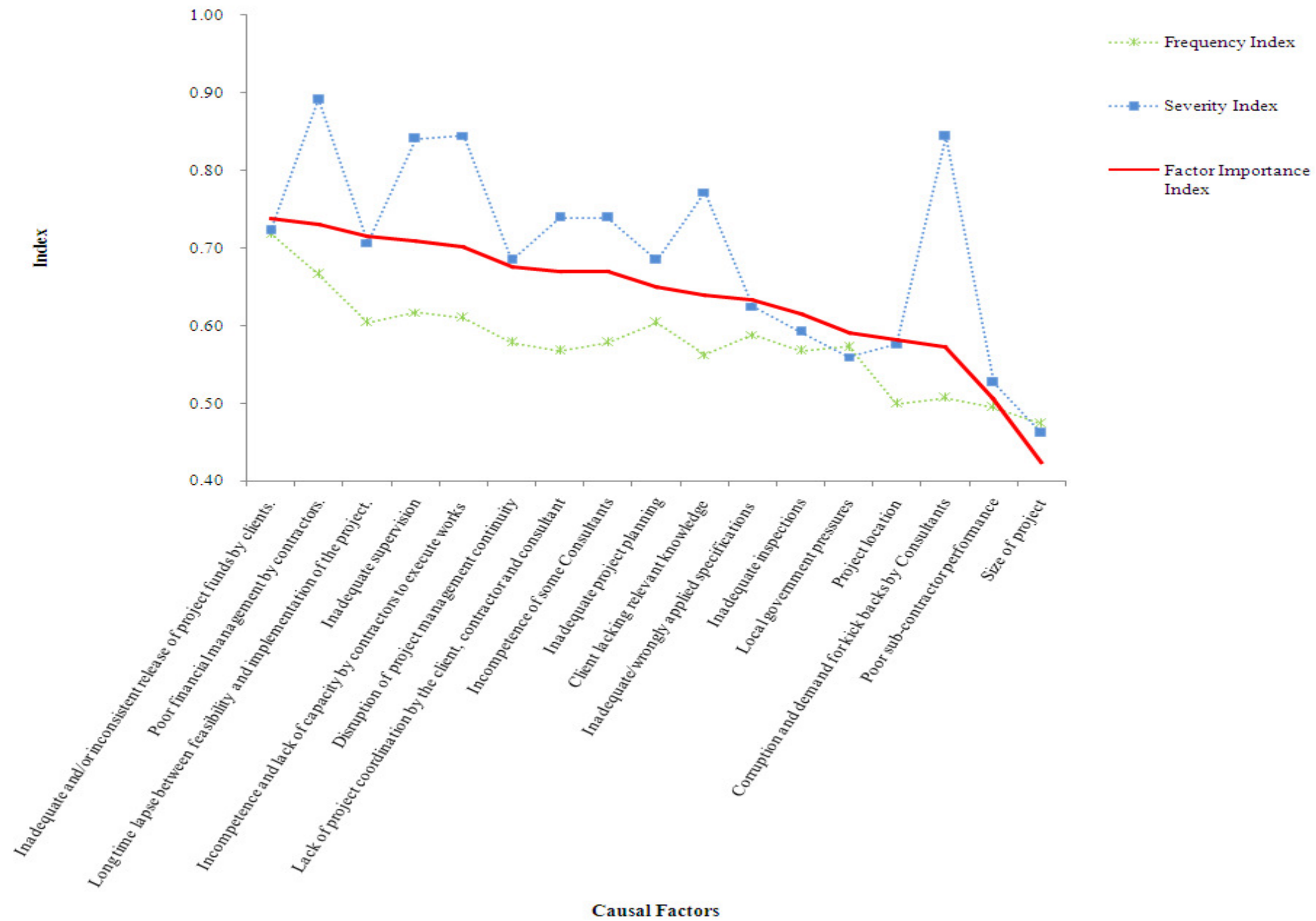


Figure 4-18: Rating of quality shortfalls causal factors based on the FII

4.3.4 Project success factors

Twenty seven project enhancement factors identified in literature were carefully analyzed and incorporated in the question survey. The respondents were asked to rate their relative importance with respect to cost, schedule and quality performance on a construction project. The use of weighted averages was adopted for developing indices (Kaliba *et al.*, 2009). The survey established that the factors identified in literature were all important in enhancing construction project delivery as they all had Importance Indices above 50%. The sections below discuss in detail the factors that can improve construction project delivery in terms of cost, time and quality.

i) Cost performance enhancement factors

The most significant project success enhancement factors with respect to cost, all having Cost Importance Index (CII) greater than 90% were found to be: adequate and comprehensive specifications; effective cost control systems; and reduced fraudulent practices. Figure 4-19 shows the rating of project success factors with respect to cost.

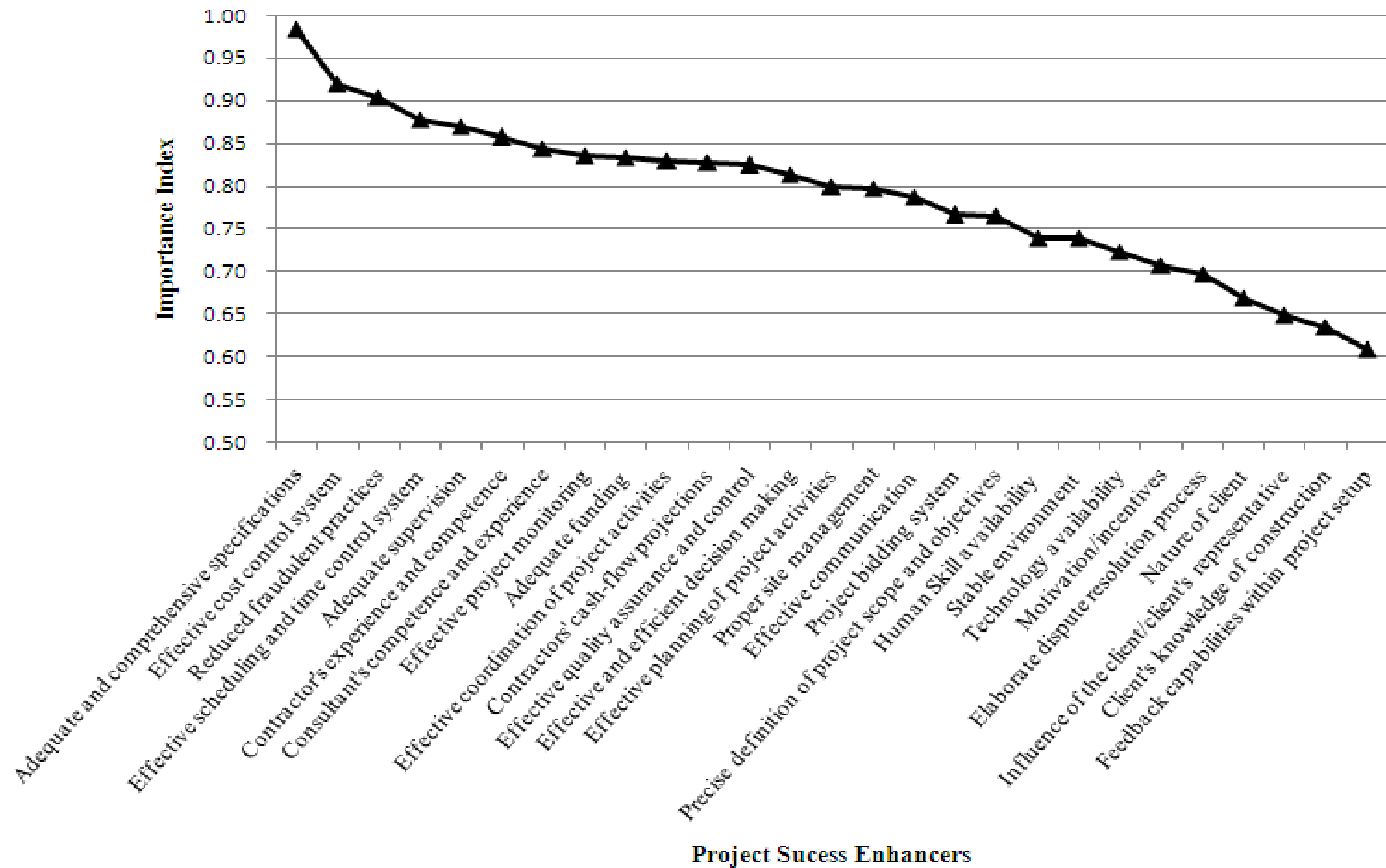


Figure 4-19: Rating of project success factors with respect to cost

ii) Schedule performance enhancement factors

The Schedule Importance Index (SII) for each of the factors were calculated and ranked. Based on the computed SII, adequate and comprehensive specifications; and effective planning of project activities were found to be the most significant project success enhancement factors with respect to schedule. Figure 4-20 shows the rating of the various project success factors with respect to time or schedule.

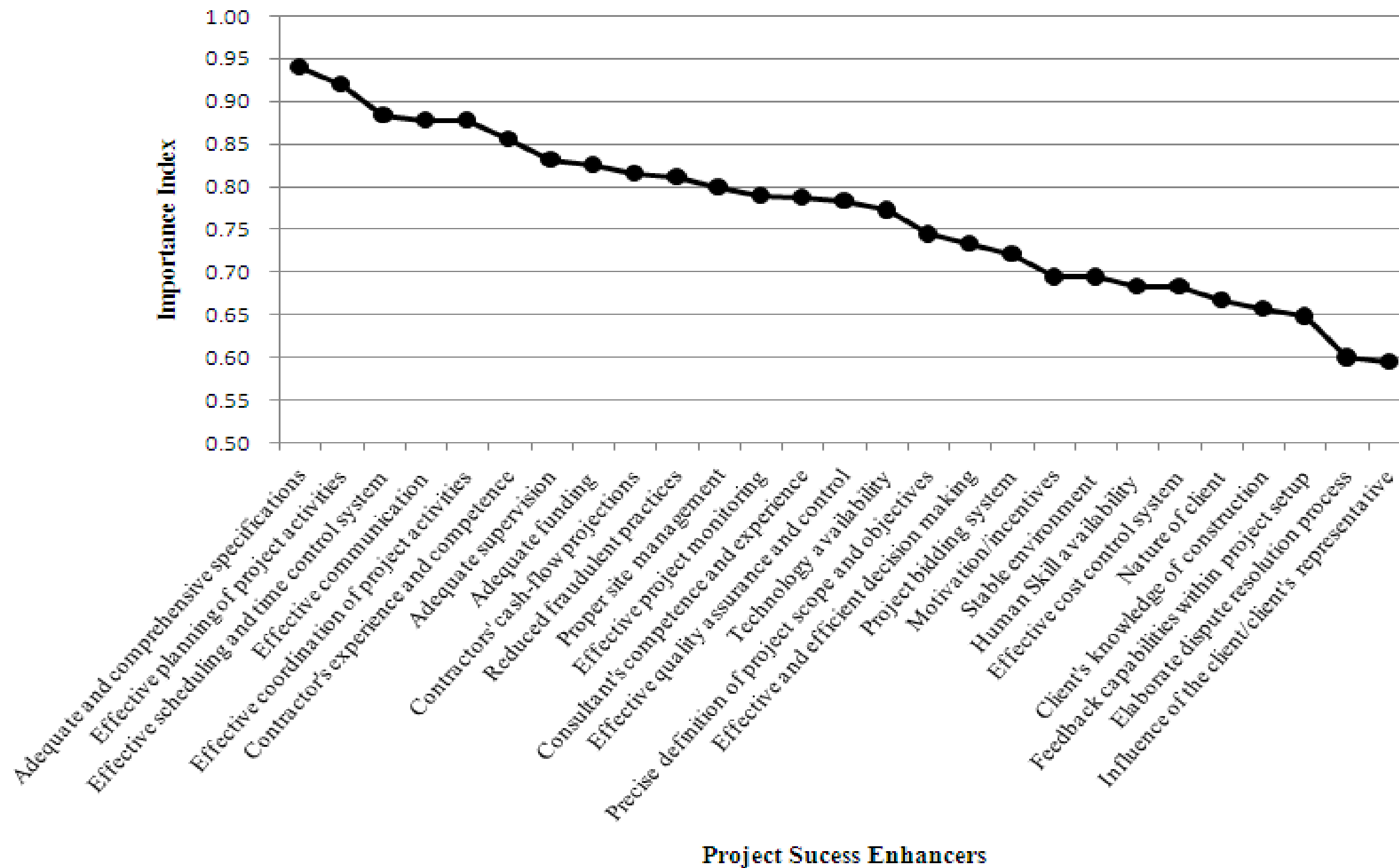


Figure 4-20: Rating of project success factors with respect to schedule

iii) Quality performance enhancement factors

The most significant factors that enhance project success with respect to quality were found to be: adequate and comprehensive specifications; consultant's competence and experience; effective quality assurance and control; contractor's experience and competence; and reduced fraudulent practices. Figure 4-21 shows the rating of the various quality performance enhancement factors in construction project delivery.

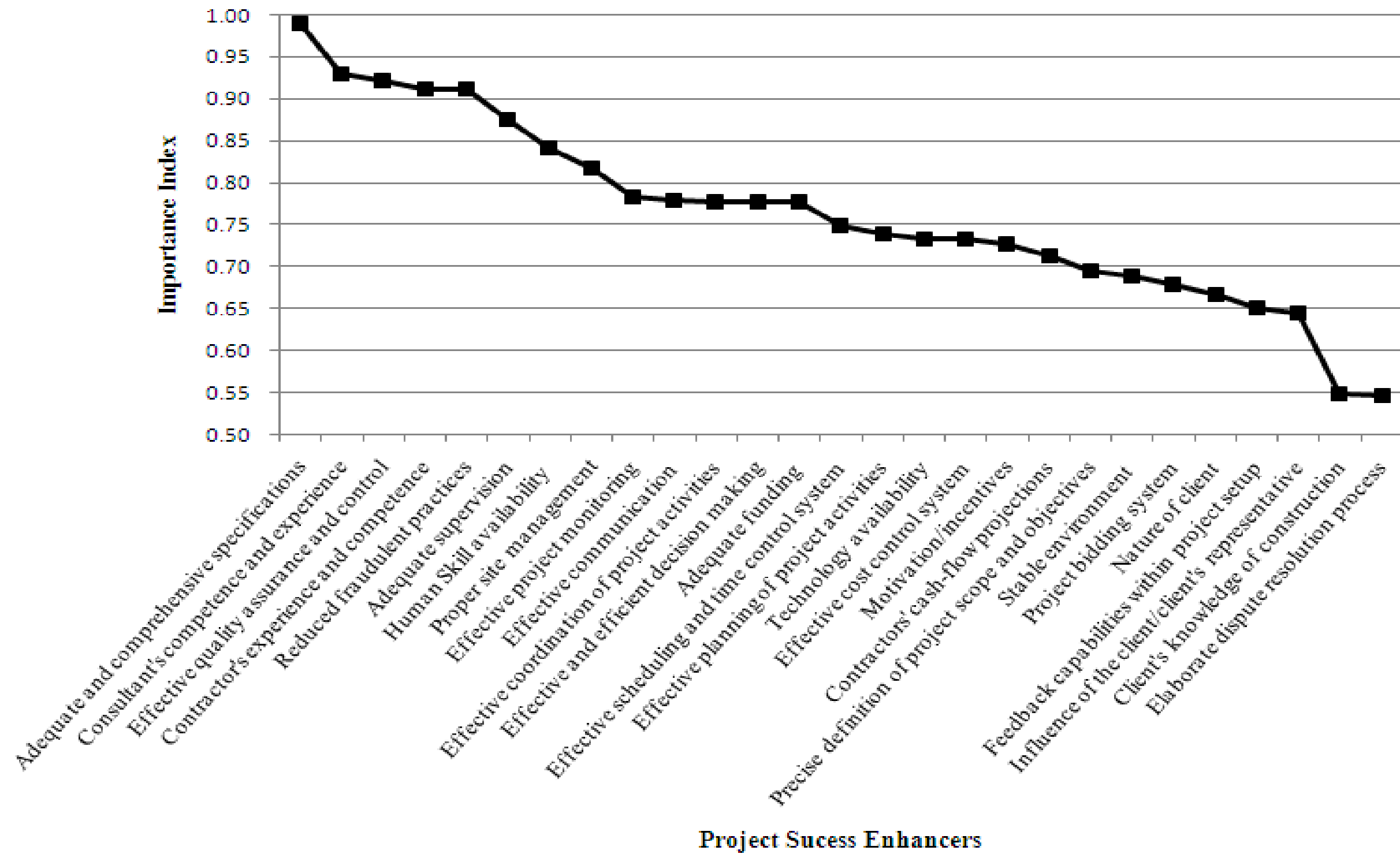


Figure 4-21: Rating of project success factors with respect to quality

4.3.5 Recommended project success and client satisfaction enhancement factors

The project success factors identified in section 4.3.4 were ranked to establish an overall importance index. Geometric mean scores of the CII, SII and QII was computed for use as a means of ranking the project success factors. Table 4-1 presents the project success enhancement factors with their geometric mean importance indices.

Table 4-1: Ranking of project success enhancement factors

Rank	Success enhancers	CII	SII	QII	Geometric Mean of II
1	Adequate and comprehensive specifications	0.98	0.94	0.99	0.97
2	Reduced fraudulent practices	0.90	0.81	0.91	0.87
3	Contractor's experience and competence	0.86	0.86	0.91	0.87
4	Adequate supervision	0.87	0.83	0.88	0.86
5	Consultant's competence and experience	0.84	0.79	0.93	0.85
6	Effective quality assurance and control	0.82	0.78	0.92	0.84
7	Effective scheduling and time control system	0.88	0.88	0.75	0.83
8	Effective coordination of project activities	0.83	0.88	0.78	0.83
9	Effective planning of project activities	0.80	0.92	0.74	0.82
10	Effective communication	0.79	0.88	0.78	0.81
11	Adequate funding	0.83	0.83	0.78	0.81
12	Proper site management	0.80	0.80	0.82	0.80
13	Effective project monitoring	0.84	0.79	0.78	0.80
14	Contractors' cash-flow projections	0.83	0.82	0.71	0.78
15	Effective cost control system	0.92	0.68	0.73	0.77
16	Effective and efficient decision making	0.81	0.73	0.78	0.77
17	Human Skill availability	0.74	0.68	0.84	0.75
18	Technology availability	0.72	0.77	0.73	0.74
19	Precise definition of project scope and objectives	0.77	0.74	0.69	0.73
20	Project bidding system	0.77	0.72	0.68	0.72
21	Motivation/incentives	0.71	0.69	0.73	0.71
22	Stable environment	0.74	0.69	0.69	0.71
23	Nature of client	0.67	0.67	0.67	0.67
24	Feedback capabilities within project setup	0.61	0.65	0.65	0.64
25	Influence of the client/client's representative	0.65	0.59	0.64	0.63
26	Elaborate dispute resolution process	0.70	0.60	0.55	0.61
27	Client's knowledge of construction	0.64	0.66	0.55	0.61

The project success enhancement factors were ranked according to the geometric mean score of their importance indices as shown in **Table 4-1**. The factors were further

analysed to determine their relevance in assuring client satisfaction. Factors with geometric mean importance indices greater than 75 percent were considered to be very significant. This was based on the interpretation that the factors had over $\frac{3}{4}$ chances of enhancing project performance and client satisfaction. For this reason, factors with geometric mean importance indices less than 0.76 were eliminated. Sixteen factors remained on the list. The AHP allows for only nine factors to be used as alternatives. This entailed scaling down the number of factors from sixteen to nine by consolidation and augmentation. The remaining sixteen factors were therefore consolidated and grouped together so as to have only nine for use in the AHP assessment. The resultant list comprised the following factors:

- adequate specifications and funds;
- reduced fraudulent practices;
- contractor's experience and competence;
- effective planning, coordination and supervision;
- consultant's competence and experience;
- effective quality assurance and control;
- effective scheduling and time control system;
- effective communication and decision making; and
- effective cost control system.

Based on the consolidated list, a recommendation was made to use the above cited factors as client satisfaction and project performance enhancement factors in the model.

4.4 Summary

The chapter presented the data obtained from interviews and questionnaire survey. The Analysis of the data elaborated which factors are significant causes of cost escalation schedule overruns and quality shortfalls in construction projects. Project success factors were also assessed. The results of this chapter were integrated in formulating a flowchart model based on Analytical Hierarchy Process (AHP) which is discussed in Chapter 6.

The next chapter presents a theoretical background of AHP.

CHAPTER 5 : BACKGROUND OF THE ANALYTIC HIERARCHY PROCESS

5.1 Introduction

The previous chapter presented the results and analysis of interview and questionnaire survey. This chapter prepares a foundation for model development based on a Multiple Criteria Decision Making (MCDM) tool known as the Analytic Hierarchy Process (AHP). It presents the basic theory of MCDMs and AHP in particular. It is not the intention of this chapter, however, to provide the mathematical theories and background of AHP. Such materials can be obtained from a number of publications such as: 'The Analytical Hierarchy Process' by Thomas Saaty (1980); 'Decision Making for Leader' by Thomas Saaty (1996) and many other publications.

5.2 Multiple criteria decision making

Multiple Criteria Decision-Making approaches are efficient tools for making critical decisions in many fields. They are utilized when decision-makers are faced with difficulties because of more than one objective or criteria that have to be satisfied in order to arrive at a successful and final selection from the available alternatives (Mann and Knapp, 1997). The MCDM approach involves structuring the problem, evaluation of criteria and alternatives, prioritization, and synthesis. In the MCDM, the first task is to obtain a set of objectives or requirements for the achievement of the overall objective.

In this study, the overall objective was to assure client satisfaction by reducing cost escalation, schedule overruns and quality shortfalls in construction projects. Identification of the objectives or requirements constituted an important component of the MCDM (Saaty 1980). The procedure would carry out comprehensive evaluations of alternatives and objectives for the purpose of selecting the best alternative. The project managers would have to determine the criteria that are important to construction management procedure and each criterion is assigned a weight according to its relative importance. After listing all the applicable criteria and determining their degree of importance, a list of alternatives would be proposed and subjected to rigorous evaluation considering all of the established criteria. Alternatives that satisfy the

predetermined important criteria would be ranked accordingly, and the alternative that scores the highest should be selected as the best solution to the project's overall objective.

The Analytic Hierarchy Process (AHP) is one of the multi-criteria approaches. AHP is a comprehensive, powerful and flexible multi-criterion decision tool that can be used for prioritizing alternatives associated with a system and for determining trade-offs among them.

5.3 The Analytic Hierarchy Process

In the complex world system, the problems dealt with are often greater than the resources available to handle them (Al-Besher 1998). To deal with such complex and unstructured problems, there is need to prioritize, agree that one objective outweighs another, and make trade-offs to serve the greatest common interest or overall objective. But with complex problems where a wide margin of error is possible in making the tradeoffs, it is always difficult to agree on which objective outweighs the other and to reach the best solution. The above difficulty proves that there is a need for a framework that enable viewing the problems in a complex but organized structure that allows for interaction and interdependence among factors and yet still enables the project participants to think about them in a simple way. The Analytic Hierarchy Process (AHP) provides this kind of framework (Saaty 1996).

The AHP is a multiple criteria decision-making approach developed by Thomas Saaty in 1971. AHP is a powerful decision-aiding tool that can deal with the intuitive, the rational, and the irrational when making decisions considering the suitability of large number of selection factors and alternatives. AHP is an appropriate MCDM approach for conducting both deductive and inductive evaluation that allows the consideration of several criteria and alternatives at a time, along with the benefit of a feedback mechanism and numerical tradeoffs. It is becoming a more popular and practical tool than the traditional multi-attribute utility theory, because it enables the decision-makers to resolve complex problems by simplifying and expediting the natural decision making processes (Al- Besher 1998). Basically AHP is a method designed to examine complex issues by breaking down the complex, unstructured problem into its constituent

elements; constructing a hierarchy with the ultimate goal at the top level; selecting criteria or objectives that must be satisfied at the next level; listing alternatives at the lowest level; assigning numerical values to subjective judgements on the relative importance of each element; and synthesizing the judgments to determine which alternatives have the highest priority. The evaluation is conducted by using the developed pairwise comparison judgements that result in the numeric representation of each comparison by a point estimate. The calculation of priorities is carried out using the Eigenvector method, and the synthesis is done using the linear additive value function.

The AHP provides an effective structure for group decision making by imposing a discipline on the group's thought processes. In addition, the consensual nature of group decision making improves the consistency of the judgments and enhances the reliability of the AHP as a decision-making tool. The AHP combines the deductive and system approaches into one integrated, logical framework. The deductive approach focuses on the parts whereas the system approach concentrates on the working of the whole (Saaty, 1980; Saaty, 1990; Saaty, 1996a; and Saaty, 1996b).

5.3.1 Advantages of AHP

AHP is the methodology which, if carefully conducted, has the following advantages (Al-Besher 1998):

- it is a flexible model that allows individuals or groups to shape ideas and define problems by making their own assumptions and deriving the desired solution from them;
- it is a practical way to understand complex problems by breaking them down into their constituent elements and measuring the intangible qualities of those elements quantitatively to determine their priority impact;
- it offers a way to integrate hard data with subjective judgements about intangible factors;
- it offers a way to incorporate judgments of several players and resolve conflicts among them;
- it utilizes a technique complementing other ones such as benefit/cost, priority and risk minimization for selecting projects or activities;

- it provides a framework for group participation in decision making;
- it enables decision-makers to test the sensitivity of the problem solution, or outcome, to changes in data;
- it is a process for identifying, understanding and assessing the interactions of a system as a whole;
- it is a practical way to deal with different kinds of functional relations in a complex network.
- it provides a communication tool for monitoring and guiding organizational performance toward a dynamic set of goals; and
- it has the advantage of being widely used in many countries.

Generally, the AHP is a systematic approach for solving the difficulties of the decision making process by conducting the following steps (Saaty, 1980):

- **Step 1:** Construct a decision hierarchy by breaking down the decision problem into a hierarchy of its elements.
- **Step 2:** Collect input by a pairwise comparison of decision elements.
- **Step 3:** Determine whether the input data satisfy a consistency test; if not, redo the pairwise comparisons.
- **Step 4:** Calculate the relative weights of the decision elements.
- **Step 5:** Aggregate the relative weight to obtain scores and hence rankings for the decision alternatives.

5.3.2 *Structuring the hierarchy*

The first step in AHP is constructing the hierarchy of the decision problem. There is no certain rule that can be followed for constructing a hierarchy. The main principle is based on brainstorming the complex problem, listing all of the important ideas, factors and alternatives, and then arranging them in a hierarchy that will enable the comparison of the elements of lower levels with some or all elements in the next higher level. It is a creative way of exploiting the human mind's ability to simplify a problem by breaking it down into the constituent elements that include the overall goal, the criteria and the decision alternatives. Following this process, a large amount of information can be integrated into the structure of the problem to form a more complete picture of the whole system. Figure 5-1 illustrates such a hierarchy.

At the top level of the hierarchy lies the overall aim of the hierarchy, such as making the best decision or selecting the best alternative. There is no limit to the number of levels in a hierarchy. However, the number of levels normally depends on the complexity of the decision problem or how much knowledge is available and usable. In most cases, the degree of detail required by decision-makers to solve a problem constitutes the driving force behind the number of levels.

The lower levels of the hierarchy contain attributes or objectives that influence the decision and will contribute to the achievement of the overall objective. Details of the attributes increase at the lower levels of the hierarchy.

The last level of the hierarchy (K) contains decision alternatives. These alternatives contribute to the achievement of the criteria in a special way (Saaty, 1990; Saaty, 1996). This provides a standard form as shown in Figure 5-1.

The completed hierarchy can be modified as needed to accommodate new and important elements that were not included during the development of the hierarchy. The use of computer programs based on AHP is constructed with this flexibility in mind (Saaty 1996).

The overall depth of detail of the hierarchy depends on the person's experience and familiarity with the subject, which will determine what to include and where to include it. When constructing hierarchies one must include enough relative detail (Saaty 1990):

- to represent the problem as thoroughly as possible, but not so thoroughly as to lose sensitivity to change in the elements;
- to consider the environment surrounding the problem;
- to identify the issues or attributes that contribute to the solution; and
- to identify the participants associated with the problem.

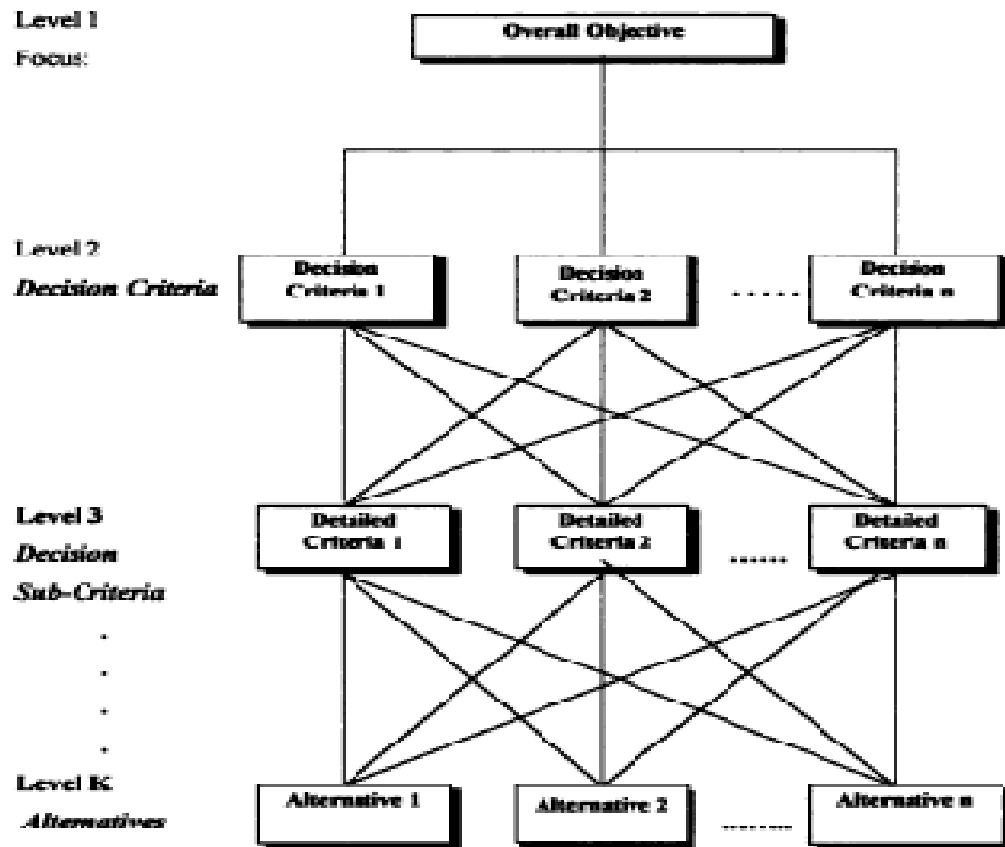


Figure 5-1: Standard Hierarchical Structure

(After Saaty, 1996)

5.3.3 Pairwise comparison

The next step is to establish the priorities for the elements i.e. criteria and alternatives presented in the hierarchy. The AHP uses the pairwise comparison in establishing priorities. The matrix is used for pairwise comparisons. The matrix is a simple, well-established tool that offers a framework for testing consistency, obtaining additional information through making all possible comparisons, and analyzing the sensitivity of overall priorities to changes in judgment (Saaty 1996).

The priority entered into the matrix indicates how much more importance one attribute has over another. The nodes in the hierarchy represent alternatives to be prioritized, and the lines reflect the relationship between the alternatives of two levels. Each relationship is weighted according to the strength of influence that an alternative at the same level K exerts on alternative at level (K-1), where $K = 1, 2, 3, \dots, N$.

In a complete system hierarchy, every element in the lower level affects every element in the upper level. But a hierarchy does not need to be complete. That is, an element in a given level does not have to function as an attribute or criterion for all the elements in the level below. An element in the higher level is said to be the parent element for those in the lower level since it contributes to or affects them. The elements in the lower level are then compared to each other based on their effect on the governing element.

The element that appears in the left-hand column of the matrix is always compared with an element appearing in the top row, and the value is given to the element in the column as it is compared with the element in the row. If element A dominates element B, then the integer is entered in row B column A, but, if element B dominates element A then the reverse occurs. For n elements there are $n(n-1)/2$ judgments required to develop the required matrix (Saaty, 1996).

The pairwise comparison process should be performed for each level in the hierarchy with respect to the level just above. This process can proceed from the top and go downward i.e. evaluating the importance of the criteria and then the preference for the alternatives. It can also be performed from the bottom upward i.e. evaluating the preference of the alternatives with respect to each criterion before evaluating the importance of the criteria. Unless the decision-maker is familiar with alternatives and the tradeoffs that affect them, it is usually best to proceed from the bottom up. By doing this, one gains insight into the tradeoffs involved and will be in a better position to evaluate the relative importance of the criteria.

The degree of importance or relative preference is measured on an integer-valued 1-9 scale for two attributes. This scale has been validated for effectiveness, not only in many applications by a number of people, but also through theoretical comparisons with a large number of other scales (Saaty, 1980; Saaty, 1996). When comparing alternatives, the term preference is appropriate, and the term importance is appropriate when comparing one criterion with another.

5.3.4 *Synthesis for overall priorities ranking*

This part of AHP deals with the calculation of the priorities of each element through the hierarchy. The calculation leads to the overall result and the ranking of the elements. The synthesis proceeds in three following steps (Saaty, 1996):

- sum the value of each column of pairwise comparison matrix;
- divide each entry in the pairwise comparison matrix by its column total. This will produce the normalized pairwise comparison matrix; and
- then, determine the average of each row of the normalized matrix by adding the value in each row of the normalized matrix and then divide by the number of entries in each row. This provides the relative priorities of the elements being compared.

AHP uses the synthesis to develop an overall priority ranking. The relative weights of various levels obtained are aggregated to produce a vector of composite weights which will serve as a ranking of the decision alternatives in achieving the most general objective of the problem.

5.3.5 *Consistency*

Depending on the decision needed, it is important to test the consistency of the decision-maker's verdict in providing their judgments to the comparison matrix. However, it is difficult to achieve perfect consistency. Analytic Hierarchy Process is a useful tool that can be used to check the judgments provided in each hierarchy. A Consistence Ratio (CR) of 10 percent or less is acceptable. Any CR value of more than 10 percent is not acceptable and the judgments made should be reconsidered to resolve inconsistencies in pair wise comparison (Saaty, 1996).

5.4 *Summary*

The chapter presented background information on multiple criteria decision making and the Analytic Hierarchy Process. The advantages of using AHP were highlighted. The chapter further presented the required steps in construction of an AHP. The next chapter goes a step further by applying to AHP principles in development of a model.

CHAPTER 6 : THE CLIENT SATISFACTION ENHANCEMENT FLOWCHART MODEL

6.1 Introduction

The previous chapter presented a brief background of the AHP and its advantages. This chapter endeavours to utilize the advantages of AHP in developing a conceptual model for construction project management. The model development is based on the need to have tools that are comprehensive, simple as well as flexible in performance, easy to review, adaptable to both individual and group and does not require inordinate specialization to master and communicate. This chapter discusses the development and testing of the Client Satisfaction Enhancement Flowchart Model (CSEFM). It also presents the ranking of the project delivery and satisfaction enhancement factors.

6.2 The Client Satisfaction Enhancement Model Development

The development of the CSEFM was based on the results obtained from the questionnaire and the consolidated list of enhancement factors presented in Section 4.3.5. A project would be said to be successful if it was implemented within the desired cost, time and it met the specified level of quality. This would bring about client satisfaction. Therefore, the objective of the developed CSEFM was enhancement of cost, schedule and quality performance on construction projects. The CSEFM would provide project managers with important and focussed factors which if understood and considered with proper objectives would successfully determine the most important factors at any stage of construction. The CSEFM utilises AHP to evaluate the project success factors.

6.2.1 Development of the CSEFM

The CSEFM was built around the AHP theory with the aim of prioritising factors that would be significant in optimising the success of construction projects. Detailed descriptions of the main steps of the development of the CSEFM are presented below. Figure 6-1 shows processes that are involved in the development of the Client Satisfaction Enhancement Flowchart Model.

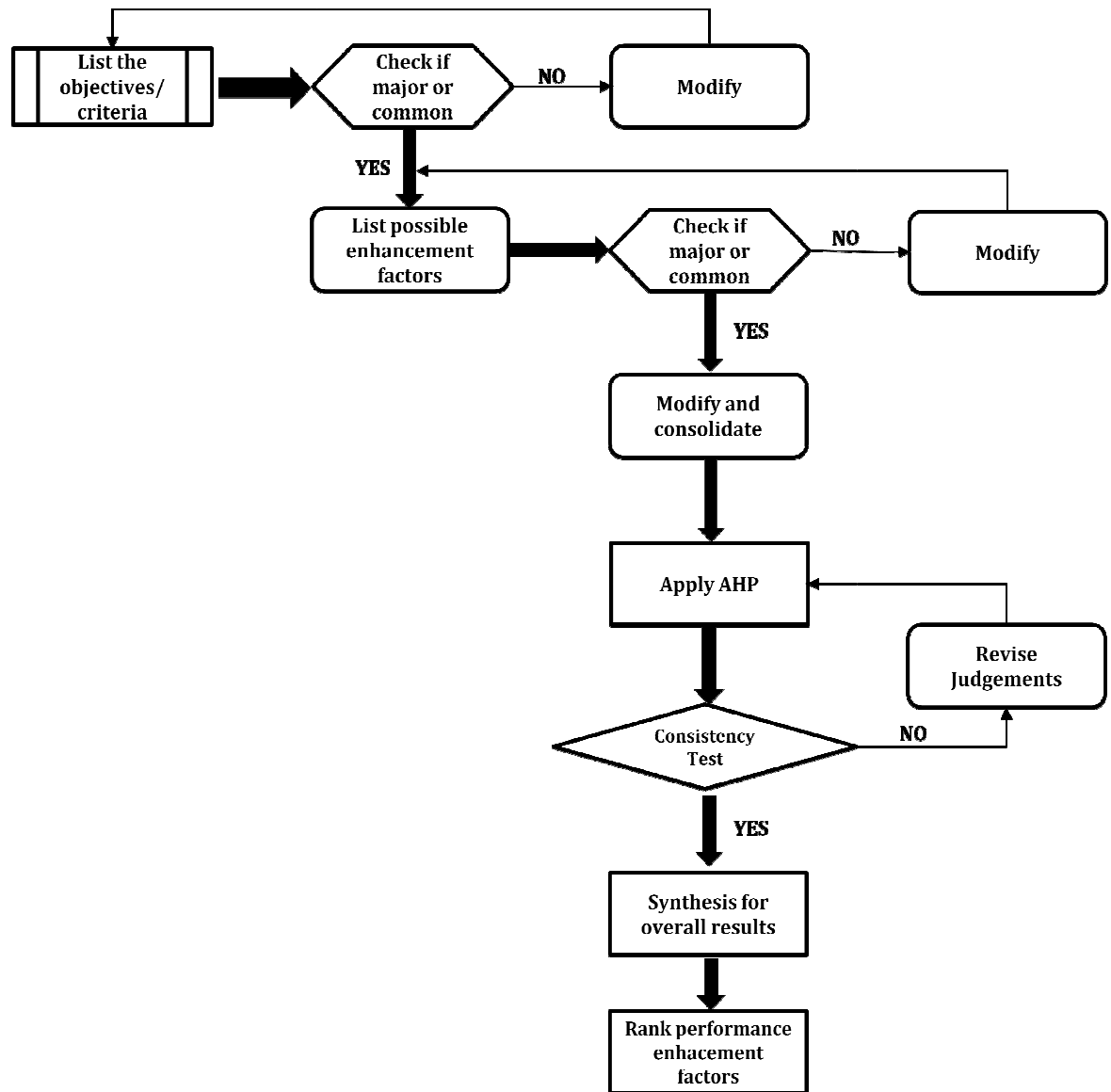


Figure 6-1: *The Client Satisfaction Enhancement Flowchart Model*

i) Identification of objectives

Regardless of the owner, project type or contractual arrangement used, client satisfaction requires a predetermined set of objectives. It is against such objectives that project success and client satisfaction would be evaluated. Therefore, the first step in developing the CSEFM was to list the desired objectives. For the purpose of this study, cost, schedule and quality performance were chosen as the objectives for assuring client satisfaction.

ii) Assessment of the objectives

To ensure effectiveness of the model, objectives must be comprehensive. The objectives needed to satisfy the main goal of the model, which was to enhance construction project success and client satisfaction in this case. It was therefore important to examine the significance and comprehensiveness of the objectives.

iii) Modification of the objectives

Depending on the purpose, project type and any other specific conditions, objectives could be modified as would be appropriate to suit and contribute to the main goal of the model. In this study, the objectives were determined to be coherent and comprehensive, and as such no modifications were necessary.

iv) Identification of client satisfaction enhancement factors

There were a number of project success enhancement factors identified from literature. When developing the CSEFM, all the factors, identified from literature that could contribute to project success and client satisfaction in construction were listed.

v) Categorisation of major client satisfaction enhancement factors

As was the case with the objectives, client satisfaction enhancement factors were checked in terms of their relevance and also grouped according to similarities.

vi) Modification of client satisfaction enhancement factors

Factors that were deemed to be insignificant were eliminated. Other factors that had similarities or were common were combined. The purpose for doing this was to reduce the total number of factors used in the model.

vii) Choice of the AHP and Expert Choice

Because of the complexity of the prevailing process in dealing with factors that affect the achievement of the goal and consistency of the judgments, the Analytic Hierarchy Process (AHP) was adopted to solve the prioritisation process. *Expert Choice (EC)*

Professional 9.0 was adopted in the study to evaluate the judgments from the respondents. EC is a popular decision support software that utilises the AHP theory in its synthesis of results.

viii) Consistency test

The consistency test is used to check how coherent the user's judgments are. For every set of judgments entered, a ratio is computed. The consistency test therefore helps to ensure high integrity of the resultant decision. In the study, every judgment entered was checked for consistency. The acceptable consistency ratio was set at 10 percent.

ix) Revision of judgments

In the event that the consistence ratio is greater than 10 percent, a revision of judgments by conducting a different set of pairwise comparison would be necessary. Re-examination of the hierarchy would also be an important step to undertake at this stage. The judgments that had consistent ratios greater than 10 percent were revisited and revised accordingly.

x) Synthesis of all respondents' judgements

After recording all preferences and important optimisation alternatives and criteria with respect to the goal of the AHP model, the next step was to synthesize the overall result of all the judgements of the respondents of client satisfaction enhancement factors with respect to the goal. This was achieved by generating the global weights of the nodes by combining the local priorities throughout the entire model.

xi) Ranking of the performance enhancement factors

Expert Choice has two modes of synthesising the decisions, i.e. distributive and ideal modes. The distributive mode distributes the weights of the objectives among the alternatives. It divides up the each objective's weights by each respondent into proportions relative to the percentage of preference of the alternatives. On the other hand, the ideal mode assigns the full weight of each objective to the alternative with the highest weight under that criterion. If the same alternative is best for all the criteria,

after weighting by the priority of the objective, that alternative receives an overall value of one while the others receive proportionately less. The distributive synthesis mode was used to perform the synthesis from the goal node to get the overall prioritisation results. The distributive synthesis mode ranks the success factors and places the most important one at the top. Unlike the ideal mode, it allows rank to reverse when a change is made to priorities of the criteria or objectives.

xii) Decision-making based on the ranked factors

The resulting ranked list of success factors forms a solid foundation from which to choose the most appropriate course of action. The courses of action at any given stage of a construction project might vary depending on the resultant priorities.

6.2.2 Structuring of the CSEFM Model

The CSEFM based on the AHP was structured using a computerised decision support system called Expert Choice. The model was structured as an upside-down tree hierarchy i.e. starting with the main goal, followed by criteria and finally the alternatives. **Table 6-1** shows the abbreviations and definition of elements used in the structuring of the model.

Table 6-1: CSEFM acronyms and their definitions

Node name	Definition
COSTPERF	Enhance Construction Cost performance
QUAPERF	Enhance Quality Performance on Construction Projects
SCHPERF	Enhance Construction Schedule Performance
CONSEXP	Consultant's experience and competence
CONTEXP	Contractor's experience and competence
EFFCCSYS	Effective cost control system
EFFCOMMU	Effective communication and decision making
EFFQA&QC	Effective quality assurance and control
EFFSCSYS	Effective scheduling and time control system
NOCORUPT	Reduced fraudulent practices
PLANCORD	Effective planning, coordination and supervision
PLSP/BUD	Adequate specifications and funds

The model consisted of three levels whose structure was as follows:

Level 1: Goal definition

The goal of the model was ‘Enhancing Construction Project Success and Client Satisfaction’.

Level 2: Main objectives

The objectives for the model were to: minimise construction cost escalation; minimise construction schedule overruns; and enhance quality performance on construction projects.

Level 3: Client satisfaction enhancement factors

The nine recommended client satisfaction enhancement factors were inserted at level three of the hierarchy as shown in **Figure 6-2**.

Level 1

Level 2

Level 3

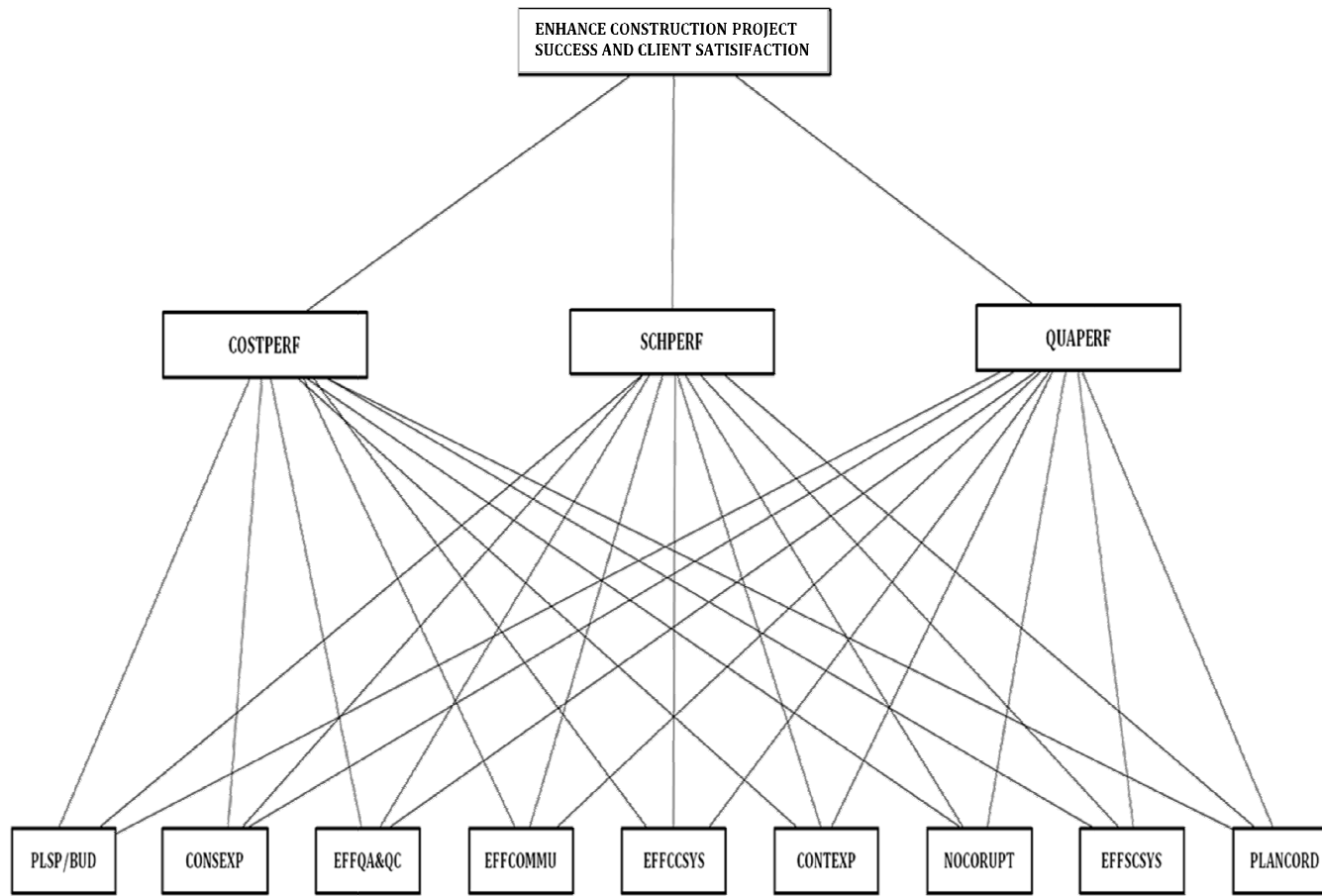


Figure 6-2: Schematic drawing of the AHP based CSEFM

6.2.3 Pre-testing of the CSEFM

Before the CSEFM could be used as a data collection and project success factor prioritisation tool, it was pre-tested by three respondents. The pre-testing process was aimed at improving the CSEFM. The respondents gave comments on the structure of the CSEFM and entered trial judgments. Ambiguous acronyms were identified and rectified. The other objective of the pre-test was to estimate the time required for each respondent to enter judgments taking into account some revision aimed at making the Consistency Ratio to be less than 10 percent.

6.2.4 Data collection and project success factor prioritisation using the CSEFM Model

The CSEFM was developed and structured using the steps described in Section 4.1 and its sub-sections above. Nine experienced respondents were selected to prioritise and rank construction project delivery and satisfaction enhancement factors. Of the nine respondents, three were from client organisations, five from consulting firms, and one from a construction financier organisation. All the respondents were selected based on their experience in the construction industry. It is noteworthy that all respondents had over 10 years of experience with a minimum qualification of a Bachelors degree.

The respondents were asked to enter their judgments in Expert Choice. The judgments were calculated using pairwise comparison. Consistency of the judgments was tested and synthesis of overall priorities for those with consistency ratios less than 10 percent was computed. Snap-shot judgments entered by Respondent Number 5 are presented in Appendix 5.

6.2.5 Results of AHP analysis using the CSEFM Model

The resultant judgements for all the nine respondents were aggregated using the arithmetic mean and sorted according to their overall priority. The overall results in Table 6-2 show that the consultant's experience and competence are a critical project success and client satisfaction enhancement factor. The second most significant factor was found to be a 'contractor's experience and competence'. The ranking of these factors shows that a prerequisite of any successful project are competent and experienced participants. Construction project success and enhancement of client satisfaction can be achieved when participants understand and pay particular attention to factors that effectively contribute towards this goal when executing infrastructural developments.

Table 6-2: Overall synthesis results by different respondents

Project delivery and satisfaction enhancement factors	RESPONDENT									Arithmetic Mean
	1	2	3	4	5	6	7	8	9	
Consultant's experience and competence	0.168	0.178	0.184	0.109	0.235	0.138	0.174	0.138	0.184	0.168
Contractor's experience and competence	0.080	0.197	0.197	0.109	0.105	0.130	0.139	0.097	0.190	0.138
Effective cost control systems	0.148	0.296	0.038	0.112	0.111	0.119	0.126	0.148	0.039	0.126
Adequate specifications and funds	0.109	0.029	0.143	0.120	0.143	0.111	0.108	0.093	0.143	0.111
Effective quality assurance and quality control systems on a project	0.078	0.030	0.159	0.106	0.083	0.100	0.093	0.159	0.162	0.108
Effective communication and decision making	0.091	0.017	0.141	0.108	0.091	0.041	0.077	0.140	0.141	0.094
Effective planning, coordination and supervision	0.131	0.032	0.051	0.109	0.095	0.117	0.090	0.131	0.052	0.090
Effective schedule and time control systems	0.090	0.096	0.052	0.122	0.085	0.144	0.104	0.041	0.052	0.087
Reduced fraudulent practices	0.105	0.125	0.037	0.104	0.053	0.101	0.090	0.053	0.037	0.078

6.3 Summary

The development of the CSEFM was presented in this chapter. Data collection and ranking of success enhancement factors by nine respondents using the CSEFM was also presented. The next chapter contains the limitations, conclusion and recommendations of the study.

CHAPTER 7 : CONCLUSIONS, STUDY LIMITATIONS AND RECOMMENDATIONS

7.1 Introduction

The previous chapter presented the CSEFM and rank-list of success enhancement factors. This chapter presents the conclusion of the study whose aim was to establish the causes and effects of cost escalation, schedule overruns and quality shortfalls in construction projects.

7.2 Conclusions

Cost escalation, schedule overruns and quality shortfalls in construction projects are always potential obstacles to project success. The study reported in this dissertation established that there are a number of causal factors which need to be adequately dealt with if cost escalation, schedule overruns and quality shortfalls are to be minimised on construction projects in Zambia. Despite being a subject of discussion for over four decades, cost escalation, schedule overruns and quality shortfalls still persist as a challenge on construction projects.

Factors that cause cost escalation, schedule overruns and quality shortfalls were identified. The study further established that: insufficient initial analysis of costs; change orders or scope changes; and inflation; were the three most significant causal factors for cost escalation. Financial difficulties on the part of contractors; change orders or scope changes; and poor sub-contractor performance were the three most significant causal factors for schedule overruns while those for quality shortfalls included: inadequate and/or inconsistent release of project funds by clients; poor financial management by contractors; and long time lapse between feasibility study and implementation of projects.

The CSEFM was developed and used to prioritise the project success factors. Using the CSEFM, the project delivery and satisfaction enhancement factors were ranked, from the most important to the least one, as follows: consultant's experience and competence; contractor's experience and competence; effective cost control systems; adequate specifications and funds; effective quality assurance and quality control systems on a

project; effective communication and decision making; effective planning, coordination and supervision; effective schedule and time control systems; and reduced fraudulent practices.

7.3 Limitations

The study reported should be considered with some limitations in mind. The study focused on construction projects from a holistic point of view. The findings might vary from one construction project type to the other. However, the basic principles certainly encompass all forms of construction.

The results also reflect situations that would be present in public projects. Projects undertaken by the private sector might have other challenges that are different from the ones highlighted in this study.

With regards to the CSEFM, a deterministic approach to decision making was considered. The CSEFM does not consider any uncertainties as such require further work and exploration.

7.4 Recommendations

In order to successfully address issues of cost escalation, schedule overruns and quality shortfalls, the causal factors need to be understood. On the other hand, it is important to ensure that project delivery and client satisfaction enhancement factors are optimised. The results of the study reported in this dissertation can help project managers and owners to carefully monitor their projects by looking out especially for factors with high Factor Importance indices on projects.

7.4.1 General recommendations

The causal factors for cost escalation, schedule overruns and quality shortfalls identified in the study need to be carefully monitored and studied by project managers. In an event that they occur on a project, they are more likely to offset the project objectives and might result in project failure. To effectively deal with the problem of insufficient initial analysis of projects, there is need to ensure feasibility studies are conducted to a

significant level of detail that outlines the possible outcomes of a project. Prior to tendering and subsequent awarding of contracts, adequate and comprehensive documents should be readily available. Such documents should be adequate in terms of the initial analysis of costs, scope of works to be executed and the expected duration.

The adequacy and completeness of documentation alone would not be enough. Project personnel should have the requisite tools and techniques to deal with project complexities. Competence and experience of contractors and consultants was identified to be crucial in assuring project success. Competent and experienced consultants would ensure that the documents prepared for projects are comprehensive and adequate. They should also have the right skills and expertise to deal with contractors during the construction supervision phase. On the other hand, competent and experienced contractors would ensure project success through timely and cost effective construction. Quality of works performed would also be assured.

Technological advancements in development of practical mechanisms or systems for effective cost, schedule or quality assurance and control was noted to be equally imperative. Practitioners should endeavour to use the already existing information in the public domain and develop means and ways of addressing the problems faced by the industry. As it is a known fact that there is not a single system that would work for all construction projects, adaptation of the various project management tools and techniques to suit a given project environment is essential. On the other hand, where all the above remedies are present but effective coordination does not exist, project success can be farfetched. Construction projects require managers with excellent coordination skills that are not limited to organizing plant, materials and work items but also the human resource, which to a greater extent, have a significant impact on project outcomes.

Inadequate project management expertise by project managers may prove to be a recipe for unsuccessful projects. The knowledge gap identified during the interview stage of the study indicates that some projects fail despite having all the requisite data and contractual arrangements. There is need to ensure that personnel or consultants managing construction projects have the necessary training in construction project management.

7.4.2 Specific recommendations

The following specific recommendations should be considered:

- the CSEFM should be explored further and developed to be part of an expert system or tool for management and decision making in construction projects;
- construction projects should be planned and managed meticulously throughout the stages; and
- relevant regulatory institutions such as National Council for Construction (NCC), should consider having ‘Construction Management’ as formal qualification required for anyone to hold the position of ‘Project Manager’ on a construction project

REFERENCES

1. Achola P. and Bless C. (1988), Fundamentals of Social Research methods; an African perspective, UNZA press, Lusaka, pp 13 – 113, 128 – 130.
2. Ahmed S., Azher S., Castillo M. and Kappagantula P. (2002) Construction delays in Florida; an empirical study, Florida, available online: [http://www.cm.fiu.edu/publication/Delays %20project.pdf](http://www.cm.fiu.edu/publication/Delays%20project.pdf)
3. Al-Besha M (1998) A Conceptual Model for Consultant Selection in Saudi Arabia, Unpublished thesis, King Fahd University Of Petroleum & Minerals, Available online: <https://eprints.kfupm.edu.sa/9805/1/9805.pdf>
4. Al-Moumani H. A. (2000), Construction Delay: A Quantitative Analysis, International Journal of Project Management, 18(1), pp. 51-9
5. Atkinson R. (1999) Project management: cost, time and quality, two best guesses and phenomenon, it's time to accept other success criteria, International Journal of Project management, 17(6) ,pp. 337-342
6. Assaf, S, AL-Khalil M. and Al Hazmi M., (1995), Causes of delay in large building construction projects, Journal of Management in Engineering, 11(2), pp. 45-50.
7. Birkby G and Brough P, (2002), Construction Companion to Extensions of Time, RIBA Enterprises Ltd, London
8. Bryman A. (2001), Social Research Methods, Oxford University press, United Kingdom, pp 177 – 487.
9. Chan D. W.M and Kumaraswamy M. M. (1997), A comparative study of causes of time overruns in Hong Kong construction projects. International Journal of Project Management, 15(1), pp 55 – 63.
10. Cross H, (1952) Engineers and Ivory Towers, McGraw-Hill Book Co., Inc., New York
11. CSPR (2006) CSPR statement on the 2006 National Budget, pp. 4
12. CSO, (2008), *Selected Socio-Economic Indicators*, THE MONTHLY, Journal of the Central Statistical Office (62), p. 20-21
13. Datta B. (2002) Management of Infrastructure Projects in Urban Local Bodies: Case Study of Kanpur Development Authority, India Infrastructure Report, pp. 207 – 211.
14. Falqi I. I. (2004) Delays in Project Completion: A comparative study of construction delay factors in. Saudi Arabia and the United Kingdom, available online: http://www.saedin.com/index.php?option=com_docman&task=doc_download&gid=48&Itemid=57

15. Flyvbjerg, B., Holm, M. S., and Buhl, S. (2002) "Underestimating Costs in Public Works Projects, Error or Lie," *Journal of the American Planning Association*, 68(3), pp 279 – 292.
16. Frimpong Y., Oluwoye J., and Crawford L., (2003), Causes of delays and cost overruns in construction of groundwater projects in a developing country; Ghana as a case study, *International Journal of Project Management*. 21, pp 321 - 326
17. GAO/RCED (1997) *Transportation Infrastructure Managing the Costs of Large-dollar Highway Projects*, Washington, D.C.
18. Hancher D. E, and Rowing R. E. (1981) *Sitting highway construction contract duration*, *Journal of Construction Engineering and Management*, 107(2), pp. 169 – 179
19. Hall, P. (1980) *Great Planning Disasters*, University of California Press, U.S.A.
20. Hendrickson C., Au T., (2003), *Project Management for Construction: Fundamental Concepts for Owners, Engineers, Architects and Builders*, Version 2.1, Pittsburgh available online: <http://www.ce.cmu.edu/pmbook>
21. Kaliba C., Muya M., and Mumba K., (2009), Cost escalation and schedule delays in road construction projects in Zambia, *International Journal of Project Management*. 27(5), pp 522 – 531
22. Languages Centre (2005), *Using the Literature; Writing up research*. Available online: <http://www.languages.ait.ac.th/EL21LIT>
23. Leavitt D., Ennis S. and McGovern P. (1993), *The Cost Escalation of Rail Projects: Using Previous Experience to Re-Evaluate the Cal Speed Estimates*, California High Speed Rail Series, April working paper.
24. Mann and Knapp (1997) *Determining the Most Important Criteria in Maintenance decision Making*. *Journal of Quality in Maintenance Engineering*, 3(4), pp. 16 – 28.
25. Mansfield N. R., Ugwu O. O. and Doran T. (1994), Causes of delay and cost overruns in Nigerian construction projects. *International Journal of Project Management*, 12(4), pp. 254 – 260.
26. McInnis A. (2001) *The New Engineering Contract: A legal Commentary*, Thomas Telford, UK
27. Merewitz, L. (1973) "Cost Overruns in Public Works." *Benefit Cost and Policy Analysis Chicago, Aldine*, pp. 227-297.

28. Merrow, E. W., Phillips, K. E., and Myers, C. W. (1981) Understanding Cost Growth and Performance Shortfalls in Pioneer Process Plants. The Rand Corporation, Santa Monica, CA.
29. Merrow, E. W. (1988) Understanding the Outcomes of Megaprojects: a Quantitative Analysis of Very Large Civilian Projects. The Rand Corporation, Santa Monica, CA.
30. Ministry of Finance and National Planning (2006) Government Republic of Zambia 2006 Budget
31. Ministry of Finance and National Planning (2006) Government Republic of Zambia's Fifth National Development Plan, pp. 36
32. Muya M., Price A., and Edum-Fotwe F. (2006), "Construction craft skills requirements in sub-Saharan Africa: a focus on Zambia", Engineering Construction and Architectural Management, 13(3), pp 223 - 241.
33. Muya M. (1999) A systematic approach for improving construction material logistics, Unpublished thesis, Loughborough University
34. NAP (2003) Completing the Big Dig; Managing the Final Stages of Boston's Central Artery/Tunnel Project, The National Academies Press, Washington, D. C. Available online: <http://www.darwin.nap.edu/books/0309088879.html>
35. NAP (1991) Inspection and other strategies for assuring quality in government construction, The National Academies Press, Washington, D.C. Available online: <http://www.nap.edu/catalog/1847.html>
36. NCC (2006) Contractor Failure Workshop, Construction News, Volume 7(3), pp 3
37. NCC (2007) Shoddy works in public sector debate: revisited, Construction News, Volume 8(3) pp 1-2
38. Nkhata L. (1997), Methodological Options in Policy Relevant Social Research, Study Fund, Lusaka, pp 77 – 170.
39. Promkuntong K and Ogunlana S. T. (1996) Construction Delays in Fast – Growing Economy: comparing Thailand with other economies, International Journal of Project management, 14(1) ,pp. 37-45
40. Roads Department (2002), Projects Progress Report
41. Road Development Agency (2005) Projects Progress Report
42. Saaty T. (1980) The Analytic Hierarchy Process, Mc Graw-Hill, New York.
43. Saaty T. (1990) How to make a Decision: The AHP Analytic Hierarchy Process, European Journal of Operational research, 48, pp 9 – 26

44. Saaty T. (1996) Multiple Criteria Decision Making: The Analytic Hierarchy Process, Vol I, AHP series, RWS Publication, Pittsburgh, Pennsylvania.
45. Saaty T. (1996) Decision Making for Leaders Vol II, AHP series, RWS Publication, Pittsburgh, Pennsylvania.
46. Schexnayder C., Fiori C., and Weber S. (2003) Project Cost Estimating: A Synthesis of Highway Practice, Arizona. Available online: <http://www4.trb.org/trb/crp.nsf/All+Projects/NCHRP+20-7>
47. Schexnayder C., Molenaar K., and Shane T. (2007) Estimating large complex projects, Revista Ingeniería de Construcción, 22 (2). Available online: www.scielo.cl/pdf/ric/v22n2/art03.pdf
48. Spector P. (1981) Research Designs; Quantitative Applications in Social Sciences working paper, 07 – 023.
49. The Hindu (2007) Hit by Delays and Cost escalation. Available online: <http://www.hindunnet.com/2007/07/06/stories/2007070657310100>
50. The Post (2008) “Simbao warns contractors”, January 10.
51. The Post (2007) “Mamba-Batoka bridge works shoddy-Lisulo”, September 23.
52. The Post (2007) “Shoddy-works on Chipata – Lundazi Road”, April 17.
53. Toor S., Ogunlana S.O., (2006), “Conquering the construction battle: overcoming the problems on large construction projects in developing economy”, Conference proceedings, International Conference in Built Environment (ICiBE).
54. University of California SC (2006) “Literature Review.” Available online: <http://www.library.ucsc.edu/ref/howto/literaturereview>
55. Zambia Daily Mail (2008) “42 barred from state tenders”, March 09.
56. Zambia Daily Mail (2008) “Minister blacklists Tomorrow Investments” January 09.

APPENDICES

APPENDIX 1

Publications from the dissertation

Published Journal Articles

1. **Kaliba C.**, Muya M., and Mumba K., (2009), *Cost escalation and schedule delays in road construction projects in Zambia*, International Journal of Project Management. Vol. 27, No. 5, pp 522 – 531. Available online: <http://dx.doi.org/10.1016/j.ijproman.2008.07.003>.
2. Sichombo B., Muya M., Shankantu W., and **Kaliba C.**, (2009), *The need for technical auditing in the Zambian construction industry*, International Journal of Project Management. Vol 27, No. 8, pp 821 - 832. Available online: <http://dx.doi.org/10.1016/j.ijproman.2009.02.001>

Conference Proceedings

1. **Kaliba C.**, Muya M., and Sichombo B., (2009) *Enhancement of Construction Projects Delivery in Zambia*, The Engineering Institution of Zambia National Symposium, Lusaka, EIZ.
2. **Kaliba C.**, Muya M., and Sichombo B., (2009) *The Need to Reduce Costs, Schedule Overruns and Quality Shortfalls in Construction*, 4th Built Environmental Conference, Livingstone, ASOCSA.
3. Sichombo B., Muya M., and **Kaliba C.**, (2009), *Promotion of Ethical conduct in the Zambian Construction Industry through Technical Auditing*, 4th Built Environmental Conference, Livingstone, ASOCSA.

Papers submitted to Journals before submission of this dissertation

1. **Kaliba C.**, Muya M., W. Shaakantu and Sichombo B., (TBA) *Causal factors of cost escalation, schedule overruns and quality shortfalls on construction projects in Zambia*, Journal of Construction and Engineering Management, ASCE.
2. **Kaliba C.**, Muya M., Sichombo B., and W. Shaakantu (TBA) *Construction project delivery success optimisation using the Analytic Hierarchy Process*, Journal of Engineering, Design and Technology.
3. Sichombo B., Muya M., Shankantu W., and **Kaliba C.**, (TBA), *A Technical Audit Model for construction projects*, Journal of Engineering, Design and Technology.

APPENDIX 2

Structured Interview Questions

The purpose of this study is to obtain a clear understanding on cost escalation, schedule overrun and quality shortfall factors in construction projects and mechanisms or ways that can be employed to minimise their occurrence and effects.

Please note:

- ❖ The answers should be based on your experience in construction projects.
- ❖ All information provided will be treated in the strictest of confidence.

Section 1. Personal Information

1.1. Name of interviewee:

1.2. Name of interviewee's firm:

1.3. Interviewee's position in firm:

1.4. Years of experience in construction:

1.5. What business in construction is your organisation involved in?

1.6. For how long has your organisation been involved in construction?

Section 2. Cost escalation, schedule overruns and quality shortfalls

2.1. Do you have any idea of what cost escalation, schedule overruns and quality shortfalls in construction projects are?

2.2. How prevalent are they and do they have any adverse effects?

2.3. What would you attribute to be the factors that cause:

2.3.1. cost escalation in construction projects?

2.3.2. schedule overruns?

2.3.3. quality shortfalls?

2.4. Are there any policies or strategies available in Zambia that can be used to prevent or minimise cost escalation? If they are available, what are the deficiencies which you feel must be addressed in order for them to function properly?

- 2.5. Are there any contractual methods that can best avoid or minimise the prevalence of cost escalation?
- 2.6. Are there any contractual provisions that can be used to minimise or eliminate cost escalation in construction projects? What are the factors that render them ineffective in addressing these problems?
- 2.7. Who is the first responsible party for cost escalation? Is it the contractor, consultant or client? Support your answer.
- 2.8. How best can cost escalation in construction projects be addressed?
- 2.9. Which project stages are best for controlling project cost? Is it at conceptual, design, preconstruction, construction or post construction stage? Support your answer.
- 2.10. Are there any policies or strategies available in Zambia that can be used to prevent or minimise schedule overruns? If they are available, what are the deficiencies which you feel must be addressed in order for them to function properly?
- 2.11. Are there any contractual methods that can best avoid or minimise the prevalence of schedule overruns?
- 2.12. Are there any contractual provisions that can be used to minimise or eliminate schedule overruns in construction projects? What are the factors that render them ineffective in addressing these problems?
- 2.13. Who is the first responsible party for schedule overruns? Is it the contractor, consultant or client? Support your answer.
- 2.14. How best can schedule overruns in construction projects be addressed?
- 2.15. Which project stages are best for controlling project time or programme? Is it at conceptual, design, preconstruction, construction or post construction stage? Support your answer.
- 2.16. Are there any policies or strategies available in Zambia that can be used to prevent or minimise quality shortfalls? If they are available, what are the deficiencies which you feel must be addressed in order for them to function properly?
- 2.17. Are there any contractual methods that can best avoid or minimise the prevalence of quality shortfalls?

- 2.18. Are there any contractual provisions that can be used to minimise or eliminate quality shortfalls in construction projects? What are the factors that render them ineffective in addressing these problems?
- 2.19. Who is the first responsible party for quality shortfalls? Is it the contractor, consultant or client? Support your answer.
- 2.20. How best can quality shortfalls in construction projects be addressed?
- 2.21. Which project stages are best for controlling quality in a project? Is it at conceptual, design, preconstruction, construction or post construction stage? Support your answer.
- 2.22. With reference to construction projects, what other views do you have about:
- a) Cost escalation?
 - b) Schedule overruns?
 - c) Quality shortfalls?

The End!

Thank you for taking time to participate in the interview.

APPENDIX 3

Cover letter to the questionnaire



The University of Zambia,

School of Engineering,
Dept of Civil & Environmental Engineering,
P. O. Box 32379, Lusaka.
Cell: +260977619877, E-mail: cjicax@yahoo.co.uk

3rd November 2008

Dear Sir or Madam,

QUESTIONNAIRE SURVEY ON CONSTRUCTION COST ESCALATION, SCHEDULE OVERRUNS AND QUALITY SHORTFALLS

I am presently pursuing a Master of Engineering degree in Construction Management by research at the University of Zambia. My research topic is "Cost escalation, schedule overruns and quality shortfalls in construction projects".

The study seeks to assess the frequency of occurrence, severity of impact, and atrociousness of cost escalation, schedule overruns and quality shortfall factors in construction projects. It also seeks to rate the importance of project success factors with respect to enhancing the efficacy of cost, schedule and quality management. The results obtained from this study will provide empirical results that can be used in developing a construction management model that will be useful in alleviating cost escalation, schedule overruns and quality shortfalls in construction projects in Zambia.

Enclosed herewith, please find a questionnaire, and based on your experience as a professional in the field of construction, kindly spare a few minutes of your valuable time to complete it. Please answer all questions where possible. All the information gathered will be kept strictly confidential and will be used only for research and analysis without mentioning the names of individuals or companies involved.

Should there be any queries, please do not hesitate to get in touch with the undersigned using the address provided above. Your assistance and cooperation will be highly appreciated.

Thank you in advance for your time and kind cooperation.

Yours Faithfully,

Kaliba Chabota I (Master of Engineering Student)

APPENDIX 4

Questionnaire

The purpose of this study is to measure the frequency of occurrence, severity of impact, and significance of cost escalation, schedule overrun and quality shortfall factors in construction projects. It also seeks to rate the importance of project success factors with respect to enhancing the efficacy of cost, schedule and quality management.

Please respond to the following questions either by ticking appropriately or by writing your answer in the space provided.

Please note:

The answers should be based on your experience in construction projects.

All information provided will be treated in the strictest of confidence.

Section 1. RESPONDENT'S EXPERIENCE.

1.1. WHAT BUSINESS IN CONSTRUCTION IS YOUR ORGANISATION INVOLVED IN?

- A. Contractor
- B. Consultant
- C. Client/ Client representative
- D. Financier
- E. Other please specify _____

1.2. WHAT IS THE SECTOR TYPE YOU WORK FOR?

- A. Public
- B. Private
- C. Both

1.3. HOW LONG HAVE YOU BEEN DEALING WITH CONSTRUCTION PROJECTS?

- A. <5 years
- B. 5-10 years
- C. 10-15 years
- D. >15 years

1.4. WHAT IS YOUR MAJOR ACTIVITY IN CONSTRUCTION?

- A. Roads
- B. Buildings
- C. Civil
- D. Building & Civil
- E. Mechanical
- F. Electrical
- G. Other please specify _____

1.5. WHAT SIZE OF PROJECTS HAVE YOU PARTICIPATED IN? PLEASE INDICATE IN THE SPACE PROVIDED THE NUMBER OF PROJECTS THAT FALLS UNDER EACH CATEGORY (YOU MAY SELECT MORE THAN ONE)

- A. More than US\$10 million _____
- B. US\$6 - 10 million _____
- C. US\$1 – 5 million _____
- D. Less than US\$1 million _____

Section 2. CONTRACTUAL ARRANGEMENTS

2.1. WHAT CONTRACTUAL ARRANGEMENT(S) HAVE YOU PREVIOUSLY BEEN INVOLVED IN? (YOU MAY SELECT MORE THAN ONE)

- A. Traditional (Design – Bid – Construct)
- B. Management contracting (All works are sub-contracted except the management responsibility)
- C. Design and build
- D. Construction management (A construction manager is engaged to supervise planning, design, construction & commissioning)
- E. Other please specify _____

2.2. WHICH CONTRACTUAL METHOD DO YOU THINK BEST AVOIDS COST ESCALATION, SCHEDULE OVERRUNS AND QUALITY SHORTFALL ON A CONSTRUCTION PROJECT?

- A. Traditional
- B. Management contracting
- C. Design and build
- D. Construction management
- E. Other please specify _____

Section 3. PERFORMANCE OF PROJECT(S) YOU HAVE BEEN INVOLVED IN

3.1. WHAT PERCENTAGE OF THOSE PROJECTS EXPERIENCED COST ESCALATION?

- A. Less than 25%
- B. 25 to 50%
- C. 51 to 75%
- D. 76 to 100%

3.2. WHAT WAS THE AVERAGE PERCENTAGE OF COST ESCALATION ON PROJECTS YOU HANDLED?

- A. Less than 10%
- B. 10 to 30%
- C. 31 to 50%
- D. 51 to 100%

E. Over 100% Please Specify _____

3.3. OF PROJECTS YOU HANDLED, WHAT PERCENTAGE EXPERIENCED SCHEDULE OVERRUNS?

- A. Less than 25%
- B. 25 to 50%
- C. 51 to 75%
- D. 76 to 100%

3.4. WHAT WAS THE AVERAGE PERCENTAGE OF SCHEDULE OVERRUNS ON PROJECTS YOU HANDLED?

- A. Less than 10%
- B. 10 to 30%
- C. 31 to 50%
- D. 51 to 100%
- E. Over 100% Please Specify _____

3.5. WHAT PERCENTAGE OF PROJECTS YOU HANDLED EXPERIENCED QUALITY SHORTFALLS?

- A. Less than 25%
- B. 25 to 50%
- C. 51 to 75%
- D. 76 to 100%

3.6. TO WHAT EXTENT WOULD YOU SAY WAS THE LEVEL OF QUALITY SHORTFALL ON PROJECTS YOU HANDLED?

- A. Less than 25%
- B. 25 to 50%
- C. 51 to 75%
- D. 76 to 100%

Section 4. CAUSES OF COST ESCALATION, SCHEDULE OVERRUNS AND QUALITY SHORTFALLS

Rank the following causes with regards to their frequency and Severity by marking in the appropriate space provided. The range of weighting is from 1 to 4 as shown in the table below.

Scale	Frequency (F)	Severity (S)
1	Never	No effect
2	Occasionally	Fairly severe
3	Frequently	Severe
4	Always	Very severe

4.1 Cost escalation

Cause	Frequency				Severity			
	1	2	3	4	1	2	3	4
Acquiring land								
Bad weather (Heavy rains and floods)								
Change orders/Scope changes								
Changes or unclear regulatory requirements								
Complexity of administrative structure								
Corruption								
Delayed or non payment of Interim Payment Certificates (IPCs)								
Disruption of management continuity								
Disruption of political continuity								
Environmental protection & mitigation costs								
Illegal encroachment on project sites								
Inexperienced administrative personnel								
Inflation								
Insufficient initial analysis of costs								
Lack of coordination on site								
Lack of organisational capacity/capabilities								
Local government pressures								
New technology requirements								
Poor contract management								
Poor technical performance								
Project conditions								
Project location								
Safety & Health issues								
Schedule delay/overrun								
Size of project								
Strikes								
Suspension of works								
Technical challenges								
Transformation of community expectation								
Unforeseen constructability issues								
Unforeseen engineering complexities								

4.2 Schedule Overruns

Cause	Frequency				Severity			
	1	2	3	4	1	2	3	4
Acquiring land								
Bad Weather (Floods or Heavy rains)								
Change order/scope changes								
Changes in Drawings & Specifications								
Changes in laws & Regulations								
Client's Financial processes								
Construction mistakes								
Contract modification								
Corruption								
Damages to structure								
Defective work								
Delayed or non payment of IPCs								
Different site conditions								
Economic problems in the country								
Equipment unavailability								
Financial difficulties on the part of the Client								
Financial difficulties on the part of the Consultant								
Financial difficulties on the part of the Contractor								
Health & Safety issues								
Inadequate planning								
Inadequate review								
Inadequate scheduling								
Incomplete documents								
Inspection								
Labour disputes & strikes								
Lack of high technology								
Lack of qualified manpower								
Material fabrication delay								
Material procurement								
Poor coordination on site								
Poor managerial skills								
Poor sub-contractor performance								
Poor supervision								
Schedule mismanagement								
Shop drawing approval								
Staffing problems								
Subsurface soil conditions								
Suspension of works								
Transportation delays								
Underestimation of productivity								

4.3 Quality Shortfalls

Cause	Frequency				Severity			
	1	2	3	4	1	2	3	4
Client lacking relevant knowledge								
Corruption and demand for kick backs by Consultants prior to certification of works.								
Disruption of project management continuity								
Inadequate and/or inconsistent release of project funds by clients.								
Inadequate inspections								
Inadequate project planning								
Inadequate supervision by contractors								
Inadequate/wrongly applied specifications								
Incompetence and lack of capacity by contractors to execute works								
Incompetence of some Consultants								
Lack of project coordination by the client, contractor and consultant								
Local government pressures								
Long time lapse between assessment, procurement and implementation of the project.								
Poor financial management by contractors.								
Poor sub-contractor performance								
Project location								
Size of project								

Section 5 : PROJECT SUCCESS ENHANCERS

Below is a list of project success enhancers. Kindly rate their importance with respect to enhancing cost, schedule or quality effectiveness on a scale of 1 to 4, with 1 having the least and 4 the highest importance score as shown below, by marking in the appropriate space provided.

Scale	Importance
1	Not important
2	Fairly Important
3	Important
4	Very Important

Success enhancers	Cost				Schedule				Quality			
	1	2	3	4	1	2	3	4	1	2	3	4
Adequate funding												
Adequate & comprehensive plans and specifications												
Adequate supervision												
Client's knowledge of construction												
Consultant's competence & experience												
Contractors' cash-flow projections												
Contractor's experience & competence												
Effective & efficient decision making												
Effective communication & speed of information flow amongst project participants												
Effective coordination of project activities												
Effective cost control system												
Effective planning of project activities												
Effective project monitoring												
Effective quality assurance and control												
Effective scheduling and time control system												
Elaborate dispute resolution process												
Feedback capabilities within project setup												
Human Skill availability												
Influence of the client/client's representative												
Motivation/incentives												
Nature of client												
Precise definition of project scope & objectives												
Project bidding system												
Proper site management												
Reduced fraudulent practices, corruption, favouritism, lack of ethics, etc												
Stable social, economic, political, industrial and administrative environment												
Technology availability												

The End!

Thank you for taking time off to complete the questionnaire.

APPENDIX 5

Snapshots from Expert Choice on the CSEFM

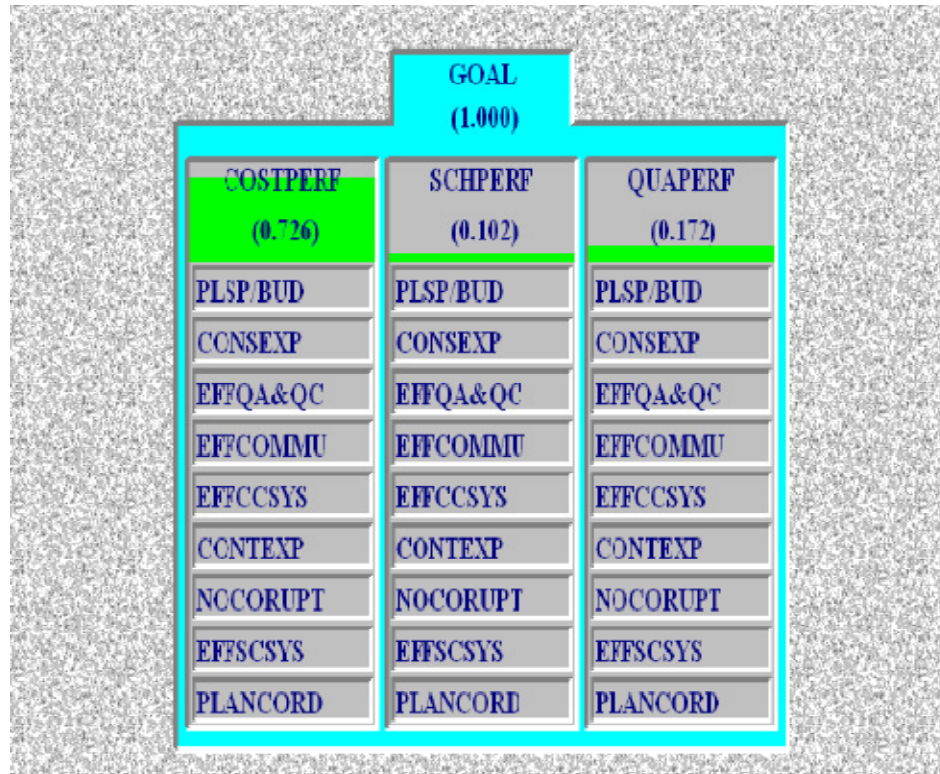


Figure A5-1: The CSEFM displayed from Goal Node (Respondent 5)

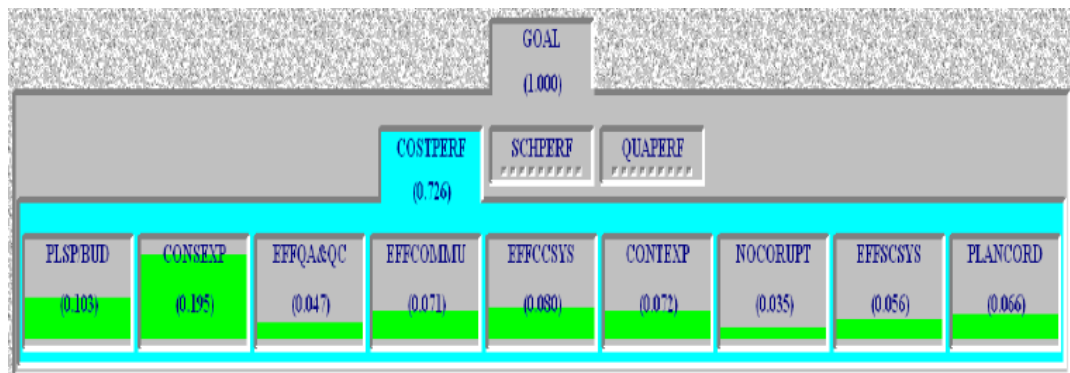


Figure A5-2: CSEFM displayed from Cost performance node (Respondent 5)

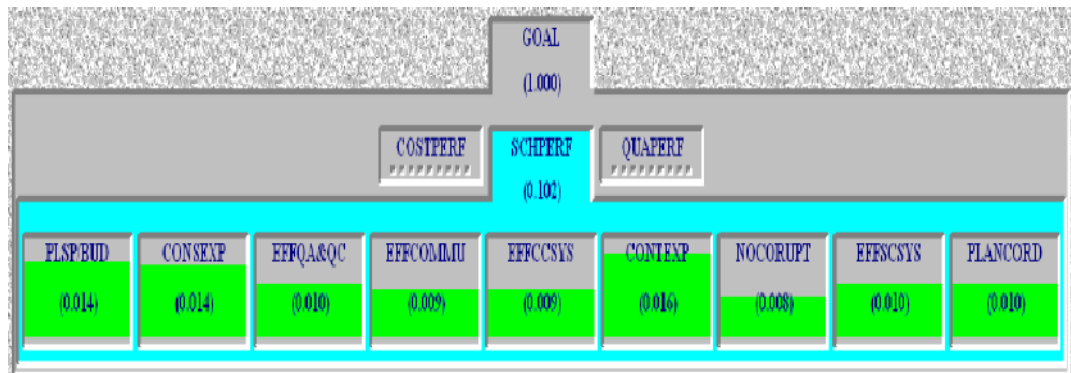


Figure A5-3: CSEFM displayed from Schedule performance node (Respondent 5)

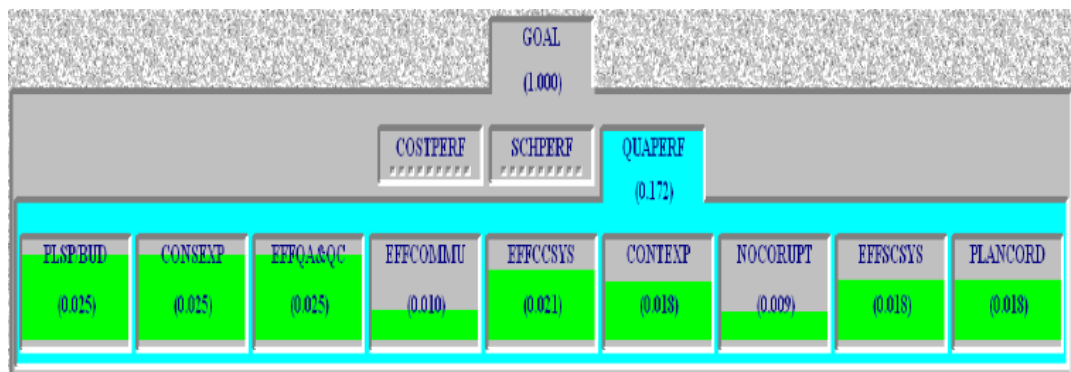


Figure A5-4: CSEFM displayed from Quality performance node (Respondent 5)

The consistence ratio for respondent 5's judgments was found to be 8 percent as such the results were synthesized. The resultant overall synthesis is presented in Figure A5-5.

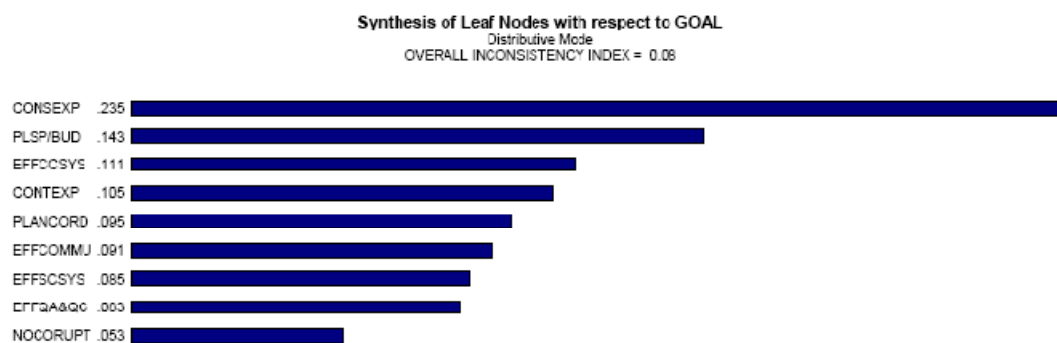


Figure A5-5: Synthesis of leaf nodes using the distributive mode as evaluated by Respondent 5