A study of causes of delay and cost overrun in office construction projects in the eThekwini Municipal Area, South Africa

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DECLARATION

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DEDICATION

THIS DISSERTATION IS DEDICATED TO MY FATHER, THE LATE TESFAHUN ADUGNA.

ACKNOWLEDGMENT

First and foremost I would like to thank the Almighty God**,** who gave me the commitment and patience to pass various obstacles and complete this research thesis.

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ABSTRACT

On-time completion and conformity with assigned cost of every project are the most important factors in the success of project plans. Cost overruns and time overrun (delays) have been critical problems of many projects around the world in general and in South Africa in particular. The main objectives of this research are to assess the dominant causes of cost and time overruns, identifying possible and practical measures that can minimize overruns in office building construction projects around eThekwini Municipal area of Kwazulu-Natal. These objectives are achieved through the implementation of the research methodologies that are mainly literature review and questionnaire survey conducted to identify and evaluate the significant factors contributing to delay and cost overruns within the projects of interest.

A review of literature identified eighty-five variables for delay, grouped in nine major categories and nine variables for cost overruns ranked in their order of importance in three sets based on the responses from the professionals working for the client, consultants and contractors. The agreement among the sets of rankings for delay and cost overruns has also been tested using statistical methods. The result indicates that there is strong agreement on ranking the importance of the individual variables of delay and cost overruns between parties. From each of the three sets of rankings, the twenty most important variables of delay and the three most important variables of cost overrun are identified as critical. Based on overall results, the top five most important causes are contractor's cash flow problems, delay in progress payments by the client, poor site supervision and management by contractor, inefficient quality control by the contractor during construction leading to rework due to errors, and contractor's difficulties in financing the project. Out of the 20 most important delay causing variables, three are found to be common between all parties. These are delay in progress payments by the client, delay in delivery and late ordering of material, and insufficient skill of labour.

Furthermore, the study reveals that all stakeholders of construction parties are deeply involved in contributing to the causes of the problems. Thus, in order to eliminate or minimize cost and time extension of office construction projects in the eThekwini Municipal area, a joint effort based on teamwork is essential through effective project planning, controlling and monitoring which boils down to putting in place best practice construction project management.

Keywords: Cost overrun, Delay, eThekwini Municipal area, Durban, Office construction projects, South Africa

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LIST OF ABBREVIATIONS

CIDB……Construction Industry Development Board

ASAQS…… Association of South African Quantity Surveyors

CBD …….Central business district

CIOB……Chartered Institute of Building

CPM…….Critical path method

GDP…….Gross Domestic Product

KZN ……KwaZulu-Natal

SAIA …….. South African Institute of Architecture

SAPOA……South African Property Owners Association

INTRODUCTION

1.1 Background

The construction sector worldwide in general and in South Africa in particular is a multibillion dollar industry that almost always grows in size and complexity of technology (South Africa Reserve Bank, 2012). It is one of the most labour intensive sectors and gives job opportunities to millions of citizens. The industry represents one of the most important sectors to the local economy (not only does it contribute to the significant portion of the country's Gross Domestic Product (GDP), but it also contains a substantial portion of the labour force). It has long been recognized that the role of the construction industry in socio-economic development goes beyond its share in national output. A number of studies have focused on the issue of employment creation and others have emphasized its multiplier effect on other sectors of the economy (Ruddock 2010; Amaratunga and Haigh, 2010; Turin, 1973). The fragmented nature of the construction service sector is especially relevant in day-to-day lives of people because it brings to them the physical infrastructure for personal shelter, water and electricity delivery, sanitation, transportation, schooling, health services, and private sector doings. It is one of the main service sectors in most economies in terms of employment and value adding. Therefore, the construction industry can be considered as one of the locomotives of national economic development, where resources, labour, materials, equipment, capital, and market exchange are provided from within the national economy. Development in this sector is imperative for growth in national revenue (Ogunlana *et al*., 1996).

The industry can be broadly divided between 'construction' and 'building' activities (Merrifield, 2002b). Construction mainly refers to infrastructure development, such as roads, bridges, dams, ports, whereas, building generally refers to residential and non-residential structures, such as houses and offices Infrastructure, traditionally provided by the public sector as a public good, increasingly involves public-private partnerships.

The biggest client of the construction industry is the government. While public sector involvement in the building industry can also be significant, the contractors in this industry are generally dominated by the private sector. The construction sector is a labour intensive sector, involving a wide range of different skills and professionals, including architects, engineers, quantity surveyors, contractors and construction managers (Stern and Teljeur, 2002). Workers with limited skills and workers with trade experience, such as plumbers, electricians and carpenters are also involved. Enterprises operating in the construction sector vary from relatively few large contractors to many small contractors and subcontractors. The labour intensity of construction makes it one of the most important sectors for South Africa's economic performance and growth (Economic sector review in construction, 2009).

The construction industry is large, complex, volatile, risky, and requires tremendous capital outlays and tight money. It provides a bigger challenge to maintain its scheduled time, budgetary cost, and appropriate quality (Shaikh *et al.*, 2010). A major criticism facing the construction industry is the growing rate of cost overrun and delays in project delivery. Enshassi *et al*. (2003, 2008) explain that the increasing complexity of construction projects and the environment within which they are constructed place greater demands on construction managers to deliver projects on time, within budget and with high quality. On-time completion and conformity with assigned cost of every project are the most important factors in the success of project plans. However, completing construction projects on time and within budget has been a major problem (Flyvbjerg *et al.*, 2003; Sanders and Eagles, 2001). Construction delay and cost overrun occurs all over the world and many studies have been carried out to assess the causes of cost and time overruns in construction projects. For example Assaf and Al-Hejji (2006) reported that 70% of the construction projects in Saudi Arabia are experiencing delay. Odeyinka and Yusif (2002) noted that seven out of ten projects in Nigeria suffered time overruns in their execution. In South-East Asia, the fast developing country Malaysia, the construction sector has not escaped the problem of delays. Among 417 public

projects, 17% projects experienced around three months of delay in 2005 (Sambasivan and Soon, 2007). Through seven years of sampling, that covered 258 projects across 20 nations and 5 continents, Flyvbjerg (2009) concluded that 90% of construction projects suffer cost and time overruns. Like elsewhere in the world, construction time delays and cost overruns are common occurrences in South African construction industry in general and in the eThekwini District Municipality of KwaZulu-Natal (KZN) construction projects in particular.

According to eThekwini Economic Development Unit Report (2006/2007), in the early 2000s the macro office sector generally experienced depressed conditions mainly reflecting a period of heightened oversupply, high vacancy rates and a resulting decline in rental increase. This not only affected the already depressed central business district (CBD) market, but also impacted on the performance of decentralized nodes. From 2004 onwards, the sector stabilized with vacancies starting to decline, that in turn has led to improved prospects for rental increases and development potentials. The CBD office sector caters for both the private and public sectors. Micro locational issues, such as the affordability of space, make it attractive for tenants to either stay, relocate or expand in the CBD. The office sector in Westville node comprises a number of relatively dispersed office parks. Generally the node has developed as a decentralized commercial node. Prime office developments include the Westway Office Park, located off the St. James Road off-ramp, on the N3. Examples of other office nodes in the Westville area are Derby Downs and Essex Terrace Office. The Umhlanga node, located to the north of Durban, is a growing office node concentrated on the eastern and western sides of Umhlanga Rocks Drive. The node has a strong residential base, which in the past few years has been complemented with retail and office developments. In close proximity to Umhlanga, the La Lucia Ridge Office Estate has become Durban's premier decentralized office location. It attracts blue-chip companies, and companies in the financial sector (Property market review 2006/2007).

The office construction projects in Durban are part of the country's development initiative. It provides a workplace and working environment primarily for administrative and managerial workers (Property market review 2006/2007). Office construction is considered unique since it can stimulate the development of other industrial sectors. Therefore, improving office construction efficiency by means of cost effectiveness and timeliness would certainly contribute to minimize disputes, claims leading to lawsuits and cost saving for the whole country. Since office construction is facing a lot of challenges such as delay to complete the project on time and expenditure exceeding the budget, efforts need to be put in place directed at managing construction cost and time effectively. Cost overruns and delays have substantial implications from an economic and political point of view. Due to delays in project implementation, the people as well as the economy need to wait longer than is necessary for the provisions of services and public goods. Thus, delays restrict the growth potential of the economy and its competitiveness (Singh, 2009). The major factors that cause project delays and time overrun in the eThekwini District Municipal area are poorly understood. Thus, this research undertakes to investigate and to identify the factors that cause time and cost overrun in office construction projects in the eThekwini Municipal area of KZN, South Africa.

1.2 Research problem

Among the construction projects undertaken in recent years, most are delayed well beyond the expected time for completion and also required additional budget more than contracted during the commencement of the respective projects (Durban CBD Office Market Report, 2012). This problem in turn is causing difficulties in financing of upcoming projects, timely utilization of the facility by the public and the relationship among stakeholders (Employer, Contractor, Financier, etc.) involved in the construction process. The main factors that are responsible for delay and cost overrun in many office construction projects are poorly understood and are investigated in this research.

1.3 Aim

Delays and cost overrun of construction projects could be minimized only when their causes are identified and recognized. Therefore, this research the problem as to why most of the office construction projects in the eThekwini Municipal area are delayed beyond their completion date and require additional budget above the respective contract prices, how these problems can be minimized and hence provides solutions to the delivery of office construction projects within the stipulated budget and time.

1.4 Research objective

The main objectives of the research are:

- To identify factors that cause delays and cost overrun in office construction projects in the eThekwini District Municipality;
- To analyse and rank in their order of significance, level of severity and the importance of the causes of delays and cost overruns perceptions of the three major parties in any construction, namely; owners, contractors and consultants;
- To analyse and rank the categories of delay and the relevant responsible parties to the causes of cost and time overrun;
- To recommend mitigation measures that minimize cost overrun and delay in future office building construction projects.

1.5 Scope of the research

Delays and cost overrun occur in most construction projects and the significance of the causes responsible for cost overrun and delay vary from project to project. This research focuses on identifying major causes of cost and time overrun on office construction

projects within the eThekwini District Municipality of KwaZulu-Natal (Figure 1), South Africa. The research further envisages identifying, analysing and ranking the major causes of office construction cost overrun and delay and coming up with a recommendation of measures that minimize and mitigate these problems.

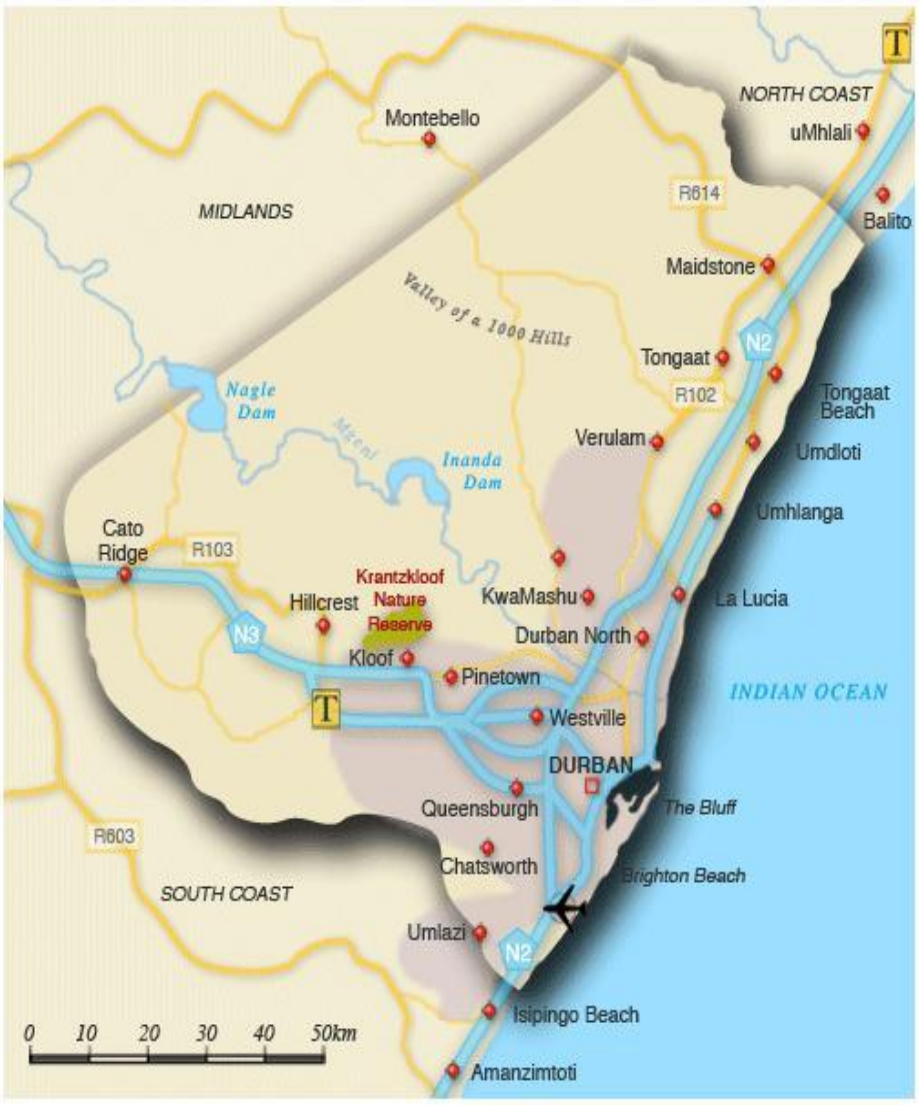

Figure 1: Location map of the eThekwini District Municipality showing the CBD and decentralized nodes (eThekwini Municipality, 2011)

1.6 Research Area

The eThekwini District Municipality (study area) is located in the east coast of South Africa. It is one of the district municipalities of KZN. The Municipality has an area of nearly 2297 km^2 and is home to approximately 3.5 million people making the area the third populous municipality in South Africa (eThekwini Municipality, 2011). The office sector in eThekwini Municipality area is mainly driven by conditions in the local economy as well as the attractiveness of the city as an office location.

1.7 Structure of the Thesis

A thorough literature review follows the identification and approval of the research problem. Various documents and relevant information are collected. The collected information along with data retrieved from questionnaire respondents are discussed and analysed. The results are interpreted and based on which conclusions and recommendations are made. In general the research thesis is structured into the following six major chapters:

Chapter 1: Introduction

The introductory chapter provides background information about the problem of construction project cost overrun and time delay in South Africa and the rationale to undertake a research.

Chapter 2: Literature Review

The purpose of this chapter is to identify the factors, as exhaustively as possible, that cause delays and cost overrun in construction projects by looking into previous studies made on the subject.

Chapter 3: Research Design and Methodology

The third chapter discuss the design or the approach adopted in this research for obtaining the information needed to structure the research questionnaire, to collect data, and methods of analysis to achieve reliable results on the study area.

Chapter 4: Data Presentation and Results

The fourth chapter provides explanations of the issues related to the way the questionnaires are distributed, responses are retrieved and subsequent analysis of the data collected through the questionnaire survey from professionals working for clients, consultants and contractors who are involved in the office building construction sector within the eThekwini District Municipality of KwaZulu-Natal, South Africa. In addition the main findings are properly described and reported.

Chapter 5: Discussion

The fifth chapter discusses on the results of data analyses and the interpretation of results obtained from the survey under the respective major categories of delay causes.

Chapter 6: Conclusions and Recommendations

Chapter 6 summarizes the whole discussion presented in the report and concisely reflects on the origin of the survey and how the research is designed and conducted, followed by highlights of the results of the survey and concludes that important recommendations that emanate from the main findings of the research are listed.

LITERATURE REVIEW

1.8 General

A successful construction project is an integrated effort by people of different qualifications ensuring its completion within the scheduled time, without exceeding the allocated budget, and within the specified quality and standards. However, for various reasons, project successes are not common in the construction industry, especially in developing countries, caused by delays and cost overrun. There are many causes of delays and cost overruns in construction projects. Several studies have pointed out various factors based on the underlying condition that the specific study is concerned with, such as project type, specific location and project size.

The main purpose of this chapter is to identify the factors that cause construction project delays and cost overruns as exhaustively as possible through an intensive and comprehensive review of past research carried out by various researchers in different construction environments. This desktop literature investigation is particularly important as it provides a substantial part of the inputs for the lists of factors to be considered for the research and to develop a conceptual framework for the research method design.

In the following sections, a brief discussion of the types of construction project delays and cost overruns are given, some basic terminologies/phrases used in the study are described and a comprehensive review of literature presented.

1.9 Construction Delays

Most construction projects need to go through various stages; from planning and developing of the project, to its approval, to tendering of the contract, and to the actual construction.

The life cycle of construction projects comprises of different phases. This may include project development, construction/procurement and operation and maintenance phase (Figure 2).

Figure 2: The different phases of construction project (Singh, 2009).

In the early stage of project development phase, the estimates of cost and time which will be needed to complete the project are prepared by the project management consultants (Singh, 2009).

Based on these estimates and other preliminary information, tender documents are prepared. During the tendering process, the contractors provide their respective prices along with their work program (schedule). After the tenders screening and appraisal process, the contract is awarded based on lowest or best evaluated offer. The contract document which is the binding agreement between the client and the contractor stipulates the project timelines for completing the scope of work within the approved cost. The actual date of completion is nearly always different from the expected date.

According to Singh (2009), time overrun is defined as the difference of time between the actual and the initially planned dates of completion. The time difference is often measured in months. A related term such as the implementation phase or implementation period is the duration in which a project is planned to be executed. Delay and cost overruns could occur in all phases of construction. However, several other studies have

reported that project delays and cost overruns occur mainly during the construction phase. This is because most of the project budget is consumed during the construction process and many unforeseen factors are always involved in the construction phase such as the performance and the involvement of other parties, resources availability, environmental conditions and contractual relations. Assaf and Al-Hejji (2006) define construction delay as the time overrun either ahead of the finishing date that is signed in the agreement or the date which has been agreed by the owner and contractor. It is a phenomenon where the project is postponed for more time than planned. On the other hand, Aibinu and Jagboro (2002) define construction delay as a circumstance where a contractor and the project owner or the client mutually or separately contribute to the non-completion of the construction project within the original (stipulated) or agreed contract period. Furthermore, Stumpf (2000) presents delay as the extension of time required for completing the task under the contract. Delay is actually lack of performance or a postponement of time from the stipulated estimated finishing time that can be caused by contractor, consultant or owner as well as by some other external aspects. Construction delay is one of the most costly, complicated and common events in construction projects because it comprises large numbers of parties as clients (owners), consultants, contractors, regulators and stakeholders. Besides, the industry plays a major role in the development and achievement of society's goals. According to Alaghbari *et al*. (2007), time delay is critically important to both the contractor (in terms of money) and to the owner (in terms of performance), which becomes the origin of regular disputes and claims leading to lawsuits. This is due to the fact that delays affect all the various construction project participants. For the client, delay can be seen as the loss of revenue due to lack of production facilities, rentable space or a dependence on present facilities.

To the professionals, time overrun implies inability to deliver value for time and money as well as tarnish their reputations and names, and results in loss of confidence rested in them by clients (Assaf and Al-Hejji, 2006). Whereas to the contractor, delay is simply an

additional liability as: (i) the construction period becomes longer, (ii) higher cost of material through inflation and due to labour cost increases, (iii) longer construction period results in higher overhead costs and expenses and (iv) the entire contractor's working capital may become trapped in one project. Al-Kharashi and Skitmore (2009) also define delays as loss of output and revenues as the contractor cannot become involved in other projects.

1.10 Types of Delays

Any delaying event in construction could happen from the fault of the employer, or the contractor or for a condition that is beyond the control of both parties. In this respect, Kaming *et al*. (1997) classified delays into excusable, inexcusable and concurrent delays and are presented diagrammatically in Figure 3.

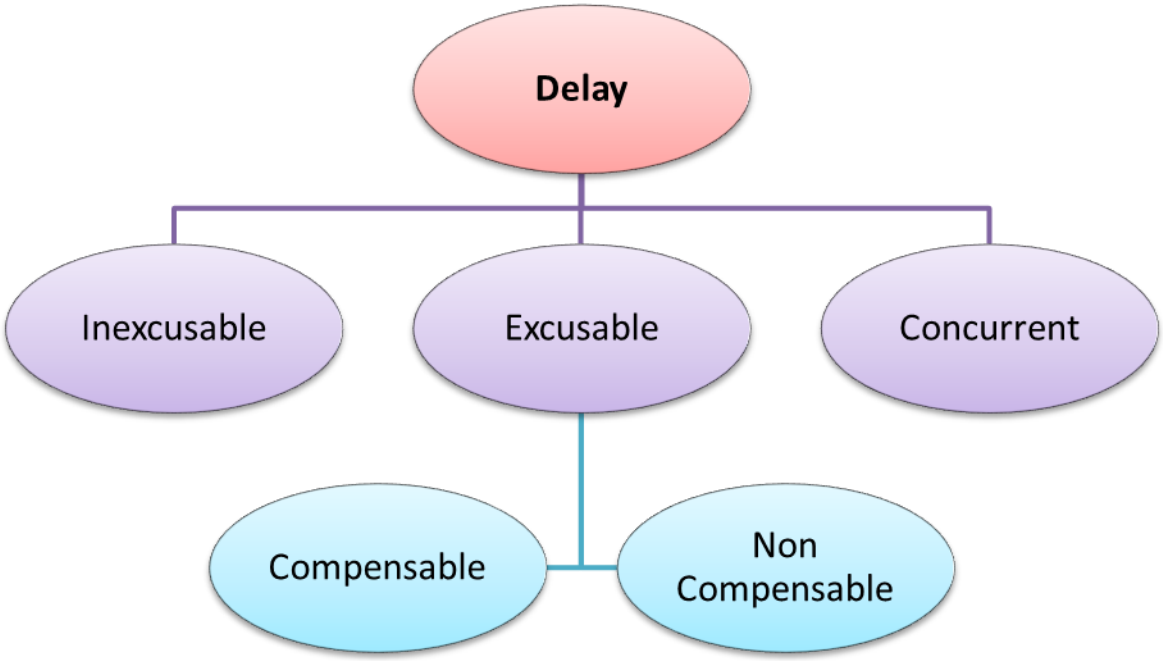

Figure 3: Diagrammatical representation of the different type of delays (Kaming *et al*., 1997; Alkass *et al*., 1996 and Yogeswaran *et al*, 1998).

1.10.1 Excusable Delays

Excusable delays are not attributable to the actions or inactions of contractor, and basically include unforeseen events. These events are out of the contractor's control and are without negligence or fault on contractor's part. According to general provisions in public agency specifications, delays resulting from the subsequent events would be considered excusable. These are general labour strikes, fires, floods, acts of God, owner-directed changes, omissions and errors in the plans and specifications, differing site conditions or concealed conditions, unusually severe weather, intervention by outside agencies and lack of action by government bodies, such as building inspection. Excusable delays can be further classified into compensable delays and non-compensable delays. Whether a delay is compensable or not it depends primarily on the agreement of the contract. In most cases, a contract specifies the kinds of delays that are non-compensable, in which the contractor does not attain any additional money but can be allowed a time extension (Kaming *et al*. 1997).

i) Compensable Delays

Compensable delay is a type of delay over which the client (or client's his representative) has control. Basically, in compensable delay the contractor will be eligible to additional reimbursement for the cost of delay and additional time for contract performance as well. If the owner causes delay like change in scope of work, impeded site access, late supply of clients materials or information, failure to provide timely and review shop drawings and differing site conditions; the contractor will be granted for additional time and money, This type of delay is a delay, for which the innocent party is eligible for extension of time and additional reimbursement for the resulting costs. The contractor is entitled due to time of the owner to offer all necessary details and instruction. For instance, where the employer or owner causes a delay, if the agreement does not include a provision acquitting the employer from liability for delays, the contractor is eligible to both time extension and compensatory damages. Building

contract agreements do not usually need the contractor to apply all of the performance time assigned by the agreement. Recognizing this, courts held owners liable for delaying contractors although the project was done within the contractually agreed time because of the fact that the contractor is prohibited from attaining an early finish. Thus, finishing on time does not necessarily prevent the recovery damages of delay where a reasonable as-planned schedule would then have yielded early completion (Alkass *et al*., 1996).

ii) Non-compensable delays

Non-compensable delays are caused by an unforeseen event or incident beyond the control of the contractor and the client. As a result, both parties can incur losses in term of cost. The contractor admits his time overrun costs for taking more time in the project while the client absorbs its additional cost in the form of liquidated damages by giving additional time to the contractor and extending the contract. Causes for this type of delay cannot be controlled by any party to take the responsibility of extra cost resulting from it. These causes of delays include events such as force major; act of public enemy; war, acts of another contractor; strike, acts of God; unusual weather, fires, actions of government in its supreme capacity. In this situation, the contractor is usually eligible to extension of time but not eligible to any additional financial compensation for delay damages from the owner. Liquidated damages are set as an amount of money stated in the contract agreement by an agency to compensate the party for unexcused interruption in the performance of the contract. The aim of the liquidated damages clause is to establish, in advance, a practical reasonable evaluation of the damages that would be incurred by the party if there is a breach of contract or an unexcused delay (Kaming *et al*. 1997).

1.10.2 Inexcusable delays

Inexcusable delays are delays over which the contractor (or any subcontractor) has control or delays that are not accepted by the client. In contrast to excusable delay, a non-excusable delay offers no bases for recovery of either the monetary or the time

impact of the delay. Accordingly, this type of delay grants no entitlement extension of time or delay damage to the contractors even if the delay affects the whole project. The owner however could be entitled to liquidate damages. For instance, a non-excusable delay could be when a contractor is not able to provide sufficient manpower to complete the work on time. In addition, non-excusable delay is in which the party accepts the risk of delayed performances and its consequences. Commonly for a contractor non-excusable delays include failure to complete work within the allotted time frame (Alkass *et al*., 1996).

1.10.3 Concurrent Delays

Concurrent delays are delays that occur, at least to some degree, during the same period of time. In construction, the term concurrent delay refers to the situation when non-excusable delay and an excusable compensable delay occur during overlapping time periods or at the same time. According to Alkass *et al*. (1996), concurrent delays refer to situation of delays while two or more than two delays (regardless of the type) exist at equal time or overlap to a certain degree. Concurrent delay is also used to denote a project overrun period that is caused by two or more effective delay causes which are nearly equal causative potency. In a nutshell, this type of delay can be described as a where there are more than one delay causes operating at a specific point of time.

However, in concurrent delay there are two events in which one is more important than the other. The contractor is eligible to additional time for the period of time overrun caused by the relevant event nevertheless the concurrent effect of other event. Concurrent delay generates complex legal issues about assessing responsibility for overall delayed project. The analysis of concurrent delays could be further complicated if: (i) the delay periods are different lengths, (ii) the delay periods are not totally concurrent, and (iii) the delay periods are periods that have different influence on the

type and number of work activities that are affected and the severity of the impacts upon the affected work activities are different for each of the delays (Yogeswaran *et al*. 1998).

Basically, such classifications are used for the purpose of defining the responsibility and subsequent entitlement for compensation of the impact of any delay event in the context of the conditions of contract provisions. Alkass *et al*. (1996) and Yogeswaran *et al*. (1998) have described the aforementioned classifications as excusable – non compensable, excusable -compensable and non-excusable delays respectively. They further explain concurrent delays where there is a situation where two or more delays exist at the same time or overlap to a certain degree. In such circumstances the combinations of the aforementioned scenarios should be considered in order to determine the possible entitlement to the contractor, either only for extension of time or extension of time with financial compensation.

It is however not a simple task to determine the amount of extension of time and/or monetary compensations as each of the concurrent delay events should be reviewed in line with the contractor's work program to see whether the delaying events are on the critical path or not. Critical path is the sequence of tasks which sum up to the longest overall duration. It is the minimum possible time required to finish the project. Any dalliance on the critical path hinders the finishing date of the project. A project could have many parallel, nearly critical paths. An additional path in the network with the duration less than the critical path is known as a sub-critical (or non-critical path). Yogeswaran *et al*. (1998) present a further detailed analysis of different scenarios of concurrent delay events with critical and non-critical activities. Hence, when there are such overlaps of causes usually the following approaches are applied:

- When the non-excusable delay is on the critical pathway and the excusable delay is non-critical, no extension of time is due.
- When the non-excusable delay is non-critical and the excusable delay is on the critical path, extension of time is due even if the non-excusable delay

commenced early in the non-critical chain of activities in so far as the non-excusable delay does not impact the critical activity.

- When both excusable and non-excusable delays are critical and commenced together and cease at the same time, both the employer and contractor should bear responsibility for them. The contractor is entitled for extension and is not entitled for associated costs even if the excusable delay is a compensable delay.
- When an excusable delay occurs first on a critical path followed by a non-excusable delay on a parallel critical path, there are grounds to argue that no compensation should be permitted but still the case will be open for debate. However, the dominant cause for the delay should be the deciding factor (Yogeswaran *et al*, 1998).

To reach to a conclusion that the contractor is entitled to a certain amount of time and/or monetary compensation or the client for liquidated damages, the agreement between the parties should have express terms in the contract for which type of delay events that the contractor is responsible and for which he is entitled to time and/or additional payment; otherwise the situation will be even more complicated. Besides, if there is any ambiguity in the extension of time clause, it will be taken against the party who was responsible for drafting the contract (Murdoch and Hughes, 2000), because of the fact that being in such a condition usually prevents the employer (client) from its right to deduct liquidated damages from the contractor.

1.11 Factors that affect construction duration

It is widely accepted that construction time has been regarded as one of the three critical success factors together with cost and quality for construction project. Many researchers reported that construction duration of a project is affected by a vast number of factors reviewed (Chan and Kumaraswamy, 1997; Kaming *et al.*, 1997 and Sambasivan and Soon, 2007). Chan and Kumaraswamy (2002) classified factors that influence duration

of construction projects in Hong Kong into four broad categories. These are project scope, complexity, environment, and management related attributes. These four categories are explored in association with their causal factors which are described as:

- Project Scope: comprises construction cost, gross floor area, number of stories, building type, contract procurement system and variations.
- Project Complexity: includes client's attributes, site condition/ site access problem, build ability of project design, quality of design co-ordination and quality management.
- Project Environment: includes physical, economic, socio-political and industrial relations.
- Management Attributes: includes client/design team management attributes, construction team management attributes, communication management for decision making, organization structures and human resources management, and productivity.

1.12 Cost Overruns in Construction Projects

Cost overrun is the difference between the final and originally estimated (i.e. initial, expected or estimated) cost of the projects (Singh, 2009). The originally expected cost is called the initial project cost and also called estimated cost of project works. Estimated costs are defined as budgeted or forecast costs which are made at the beginning of the project to build a project. Even if the project planning and scheduling process varies with project type, time and country, it is possible to locate for a particular project a specific point in the procedure that could be identified as the time where the formal decision is made to build the project. Actual cost is defined as real, accounted cost determined at the time of completing a project.

Costs overrun is an occurrence in which the provision of contracted projects, service or goods are claimed to require extra financial resources than initially agreed between a project owner and a contractor. Cost overrun is defined as an increase of cost which is not expected (i.e. excess of a budgeted cost) during estimation of the initial budget.

1.13 Factors that Influence Construction Cost

Many researchers report that a wide variety of factors affects construction costs. In a study conducted in Newfoundland on highways, Hegazy and AmrAyed (1998) found that season, location, type of project, contract size and contract duration have a significant effect on individual contract costs. Some factors are basically related to construction organizations which are solely responsible for managing them, whereas others are closely related to socio-cultural, economic, technological and political environments within which most organization separate. According to Molenaar (2005) cost overrun arises primarily because of four factors. These are: (i) external risk which includes adjustments in the scope of a project, besides changes in the economic, legal, and technologic environments; (ii) technical complexity of the project including size, duration, and technical difficulty; and (iii) inadequate project management which consists of poor control of internal resources, poor labour relations, unrealistic estimates and low productivity because of the uncertainties involved.

1.14 Cost Underestimation

The accurate, early cost estimate for construction and engineering projects are very important to sponsoring organizations. A more serious situation can challenge a client when there have been deliberate underestimate costs in order to attain approval of projects or for fraudulent practices. Researchers also demonstrated that methodology of estimating and accuracy of estimates can be major reasons for cost overrun. According to studies done by Flyvbjerg *et al*. (2003), large projects have been purposely underestimated in order to get voter support for financial approvals. It is further stated

that whatever the cause, almost all big public projects contain original cost estimating faults that result in the necessity for increased funding to accomplish the projects. Promoters and forecasters intentionally under estimate cost and overestimate benefits to get approval of the projects. Flyvbjerg *et al*. (2003) classified cost underestimation into four categories as technical, economical, psychological and political.

Technical Explanations: technical explanations refer to those terms of imperfect forecasting techniques. Most surveys that compare real and estimated costs of infrastructure project explain what they call "forecasting errors" which refer to imperfect techniques, lack of experience in forecasting, inadequate data, inherent challenge of predicting the future, and honest mistakes.

Economical Explanations: economic explanations considers of cost underestimation in terms of economic rationality. There are two types of economic explanation: the first explanation is regarding to the economic self-interest, while the second is with respect to public interest. As regard to self-interest, when projects go forward, they create work for construction firms and engineers, besides many stakeholders generate money. If these stakeholders are involved directly or indirectly influence the process of forecasting, then this may influence outcomes in ways as to how the project will be completed. Having costs underestimated and benefit overestimated could be economically rational for stakeholders because it could increase the likelihood of revenues. As regard to the public interest, forecasters and project promoters may intentionally underestimate costs so as to offer public officials a chance to cut costs and thereby to set aside public money. According to economic explanation, higher cost estimates could be an incentive for wasteful contractors to spend much of the taxpayer’s money. Practical studies have acknowledged that promoters and forecasters underestimate costs with this purpose and in this manner.

Psychological Explanations: psychological explanations attempt to describe the biases which are introduced to influence the mental setting of the project promoters and

forecasters. Politicians could have a "monument complex," engineers would like to build things, also local transportation officials sometimes have the mentality of empire builders. The best common psychological explanation is "appraisal optimism". Based on this explanation, forecasters and promoters are believed to be extremely optimistic about project fallouts in the appraisal stage, when a project is planned and decided. An optimistic cost estimate is obviously a low one. The presence of appraisal optimism in forecasters and promoters would result in real costs being higher than estimated costs. Subsequently, the existence of appraisal optimism would be able to account, in part or in whole the peculiar bias of cost estimates, when costs are systematically underestimated.

Political Explanations: according to Flyvbjerg *et al*. (2002) political explanations assume cost underestimation with respect to interest and power. The most important factor for the explanation is whether forecasters are intentionally biased to claim the interest of project promoters in starting the project. For legal, economical, moral and other reasons, promoters and forecasters would intentionally fabricate a false cost estimate for a project to get started. However, they are reluctant to tell researcher or other that this is the reason.

1.15 Cost and Delay Relationship

Research works had revealed that cost overrun has positive and strong linear relationship with time overrun (Abdullah *et al*., 2009). With regard to financial implications, all delays in construction projects usually cost money (Kaming *et al*., 1997) and lead to losses and/or difficulties for all project participants, apart from being causes for claims and disputes (Yogeswaran *et al*., 1998). If a project completion is delayed due to the reasons attributable to the employer, extension of time will be granted to the contractor which will implicate requirement of additional payment for time related costs, such as overhead and profit. In addition to this, delays defer income, whereas interest and interest on interest, keep accumulating. Extended delays might result in projects close up

in the so-called ‘interest trap’ (Flyvbjerg *et al*., 2004), where a combination of escalating construction costs, increasing interest payments and delays result in cost overrun. According to Ardit *et al*. (1985), lengthy delay within inflationary environments increase cost overrun tremendously. This is further supported by Sambasivan and Soon (2007) who found that cost overrun is ranked second in their survey of delay effects in the Malaysian construction industry. This is because of overtime costs in order to carry on the construction work activities and any compensation required for the delay (Hanna *et al*., 2004). On top of that, additional money is needed for rework if any construction mistakes occurred. As stated by Sun and Meng (2009), the cost of rework could be as high as 10 to 15% of the initially estimated project cost. This indicates that cost overrun is the most frequent causes of delay in the construction industry.

As suggested by Sun and Meng (2009), time overrun and cost overrun are inter-related whereby delay will cause cost overrun in most cases. Delay will cost more money due to labour salaries and leasing of equipment and tools. Extra expenditure is required to hire labour and for leasing equipment for construction because the budget calculated for those fees is based on the original time estimate for project completion. Besides that, required rework due to construction mistakes and defective works requires a further amount of additional expenditure which will consequently lead to cost overrun.

In construction, delay events either cause delay in overall project completion or cause disruption. Thomas (2001) described that delay in construction projects include any of the following conditions: (i) delays to individual activities force contractors to retain their manpower for prolonged period for executing the same quantum of work; (ii) delays to individual activities causes changed sequence of works that subsequently affects the effective use of manpower, and in the first stages of the activity in which the manpower has redeployed, there is normally lower rate of production; (iii) interruption and disturbance to other secondary activities; (iv) idle (or non-productive) time caused by out of sequence working and rescheduling; (v) congestion in sections of the work in

which rescheduled manpower's are transferred thus affecting productivity and progress of the work and; (vi) general loss of productivity due to work being done piecemeal.

In addition to disruption, there are other factors that cause cost overruns in construction projects which are not directly associated with delay events such as change in legislation, price escalation and acceleration.

1.16 Causes of Delays and Cost Overruns

What has been explained so far is about definition, impacts and processes of determining liabilities for losses that already happened due to different factors in a project? It is however possible to reduce the impacts by learning from the problems experienced in previously executed construction projects elsewhere. In doing so, it is important to identify first the root causes to the problems, make assessment to the major factors and then analyse the major variables towards recommending a workable solution. As part of this process, the assessment for the identification of factors that cause delays and cost overruns has been conducted from review of previous research done on the subject.

In this research, delay refers to the time overrun beyond the completion date agreed between the parties during contract signature and specified on the contract. Similarly, cost overrun refers to the extra amount of money required to complete the project over and above what has been specified in the contract as total cost of the project.

A comprehensive literature review finds a common set of factors that cause time and cost overrun of construction projects to develop a questionnaire. A questionnaire survey is also deployed to assess the perception of experienced respondents (contractors, consultant and client) based on the frequency of occurrence, severity and important index to achieve the research objectives and to investigate other causal factors. Many studies conducted on how to manage causes of cost overrun and delay in construction projects both in African countries and elsewhere in the world are have been reviewed (Al-Ghafly, 1995; Al-Momani, 2000; Apolot *et al*., 2012, Assaf and Al-Hejji, 2006;

Baloyi and Bekker , 2011; Baldwin *et al*., 1971; Chan and Kumaraswamy, 1997; Elinwa and Buba, 1993; El-Razek *et al*., 2008; Frimpong *et al*., 2003; Kaliba *et al*., 2009, Kaming *et al.*, 1997; Koushki *et al*., 2005; Le-Hoai *et al*., 2008; Ogunlana *et al*., 1996; Olatunji, 2010; Sambasivan and Soon, 2007 and Tumi *et al*., 2009).There are no previously published research works on this topic in the greater Durban area's office construction industry. The factors reviewed in the literature are used as references to support the research survey in this study.

Surveys conducted by Le-Hoai *et al*. (2008) studied delay and cost overruns in Vietnam's large construction projects by comparison with some selected countries. In this survey, twenty one causes of cost and time overruns suitable with building and industrial construction projects are identified and ranked. Evaluation of causes of cost and time overruns are done with different model construction industries in Africa and Asia. The factor analysis method was applied to categorize the causes, as a result seven factors are determined, namely: lack of constraint and slowness, design, estimate and market, financial capability, incompetence worker and Government. These results might encourage practitioners to focus on time and cost overrun problems that might have been in their future or present projects.

Kaming *et al*. (1997) investigate the factors influencing construction building cost and time overruns on high-rising projects in Indonesia. A questionnaire survey of project managers working on high-rise building construction projects in Indonesian cities of Jakarta and Yogyakarta was undertaken. The variables identified are ranked according to their perceived frequencies of occurrence and severity of importance and it is observed that cost overruns are more severe and occur more frequently than time overruns. They point out that the most significant factors affecting cost overruns are material cost increases, inaccuracy of estimates, and degree of project complexity while the main factors influencing time overruns are design changes, poor labour productivity, inadequate planning and resource shortage.

A survey is also done by Sambasivan and Soon (2007) to establish the most important causes and effects of delay in the Malaysian construction industry. A questionnaire survey and relative importance index methods are used to identify the causes and effects of delay from clients, consultants, and contractors. The top ten most important causes identified from the survey include, among others, improper planning of contractors, poor site management of contractors, insufficient contractor experience, insufficient client's finance and payments for accomplished works, problems with subcontractors, shortage in labour and material supply, lack of equipment and failure, mistakes during the construction stage and poor communication between parties.

A study done on construction projects in the Gaza Strip, Palestine by Enshassi *et al*. (2009) indicates that all three key groups agree on the fact that the most significant causes affecting project performance are time overrun because of the closure of borders/roads which lead to shortage of materials, low level of project leadership skills, unavailability of resources, price escalation of materials, availability of poor quality of equipment and raw materials, and unavailability of highly experienced and qualified workers. The researchers recommend that: (i) in order to overcome delays, project owner (client) should work collaboratively with contractors to facilitate payments regularly; (ii) project participants should have an active role in the process of decision-making; and (iii) continuous relationship and coordination among project participants are essential through the life cycle of the project in order to develop project performance

A research was carried out by Chan and Kumaraswamy (1997) in Hong Kong construction projects to assess the relative importance of eighty three possible delay factors. The main reasons for delay are analysed, ranked and classified on the basis of a) responsibility of the parties in the construction industry, and b) the type of projects. Data are collected from 167 local construction organizations and analysed by using the relative impact index method in order to rank the determinant delay factors for different types of construction projects. As a result, five principal factors are identified. These

are poor supervision and risk management, unpredicted site conditions, slow decision making, owner-initiated variations, and variation works.

A survey to find out the causes of delay and their prominence according to each of the three key project participants (owner, consultant and contractor) in construction projects of Saudi Arabia has also been done by Assaf and Al-Hejji (2006). The field survey carried out includes fifteen owners, twenty-three contractors, nineteen consultants. Seventy-three causes of delay are identified through literature review and discussion with other parties involved in the construction industry. These factors are classified into nine groups based on the following sources of delay: factors related to client, consultant, contractor, project, man power, materials, design-team, equipment, and external factors. Owners explained that causes of delay are associated to contractor and labour. Their study points out the severe causes of delay for the contractor are related to owner while client and consultants recognize highest frequent factor of delay is that awarding to the lowest bidder. The common cause of delay that all parties agreed is the change of orders by client during construction. Several common causes between two parties, such as improper planning and scheduling by contractors, delay in progress payments, poor site management and supervision by contractors, difficulties in financing by contractor and shortage of labour. All key parties agree that the subsequent causes are the least important: accidents during construction, restrictions at site and traffic control, effect of social and cultural factors and changes in government regulations. However, the study revealed that the contractors identified that the main sources of delay were owners and consultant while both consultants and owners specify contractor and labour related causes are the severe and significant sources of delay.

A survey was done by Al-Ghafly (1995) in Saudi Arabia to identify the possible causes of delay in public sewage and water projects and identified, and classified sixty causes of delay. In medium and large size projects, delay occurs more frequently, and reflects severity in small size projects. From the identified cause of delay, most significant are related to contractor performance, owner involvement, and the premature planning and

design of the project. Some of the important causes are delay in approvals and making decisions by client, financial difficulties, changes in the design and scope, communication and coordination problems, and problems in getting work permit.

In Malaysia, Memon *et al*. (2011) did a study on causative causes leading to construction cost overrun. To investigate the important factors causing cost overrun a questionnaire survey and interviews were conducted amongst selected experienced personnel for expert opinion, and results showed that poor design and delays in design, unrealistic contract duration and requirements imposed, mistakes during construction, late delivery of materials and equipment, lack of experience, relationship between management and labour, delay preparation and approval of drawings, inadequate planning and scheduling, poor site management and supervision are most significant and common factors causing cost overrun in Malaysia.

A survey undertaken by Koushki *et al*. (2005) to assess delays and cost increases in the private residential construction projects in Kuwait concluded that cost increases are greater when the total cost of a residential building project is higher. The shortage of money and time assigned to the design phase is the major factor contributing to the cost increase and time-delay. The study also points out three main causes of time-delays including change orders, clients' financial constraints and clients' lack of experience in the construction industry. Regarding cost overruns, the three major factors are identified as material-related problems, contractor-related problems, and clients' financial constraints. Another research conducted by Baldwin *et al*. (1971) to investigate causes of delay in construction industry in United States indicated that inclement weather; shortages of labour supply and system of subcontracting are the main causes of delay.

A survey conducted to explore the likely causes of delays in high-rise building construction projects in Bangkok, Thailand (Ogunlana *et al*., 1996.). The findings compared with other surveys of cost overruns and delays around the world and their review finds out that the problems of the building construction industry in developing

economies could be categorized in three levels: (i) inadequacies or shortage in industry infrastructure (particularly supply of resources); (ii) problems caused by consultants and owner and (iii) problems caused by contractor inadequacies or incompetence.

Greenwood *et al*. (2001) did a comparative analysis of administrative delays in hospital building in order to examine whether the construction of large hospitals are susceptible to common delays or not. Two completed hospital building projects were chosen as case studies: the Tripoli Medical Centre in Libya and Guy's Hospital in London. One of the most influential causes of delay on large public projects such as these hospitals has been found to be administrative reasons. Despite the obvious differences between them, the problems encountered by the two projects exhibit some interesting similarities:

- Administrative failings associated with large public sector projects are similar regardless of factors such as geographical location and relative economic development.
- The preliminary findings show that, in most cases, hospital projects in any part of the world face similar difficulties, including slow decision-making, late approvals and changes to the make-up of administrative teams.

In Jordan, causes of delay in 130 public projects are explored by Al-Momani (2000). The projects include residential, office and administration school buildings, medical centres, and communication facilities. The results indicate that the major causes of delay are related to designer, site conditions, user changes, weather, late deliveries, increase in quantity and economic conditions. The review suggested that special awareness to these factors will support industry practitioners in diminishing contract disputes. Failure and ineffective performance of the contractors will have strong relationships with delays.

The problem of delay and cost overrun in African countries' construction projects are no different. Causes of delay in building construction projects in Egypt are discussed by El-Razek *et al*. (2008). The main causes of delay in these construction projects are constraints in financing by the contractor during construction, design changes by client

or his agent during construction, delays in contractor's payment by owner, partial payments during construction, and no utilization of qualified construction/contractual management. The results show that the consultant is found as having more intermediate views, whereas clients and contractors are seen having opposing views, usually blaming each other for delays.

A study on the Nigerian construction industry projects which was carried out by Elinwa and Buba (1993), identified variables that have led to cost overruns and project delays. The study reveals that high costs could be minimized by minimizing lapses in the management of human and material resources. Four major reasons for high construction costs are identified: (i) shortage of construction materials, (ii) techniques of financing and payment for executed works, (iii) poor contract management and (iv) price fluctuations. They suggest that all the major causes of cost overruns could be minimized or eliminated by implementing an advanced human input at the project inception phase. Furthermore, Aibinu and Jagboro (2002) reported construction delay to have reached an endemic level in Nigeria. They examined the effects of delays on the delivery of construction projects in the country. Utilizing a questionnaire survey of 61 construction projects, the authors identify and assess the impact of delays on the delivery of construction projects and finds out client-related delay is significant in Nigeria. The study recommend that acceleration of site activities coupled with improved clients' project management procedures and inclusion of appropriate contingency allowance in pre-contract estimate should assuage the adverse effect of construction delays.

Tumi *et al*. (2009) conducted research to identify causes of delays in construction projects in Benghazi city, Libya and five principal factors are identified. The first ranking is improper planning followed by lack of effective communication, shortage of supply such as steel, concrete and design errors seem to be the third-ranked reasons that cause delays. Consequently, factors such as slow decision making and financial issues are ranked fourth. The next important factor is shortage of material ranked as fifth.

In Uganda, Apolot *et al*. (2012) investigated the causes of delays and cost overruns in public sector construction projects. The study is targeted to identify the causes and rank them according to their severity, frequency and importance. They point out that delayed payments, poor monitoring and control, change of work scope, political instability/insecurity and high cost of capital, are the five most significant causes of delays in public construction projects.

Frimpong *et al*. (2003) report that delay and cost overruns are common in construction projects and not exception for groundwater construction projects in Ghana. In order to determine and assess the relative importance of the key factors contributing to cost overrun and delays, they carefully designed a questionnaire with 26 factors and asked three types of participants in both private and public organizations working in ground water projects, namely: owners, consulting offices, and contractors. The result of the study reveals that according to the contractors and consultants, difficulties in monthly payments are the most important cost overruns factor, whereas clients ranked poor management of contractor as the most important factor. In spite of some difference in the viewpoints among the three groups surveyed, the degree of agreement among them with respect to their ranking of the factors is very high. The overall ranking results indicate that the three groups felt that the major factors that can cause excessive groundwater project cost overruns in developing countries are monthly payment difficulties, poor contractor management, and escalation of material prices, poor technical performances, and material procurement. Similarly in Ghana, Fugar and Agyakwah-Baah (2010) investigate the most important causes of delay of building construction projects according to the key project participants. All major stakeholders agree that the top ten most important factors are delay in honouring payment certificates, underestimation of the cost of project, underestimation of complexity of the project, poor supervision, underestimation of time required for completion of projects by contractors, difficulty in accessing bank credit, poor professional management,

fluctuation of prices/rising cost of materials, shortage of materials and poor site management.

Kaliba *et al*. (2009) conducted a research on cost escalation and delay in road construction projects in Zambia. They conclude that cost escalation of construction projects in Zambia are caused by factors such as inclement weather, scope changes, environment protection and mitigation costs, schedule delay, strikes, technical challenges and inflation. Dibonwa (2008) identifies causes and remedies for cost overruns in Botswana's public construction projects. Three test techniques are used in his research: (i) case study project analysis, (ii) respondents' rank scoring and the Kendell's correlation coefficient is used for factor comparison (triangulation). Four major cost overrun causal factors peculiar to Botswana are identified as (i) insufficient/inadequate design, (ii) lack of project coordination, (iii) contractual claims and (iv) inadequate project brief. There are three most effective cost control measures identified which are: (i) competent project team personnel, (ii) improved project monitoring, and (iii) good time and financial management.

In South Africa, the construction industry is playing a significant role in the economy, generating both wealth and employment. Nevertheless, many projects are facing extensive delays and subsequently exceed initial cost and time estimates. Olatunji (2010) investigate the causes of delays in project delivery in South Africa in Metropolitan cities of five provinces. The provinces are Eastern Cape, Free State, Gauteng, KwaZulu-Natal, and Western Cape while the corresponding Metropolitan cities are Bloemfontein, Cape Town, Durban, Johannesburg, and Port Elizabeth. Factors which negatively influence project delivery time in South Africa are lack of adequate planning, management style, the lack of reviews of designs, inadequate motivation of workers, economic policies, lack of prompt payment to contractors, and quality of management during design and construction. Similarly, in the South African building industry, Hanson *et al*. (2003) examine causes of client dissatisfaction and find that incompetence of contractors;

conflict and poor workmanship are the factors that negatively impact on project performance.

Baloyi and Bekker (2011) state that, even though South Africa has completed numerous large construction projects successfully over the years, the award of the FIFA Soccer World Cup in 2010 drew the attention to South Africa's ability to deliver large construction projects within time and budget. Although all the stadia were ready for the games, nearly all projects experienced time delays and cost overruns. The most significant contributing factor for the cost overrun was the increase in material cost, while for time delays it was design-related factors.

All the preceding discussions show that there is a great concern for construction project delays and cost overruns globally in general and in South Africa in particular as most of these projects are implemented using tax payers' money. Moreover, the funding for construction industrial activities worldwide are used to regulate the economy and as the construction industry continues to grow in size, so do planning and budgeting problems. Aibinu and Jagboro (2002) state that the contribution of the construction industry to national economic growth necessitates efforts geared towards improving construction efficiency by means of precision and cost-effectiveness. They believe that such efforts will be beneficial and contribute to cost saving for the whole country. Time, cost, quality and participant satisfactions have been identified as the main criteria in measuring the overall success of construction projects.

Among office construction projects undertaken in recent years in South Africa, particularly around Durban, (Durban CBD Office Market Report, 2012) reported that most of them are delayed well beyond the expected time for completion and also required additional budget more than envisaged during the commencement of the respective projects. This problem in turn is causing difficulties in:

- financing of upcoming projects,
- timely utilisation of the facility by the public, and

- the relationship of the stakeholders (Employer, Contractor, and Financier) involved in the construction process.

1.17 Conclusion

Taking these into account, this research is aimed at investigating the problems as to why most office construction projects in and around Durban are delayed beyond their completion date and require additional budget beyond the initial contract prices. Furthermore, the research looks into how these problems could be substantially minimized and the responsible party for the causes of cost and time overrun in office construction projects are identified from the stake holders. In order to attain these objectives and identify the factors that cause time and cost overrun in office construction projects in and around Durban, a comprehensive literature review undertakes to generate a set of factors that are believed to be the most common and frequently occurring causes. From the literature review, more than eighty seven variables are identified that are known to cause delay and cost overrun of construction projects worldwide. Based on these identified variables, a questionnaire is developed which are distributed to the main office construction stakeholders (clients, contractors and consultants) that operate in and around Durban so as to identify the most important factors that cause delay and cost overrun in construction projects in the area and come up with possible solutions/recommendations to the problem.

RESEARCH METHODOLOGY

1.18 Introduction

Research methodology is the step by step procedure used to determine a solution to a particular problem. The methodology adopted in this research provides the procedures that are necessary for obtaining the information needed to structure the research questionnaire, collect data, analyse the collected data, and interpret and present the results. The methodologies followed in this survey are outlined in the following sections.

1.19 Research Type

Research could be descriptive or exploratory. Exploratory research is a research used to explore or search through a problem or a situation to provide insights and understanding. Descriptive research is to portray an accurate profile of persons, events or situations (Malhotra 2004). This research which deals with investigation of the practical problem of time and cost overruns is undertaken on the basis of observation of construction projects. The research questions are designed to explore the causes of project delays and cost overrun. The research can be categorized as exploratory, descriptive and co-relational type. The research is exploratory because it is initiated from practical problems and investigates whether the causes of cost and time overrun exist. It is also descriptive because it tries to describe the causes of cost and time overrun in the office building construction projects in and around Durban. The descriptive research method adopted in this study is to reveal an accurate picture of the respondents' (professionals) opinion that might help to assess the dominant causes and identify possible and practical measures for minimizing cost and time overruns in office construction projects in eThekwini District Municipality of KwaZulu-Natal.

1.20 Research Approaches

There are two basic approaches to research: quantitative and qualitative (Leedy *et al*. 2005). The former involves the generation of data in quantitative form which could be subjected to accurate quantitative analysis in a proper and rigorous manner and in the form of a data base from which to realize characteristics or relationships. In quantitative research, samples of a population are studied (observed or questioned) to establish its characteristics, in short, a quantitative approach attempts to produce "real answers" from "hard data", whereas a qualitative approach is concerned with subjective evaluation of opinions, behaviour and attitudes. Research in such a situation is a purpose of the researcher's insights and impressions, and the techniques involved are projective techniques, focus group interviews and depth interviews. Qualitative methods are not good at giving direct answers, but are good at developing more questions, because of consistent use of "soft data" (Higgins, 2009). Therefore in this research quantitative approach is used.

1.21 The Research Process

Research process consists of a series of steps necessary to carry out research and the desired sequencing of the actions to be undertaken. The research process is a simple way of effectively locating information for a research project.

The current research takes a qualitative approach and is conducted in the following stages, namely: problem identification, literature review, research design, data collection, data analysis and result interpretation and reporting. The approach entails researching to assess the dominant causes of cost and time overruns, identifying possible and practical measures that can minimize overruns in office construction projects around

Durban. These objectives are achieved through the implementation of the research methodologies that are mainly literature review and questionnaire survey. The literature review focuses on similar past research studies and helps in the identification of factors and categories, research methodology and analysis of data. Ninety-four causes of delay and time overrun are identified and categorized in 9 main groups according to their sources of delay and time overrun. These causes are compiled and structured into questions to evaluate the frequency of occurrence, severity and importance of the identified causes. In order to collect the necessary data, a questionnaire that consists of the following three major sections is carefully designed and tested in light of attaining high response rates from respondents. These are the general background information of the respondents and their organization, degree of impact and frequency of occurrence of the identified variables/factors, and assessment of controlling mechanisms of time and cost overrun problems. The designed questionnaire is distributed to solicit perception of professionals in construction industries (clients, consultant and contractors) involved in office construction projects in Durban. Analysis of the data obtained from the questionnaire is undertaken through statistical methods (frequency, severity and importance indices), visual examination, tabulating and categorizing. After the analysing the collected data, the findings and results are interpreted and discussed. Finally, the research conclusions are drawn and provide the basis on which recommendations are given. The steps that are followed in this research are illustrated in Figure 4.

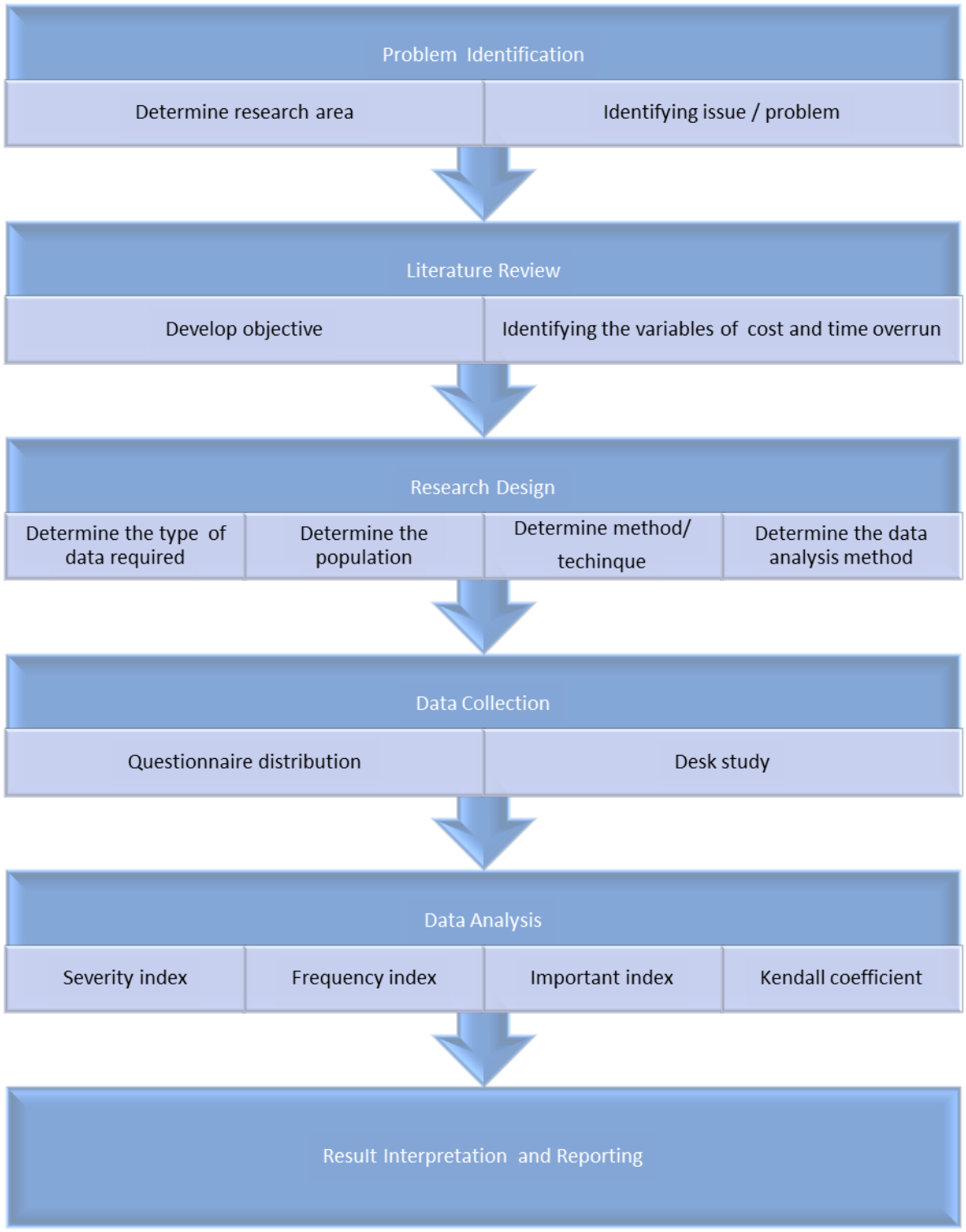

Figure 4 Flow chart illustrating the process followed in this research project

1.22 Data Source and data collection

There are two types of research data collection, namely: primary and secondary data collection. When the data is collected either through survey or through experiment, it is defined as primary data. If the researcher performs an experiment, one can observe a number of quantitative measurements or data that help to examine the truth contained in the hypothesis. But when a survey is undertaken, data can be collected through observation, personal interview, telephone interview, by mailing of questionnaires and other methods.

Secondary data can be collected by the user or someone other than the user. It is rapid and can be relatively inexpensive to collect if available through open source channels. It plays an important role in the literature survey assessment, helping to define the key issues. The secondary data used in this research are obtained from various South African and international sources, including company brochures and reports, journal articles, conference papers, dissertations and theses. Since the secondary data collected were found inadequate, it becomes necessary to collect supplementary primary data. The primary data used in this study are collected through a questionnaire survey. A questionnaire designed from extensive literature review of various causes of cost and time overrun in construction projects and from secondary data sources are distributed to the main office construction stakeholders (clients, contractors and consultants) that operate in and around Durban so as to identify the most important factors that cause delay and cost overrun in construction projects in the area and come up with possible solutions/recommendations to the problem.

1.23 The target population

The targeted population selected for this research to evaluate and analyse the main causes of delay and cost overrun in office construction projects in and around Durban,

the research samples are taken from the different stakeholders of the office construction industry. The categories of respondents identified for data gathering belong to private and public sectors. The private sector consists of respondents from the South African Institute of Architecture (SAIA), the Association of South African Quantity Surveyors (ASAQS), the South African Property Owners Association (SAPOA), with the public sector respondents from the KZN Department of Public Works and the eThekwini District Municipality. A wide range of personnel involved in Durban office constructions are targeted depending on their direct exposure to office building construction activities. For this study, the questionnaires are distributed to hundred respondents mainly through office and project site visits and hand to hand distribution of the questionnaire, email and Tele fax. The questionnaire is accompanied with a cover letter explaining the purpose of the research.

1.24 Variables of Delays and Cost Overruns in Construction Projects

There is no consensus in the literature on the identification of factors which affect time and cost of a construction project, as each independent research views the subject from different perspectives. This may be the project type, size, location, type of contract, etc. The global nature of the construction delay and cost overrun problems meant that most ideas from other researchers' findings would be relevant to office building construction projects in Durban. The purpose of this section is therefore to screen the factors identified from literature review that are relevant to the conditions of office construction projects in Durban.

1.24.1 Identification and classification of Relevant Variables

Out of the eighty-seven variables identified in the literature review (section 2.8), seventy-eight are found to be relevant to this research. Moreover, sixteen additional

variables have been added to the list from personal experience and from independent expert opinion. A total of ninety- four variables that are expected to cause delays and cost overruns (eighty-five for delays and nine for cost overrun) are selected. The remaining of the variables are relevant only to civil construction but not to building construction. While selecting the variables, the fundamental requirements considered are the applicability to:

- building construction projects
- public procurement with open competitive tendering procedure
- traditional general contracting

The variables are adopted by many researchers (Assaf and Al-Hejji, 2006; Al-Khalil and Al-Ghafly, 1999; and Chan and Kumaraswamy, 1997) and can be classified into groups according to sources of delays within the scope of influence. Thus, the eighty-five variables that cause delay have been classified into nine groups (Table 1). The grouping or classification of variables into groups is based on the source of delay, i.e., those related to project, client, contractor, consultant/engineer, design, material, equipment, labour and external causes.

Project related factors are those associated to a specific project, and mostly are derived from the particular provisions of tender/contract documents such as short project duration, type of contract, unavailability of bonus for early completion, etc. Client caused delay can result from failure to fulfil contractual responsibilities, changes made in the work required under the construction contract, interference with responsibilities of the contractor and failure to coordinate the activities of separate contractors. Although specific duties depend upon the individual contract, the owner's contractual responsibilities can be generalized to responsibility to provide the project site, finances, approvals and design as well as contract administrations. Contractor related factors are those delays attributable to the contractor failure to evaluate the site or design, contractor management problems, inadequate resources such as cash, material, labour, poor

workmanship and subcontractor failures. Design related causes generally result from four common deficiencies: defects in design, slow correction of design problems, late review of shop drawings and delays in tests and inspections. External factors are the ones which happen beyond the control of any of the parties involved in a project such as adverse weather condition, change in legislation, effects of social and cultural factors, etc.

With regard to variables for cost overruns, most of the delay factors are associated with additional cost, and hence to avoid repetition of most of the factors identified for delay, they are summarized with a single variable "Delays caused by the owner and his/her agent". Eight other additional variables are selected and listed in Table 1.

Table 1: List of identified causes of delay and cost overruns in office building construction projects

No	**Factors Causing Delay**
	1 Design related delay causes
1.	Mistakes, inconsistencies and ambiguities, in specifications and drawings
2.	Inadequate and unclear details in working drawing
3.	Project design
4.	Insufficient communication between owner and designer during the design phase
5.	Inadequate investigations by the designer during the design phase
	2 Project related delay causes
6.	Original contract duration is too short
7.	Corruption
8.	Unavailability of bonus for early completion
9.	Ineffective penalties for delay
10.	Type of construction contract agreement like Turnkey
11.	Type of project bidding and award (Selection based on least evaluated bidder)
	3 Client related delay causes
12.	Delay in progress payments by the owner
13.	Delay by the client to hand over and deliver the site to the contractor
14.	Delay in change orders (Variation orders) by the owner
15.	Changes in scope of the project
16.	Owner's poor communication with government and construction parties
17.	Poor coordination by the client with the other parties during construction
18.	Slowness in decision making process by owner
19.	Restriction of site supervisor's authority by the owner

20. Excessive bureaucracy in the owner' s administration
21. Uncooperative client with the contractor complicating contract management
22. Suspension of work by owner
23. Delay in settlement of contractor claims by owner
4 Contractor related delay causes
24. Contractors' difficulties in financing the project
25. Contractors' cash flow problems
26. Poor site supervision and management by contractor
27. Inefficient quality control by the contractor during construction, leading to rework
28. Ineffective scheduling and planning of project by contractor
29. Improper construction techniques implemented by the contractor
30. Delay in site mobilization
31. Delay of field survey by the contractor before start of permanent works
32. Lack of experience of project type
33. Lack of experience of local regulations
34. Lack of experience of project location
35. Lack of inadequate planning
36. Slow preparation of change order requests by the contractor
37. During the bidding stage, improper technical study by the contractor
38. Conflicts between other parties and contractor
39. Poor communication of contractor's within the parties involved in the project
40. Poor coordination of contractor's with the parties involved in the project
41. Delays in sub-contractors work
42. Conflicts in sub-contractors programme in implementation of project
43. Because of their incompetent work, frequent change of sub-contractors
44. Difficulties among the contractor and his subcontractors with regards to payments
45. Ineffective involvement of contractor's head office in the project
46. Failure to apply safety rules and regulations within the contractor's organization
5 Consultant/Engineer related delay causes
47. Poor qualification of consultant/ engineer's staff assigned to the project
48. Engineer's late approval of contractor's submissions
49. Poor communication among the engineer/ consultant and other parties involved
50. Consultant's poor coordination with other parties involved
51. Delay in inspection, performing and testing by the engineer/ consultant
52. Late response of engineer to contractor inquiries
53. Inflexibility of consultant
54. Delay in correcting mistakes and integration disagreement in the contract
55. Late instructions by the consultant/ engineer
6 Material related delay causes
56. Change in material prices
57. Shortage of construction materials required
58. Changes in specifications and types of material during construction
59. Delay in material delivery
60. Late procurement of materials by the contractor

7 Equipment related delay causes
61. Equipment breakdowns
62. Shortage of equipment required
63. Level of equipment-operator's skill is low
64. Low efficiency and productivity of equipment
8 Labour related delay causes
65. Manpower shortage (skilled and unskilled labour)
66. Insufficient skill of labour
67. Shortage of contractor's administrative staff
68. lack of technical professional in the contractor's organization
69. Low skill of manpower
70. Low qualification of the contractor' s technical employees assigned to the project
71. Low productivity level of labours
72. Inadequate living condition for labour
73. Labour strikes by the contractor workforce
9 External delay causes
74. Effects of subsurface (underground) conditions
75. Delay in getting permits from different government offices
76. Severe weather conditions on the job site
77. Inaccessibility of utilities in site (telephone, water, electricity, etc.)
78. Effect of social and cultural factors
79. Accident during construction
80. Changes in government laws and regulations
81. Work obstruction between various contractors
82. Traffic control and restrictions on construction site
83. Unforeseen circumstances
84. Government tendering system of choosing the lowest bidder
85. Interference by financiers in the contract administration and construction
Factors Causing Cost Overrun
1. Delays caused by the owner and his agent
2. Design change
3. Quantity underestimation
4. Acceleration
5. Price escalation
6. Change in legislation
7. Corruption
8. Wastage
9. Lack of quality

1.25 The research Questionnaire survey

Due to the large number of public agencies that own office construction projects in Durban and the large number of consulting and contracting companies that undertake work for private and public agencies, a questionnaire survey is found suitable for this research. According to Leedy *et al*. (2005), questionnaires can be used for the acquisition of qualitative data using quantitative scales to quantify the data obtained in order to produce descriptive results. There are two types of survey questions from which to select: closed-ended and open-ended. The questionnaire survey adopted in this research utilizes closed-ended questionnaires. Closed questions are easier to analyse and often provide fixed alternatives. However, an open-ended question is also added to allow respondents to provide further details.

Before distributing the final questionnaire, a pilot questionnaire survey performs to test for its validity and sufficiency. The validity is tested by referring to 8 experts who have more than 15 years of experience and are familiar with the Durban construction industry. They are asked to review critically the design and structure of the questionnaire. Their valuable comments use to revise the research questionnaire. The revised questionnaires are then distributed among the selected samples of the population. The non-probability sampling method, involving convenience and snowball sampling technique used for this study as applied by other researchers on similar research works in other parts of the world (Sambasivan and Soon, 2007; Baloyi and Bekker, 2011 and Dibonwa, 2008). The non-probability method is ideal when you do not know the likelihood that any element of population is selected for study. According to Uma (2000), where members of a special population are difficult to get responses from sample elements selected at random, snowball sampling method are commonly preferred as convenience. This sampling comes under the class of non-probability sampling techniques (Babbie, 2001). As the name implies, sample elements are identified by convenience and through referral networks. The questionnaires are distributed through acquaintances and these in turn

distribute to their acquaintances working in office construction projects in Durban. According to Sambasivan and Soon (2007), this sampling method enables to obtain a large number of completed questionnaires quickly and economically. One hundred sets of questionnaires are distributed to potential respondents from the South African Institute of Architecture (SAIA), South African Property Owners Association (SAPOA), the Association of South African Quantity Surveyors (ASAQS), members of Chartered Institute of Building (CIOB), Clients, Consultants, Contractors and anyone working in the built environment depending on direct exposure to office construction projects in Durban. Face to face deliveries are preferred to promote respondents and to raise the response rate but several different means such as email, fax and postal service are also employed. Follow up contacts made through telephonic and email communications.

1.25.1 Questionnaire design

Good questionnaire design is a key to obtaining good survey results and warranting a high rate of return (Zikmund, 2000). The questionnaire design in this study utilised the information sourced from the extensive literature review. The global nature of the construction industry's delay and cost overrun problems mean that most of the ideas from other researchers' findings would be relevant to office construction project context in and around Durban. After assessing the possible variables that cause time and cost overruns applicable for the office construction projects in Durban, eighty-five variables for delay, and nine variables for cost overruns have been identified (Table 1). In addition to that, the following points are also addressed:

- While selecting the variables, checks have been made whether or not they are relevant for the underlying conditions in Durban.
- Identified variables for delay have been categorized in nine major groups based on the sources of delay.

- To avoid duplication of factors used for delays for the assessment of cost overruns, it is preferred to use a generalized variable *"*Delays caused by the owner and his agent".

Taking all the above into account, the questionnaire is designed carefully to get high response rate from respondents of all professionals in construction industries comprising six professional fields: i) Project Managers, ii) Architects, iii) Engineers, iv) Quantity Surveyors, v) Project Financial Planners/Managers and vi) Construction Managers/Contractors. The designed questionnaire that consists of three major sections is basically aimed at acquiring data on the general background information of the respondents and their organization, degree of impact and frequency of occurrence of the identified variables/factors, and also on assessment of controlling mechanisms of time and cost overrun problems.

The structured part of the questionnaire is answered based on Likert's-scale of five and four ordinal measures of agreement to each statement from 1 to 5 (Susan, 2004) as shown in the following sections. Likert's-scale is important to know respondents' outlooks or attitudes about something. The reasons for adopting this simple scale are:

- To make the evaluation of the collected data easier, and
- To provide simplicity for the respondent to answer

The respondents should indicate how closely their approaches match with the question or statement on a ranking scale. Respondents are asked about their agreement on the variables causing cost and time overrun. For each variable, two questions are asked: the degree of impact and the frequency of occurrence. The degree of impact and the frequency of occurrence are categorized on a five and four point scale, respectively, as shown in Table 2.

Table 2: Categories for the degree of impact and frequency of occurrence of variables

Degree of Impact		Frequency of Occurrence	
Scale	Description	Scale	Description
1	None	1	Never
2	Neutral	2	Low
3	Moderate	3	Medium
4	High	4	High
5	Very high		

For controlling time and cost overrun problems in office construction projects in Durban, the respondents are asked to highlight their recommendations to minimize and control time and cost overrun in Durban office construction projects through an open ended question. After data is collected on causes of time and cost overrun, the responsible party for the causes of time overrun from stakeholders of office construction industry are identified and mitigation measures recommended.

1.25.2 Questionnaire format and sections

The questionnaire contained the following three major sections:

Section 1: Demographic

The demographic section consists of inquiries on general background information of the respondent professional's field of expertise, their professional status in the organisation and duration of professional work experience, size of the organization and type of organization in which the respondent is representing.

Section 2: Causes of cost overrun and time overrun

The second part of the questionnaire incorporates a list of identified possible variables of delay and cost overruns in office construction projects. These causes are categorized

into nine groups according to the source of time and cost overrun. For each variable, two questions are asked: the degree of impact and the frequency of occurrence.

Section 3: Possible recommendation to control time and cost overrun

The third section incorporates the respondents' recommendations to minimize and control time and cost overrun in Durban's office construction projects based on their experience. The questionnaire developed and used is presented in appendix 1.

1.26 Method of Analysis

For each of the variables that cause delay and cost overrun, respondents are requested to indicate the degree of impact (or severity) and frequency of occurrence. The degree of impact is categorized into five scales and the frequency of occurrence into four scales (Table 2). The responses given by each of the respondents are summarized and counted in their respective categories separately for client, consultant and contractor. Le-Hoai *et al*. (2008), Al-Khalil and Al Ghafly (1999), Assaf and Hejji, (2006), and Apolot *et al*. (2012) used Severity Index (SI), Frequency Index (FI) and Importance Index (II) data analysis methods to identify, to rank and to examine the importance in terms of degree of occurrence and level of severity for the root causes of delay and cost overruns in construction projects. The same method is adopted in this study to analyse and assess the research data collected. Data are analysed using Equations 1 to 5 and other statistical methods. These equations are described as follows (Assaf and Hejji, 2006):

a) The Severity Index (SI) for each of the variables is computed with the formula:

$$\text{SI (\%)} = \left(\frac{\sum_{i=1}^{5} A_i N_i}{5 \sum_{i=1}^{5} N_i} \right) \text{ x } 100\% \qquad (1)$$

Where A is the constant expressing the weighting given to each response, it ranges from 1 for none to 5 for very high; N is the frequency of the responses.

b) Similarly, the Frequency Index (FI) for each of the variables is computed with the formula:

$$\text{FI (\%)} = \left(\frac{\sum_{i=1}^{4} B_i N_i}{4 \sum_{i=1}^{4} N_i} \right) \text{ x } 100\% \qquad (2)$$

Where B is the constant expressing the weighting given to each response, it ranges from 1 for never to 4 for high; N is the frequency of the responses.

c) Importance Index (II) for each of the variables is computed as a product of both severity and frequency indices. It is given by:

$$\text{II (\%)} = \left[S.I(\%) \times F.I(\%) \right] / 100 \qquad (3)$$

d) Ranking of variables is made using the Importance Index (II) by assigning the first rank for the highest value, the second rank to the next highest value and so on.

e) The Kendall coefficient of concordance (*W*) is used to measure the communality of ranks for *m* observers. It is computed with the following formula (Kendall, 1970):

$$W = \frac{12S}{m^2(n^3 - n)} \tag{4}$$

Where S is the sum of squares of deviations of the rankings, that is:

$$S = \sum_{i=1}^{N} \left(R_i - \overline{R}\right)^2 \tag{5}$$

m is the number of sets of rankings, *n* is the number of variables being ranked, R_i is the sum of ranks for i^{th} variable and $\overline{R}$ is mean of sum of the ranks.

W ranges between 0 and 1, *W* = 1 indicate a perfect agreement; but if the rankings by various groups differ very much, the sum of rankings (R_i) is more or less equal for each of the factors and hence the value of S becomes small and so does *W*.

The data collection and analysis methods explored in the literature review are used to provide appropriate formulae upon which to test the research findings in office construction projects in Durban. The four formulae: (1) the Severity Index, (2) the Frequency Index, (3) Importance Index, (4) the Kendall's Coefficient play a significant role in producing ordered ranking lists, for the most important causes of cost and time overrun factors, and the responsible party from stakeholders in office construction industry and time and cost overrun control remedial measures with possible solutions/recommendations to minimize the problem.

The description of the office construction project data collected for the research, the analysis techniques using the methodology and the statistics are described in the following chapter 4.

DATA PRESENTATION AND RESULTS

1.27 Introduction

Chapter four presents the way the questionnaires are distributed, responses are retrieved and subsequent analysis of the data collected through the questionnaire survey from professionals working for clients, consultants and contractors who are involved in the office building construction sector within the eThekwini District Municipality of KwaZulu-Natal, South Africa. The principal purpose of the survey is to rank the already identified variables of construction projects delay and cost overruns and then to find out the critical factors that are required to be given due attention in order to substantially minimize delay and cost overrun problems in office building construction projects within the study area.

1.28 Questionnaire Response Rate

Hand-to-hand delivery is preferred to improve the response rate and to encourage respondents but several alternative means such as post and email are also employed. Moreover, phone calls are frequently made to remind respondents to complete the questionnaire. A total of 100 questionnaire sets were aimed to be distribute to individuals; i.e., 30 professionals working for the client, 40 for consultants and 30 for contractors, However only 24 questionnaires could be distributed to contractors due to extended Christmas and new year holiday seasons.

Table 3: Questionnaire distribution and response

Description	Number distributed	Number of respondents	% of responses received	% of responses from total
Client	30	24	80	32.00
Consultant	40	36	90	48.00
Contractor	24	15	71.43	20.00
Total	94	75	79.79	100.00

From the total of 94 questionnaires distributed, 75 responses are received (Table 3). These are 24 (32%) from the client, 36 (48%) from consultants and 15 (20%) from contractors. The overall response rate is 79.79% (Table 3). As compared with that of the clients and consultants, the response rate from the contractors (71.43%) seems to be on the lower side, most likely because of their busy schedule. However, the contractor's response rate for this survey is considered to be adequate for data analysis. According to Moser and Kalton (1993), in order for data to be acceptable for analysis, the response rate should be as much as possible above 40% and if the response rate is lower than 30%, the data fails to be representative and the result of the analysis are of little value for further interpretation.

1.29 General Characteristics of Respondents

The demographic characteristics of the respondents surveyed in this research, that is their organization's experience in construction projects, the type of construction projects they have been involved in, and the position of the respondents within their organization are presented in Figure 5.

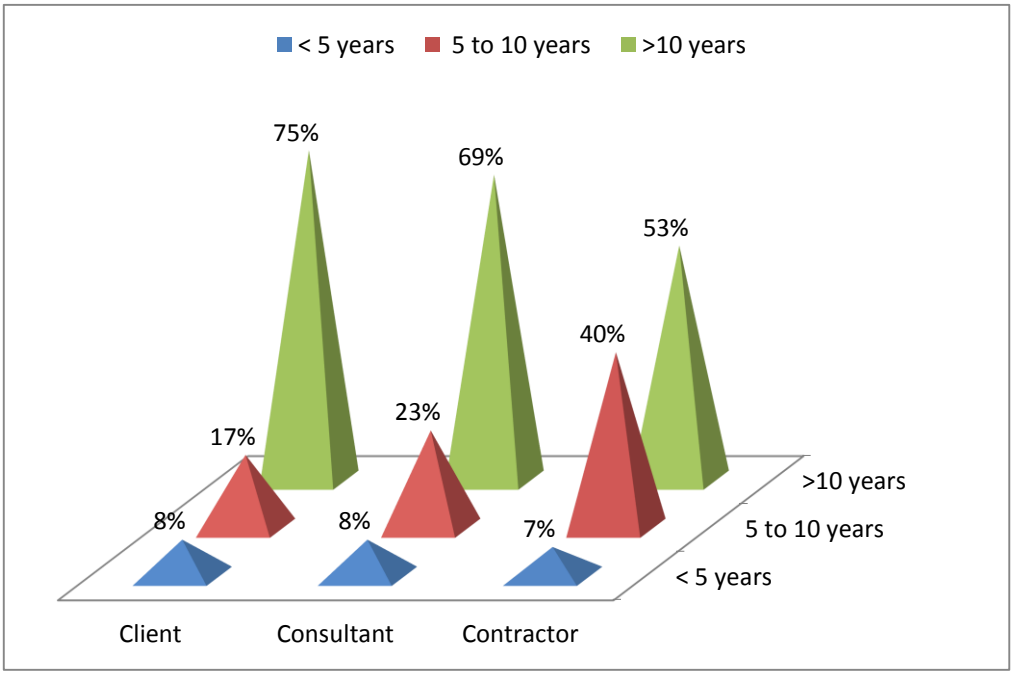

Figure 5: Graph showing the range of experiences of the respondents' organization involved in this research survey

As shown in Figure 5, the percentage of respondents from the clients side work for organizations (companies) having the following experience: 8% of them work for organizations having less than 5 years' experience, 17% work for organizations having experience between 5 to10 years and 75% work for organizations having more than10 years' experience. Similarly, 8% of the respondents from the consultant's side work for firms that have less than five years' experience, 23% work for firms having between 5 to 10 years of experience and 69% work for firms having more than 10 years of experience. Likewise, 6%, 44% and 50% of respondents on the contractors' side work for companies having less than five years, between 5 and 10 years and more than 10 years of experience respectively.

Table 4: Type of building construction projects being constructed

Type of building	No of Responses			% of Responses from Total
	Client	Consultant	Contractor	
Residential	34	21	14	92%
Office	36	24	15	100%
Education	29	22	15	88%
Motel	12	14	12	51%
Health	29	16	15	80%
Industrial	32	15	14	81%

As shown in Table 4, all of the respondent's organizations have been participating in the office construction sector for some years. In addition to this, more than78% of the organization have been participating in residential, educational, health, hotel, industrial, place of worship, commercial and strategic building and civil construction projects. It can be observed from the data that respondents have been involved in different kinds of construction projects that have long durations. These experiences have equipped them with a wealth of knowledge that helped them to answer the survey questions satisfactorily and provided valuable additional comments which have improved the quality of data collected in this research.

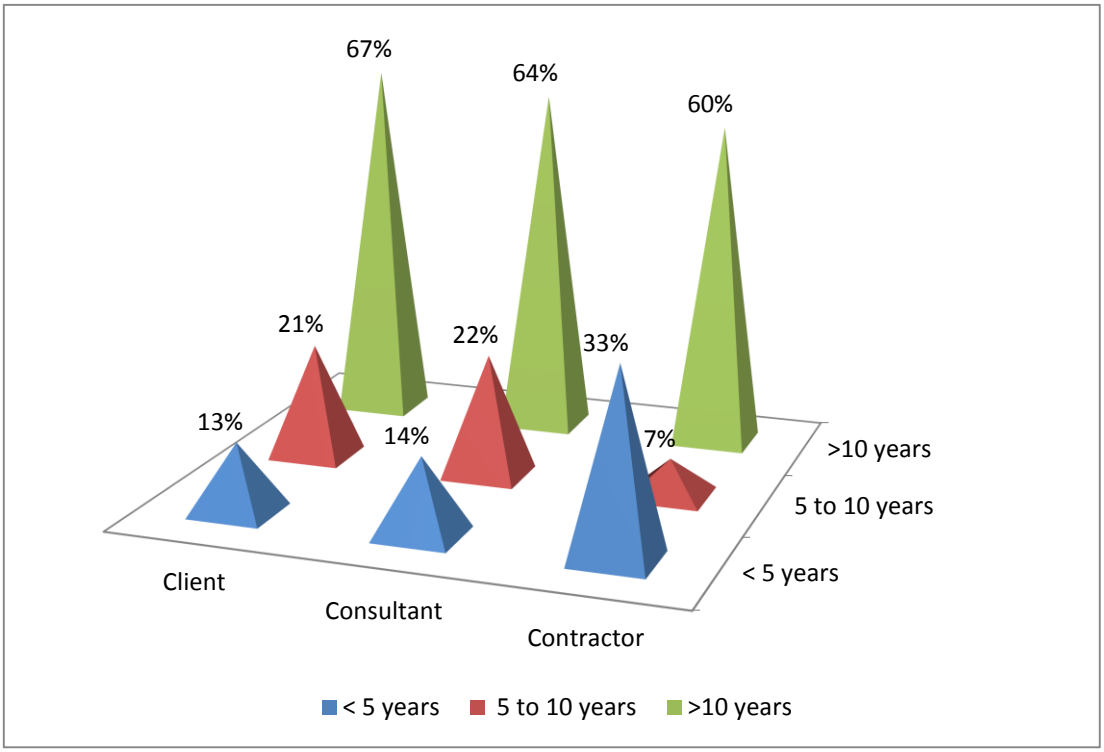

Figure 6: Experiences of individual respondents representing each group involved in the survey

Assessment of experiences of individual respondents (Figure 6) shows that over 64% of the total respondents have more than 10 years of experience in building construction projects; and the remaining 19% and 17% have between 5 to 10 years and less than 5 years of experience in construction projects respectively. It can be concluded that respondents that are involved the current research survey are well experienced and are likely to shoulder responsibilities with a greater probability of being responsible.

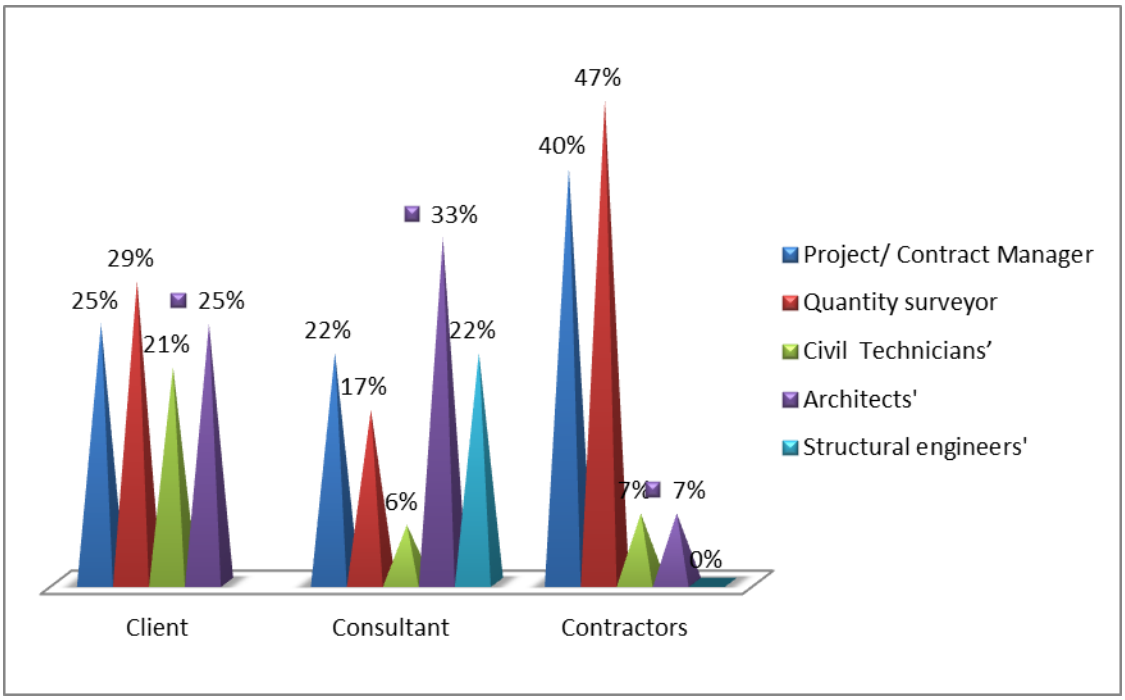

Figure 7: Graph indicating the qualification of respondent to the survey in each group

As shown in Figure 7, the predominant respondents representing clients are 29% quantity surveyor followed by 25 % project or contract managers, and architect and 21% civil technicians. Similarly the majority of respondents representing the consultants are architect (33%) followed by engineer and Project/ contract managers (22%), quantity surveyors (17%) and the least is civil technicians (6%). Likewise, 47% of respondents on the contractors' side are quantity surveyors, followed by 40% project / contract managers and architects and civil technical with (7%). The preceding information explains the diversity of qualified professionals deployed in the construction industry and which in turn points out the fact that their perceptions can be relied up on.

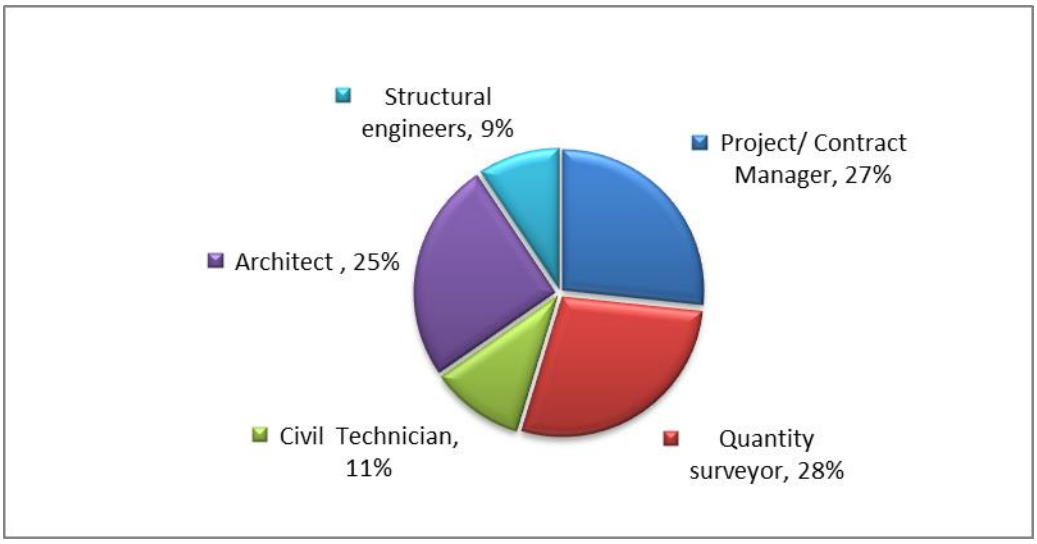

Figure 8: Total percentage distribution of respondents' qualifications in this survey

The percentage distribution of professions among the respondents are comparable as can be illustrated in Figure 8, where 28% are quantity surveyors followed by project/ contract managers (27%), architects (25%). The least percentage is recorded for civil technician (11%) and engineers (9%). With regard to respondent's position in their organization, 43% of respondents are managing directors/principals/ managing members, 27% of senior staff members and the rest have other different responsibility levels in their organization.

1.30 Data Analysis Approach

For each of variables of delay and cost overruns respondents are requested to indicate the degree of impact (or severity) and frequency of occurrence of these variables. The degree of impact is categorized into five scales and the frequency of occurrence into four scales. Before the start of the analysis, weightings have been assigned to each of the categories. For degree of impact the weightings assigned are 5 for very high, 4 for high, 3 for moderate, 2 for neutral, and 1 for none. Similarly, the weightings for frequency of

occurrence are 4 for high, 3 for medium, 2 for low, and 1 for never. Then the responses given by each of the respondents are summarized and counted in their respective categories separately for client, consultant and contractor. Summaries of responses are reported in Appendix B.

1.31 Research Findings and Results

Analysis of the data is undertaken using the statistical methods outlined in chapter 3. The analysis illustrates the findings and results of the survey for the severity, frequency and importance indices of all the variables of delay and cost overruns; and also for the nine major categories of causes of delay.

1.31.1 Severity of the causes of delay and cost overruns

Severity indices of all the variables of delay and cost overruns are computed using equation (1) for each of the three parties' client, consultant and contractor independently and the results are presented in Table 5.

Table 5: The most severe causes of delay identified in this research

Rank	Client	Consultant	Contractor
1	Contractor's cash flow problems	Poor site supervision and management by contractor	Inadequate and unclear details in drawings
2	Manpower Shortage (skilled and unskilled labour)	Contractor's difficulties in financing the project	Contractor's difficulties in financing the project
3	Contractor's difficulties in financing the project	Contractor's cash flow problems.	Mistakes, inconsistencies and ambiguities in specifications and drawings
4	Delay in progress payments by the client	Inefficient quality control by the contractor during construction, leading to rework due to errors	Changes in scope of the project

5	Poor site supervision and management by contractor	Government tendering system of choosing the lowest bidder	Poor site supervision and management by contractor
6	Labour strikes by the contractor workforce	Ineffective scheduling and planning of project by contractor	Poor qualification of engineer's staff assigned to the project
7	Changes in scope of the project	Difficulties among the contractor and subcontractors with regards to payments	Delay in progress payments by the client
8	Inefficient quality control by the contractor during construction, leading to rework due to errors	Delay in progress payments by the client	Delay to furnish and deliver the site to the contractor by the owner

The analysis of severity of variables indicates that, with respect to client's opinion the top five most severe causes of delay are:

- Contractors' cash flow problems
- Manpower shortage (skilled and unskilled labour)
- Contractors' difficulties in financing the project
- Poor site supervision and management by contractor
- Delay in progress payments by the client.

This shows that the top five severe causes of delay are related to: contractor, labour and client problem.

From the consultants' viewpoint the top five severe causes of delay are:

- Poor site supervision and management by contractor
- Contractor's difficulties in financing the project
- Contractor's cash flow problems
- Inefficient quality control by the contractor during construction, leading to rework due to errors
- Government tendering system of choosing the lowest bidder

This indicates that the five most severe causes of delays are related to contractor and external causes of delay. It is also to be noted that three of these factors are similar to those asserted by the client.

According to the contractors' perspective the first five severe causes of delays are:

- Inadequate and unclear details in drawing
- Contractor's difficulties in financing the project
- Mistakes, inconsistencies and ambiguities in specification and drawing
- Poor qualification of engineer's staff assigned to the project
- Change in scope of the project
- Poor site supervision and management by contractor

These causes are related to design, contractor and client. It is also found that two of the factors, which are "Contractor's difficulties in financing the project" and "Poor site supervision and management by contractor", are commonly identified by the three parties as most severe delay causes.

The most severe causes of cost overrun according to contractors, clients and consultants are listed in Table 6.

Table 6: The most severe causes of cost overrun identified for the study area

Rank	Client	Consultant	Contractor
1	Price escalation	Design change	Design change
2	Design change	Quantity underestimation	Quantity underestimation
3	Corruption	Price escalation	Price escalation

From client's point of view, the most severe causes of cost overrun are:

- Price escalation
- Design change
- Corruption

The three most severe causes of cost overrun, identified by contractors and consultants are identical and the rankings of all the three variables by the consultant are the same as that of contractor. These are:

- Design change
- Quantity underestimation
- Price escalation

Two of the causes perceived in common by all parties (clients, consultants and contractors) are design change and price escalation.

1.31.2 Frequency of delay and cost overrun causes

Frequency indices are calculated using equation 2 and the significant frequent causes of delay according to contractors, clients and consultants are shown in Table 7. From the contractor's point of view, the most significant frequent causes of delay are related to client, contractor and design.

Table 7: The most frequent causes of delay identified for the study area

Rank	Contractor	Client	Consultant
1	Delay in progress payments by the client	Poor site supervision and management by contractor	Government tendering system of choosing the lowest bidder
2	Conflicts with sub-contractors schedule and implementation of works	Contractor's difficulties in financing the project	Difficulties among the contractor and subcontractors with regards to payments
3	Slowness in decision making process by owner	Contractor's cash flow problems	Contractor's cash flow problems
4	Delays in sub-contractors work	Ineffective scheduling and planning of project by contractor	Ineffective scheduling and planning of project by contractor
5	Frequent change of sub-contractors due to their inefficient work and poor screening of subcontractors	Inefficient quality control by the contractor during construction, leading to rework due to errors	Poor site supervision and management by contractor

The results in Table 7, indicate that contractors are realizing that delay in progress payments by the client, conflicts with sub-contractors' schedule and implementation of works, slowness in decision making process by owner, delays in sub-contractors' work, frequent change of sub-contractors due to their inefficient work and poor screening of subcontractors, inadequate and unclear details in drawings and changes in scope of the project are the highest frequent factors of delay.

Inputs of the client indicate that the more frequent causes of delay are allied to the contractor and material. Like poor site supervision and management by contractor, contractor's difficulties in financing the project, contractor's cash flow problems. Ineffective scheduling and planning of project by contractor, inefficient quality control by the contractor during construction, leading to rework due to errors.

Unlike the contractors and clients, the consultants point out that the most important frequent delay causes are related to external factors and contractor. The results also indicate that Government's tendering system of choosing the lowest bidder, difficulties among the contractors and subcontractors with regards to payments, contractors' cash flow problems, ineffective scheduling and planning of project by contractor, poor site supervision and management by contractor and lack of technical professionals in the contractor's organization are the most frequent causes of delay. Mostly the lowest bidders are unqualified contractors with low capabilities and inadequate resources, which directs to low performance and cause delay.

Concerning the frequency of causes of cost overrun, again clients and consultants identified the same variables as the three most frequent causes, and the rankings of all the three variables by the client are not the same as those of consultants except for design change. As for the severity the most frequent causes identified are:

- Design change
- Quantity underestimation
- Price escalation

Design change, quantity underestimation and wastage are also the most frequent causes of cost overrun for contractors. Unlike the client and consultants, contractors pointed out wastage as the third most frequent cause of cost overrun. The most frequent and commonly identified causes of cost overrun by all parties are design change and quantity underestimation (Table 8).

Table 8: Most frequent causes of cost overrun

Rank	Client	Consultant	Contractor
1	Design change	Design change	Design change
2	Quantity underestimation	Quantity underestimation	Quantity underestimation
3	Price escalation	Price escalation	wastage

1.31.3 Importance Index of the causes of delay and cost overruns

The importance index (II) is computed for each cause to point out the most significant causes. The Importance index is a product of severity and frequency indices and it is used to rank the variables for both delay and cost overrun using equation 3. The variables are ranked independently based on the II value of responses given by clients, consultants and contractors, and the results are shown in Appendix B. From the ranking assigned to each variable of delays, it is possible to identify the most significant important causes of delays in building construction projects in eThekwini District Municipality of KZN (Table 9).

Table 9: The 20 Most Important Causes of Delays identified in the current research survey

Rank	Over all	Client	Consultant	Contactor
1	Contractor's cash flow problems	**Contractor's cash flow problems**	**Poor site supervision and management by contractor**	**Delay in progress payments by the client**
2	Delay in progress payments by the client	**Contractor's difficulties in financing the project**	Government tendering system of choosing the lowest bidder	Inadequate and unclear details in drawings
3	Poor site supervision and management by contractor	**Poor site supervision and management by contractor**	**Contractor's cash flow problems.**	**Changes in scope of the project**
4	Inefficient quality control by the contractor during construction, leading to rework due to errors	**Manpower Shortage (skilled and unskilled labour)**	**Ineffective scheduling and planning of project by contractor**	Delays in sub-contractors work
5	Contractor's difficulties in financing the project	**Inefficient quality control by the contractor during construction, leading to rework due to errors**	Difficulties among the contractor and subcontractors with regards to payments	Conflicts with sub-contractors schedule and implementation of works
6	Difficulties among the contractor and subcontractors with regards to payments	**Late procurement of materials by the contractor**	**Inefficient quality control by the contractor during construction, leading to rework due to errors**	**Slowness in decision making process by owner**
7	Delay in delivery and late ordering of material	Labour strikes by the contractor workforce	**Contractor's difficulties in financing the project**	Frequent change of sub-contractors due to their inefficient work and poor screening of subcontractors
8	Insufficient skill of labour	Changes in specifications and material types during construction	**Lack of technical professionals in the contractor's organization**	Late response from the consultant to contractor inquiries

9	Ineffective scheduling and planning of project by contractor	Changes in scope of the project	**Delay in progress payments by the client**	Original contract duration is too short
10	Late procurement of materials by the contractor	**Low productivity level of labour**	Insufficient skill of labour	**Delay in delivery and late ordering of material**
11	Changes in scope of the project	Shortage of construction materials required	**Late procurement of materials by the contractor**	Consultant's poor coordination with other parties involved
12	Government tendering system of choosing the lowest bidder	**Delay in progress payments by the client**	**Delay in delivery and late ordering of material**	Changes in specifications and material types during construction
13	Delays in sub-contractors work	Insufficient skill of labour	Delays in sub-contractors work	Late instructions by the consultant/ engineer
14	Manpower Shortage (skilled and unskilled labour)	Ineffective scheduling and planning of project by contractor	**Low productivity level of labour**	Severe weather conditions on the job site
15	Low productivity level of labour	**Delay in delivery and late ordering of material**	Low qualification of the contractor's technical personnel assigned to the project	Mistakes, inconsistencies and ambiguities in specifications and drawings
16	Lack of technical professionals in the contractor's organization	Slowness in decision making process by owner	Effects of subsurface (underground) conditions	Delay in issuance of change orders (Variation orders) by the owner
17	Slowness in decision making process by owner	Owner's poor communication with government and construction parties	Delay in getting permits from different government offices	Delay to furnish and deliver the site to the contractor by the owner
18	Changes in specifications and material types during construction	**Lack of technical professionals in the contractor's organization**	During the bidding stage, inadequate technical study by the contractor	Poor communication among the consultant and other parties involved

19	Labour strikes by the contractor workforce	Poor coordination by the client with the other parties during construction	Improper construction techniques implemented by the contractor	**Difficulties among the contractor and subcontractors with regards to payments**
20	Conflicts with sub-contractors schedule and implementation of works	Low qualification of the contractor's technical personnel assigned to the project	Low skill of manpower	**Insufficient skill of labour**

II = Importance Index

Twenty most important causes of construction project delay in eThekwini of KZN are selected from each set of rankings, and these are listed in Table 9. The results show that there are several important variables that explain the underlying causes of delay. From these variables, the top five most important causes identified by the analysis of the survey, and based on overall results, are: contractor's cash flow problems, delay in progress payments by the client, poor site supervision and management by contractor, inefficient quality control by the contractor during construction, leading to rework due to errors, and contractor's difficulties in financing the project.

From client's point of view, the top most five important factors which are the main causes of delay are: contractor's cash flow problems, contractor's difficulties in financing the project, poor site supervision and management by contractor; manpower shortage (skilled and unskilled labour) and inefficient quality control by the contractor during construction, leading to rework due to errors.

The top five important causes of delay as perceived by the consultants are the following:

- Poor site supervision and management by contractor
- Government tendering system of choosing the lowest bidder
- Contractor's cash flow problems
- Ineffective scheduling and planning of project by contractor
- Difficulties among the contractor and subcontractors with regards to payments.

The contractors' top five important causes of delay are: delay in progress payments by the client, inadequate and unclear details in drawings, changes in scope of the project, delay in sub-contractors' work, conflicts with sub-contractors' schedule and implementation of works.

With regard to delay variables, 20 most important factors have been identified for each set of rankings. Out of these most important delay variables, three are found to be common for all parties, namely delay in progress payments by the client; delay in

delivery and late ordering of material; and insufficient skill of labour. There are also many causes which are shared common between two parties, such as contractor's cash flow problems, contractor's difficulties in financing the project, poor site supervision and management by contractor, changes in scope of the project, delays in sub-contractors work, etc. which are highlighted in bold from Table 9. It was observed that all the three parties agree that the least important causes of delay are unavailability of bonus for early completion and effect of cultural and social factors.

The most important causes of cost overrun, according to clients, consultants and contractors are presented in Table 10. The table shows the importance and rankings of the causes of cost overrun common to the three parties surveyed.

Table 10: Important causes of cost overrun identified for the study area

Rank	Client	Consultant	Contractor
1	Price escalation	Design change	Design change
2	Design change	Price escalation	Quantity underestimation
3	Quantity underestimation	Quantity underestimation	Price escalation
4	Lack of quality	Lack of quality	Wastage
5	Corruption	Delays caused by the owner and his/her agent	Acceleration
6	Wastage	Acceleration	Lack of quality
7	Delays caused by the owner and his/her agent	Corruption	Delays caused by the owner and his/her agent
8	Acceleration	Wastage	Corruption
9	Change in legislation	Change in legislation	Change in legislation

The top three most important causes of cost overrun commonly identified by all parties are:

- Price escalation
- Design change
- Quantity underestimation

All parties came to agree that change in legislation is the least important cause of cost overrun.

1.32 Analysis of Major Categories of Delay Causes and Responsible parties

Identifying the responsible parties in the construction industry who are accountable for causing delays and cost overrun in office building construction in Durban is the most important information needed to take remedial measures for eliminating or minimizing delays and cost overrun. Identification of responsible party is useful to recognize who is causing delays and cost overruns so that the concerned parties will give more attention to avoid or to minimize the problem of time and cost overruns.

It is recalled that the causes of delays have been categorized into nine major groups depending on the source of delay (Table 1). The responsibility is assessed for each category of delay among the major stakeholders of industries that can be involved directly or indirectly in a construction project: starting from the client, consultant and contractor. For other delays categories, which have not come from these three parties, the responsibilities are based on external causes such as from the government, weather, labour or material suppliers and others.

Client's contractual responsibilities could be generalized to responsibilities to providing finances, project site, design, approvals and as well as contract administrations. The contractors have the major responsibility for delay causes in construction related delays. The consultants play a very important role in design related delays because they are in charge of the design procedure in conjunction with the owner of the project.

The ranking of major groups and the responsible parties have also been exercised based on the frequency, severity and importance indices of the variables under each of them. The indices of each group are determined by taking the average of the frequency, severity and importance indices of the variables under the group in question.

The following tables (Tables 11 to Table 13) show the severity, frequency, importance of indices and rankings of major categories of delay and responsible parties for the delay causes consistent with various parties. The responsibility of the delay causes is illustrated in the responsibility column of Table 12 in conjunction with categories of delay.

Table 11: FI and ranking of categories of delay causes

Categories	**Client**		**Consultant**		**Contractor**		**Over all**	
(sources)	**FI**	**Rank**	**FI**	**Rank**	**FI**	**Rank**	**FI**	**Rank**
Design related	65.42	9	57.65	8	61.67	4	61.58	7
Project related	65.80	8	57.75	7	54.72	5	59.43	9
Client related	73.18	4	66.80	4	62.36	3	67.45	3
Contractor related	76.18	3	70.77	2	54.06	7	67.00	4
Consultant related	67.59	6	57.25	9	64.44	1	63.10	5
Material related	80.00	1	69.72	3	64.00	2	71.24	1
Equipment related	70.31	5	65.10	5	43.75	9	59.72	8
Labour related	77.66	2	73.61	1	54.07	6	68.45	2
External	66.83	7	64.35	6	54.03	8	61.74	6

FI = Frequency Index

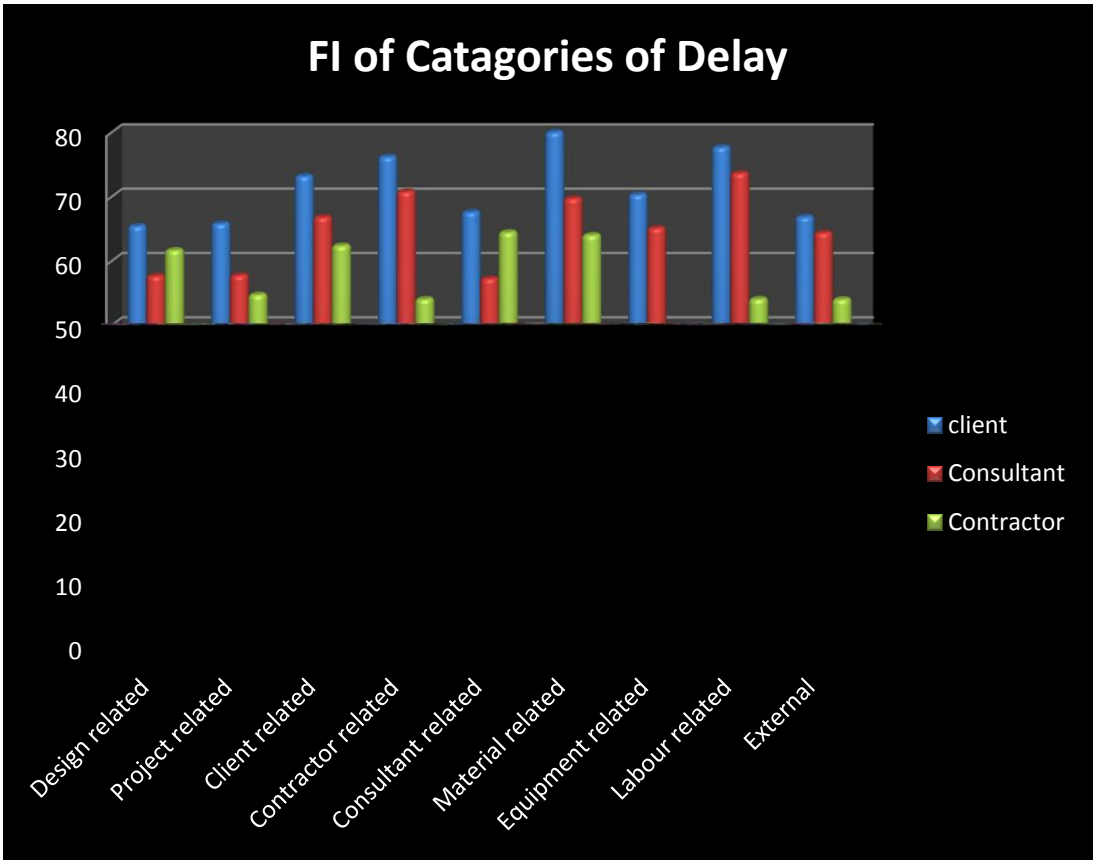

Figure 9: Frequency index of categories of delay

Table 12: SI and ranking of categories of delay causes

Categories (sources)	Client		Consultant		Contractor		Over all	
	SI	Rank	SI	Rank	SI	Rank	SI	Rank
Design related	66.39	8	61.44	8	77.8	1	68.57	6
Project related	63.06	9	56.02	9	58.22	9	59.10	9
Client related	74.17	4	68.70	5	71.22	6	71.36	4
Contractor related	74.38	3	70.77	3	71.62	4	72.26	3
Consultant related	67.87	6	62.35	7	73.33	2	67.85	7
Material related	77.00	1	73.67	1	73.07	3	74.58	1
Equipment related	70.63	5	69.44	4	67.00	7	69.02	5
Labour related	76.14	2	71.67	2	71.26	5	73.02	2
External	66.53	7	64.53	6	66.07	8	65.71	8

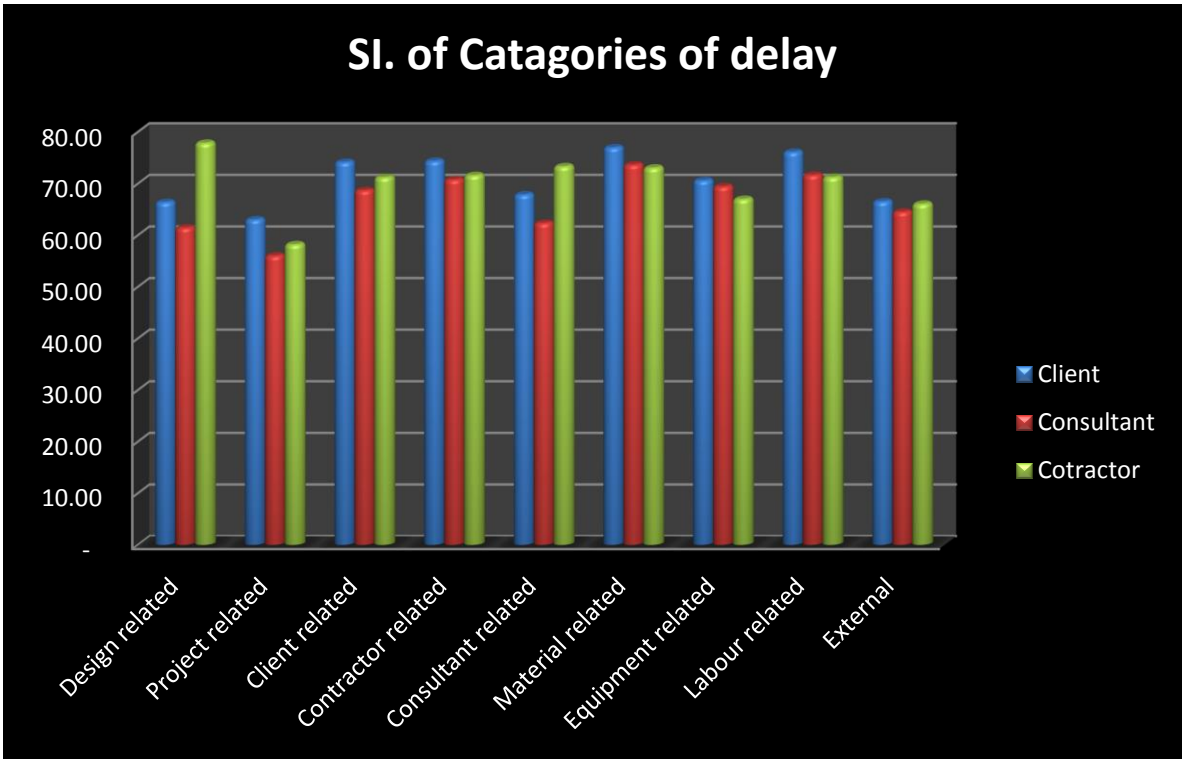

Figure 10: Severity index of categories of delay

SI = Severity Index

Table 13: II and ranking of categories of causes of delay and responsible parties

Categories (sources)	Client		Consultant		Contractor		Over all		Responsible parties
	II	Rank	II	Rank	II	Rank	II	Rank	
Design related	43.61	8	35.46	8	48.39	1	42.49	6	Client & consultant
Project related	41.69	9	32.78	9	32.65	8	35.71	9	Client & consultant
Client related	54.47	4	46.40	4	44.78	4	48.55	4	Client
Contractor related	56.94	3	50.51	3	38.79	5	48.75	3	Contractor
Consultant related	45.98	6	35.79	7	47.21	2	43.00	5	Consultant
Material related	61.65	1	51.52	2	46.87	3	53.34	1	All and Government
Equipment related	49.72	5	45.34	5	29.34	9	41.47	7	Contractor
Labour related	59.25	2	53.00	1	38.75	6	50.33	2	Consultant, contractor & Government
External	44.64	7	42.17	6	36.00	7	40.94	8	Government and others

II = Importance Index

Table 13 , Figure 9 and Figure 10 shows the summary of severity , frequency and importance indices of all categories of delay causes in office building construction projects in eThekwini Municipal area, Kwazulu-Natal consistent with various responsible parties. As importance index is the product of frequency index and severity index, the corresponding ranking is made based on Pareto rule assumption that the highest ranked have the greatest influence.

As shown in Table 13, the result of material related category of delay indicates the greatest sources of delay for the three respondents of the survey and is ranked first, second and third according to client, consultant and contractor respectively. This result is consistent with the outcome of the overall analysis as material related category of delay is highly ranked and is placed at the first position. This agreement between all respondents of the survey is traced to the difficult political situation from which South Africa suffers. Due to slow down of global economic and change in currency exchange rate the construction sector has been experiencing a slowdown in South Africa especially with respect to imported construction materials. According to Olatunji, (2010) the economic policy of South African construction industry significantly affects project delivery time.

Material related category of delay can be considered as important source of delay for the three stake holders since it directly affects the performance of the project. If materials are not available as intended through construction project duration, the project will suffer from the problem of delay and cost overrun. Material related delay causes have mixed responsible parties: clients, consultants, contractors and governments. No single party is responsible for this category of delay causes, means that any effort to prevent or minimize delay has to be a joint endeavour and based upon teamwork. A similar observation is suggested in the survey of Abdul-Rahman *et al*. (2006) conducted in Malaysia.

The results of Table 13 show that design related and consultant related sources of delay are highly ranked by the contractor respondents in the first and second position respectively. However, both consultants' and clients' respondents held different views and gave these sources lesser rakings, i.e. from sixth and to eighth positions although such delays usually originate from the consultant and client related problems. The result shows that there is agreement between consultants' and clients' point of views. Whereas, with regard to contractors' point of views, there is disagreement with these source of delay. The opposing views between these respondents of parties appear to resemble conflicting attitudes. On the other hand, both consultants and clients are not willing to admit or take the responsibility for project delays and also it can be considered as "pinpointing" of accountability of delay on other parties. It is predictable that consultants and clients are more responsible for design and consultant related categories of project delays. These adversarial points of views, blaming each other for delay causes are not very helpful for the project success; however, in order to reduce or to eliminate delays teamwork is required.

Overall delay sources in construction projects are caused by various factors, some of which are within the consultant's responsibilities, some are owner's responsibilities and some are within the contractor's responsibilities. According to Arditi *et al* (1985), the overlapping nature of construction events makes it difficult to distinguish what proportion of the overall delay source is which party's responsibility. Delays and cost overrun in office building construction can be reduced through the joint efforts of the participants of the construction industry i.e. clients, contractors and consultants. It is also the responsibility of Government to create stable economy, to co-operate necessary facilities and to renew or develop infrastructure to control time and cost overruns.

Based on overall results, project and external related categories of delay have less important causes identified by the survey. The results show good agreement between the respondents of project parties in ranking of sources of delay being the least categories.

Furthermore, the results of Table 13 show that the clients and consultants have similar views in ranking of the categories of delay. This can be traced to the fact that in most building construction projects, the position of the consultant may be seen as more favourable to the owner, because of the contractual relationship between them. This research reinforces the fact that the intermediate positions of consultants means that they have partial views and often tend to take the client's side.

Summary of combined frequency index, severity index, importance index, rank for the categories (sources) of delays and responsible parties by all respondents of the survey in Durban building construction projects are shown in Table 14. From the analysis of the results, it is found that the most frequent, severe and important source of delay is material related as it has the first rank among all categories of delay and scores a similar rank for all indices. Similarly labour related delay has been ranked in the second position and has got a similar score. For these sources of delays, project owners (clients), contractors, consultants and governments are found to be responsible. Project related category of delay is the least frequent, severe and important source of delay and has been ranked in 9th position.

Table 14: Overall ranking of sources (categories) of delay by all parties (combined)

Categories	FI	Rank	SI	Rank	II	Rank
Material related	71.24	1	74.58	1	53.34	1
Labour related	68.45	2	73.02	2	50.33	2
Contractor related	67.00	4	72.26	3	48.75	3
Client related	67.45	3	71.36	4	48.55	4
Consultant related	63.10	5	67.85	7	43.00	5
Design related	61.58	7	68.57	6	42.49	6
Equipment related	59.72	8	69.02	5	41.47	7
External	61.74	6	65.71	8	40.94	8
Project related	59.43	9	59.10	9	35.71	9

1.33 Kendall coefficient of concordance

To determine the agreement of ranks among the client, consultants and contractors, Kendall coefficient of concordance (*W*) is used. W is computed according to the equation 4 and 5 outlined in Chapter 3. Accordingly, the values of *W* for rankings of delay causes are found to be 0.762 and that for cost overruns is 0.840. In order to know whether there is agreement or disagreement between the three groups on ranking the factors, a test of hypothesis is needed.

- Null hypothesis: H0: Disagreement in rankings among the three groups.
- Alternative hypothesis: H1: Agreement in rankings among the three groups.

Siegel and Castellan (1988) assert that the null hypothesis is usually formulated to express the purpose of being rejected; it is the opposite of an alternative hypothesis that one is attempting to prove. The null hypothesis is rejected, in favour of the alternative hypothesis, if its associated probability of occurrence is equal to or less than some small probability (p). That probability is called level of significance, and its common values are 0.05 and 0.01. The level of significance of 0.05 is selected for this research.

The probability associated with the occurrence when the null hypothesis is true of any value may be determined after finding χ_r^2 using equation (6) and determining the probability associated with as large a value of χ_r^2 by referring to chi-square (χ^2) distribution table [Siegel and Castellan, 1988].

$$\chi_r^2 = m(n-1)W \qquad (6)$$

The significance, however, since the degree of freedom for delay variables is larger than the values indicated in the chi-square (χ^2) distribution tables, the value of significance level (p) is determined using Microsoft Excel function CHIDIST with degree of freedom

of n-1, which in this case is 84 for delay causes and 8 for causes of cost overrun. The respective results are shown in Table 15.

Table 15: Analysis of coefficient of concordance and significance level

Description	m	n	*W*	χ_r^2	p
Ranking for Delay variables	3	85	0.762	192.05	0.00000000019
Ranking for Cost Overrun variables	3	9	0.840	20.18	0.009683982

The values of level (p) are less than 0.05, and hence verify that the null hypothesis *"*there is no agreement among the sets of rankings by the parties (client, consultant and contractor)" has to be rejected. Subsequently, the alternative hypothesis; i.e., "there is agreement among the sets of rankings by the parties" is supported with confidence level of more than 95%. Computation of Kendall coefficient of concordance and level of significance (p) is indicated in Appendix C.

The flowing chapter 5 discusses the research findings in fulfilment of objectives and also suggests how to minimise the impacts of those identified factors in the implementation of the upcoming projects.

DISCUSSION

Chapter five focuses on discussion of results obtained in earlier chapter and answers the fourth underling research question: how delays and cost overruns could be substantially minimized in office building construction projects in eThekwini Municipal area, KZN. The critical factors have already been identified in Chapter 4, and it is deemed that mitigating these factors would substantially minimize the problems of delays and cost overruns in office building construction projects in eThekwini Municipal area, KZN. Accordingly, in this chapter the results of the data analyses are discussed, interpretations and mitigating solutions are provided under the respective major categories of delay causes.

1.34 Design related causes of delays

The major category "Design related delay causes" includes causes 1-5 of Table 1. Out of the five variables only two are identified by the contractor in the 20 most important delay causes. These are inadequate and unclear details in drawings and mistakes, inconsistencies and ambiguities in specifications and drawings. Design related category of causes has been ranked by the contractor respondents in the 1st position. However, consultant and client respondents have ranked it in the 8^{th} position. This reflects the adversarial relationship of contractors with consultants and clients. It also shows that clients and consultants did not see themselves as responsible for projects delay. It is not surprising to observe that the design related group of causes is the most important one for contractors because any modification and mistakes in design strongly affects the time performance of work, cost and productivity of the contractor during construction. However, these causes exist frequently due to inadequate attention to low competence of designer and lack of consultants providing detailed specification and clear working

drawings to be used on site. Additionally, clients' demands for a change in design to meet their preferences and requirements affects the project delivery time.

Furthermore, design changes are considered as one of the major factors for increasing the cost of projects. Any modification in the design will affect the budget located for the project, the volume of required materials, type of required materials and needed labour. Sometimes, design changes cause the rework of already completed items, which means increased project durations and loss of materials. The research results of Chimwaso (2001) and Kaming *et al.* (1997) support this result, in that design changes are one of the major factors to cause cost overruns. The design related problems are not only found in eThekwini Municipal area, KZN but also exist elsewhere in the world, occurring in almost all of the projects and require special attention by the client and consultant. The following points will help to alleviate the problem.

- The client needs to institute a mechanism whereby design consultants are held accountable even through the construction stage and beyond where they continue to carry professional liability.
- If the current design period is too short to conduct detailed investigation and produce complete and sound design, allowing more time for the design phase would assist in reducing the problems related to design,
- It is also crucial for the client to improve the selection process for design consultants to guarantee assignment of qualified consultants,
- The client needs to have qualified and well experienced personnel and conduct detailed reviews of documents produced by design consultants.

1.35 Project related causes of delays

The major delay category "Project related causes of delay" consists of six factors. Among these only the contractor identified the factor "Original contract duration is too short" as one of the most important 20 delay causes.

"Original contract duration is too short" refers to inaccurate time plan estimates for delivery or completion of project. Projects are hardly ever completed without presenting changes to their forecasting baseline schedule and the key challenge is accurate estimate of project delivery time. Contract estimates (accurate or not) usually become 'milestone', and the actual completion time is unrealistically expected to agree with the contract estimate. There is a discrepancy between original contract time and actual project completion time due to the amount of information available (i.e. scope definition) during the preparation of contract duration estimate. The accuracy of time and cost estimate is extremely dependent on the level of detail in the project scope definition. Lack of scope definition often leads to inaccurate estimate and potentially creates a situation of delays and cost overrun in reality. However, the more experienced the estimator the greater possibility that the subjective decision will be based on the objective experience. Deciding the expected time range of project completion is subjective. The more detailed estimates of the duration of each activity result in more accurate completion time. Ideally, each activity should be included with an accurate time and cost estimate provided a critical path method (CPM) management system is used. Both consultant and contractors should provide their own CPM program which should be correlated, similar to bills. Due to the contractor's freedom to choose how and when work is to be done, possibly only milestones can be correlated.

As suggested by Long *et al*. (2004), the ultimate responsible parties for poor estimation are contractors but clients and consultants are also responsible. In order to get accurate estimates, the contractors must pay attention and consultants and clients need to allow the various parties sufficient time and resources. Moreover, the parties should have commitment and competence in scheduling and careful surveying.

1.36 Client related causes of delays

Client related causes of delay are ranked by clients, consultants, and contractors in the 4th position and includes causes 12-23 of Table 1. From these variables, delay in progress payments by the client is commonly identified by all parties and the overall ranking shows that it is 2nd most important causes of delay in eThekwini Municipal area. There are also two common causes identified by client and contractor "Changes in scope of the project" and "Slowness in decision making process by owner". Furthermore contractors blame the owners' inability to furnish and deliver the site to the contractor and delaying in issuance of change orders (Variation orders) while clients admit that owner's poor communication with government and construction parties and poor coordination by the client with the other parties during construction as the most important causes of delay.

Based on the overall result "Delay in progress payments by the client'' is identified as the second most important cause of delay in eThekwini Municipal area. Besides all the respondents of parties highly ranked and identified this cause as the 20 most important causes of delay in this survey. This agreement between the respondents of the survey is traced to disputes that will occur between construction project parties, when the payment from the client is delayed. This highly affects the time performance of projects. Furthermore contractors are more aware of this problem and give them first priority. Since construction works hold huge amounts of money, it is very difficult to absorb the heavy daily construction expenses of contractors when the payments are delayed. A late payment from the owner causes inadequate cash flow to support construction expenses especially for contractors who are not financially sound. According to Oglesby *et al*. (1989), a failure to provide sufficient funding resources to contractors for the work done will make it difficult for the contractors to meet project objectives.

With regard to delay related to issuance of change orders and change in scope are basically a problem of lack of clear definition of client objectives. As the construction is on progress, the client keeps on changing its mind to accommodate the interests of different stakeholders causing late variations on projects.

Slowness in the decision-making process by the owner, since the ultimate power resets with the owner, the management should be cooperative, not adversarial. All the team should work together including the owner, to achieve success of project within a stipulated time, budget and specified quality standard with least waste. Get it right first time means deciding the detail as soon as possible. Therefore to mitigate these problems the following points are suggested,

- Clients assure the contractor that they have an available fund for project, build a financial plan, and should work in collaboration with the financing bodies and institutions to pay contractors according to agreement and scheduled time (Alkass *et al*, 1996).
- Client's objectives should be well established before the start of the design phase by considering the interests of all the stakeholders.
- Clients must give quick decisions to resolve any problems that are raised during construction since the ultimate power rests with the owner, the management should be cooperative, not adversarial. All the team should work together including the owner, to achieve success of project within a stipulated time, budget and specified quality standard with least waste. Get it right first time means deciding the detail as soon as possible.
- Clients should devolve power to the lower levels and ensure responsibility and accountability each level.

1.37 Contractor related causes of delays

Contractor related group of delay is ranked high by both clients and consultants and low by contractors. Clients and consultants are more aware of these problems and give them greater priority. This major category of delay includes causes 20-41 of Table 1. Out of the 22 variables, five are identified in the most 20 delay causes by the clients and consultants. These are Contractor's difficulties in financing the project, Contractor's cash flow problems, Poor site supervision and management by contractor, inefficient quality control by the contractor during construction, leading to rework due to errors, Ineffective scheduling and planning of project by contractor. Likewise the respondents of the contractor and consultant commonly identified four variables of delays. These are delays in sub-contractors work; conflicts with sub-contractors schedule and implementation of works; frequent change of sub-contractors due to their inefficient work and poor screening of subcontractor; and Difficulties among the contractor and subcontractors with regards to payments as the most 20 delay causes. These problems are related to sub-contractors. According to Sambasivan and Soon (2007), if subcontractors are capable the projects could be completed on time. If the sub-contractor under performs because of insufficient experience and capability the project can be delayed.

Under the responsibility of contractors "Contractors cash flow problem" and "Contractor's difficulties in financing the project" are identified as the first and fifth most important cause of delay in eThekwini Municipal area of Kwazulu-Natal based on the overall analysis respectively. These factors are related to financial capability of the contractors and seriously affect performance of project and causes delay. These causes may be due to delay in progress payments by the client, inadequate capabilities of the contractor and insufficient cash flow of the contractor to sustain the expenses of the construction work. This is supported by Sambasivan and Soon (2007), Assaf and Al-Hejji (2006), Al-Khalil and Al-Ghafly (1999), Frimpong *et al*. (2003) who reported that

delay in progress payment by the owner would eventually cause cash flow problem and financial difficulties to the contractor. Therefore, most of building construction works cannot be accomplished due to these financial difficulties. Moreover, the economic crisis of South Africa also affects turnover of the contractors and causes delay in building construction works because the job cannot be carried out on time. This may be due to some contractors having gone out of business or do not have the financial competency to complete the project.

Poor site supervision and management by contractor has been ranked by client and consultant respondents in the third position. The results of overall ranking show that it is the third most important causes of delay in Durban. Inefficient quality control by the contractor during construction, leading to rework due to errors, difficulties among the contractor and subcontractors with regards to payments, ineffective scheduling and planning of project by contractor are also ranked fourth, fifth and ninth respectively according to the overall results. These variables represent the weakness of contractors, not having enough experience and suffer from inadequate knowledge in managing the project team. Most of the lowest bidders may not have enough management skills and pay less attention to overall site management, cost control, contractor's plan, and resource allocation, i.e., financial, human, and material resources. Wahab (1997) suggests that many contractors in developing countries are entrepreneurs which are in the business of making money.

In order to substantially reduce the occurrences of the aforementioned factors in building construction projects, it is suggested that:

- The client should improve the method of evaluation of bids to guarantee selection of well performing contractors with sound financial capacity.
- The client needs to restrict the number of projects to be awarded to a contractor to avoid cash flow problems during construction.

- In pre-qualification stage, contractors' ability to avail the minimum requirement for provision of resources should be considered as major criteria.
- During the course of construction, contractor's deployment of resources should be periodically reviewed in line with the approved work program.
- Contractors should have enough cash before the start of any project to reduce financial problems. Consultants should improve the communication and coordination between parties by holding weekly / monthly meeting with key staff.
- Contractors are advised to monitor financial spending because any financial problem may lead to cost and time overruns.
- Contractors should assign experienced personnel dedicated to preparation and subsequent revision of work program.
- Contractor's use of appropriate planning techniques should be assessed during the bid evaluation process.
- Contractors' quality assurance manual should be reviewed before the award of the contract and during construction there has to be close follow-up by the consultant/engineer towards its implementation.
- The client should allow for longer bidding periods in order for contractors to have sufficient time for detailed technical study. This will help contractors to estimate their bid and devise their work program with a better certainty.

1.38 Consultant/Engineer related causes of delays

The analyses of categories of delay indicate that consultant related cause of delay is ranked sixth and seventh according to client and consultant results, respectively. It has the second position in the contractors' responses. It seems that consultants and owners are not willing to admit the responsibility for the delayed project. This major category includes causes 42-50 of Table 1. Out of the 9 variables only 3 are identified in the 20 most important causes of delay by the respondents of contractors. Contractors are

blaming the consultant's poor coordination with other parties involved; late response from the consultant to contractor inquiries; and late instructions by the consultant/ engineer; amongst the 20 most important causes of delay. These factors are reliant on coordination and performances of consulting firms assigned for a project. According to Assaf *et al*. (1995), a difficulty in coordination among the parties is one of the factors that cause delay. Since there are many parties involved in a construction project, such as contractor, sub-contractor, client and consultant, mostly it might be difficult to coordinate well these various separate parties in order to complete the project within the stipulated time frame. To mitigate these problems the following points are proposed

- Consultants should improve the communication and coordination between parties.
- The client should reasonably relax the restrictions on the engineer's duties and authority for proper administration of contract between the client and contractor.
- The client should introduce a system of evaluating the performance of consultants for possible award of other projects or blacklisting.

1.39 Material related causes of delays

Material related category of delay is ranked high by all parties. The clients ranked this group as first, consultants ranked second and the contractors ranked as the third most important source of delay. Based on the overall results, this delay cause category is the most critical category for delay as it ranked first. The outcome of the individual causes as delay in delivery and late ordering of material is identified by all parties in the top 20 most important delay causes. While the contractors and the clients identified changes in specifications and material types during construction, late procurement of materials by the contractor as most important delay causes. Clients further consider shortage of construction materials required as the most important delay factor.

Delay of material delivery to site is relatively highly ranked by all participants of the survey. The reasons for delays of material delivery to site are caused by (a) problems related to transportation of materials (e.g. road traffic jams, the severe weather and other factors); (b) an unanticipated increase in demand, due to poor coordination and planning between contractors and suppliers.

In South Africa, most of the products supplied by building material manufacturers could not be used in alternative industries. Consequently, for these products, the suppliers are highly dependent on the activity of the construction sector. According to Frost and Sullivan (2011), the lack of competitive markets for building materials in South Africa results in the suppliers being heavily dependent on the health of the construction sector. In 2010 following the global economic slowdown, the construction has been suffering a slowdown in South Africa since 2010. Therefore, the failure of the supplier to deliver on time can interrupt work and delay the completion of a project (Ruiz-Torres and Farzad, 2006). The research results of Alaghbari *et al.* (2007) are similar in that "the delay of materials delivery to the site" is a significant cause of delay. This is also further supported by Aibinu and Odeyinka (2006) whose investigation shows that late delivery of materials is the critical cause of delay in Nigerian construction projects.

The delivery of materials in time to construction site is vital for the smooth flow of activities. The management of materials must be a planned procedure which includes purchasing, delivery, handling and reduction of waste. Besides that the movement of material should be developed alongside of the work scheduled. This helps for effective coordination of resources with respect to materials in need, stock in material and ordering dates (Olatunji, 2010). The following measures are suggested:

- To increases the rapidity of delivery of material, asphalt road is recommended for movement of vehicles.
- During design phase detailed investigation of construction materials should be conducted with reliable estimation of quantities.

- The site supervision team should also follow up status of material procurement starting from the day of ordering until time of delivery in line with the work program of the contractor. The contractor should ensure timely ordering and delivery of materials.

1.40 Equipment related causes of delays

The major category "Equipment related causes of delay" includes late ordering of equipment, equipment breakdowns, shortage of equipment required, low equipment-operator's skill and low efficiency and productivity of equipment. All parties agreed that equipment related causes of delay variables are not the most important factors contributing delay of office building construction projects around Durban.

The contractors are more responsible parties for this category of causes of delay. It is recommended that during bidding stage, the contractors should assess:

- The ability to avail the minimum requirements of major equipment,
- The ability of acquiring sufficient stock of spare parts and/or access to replacement equipment in cases of breakdown of major equipment.

During construction phase, the supervision team should assess the average productivity of contractors' major equipment in line with the approved work program.

1.41 Labour related causes of delays

Labour related causes of delay is one of the most important category of delay causes as it has the second rank among all categories of delay causes and includes causes from 63-70 of Table 1. Insufficient skill of labour is identified in the 20 most important causes of delay by all the three sets of rankings. In addition, the client and consultants have identified manpower shortage (skilled and unskilled labour); lack of technical

professionals in the contractor's organization; low qualification of the contractor's technical personnel assigned to the project; and low productivity level of labour to be among the important contributing factors.

Construction of buildings is a labour intensive sector comprising either semi or highly skilled employees. Insufficient skill of labourers and shortage of manpower in South Africa has resulted in the construction companies to employ foreign migrants, especially through broking companies and subcontracting, however there is a growing tendency for construction firms to prioritize the usage of locally available labour. Many construction labours come from neighbouring countries such as Zimbabwe, Lesotho and Mozambique. According IOM/SAMP (2005), South Africa's immigration rules make it difficult to import labours legally from these countries as a result companies tend to employ workers who are already in the country and who are often to be found gathering on street corners, looking for casual employment. The effect of this is that contractors employ irregular migrants and consequently unable to judge their ability and the level of skill of their labours. Besides, the quality of labour available is generally quite poor, which leads to low productivity and poor quality of work and this directly affects the completion time of the project and causes delay. Similar to this survey, Sambasivan and Soon (2007) reported in the Malaysian construction industry where most labourers are unskilled and foreigners. According to SAFCE (2008), in South Africa 95% of the construction industry experiences a critical shortage in number of engineers compared with other countries. In order to fill the skills gap the government has committed itself to improve the development of skills and overcome the existing skills gap. Partnership initiatives and co-ordinated efforts with service providers have been adopted to implement that strategy; development programmes and community outreach contribute to the education and skills development of citizens and eventually their economic and social wellbeing. Moreover, it is suggested to develop human resources in the construction industry through continuous and proper training programs so as to improve the performance of construction projects.

With respect to quality of contractors' personnel assigned to a project, the client needs to assess both qualifications and number of technical professionals during bidding stage and same has to be carefully monitored during construction. Any proposal for replacement of these personnel should consider better or equivalent qualifications. Furthermore, bidders are required to assess the availability of manpower within the locality depending on the project location.

1.42 External causes of delays

The major category "External causes of delays" includes causes 73-84 (Table 1). Among these variables, government tendering system of choosing the lowest bidder is identified by consultants as the second most important cause of delay and delay in getting permits from different government offices is identified as one of the 20 most important delay causes and is ranked 20. The contractors also identified severe weather conditions on the job site to be among the critical factors in construction that cause delays.

Government tendering system of choosing the lowest bidder is the strategy in the majority of building projects in developing countries and some clients or governments award the lowest bidder to accomplish their projects. Mostly the least bidders are unqualified contractors with low capabilities, shortage in resources and lack of management skills, which lead to low performance and cause delay in accomplishing the project. According to Wahab (1997) and Ogunlana and Olomolaiye (1989), most contactors in developing countries are entrepreneurs who make business (money) at the expense of good management, by summiting very low bid and by paying low wedges.
External delay causes are those which are beyond the control of none of the parties but still impact on projects and affect at least one of the parties. Hence, it is the responsibility of the client to clearly indicate risk allocation through the contract documents. In addition, both parties should execute risk assessment and need to prepare

themselves to manage same depending on the allocation of risks stipulated in the contract.

With regards to "Government tendering system of choosing the lowest bidder" the client and government should improve the method of evaluation of bids to guarantee selection of well performing contractors with sound financial capacity and technical performance.

1.43 Factors causing cost overruns

Cause of delays in construction projects is directly related to cost overruns, and hence most of the aforementioned justifications play an important role in minimizing cost overruns. Furthermore, in all the three sets of rankings, design change, quantity underestimation, and price escalation have been regarded as the most critical factors for cost overruns.

To substantially reduce the impacts of the first two factors, it is enough to refer to those suggestions under sections 5.1 and 5.2. With respect to the problems associated with price escalation the following measures are recommended to be implemented:

- To absorb the impact of price escalation, the client should make detailed assessments of price fluctuations in previous projects and forecast the amount with a better certainty.
- The client should also look into escalations made after project completion date, where the delays are attributable to the contractor.

CONCLUSION AND RECOMMENDATIONS

1.44 Summary

The office sector in the eThekwini Municipal area is mainly driven by conditions in the local economy as well as the attractiveness of the city as an office location. Therefore, this sector is severely suffering from over extended project delays and excessive cost overruns, affecting the implementation of the country's construction sector development programs and the country's economy by losing investments on a project.

There are many causes of delays and cost overruns in construction projects and several studies have pointed out various factors based on the underlying conditions that their specific study is concerned with. Therefore, this research attempts to investigate the problems particularly for office building construction projects in eThekwini Municipal District of KwaZulu-Natal.

The research has been undertaken by reviewing literature, which was used to identify the possible variables causing delays and cost overruns in construction projects as a whole. Then the variables have been scrutinized in line with the office building construction. Eighty-five variables for delay and nine variables for cost overruns have then been identified. The variables for delay have been categorized in nine major groups based on the sources of delay. These variables are then used to design a questionnaire, which is designed to consist of three major sections. It basically aims to acquire data on the general background information of the respondents and their organization; degree of impact and frequency of occurrence of the identified variables/factors; and assessment of minimizing or controlling mechanisms of time and cost overrun problems from their personal comments.

After distributing the questionnaire for professionals who have experience in building construction projects in eThekwini Municipal area, sufficient responses are collected

with a response rate of more than 80%, which is well above the minimum required for conducting the analysis. The data has been classified into three groups according to the type of respondents: client, contractor and consultant. From the data retrieved in each group, severity, frequency and importance indices are calculated. Based on the respective importance indices, the variables are ranked separately for delays and cost overruns. The agreement among the rankings is checked using Kendall coefficient of concordance, which result in high values of the coefficient confirming strong agreement among the rankings. Besides, significance levels for the null hypothesis to be true are found out to be less than 0.05, confirming that the alternative hypothesis, there is agreement among the sets of rankings by the parties, is verified with more than 95% confidence level.

With regard to delay variables the 20 most important factors have been identified for each set of ranks. The most important causes identified by the survey, and based on overall results, are: Contractor's cash flow problems; delay in progress payments by the client; poor site supervision and management by contractor; inefficient quality control by the contractor during construction, leading to rework due to errors; and contractor's difficulties in financing the project. Out of these most important delay variables, three are found to be common between all parties, which are ''delay in progress payments by the client"; "delay in delivery and late ordering of material"; and "insufficient skill of labour". The respondent groups show disagreement in some causes of delay, where one points out the responsibility of delay causes on other parties. For instance, the contractor ranked "inadequate and unclear details in drawings" and "changes in scope of the project" as the second and third most important causes of delay respectively, blaming the other parties. However, the clients and consultants gave these causes a lesser ranking. Likewise, the clients and consultants highly ranked contractor's difficulties in financing the project, contractor's cash flow problems, poor site supervision and management by contractor, and inefficient quality control by the contractor during construction, leading to rework due to errors" which usually originated from contractors, as the main causes, while the contractors did not include these causes in the 20 top important causes of delay.

Furthermore, the categories of causes of delay with respect to responsible parties are analysed based on the overall results. The categories of indices of each group are determined by taking the average of the frequency, severity and important indices of the variables under the group in question. The results of the material categories show the greatest source in project delay as it is highly ranked by all parties. The slowdown of global economy, the fluctuation of currency exchange rate for imported material and inflation of materials challenge the clients, contractors and consultants to complete projects within scheduled time and budget. This is in agreement with the conclusion of Olatunji, (2010) that economic policies of South African construction industry do significantly affect project delivery time.

Similarly variables of cost overruns are also ranked in their order of importance. Besides, in all the three sets of rankings design change, quantity underestimation, and price escalation have been regarded as the most critical factors for cost overruns.

1.45 Conclusion

The overall result shows that most important of the causes of time and cost overrun in the office building construction projects in eThekwini Municipal area originate from financial and poor resources management (technical, human, and materials). In order to minimize these causes, owners should have an available fund for project and pay in time to the contractors according to the agreement. On the other hand, contractors should have strong backing from financial institution and be financially sound.

The cost of individual construction projects needs to be accurately estimated and any potential project risks that can lead to cost and time overruns are to be adequately identified and managed accordingly. Moreover, human resources should have good training in managerial and technical aspects of the construction projects. These programs can update participants to have good practice in planning coordinating, controlling and monitoring of resources in scheduled time.

Finally, recommendations are made to substantially minimize the impacts of these critical factors causing delays and cost overruns. The outcome of the analysis indicates that all of the parties are deeply involved in causing the problems due to the

overlapping nature of construction events and it is difficult to distinguish what proportion of the overall delay source is which party's responsibility. Blaming each other on who causes delay is not very helpful and a lot of work is expected to be done by each of the parties in order to minimize the problems of time and cost overruns in office building construction projects in eThekwini Municipal area of KwaZulu-Natal.

1.46 Recommendations

The problems of time and cost overrun are badly affecting the building construction industry in the eThekwini Municipal area. All stakeholders (clients, contractors and consultants) should work together to achieve successful projects within the stipulated time and budget, and exceed the anticipated quality standard. Especially competent project team and construction managers' should pay close attention to planning and preventive action to keep the construction project on budget and schedule, and play an important role in preventing projects from delay or extra cost. Therefore, implementing quality management system through skilled, competent and trustworthy project managers is vital, since project managers are the individuals who are engaged in the overall planning, coordination, monitor of risks and control of a project from beginning to completion. In order to minimize the incidences of delay and cost overrun in office construction projects construction managers should:

- Pay serious attention to the feasibility study and make sure that it is done carefully;
- Monitor risk and respond events that occur over the course of project by updating risk management plans with new information,
- Specify project objectives and strategies including delineation of scope, budget and schedule;
- Set performance requirements for selecting project participants i.e. competent consultants and well performing and reliable contractors;
- Maximize the resource efficiency through procurement of labour, materials and equipment;

- Implement various operations through proper coordination and control of planning, design, estimating, contracting and construction in the entire process.
- Develop effective mechanisms and communications for resolving conflicts that cannot be avoided;
- Use modern management systems and up to date technology such as 3D CAD and BIM (Building Information Modelling);
- Ensure all payments are made timeously;
- Make sure that sufficient contingency is available on the owner's side to spend on acceleration costs in the event of any delay.

Further studies are recommended to be undertaken in other areas of South Africa on various building and civil construction projects in order to come up with a nationwide mechanism for minimizing cost overruns and delays in the general construction industry.

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APPENDIX A: QUESTIONNAIRE

Date: 06/09/2013

Dear participant,

I am currently working on a research study on Time and Cost Overruns in Building Construction Projects in the eThekwini Municipal area, Kwazulu-Natal in fulfilment for my M.Tech. study in construction management at the Durban University of Technology. This research is aimed to investigate the problem why most building construction projects within the District Municipality are delayed beyond their time for completion and require additional budget than agreed contract prices. Identifying the factors/variables that contribute to delays and cost overruns in building construction projects in the District Municipality and rank them in their order of severity have paramount importance to conduct analysis and subsequent recommendation of the possible solutions towards minimizing the problem.

To successfully undertake this research it is mandatory to look into the issues from different perspectives by involving professionals who have experience in the building construction sector within the Municipality. In this respect, you are the one who can give the correct and necessary information. Hence, I kindly request you to complete the accompanying questionnaire.

I would like to confirm you that your response will be kept strictly confidential and it will be used exclusively for the purpose of this research. Besides, your quick response is vitally important in order to finalize the research timely and I would appreciate if you return the completed questionnaire within ***two weeks*** of your receipt of same.

Thank you very much for your time and cooperation, and looking forward to receiving your response.

Yours Sincerely,

Nafkote Tesfahun Adugna
Durban University of Technology
Department of Quantity Surveying and Construction Management

Questionnaire Section 1: General Background Information

The questions below are related to your organization and yourself. Please indicate your response by marking (X or √) the appropriate boxes, and filling the blank spaces provided as appropriate.

1.1 Category/ class of organization: _____

1.2 Type of organization:

Client ☐ Contractor ☐ Consultant ☐

Other ☐ (Please specify) _____

1.3 Years of your organization involved in construction

< 5 years ☐ 5 – 10 years ☐ > 10 years ☐

1.4 Type of construction projects your organization has been participating:

Residential ☐ Educational ☐ Health ☐

Office ☐ Hotel/Motel ☐ Industrial ☐

Others (Please specify) _____

1.5 Your work experience in building construction related projects

< 5 years ☐ 5 – 10 years ☐ > 10 years ☐

1.6 Position in your organization : _____

Section 2: Assessment of Degree of Impact and Frequency of Occurrence

No.	2.1 Factors Causing Delay	Degree of Impact					Frequency			
		Very high	High	Moderate	Neutral	None	High	Medium	Low	Never
	2.1.1 Design related delay causes									
1.	Mistakes, inconsistencies and ambiguities in specifications and drawings									
2.	Inadequate and unclear details in drawings									
3.	Project design complexity									
4.	Inadequate communication between owner and designer during the design phase									
5.	Inadequate investigations by the designer during the design phase									
	2.1.2 Project related causes of delays									
6.	Original contract duration is too short									
7.	Corruption									
8.	Ineffective penalties for delay									
9.	Unavailability of bonus for early completion									
10.	Type of construction contract									
11.	Type of project bidding and award									
	2.1.3 Client related causes of delay									
12.	Delay in progress payments by the client									
13.	Delay to furnish and deliver the site to the contractor by the owner									
14.	Delay in issuance of change orders (Variation orders) by the owner									
15.	Changes in scope of the project									
16.	Owner's poor communication with government and construction parties									
17.	Poor coordination by the client with the other parties during construction									
18.	Slowness in decision making process by owner									
19.	Restriction of site supervisor's authority by the client									
20.	Excessive bureaucracy in the owner's administration									
21.	Uncooperative client with the contractor complicating contract administration									
22.	Suspension of work by owner									
23.	Delay in settlement of contractor claims by owner									
	2.1.4 Contractor related delay causes									
24.	Contractor's difficulties in financing the project									
25.	Contractor's cash flow problems.									
26.	Poor site supervision and management by contractor									

No.	2.1 Factors Causing Delay	Degree of Impact					Frequency			
		Very high	High	Moderate	Neutral	None	High	Medium	Low	Never
27.	Inefficient quality control by the contractor during construction, leading to rework due to errors									
28.	Ineffective scheduling and planning of project by contractor									
29.	Improper construction techniques implemented by the contractor									
30.	Delay in site mobilization									
31.	Delay of field survey by the contractor before start of permanent works									
32.	Lack of experience of project type									
33.	Lack of experience of local regulations									
34.	Lack of experience of project location									
35.	Lack or inadequate planning									
36.	Slow preparation of change order requests by the contractor									
37.	During the bidding stage, inadequate technical study by the contractor									
38.	Conflicts between other parties and contractor (consultant and client)									
39.	Poor communication with other parties involved in the project by the contractor									
40.	Poor coordination of Contractor with the parties involved in the project									
41.	Delays in sub-contractors work									
42.	Conflicts with sub-contractors schedule and implementation of works									
43.	Frequent change of sub-contractors due to their inefficient work and poor screening of subcontractors									
44.	Difficulties among the contractor and subcontractors with regards to payments									
45.	Ineffective involvement of contractor's head office in the project									
46.	Failure to apply safety rules and regulations within the contractor's organization									
	2.1.5 Consultant/Engineer related delay causes									
47.	Poor qualification of engineer's staff assigned to the project									
48.	Late approval of contractor submissions by the consultant									
49.	Poor communication among the consultant and other parties involved									
50.	Consultant's poor coordination with other parties involved									

No.	2.1 Factors Causing Delay	Degree of Impact					Frequency			
		Very high	High	Moderate	Neutral	None	High	Medium	Low	Never
51.	Delay in inspection, performing and testing by the consultant									
52.	Late response from the consultant to contractor inquiries									
53.	Inflexibility (rigidity) of consultant/engineer									
54.	Delay in correcting mistakes and reconciling discrepancies in the contract document									
55.	Late instructions by the consultant/ engineer									
	2.1.6 Material related delay causes									
56.	Change in material prices									
57.	Shortage of construction materials required									
58.	Changes in specifications and material types during construction									
59.	Delay in delivery and late ordering of material									
60.	Late procurement of materials by the contractor									
	2.1.7 Equipment related delay causes									
61.	Late ordering of equipment breakdowns									
62.	Shortage of equipment required									
63.	Equipment-operator's skill level is Low									
64.	Low efficiency and productivity of equipment									
	2.1.8 Labour related delay causes									
65.	Manpower Shortage (skilled and unskilled labour)									
66.	Insufficient skill of labour									
67.	Shortage of contractor's administrative staff									
68.	Lack of technical professionals in the contractor's organization									
69.	Low skill of manpower									
70.	Low qualification of the contractor's technical personnel assigned to the project									
71.	Low productivity level of labour									
72.	Inadequate living condition for labour									
73.	Labour strikes by the contractor workforce									
	2.1.9 External delay causes									
74.	Effects of subsurface (underground) conditions									
75.	Delay in getting permits from different government offices									
76.	Severe weather conditions on the job site									
77.	Inaccessibility of utilities in site (telephone, water, electricity, etc.)									
78.	Effect of cultural and social factors									
79.	Accident during construction									
80.	Changes in government laws and regulations									
81.	Restrictions on job site and traffic control									
82.	Work interference between various contractors									

No.	2.1 Factors Causing Delay	Degree of Impact					Frequency			
		Very high	High	Moderate	Neutral	None	High	Medium	Low	Never
83.	Unforeseen circumstances									
84.	Government tendering system of choosing the lowest bidder									
85.	Interference by financiers in the contract administration and construction operations									
	Additional factors, if any									
2.2 Factors Causing Cost Overrun										
1.	Delays caused by the owner and his/her agent									
2.	Design change									
3.	Acceleration									
4.	Quantity underestimation									
5.	Price escalation									
6.	Change in legislation									
7.	Corruption									
8.	Wastage									
9.	Lack of quality									
	Additional factors, if any									

Section 3: Controlling Mechanisms

Please highlight your possible recommendation to minimize and to control time and cost overrun problem encountered in building construction projects in Durban.

Would you please make sure that you haven't skipped any of the questions in all sections?

I Thank You!!!

APPENDIX: B

Summary of Responses and Computation of Severity, Frequency of occurrence, Important index and Ranking of variables - Client

No	Degree of impact					Total responses	Severity Index %	Rank	Frequency of Occurrence				Total responses	Frequency Index	Rank	Importance Index	Rank
	None	Neutral	Moderate	High	Very high				Never	Low	Medium	High					
	1	2	3	4	5				1	2	3	4					
	Design related								**Design related**								
1.	0	2	6	9	7	24	77.5	13	0	9	9	6	24	71.88	47	55.70	31
2.	1	4	11	6	2	24	63.3	75	0	12	10	2	24	64.58	71	40.90	74
3.	2	5	9	7	1	24	60.0	83	3	8	9	4	24	64.58	71	38.75	80
4.	1	7	5	8	3	24	64.2	70	1	14	7	2	24	60.42	81	38.77	79
5.	1	6	4	8	4	23	67.0	62	1	12	6	5	24	65.63	64	43.94	67
	Project related causes								**Project related causes**								
6.	0	4	8	7	5	24	70.8	48	2	10	8	4	24	64.58	71	45.75	61
7.	2	2	5	9	6	24	72.5	37	2	9	6	7	24	68.75	56	49.84	49
8.	1	7	6	8	2	24	62.5	76	0	7	10	7	24	75.00	32	46.88	57
9.	4	9	6	3	2	24	51.7	85	8	5	8	3	24	56.25	85	29.06	85
10.	2	6	9	6	1	24	58.3	84	0	9	14	1	24	66.67	63	38.89	78
11.	1	4	11	7	1	24	62.5	76	1	11	10	2	24	63.54	75	39.71	77
	Client related causes								**Client related causes**								
12.	0	1	3	12	8	24	82.5	4	0	8	7	9	24	76.04	26	62.73	12
13.	0	5	6	9	4	24	70.0	52	1	9	8	6	24	69.79	53	48.85	51
14.	0	3	4	12	5	24	75.8	22	0	9	7	8	24	73.96	36	56.09	30
15.	0	1	4	11	8	24	81.7	7	0	7	7	10	24	78.13	15	63.80	9
16.	0	1	7	8	8	24	79.2	10	0	6	9	9	24	78.13	15	61.85	17
17.	0	2	4	14	4	24	76.7	18	0	5	11	8	24	78.13	15	59.90	19
18.	0	3	2	14	5	24	77.5	13	1	4	8	11	24	80.21	10	62.16	16
19.	1	1	11	10	1	24	67.5	57	2	8	8	6	24	68.75	56	46.41	58
20.	0	3	10	10	1	24	67.5	57	0	7	9	8	24	76.04	26	51.33	47
21.	0	2	9	10	3	24	71.7	43	2	6	10	6	24	70.83	49	50.76	48
22.	2	4	5	7	6	24	69.2	53	4	11	5	4	24	59.38	82	41.07	73
23.	1	3	5	12	3	24	70.8	48	3	7	7	7	24	68.75	56	48.70	52
	Contractor related cau ses								**Contractor related causes**								
24.	0	1	4	8	11	24	84.2	3	1	1	8	14	24	86.46	2	72.77	2
25.	0	1	2	10	11	24	85.8	1	1	0	11	12	24	85.42	3	73.32	1
26.	1	1	2	10	10	24	82.5	4	0	1	10	13	24	87.50	1	72.19	3
27.	0	1	5	10	8	24	80.8	8	0	4	9	11	24	82.29	5	66.52	5
28.	1	3	5	9	6	24	73.3	33	0	2	10	12	24	85.42	3	62.64	14
29.	0	4	6	8	6	24	73.3	33	1	5	12	6	24	73.96	36	54.24	37
30.	1	2	9	7	5	24	70.8	48	1	6	11	6	24	72.92	43	51.65	45
31.	0	5	9	6	4	24	67.5	57	0	10	10	4	24	68.75	56	46.41	58
32.	0	4	5	10	5	24	73.3	33	0	6	10	8	24	77.08	19	56.53	27
33.	1	3	6	9	5	24	71.7	43	0	8	6	10	24	77.08	19	55.24	34
34.	3	3	10	5	3	24	61.7	81	3	8	8	5	24	65.63	64	40.47	75

Summary of Responses and Computation of Severity, Frequency of occurrence, Important index and Ranking of variables - Client

No	Degree of impact					Total responses	Severity Index %	Rank	Frequency of Occurrence				Total responses	Frequency Index	Rank	Importance Index	Rank
	None	Neutral	Moderate	High	Very high				Never	Low	Medium	High					
	1	2	3	4	5				1	2	3	4					
35.	0	4	8	6	6	24	71.7	43	0	5	15	4	24	73.96	36	53.00	40
36.	0	3	7	10	4	24	72.5	37	0	7	12	5	24	72.92	43	52.86	41
37.	0	2	7	11	4	24	74.2	31	0	7	8	9	24	77.08	19	57.17	26
38.	1	1	7	9	6	24	75.0	28	1	4	13	6	24	75.00	32	56.25	28
39.	1	3	4	9	7	24	75.0	28	1	5	12	6	24	73.96	36	55.47	32
40.	1	3	5	6	9	24	75.8	22	0	6	10	8	24	77.08	19	58.45	21
41.	0	2	7	9	6	24	75.8	22	0	8	10	6	24	72.92	43	55.30	33
42.	1	3	5	6	9	24	75.8	22	0	7	9	8	24	76.04	26	57.66	25
43.	0	2	9	9	4	24	72.5	37	0	7	12	5	24	72.92	43	52.86	41
44.	0	1	7	11	5	24	76.7	18	0	4	15	5	24	76.04	26	58.30	23
45.	1	6	6	9	2	24	64.2	70	2	7	13	2	24	65.63	64	42.11	70
46.	1	1	5	11	6	24	76.7	18	1	3	14	6	24	76.04	26	58.30	23
	Consultant related causes								**Consultant/Engineer related**								
47.	2	5	9	4	4	24	62.5	76	3	12	8	1	24	57.29	84	35.81	84
48.	1	5	9	5	4	24	65.0	67	1	11	10	2	24	63.54	75	41.30	71
49.	2	6	4	7	5	24	65.8	64	0	11	8	5	24	68.75	56	45.26	64
50.	2	4	6	7	5	24	67.5	57	0	10	8	6	24	70.83	49	47.81	53
51.	0	3	9	6	6	24	72.5	37	0	11	9	4	24	67.71	62	49.09	50
52.	0	4	7	8	5	24	71.7	43	0	12	9	3	24	65.63	64	47.03	56
53.	1	6	6	9	2	24	64.2	70	0	10	8	6	24	70.83	49	45.45	62
54.	1	5	6	9	3	24	66.7	63	1	8	11	4	24	68.75	56	45.83	60
55.	0	4	5	8	7	24	75.0	28	0	6	12	6	24	75.00	32	56.25	28
	Material related delay								**Material related delay**								
56.	0	3	7	9	5	24	73.3	33	0	7	11	6	24	73.96	36	54.24	37
57.	0	1	7	10	6	24	77.5	13	0	4	10	10	24	81.25	9	62.97	11
58.	0	1	5	11	7	24	80.0	9	0	4	11	9	24	80.21	10	64.17	8
59.	0	1	8	10	5	24	75.8	22	0	2	13	9	24	82.29	5	62.40	15
60.	0	2	6	8	8	24	78.3	12	0	4	9	11	24	82.29	5	64.46	6
	Equipment related dela								**Equipment related delay causes**								
61.	0	0	12	9	3	24	72.5	37	0	5	14	5	24	75.00	32	54.38	36
62.	0	1	7	14	2	24	74.2	31	0	9	10	5	24	70.83	49	52.53	43
63.	1	2	9	10	2	24	68.3	55	1	9	12	2	24	65.63	64	44.84	65
64.	1	3	7	12	1	24	67.5	57	1	5	16	2	24	69.79	53	47.11	55
	Labour related causes								**Labour related causes**								
65.	0	2	2	7	12	23	85.2	2	0	4	11	9	24	80.21	10	68.35	4
66.	0	3	2	12	7	24	79.2	10	1	6	5	12	24	79.17	13	62.67	13
67.	1	2	6	12	3	24	71.7	43	1	8	8	7	24	71.88	47	51.51	46
68.	1	1	5	11	6	24	76.7	18	1	5	7	11	24	79.17	13	60.69	18
69.	1	2	5	15	1	24	70.8	48	1	6	7	10	24	77.08	19	54.60	35
70.	0	1	4	16	3	24	77.5	13	0	5	12	7	24	77.08	19	59.74	20
71.	0	0	7	13	4	24	77.5	13	0	2	13	9	24	82.29	5	63.78	10
72.	0	6	7	11	0	24	64.2	70	0	9	7	8	24	73.96	36	47.46	54
73.	0	1	5	8	10	24	82.5	4	0	7	7	10	24	78.13	15	64.45	7

Summary of Responses and Computation of Severity, Frequency of occurrence, Important index and Ranking of variables - Client

No	Degree of impact					Total responses	Severity Index %	Rank	Frequency of Occurrence				Total responses	Frequency Index	Rank	Importance Index	Rank
	None	Neutral	Moderate	High	Very high				Never	Low	Medium	High					
	1	2	3	4	5				1	2	3	4					
	External delay causes								**External delay causes**								
74.	0	5	9	5	5	24	68.3	55	0	8	7	9	24	76.04	26	51.96	44
75.	0	2	8	7	7	24	75.8	22	0	6	10	8	24	77.08	19	58.45	21
76.	0	4	11	7	2	24	65.8	64	0	13	7	4	24	65.63	64	43.20	68
77.	1	3	9	11	0	24	65.0	67	1	8	10	5	24	69.79	53	45.36	63
78.	1	6	7	7	3	24	64.2	70	2	9	7	1	19	59.21	83	37.99	83
79.	0	5	8	6	5	24	69.2	53	3	7	12	2	24	63.54	75	43.95	66
80.	1	4	7	11	1	24	65.8	64	3	9	9	3	24	62.50	78	41.15	72
81.	1	4	8	10	1	24	65.0	67	1	8	14	1	24	65.63	64	42.66	69
82.	1	7	6	9	1	24	61.7	81	1	11	11	1	24	62.50	78	38.54	81
83.	0	8	6	9	1	24	62.5	76	3	6	13	2	24	64.58	71	40.36	76
84.	1	2	8	7	6	24	72.5	37	0	7	11	6	24	73.96	36	53.62	39
85.	2	4	9	7	2	24	62.5	76	0	15	7	2	24	61.46	80	38.41	82
	Factors Causing Cost Overrun								**Factors Causing Cost Overrun**								
1.	0	0	10	9	5	24	75.8	7	0	5	15	4	24	73.96	7	56.09	7
2.	0	0	6	14	4	24	78.3	2	0	3	10	11	24	83.33	1	65.28	2
3.	1	1	9	9	4	24	71.7	8	1	6	13	4	24	70.83	8	50.76	8
4.	0	2	7	8	7	24	76.7	4	0	4	8	12	24	83.33	1	63.89	3
5.	0	1	4	12	7	24	80.8	1	0	2	13	9	24	82.29	3	66.52	1
6.	2	3	11	6	2	24	62.5	9	2	10	7	5	24	65.63	9	41.02	9
7.	1	0	6	11	6	24	77.5	3	1	3	12	8	24	78.13	5	60.55	5
8.	0	3	4	11	6	24	76.7	4	0	7	9	8	24	76.04	6	58.30	6
9.	1	2	5	8	8	24	76.7	4	1	3	10	10	24	80.21	4	61.49	4

Severity Index (S.I) (%) = $\left(\dfrac{\sum_{i=1}^{5} A_i N_i}{5 \sum_{i=1}^{5} N_i} \right)$ **Frequency Index (F.I) (%) =** $\left(\dfrac{\sum_{i=1}^{4} B_i N_i}{4 \sum_{i=1}^{4} N_i} \right)$ *** 100%**

Importance Index (I.I) (%) = $[S.I(\%) * F.I(\%)]/100$

Summary of Responses and Computation of Severity, Frequency of occurrence, Important index and Ranking of variables - Consultant

No	Degree of impact					Total responses	Severity Index %	Rank	Frequency of Occurrence				Total responses	Frequency Index	Rank	Importance Index	Rank
	None	Neutral	Moderate	High	Very high				Never	Low	Medium	High					
	1	2	3	4	5				1	2	3	4					
	Design related delay								Design related delay								
1.	1	8	15	2	10	36	66.7	42	1	25	9	1	36	56.94	71	37.96	62
2.	1	12	11	3	9	36	63.9	56	1	24	10	1	36	57.64	67	36.82	64
3.	2	6	16	11	1	36	61.7	68	3	20	10	3	36	59.03	63	36.40	70
4.	3	12	8	9	4	36	59.4	72	2	19	11	4	36	61.81	57	36.74	65
5.	6	11	8	7	4	36	55.6	78	7	18	9	1	35	52.86	81	29.37	81
	Project related causes								Project related causes								
6.	3	4	14	12	3	36	64.4	51	5	13	12	6	36	63.19	54	40.73	51
7.	7	7	8	7	7	36	60.0	71	12	8	12	4	36	55.56	76	33.33	72
8.	8	8	12	5	3	36	52.8	82	8	13	9	6	36	59.03	63	31.15	77
9.	17	7	8	1	3	36	41.1	85	13	17	4	2	36	46.53	85	19.13	85
10.	5	11	11	7	2	36	54.4	79	6	15	14	1	36	56.94	71	31.00	78
11.	2	7	15	7	5	36	63.3	58	4	12	14	6	36	65.28	44	41.34	49
	Client related causes								Client related causes								
12.	2	3	6	11	14	36	77.8	8	3	3	16	14	36	78.47	7	61.03	8
13.	3	7	14	6	6	36	62.8	62	3	13	17	3	36	63.89	46	40.11	53
14.	2	7	8	6	13	36	71.7	27	3	8	14	11	36	72.92	20	52.26	24
15.	0	4	14	8	10	36	73.3	17	0	11	19	6	36	71.53	25	52.45	23
16.	2	5	11	10	8	36	69.4	33	2	15	12	7	36	66.67	39	46.30	37
17.	2	6	12	8	8	36	67.8	39	2	14	11	8	36	65.97	42	44.71	41
18.	1	5	9	10	11	36	73.9	15	1	13	12	9	36	68.75	32	50.80	26
19.	5	12	9	8	2	36	54.4	79	4	21	10	1	36	55.56	76	30.25	79
20.	3	9	8	11	5	36	63.3	58	3	16	11	6	36	63.89	46	40.46	52
21.	3	10	10	8	5	36	61.1	69	3	17	11	5	36	62.50	56	38.19	60
22.	8	10	9	7	2	36	51.7	83	8	20	7	1	36	50.69	84	26.19	84
23.	1	6	6	15	8	36	72.8	22	1	16	10	8	36	65.97	42	48.01	32
	Contractor related causes								Contractor related causes								
24.	0	2	7	13	14	36	81.7	2	0	11	15	10	36	74.31	15	60.68	9
25.	0	3	6	12	15	36	81.7	2	0	3	21	12	36	81.25	3	66.35	1
26.	0	0	10	11	15	36	82.8	1	1	5	17	13	36	79.17	5	65.53	3
27.	0	2	6	16	12	36	81.1	4	0	7	17	12	36	78.47	7	63.65	5
28.	0	1	9	18	8	36	78.3	6	0	5	18	13	36	80.56	4	63.10	6
29.	0	4	13	10	9	36	73.3	17	1	9	17	9	36	73.61	17	53.98	17
30.	0	7	14	9	6	36	67.8	39	1	13	15	7	36	69.44	29	47.07	35
31.	1	13	8	9	5	36	62.2	67	1	19	11	5	36	63.89	46	39.75	56
32.	1	7	6	16	6	36	70.6	30	1	18	13	4	36	63.89	46	45.08	39
33.	1	7	15	9	4	36	64.4	51	1	18	13	4	36	63.89	46	41.17	50
34.	2	13	12	5	4	36	57.8	74	3	21	12	0	36	56.25	74	32.50	73
35.	1	6	12	12	5	36	67.8	39	1	11	20	4	36	68.75	32	46.60	36

Summary of Responses and Computation of Severity, Frequency of occurrence, Important index and Ranking of variables - Consultant

	Degree of impact								Frequency of Occurrence									
	None	Neutral	Moderate	High	Very high	Total responses	Severity Index %	Rank	Never	Low	Medium	High	Total responses	Frequency Index	Rank	**Importance Index**	Rank
No	1	2	3	4	5				1	2	3	4					
36.	4	5	12	9	6	36	64.4	51	2	13	15	6	36	67.36	36	43.41	45
37.	0	6	8	15	7	36	72.8	22	0	14	9	13	36	74.31	15	54.08	16
38.	1	12	8	11	4	36	62.8	62	2	18	10	6	36	63.89	46	40.11	53
39.	0	7	11	10	8	36	70.6	30	0	16	12	8	36	69.44	29	49.00	30
40.	1	7	14	8	6	36	66.1	44	2	16	10	8	36	66.67	39	44.07	43
41.	0	3	10	20	3	36	72.8	22	0	6	21	9	36	77.08	10	56.10	14
42.	0	5	14	14	3	36	68.3	36	0	10	19	7	36	72.92	20	49.83	27
43.	0	7	8	18	3	36	69.4	33	0	17	11	8	36	68.75	32	47.74	34
44.	0	3	5	19	9	36	78.9	5	0	7	12	17	36	81.94	2	64.65	4
45.	3	2	15	12	4	36	66.7	42	2	16	9	9	36	67.36	36	44.91	40
46.	1	7	14	9	5	36	65.6	47	1	15	14	5	36	64.58	45	42.34	48
	Consultant related causes								Consultant related causes								
47.	5	3	9	14	5	36	66.1	44	6	14	11	5	36	60.42	59	39.94	55
48.	3	7	12	10	4	36	62.8	62	4	21	6	5	36	58.33	66	36.62	66
49.	1	8	12	12	3	36	64.4	51	2	23	7	4	36	59.03	63	38.04	61
50.	0	8	13	12	3	36	65.6	47	1	23	9	3	36	59.72	62	39.15	58
51.	1	10	13	7	5	36	62.8	62	3	21	10	2	36	57.64	67	36.18	71
52.	1	8	15	8	4	36	63.3	58	3	19	14	0	36	57.64	67	36.50	68
53.	2	14	16	1	3	36	53.9	81	4	26	6	0	36	51.39	83	27.69	82
54.	3	12	12	2	7	36	58.9	73	5	23	6	2	36	53.47	80	31.49	76
55.	3	9	12	3	9	36	63.3	58	3	21	10	2	36	57.64	67	36.50	68
	Material related causes								Material related causes								
56.	2	8	10	5	11	36	68.3	36	2	16	14	4	36	63.89	46	43.66	44
57.	1	4	13	9	9	36	71.7	27	2	9	22	3	36	68.06	35	48.77	31
58.	0	4	14	9	9	36	72.8	22	0	14	19	3	36	67.36	36	49.02	29
59.	0	4	11	6	15	36	77.8	8	0	10	18	8	36	73.61	17	57.25	12
60.	1	4	8	8	15	36	77.8	8	1	6	20	9	36	75.69	13	58.87	11
	Equipment related causes								Equipment related causes								
61.	0	10	6	8	12	36	72.2	26	0	15	12	9	36	70.83	27	51.16	25
62.	1	7	9	9	10	36	71.1	29	0	14	16	6	36	69.44	29	49.38	28
63.	2	5	15	4	10	36	68.3	36	2	15	17	2	36	63.19	54	43.18	46
64.	4	4	15	3	10	36	66.1	44	4	18	14	0	36	56.94	71	37.65	63
	Labour related delay cause								Labour related delay causes								
65.	1	4	11	10	10	36	73.3	17	2	7	20	7	36	72.22	23	52.96	22
66.	1	2	9	13	11	36	77.2	12	1	4	21	10	36	77.78	9	60.06	10
67.	0	4	23	6	3	36	64.4	51	1	7	24	4	36	71.53	25	46.10	38
68.	0	3	10	11	12	36	77.8	8	1	2	23	10	36	79.17	5	61.57	7
69.	0	4	15	12	5	36	70.0	32	1	7	16	12	36	77.08	10	53.96	18
70.	0	4	13	10	9	36	73.3	17	1	7	19	9	36	75.00	14	55.00	15
71.	0	4	12	11	9	36	73.9	15	1	5	20	10	36	77.08	10	56.96	13
72.	2	11	10	10	3	36	60.6	70	7	12	12	5	36	60.42	59	36.59	67
73.	1	5	8	11	11	36	74.4	14	3	7	17	9	36	72.22	23	53.77	19

Summary of Responses and Computation of Severity, Frequency of occurrence, Important index and Ranking of variables - Consultant

No	Degree of impact: None	Neutral	Moderate	High	Very high	Total responses	Severity Index %	Rank	Frequency of Occurrence: Never	Low	Medium	High	Total responses	Frequency Index	Rank	Importance Index	Rank
	1	2	3	4	5				1	2	3	4					
	External delay causes								External delay causes								
74.	1	3	8	16	8	36	75.0	13	1	11	17	7	36	70.83	27	53.13	21
75.	2	3	10	11	10	36	73.3	17	4	9	9	14	36	72.92	20	53.47	20
76.	0	4	13	17	2	36	69.4	33	0	17	18	1	36	63.89	46	44.37	42
77.	2	10	11	7	6	36	62.8	62	3	18	10	5	36	61.81	57	38.80	59
78.	7	11	17	3	2	40	51.0	84	3	25	7	1	36	54.17	79	27.63	83
79.	1	13	15	5	2	36	56.7	76	3	27	5	1	36	52.78	82	29.91	80
80.	1	15	13	4	3	36	56.1	77	5	18	12	1	36	56.25	74	31.56	75
81.	0	16	10	8	2	36	57.8	74	1	27	8	0	36	54.86	78	31.70	74
82.	2	8	11	9	6	36	65.0	49	3	17	14	2	36	60.42	59	39.27	57
83.	0	7	18	8	3	36	63.9	56	0	15	18	3	36	66.67	39	42.59	47
84.	1	1	8	16	10	36	78.3	6	1	1	14	19	36	84.03	1	65.82	2
85.	2	9	9	10	6	36	65	49	2	11	10	13	36	73.61	17	47.85	33
	Factors Causing Cost Overrun								Factors Causing Cost Overrun								
1.	0	5	16	11	4	36	62.2	4	0	11	19	6	36	71.53	4	44.51	4
2.	0	3	14	7	12	36	72.2	1	0	12	13	11	36	74.31	1	53.67	1
3.	0	8	18	8	2	36	53.3	7	0	12	20	4	36	69.44	5	37.04	6
4.	0	6	5	14	11	36	70.8	2	0	10	18	8	36	73.61	3	52.14	3
5.	1	4	9	12	10	36	70.3	3	2	6	19	9	36	74.31	1	52.26	2
6.	3	11	13	5	4	36	48.0	9	5	14	14	3	36	60.42	9	29.00	9
7.	5	7	10	5	9	36	56.7	6	5	10	9	10	36	63.89	7	36.24	7
8.	1	10	12	8	5	36	53.3	7	1	16	15	4	36	65.28	6	34.81	8
9.	0	9	9	10	8	36	62.2	5	1	8	17	6	36	63.89	7	39.74	5

$$II\ (\%) = [S.I(\%) x F.I(\%)]/100$$

$$FI\ (\%) = \left(\frac{\sum_{i=1}^{4} B_i N_i}{4\sum_{i=1}^{4} N_i} \right) \text{ x } 100\%$$

$$SI\ (\%) = \left(\frac{\sum_{i=1}^{5} A_i N_i}{5\sum_{i=1}^{5} N_i} \right) \text{ x } 100\%$$

Summary of Responses and computation of severity, frequency of occurrence, important index and ranking of variables - Contractor

No	Degree of impact					Total responses	Severity Index %	Rank	Frequency of Occurrence				Total responses	Frequency Index	Rank	Importance Index	Rank
	None	Neutral	Moderate	High	Very high				Never	Low	Medium	High					
	1	2	3	4	5				1	2	3	4					
	Design related causes								Design related causes								
1.	0	1	5	1	8	15	81.3	3	0	10	3	2	15	61.67	20	50.16	15
2.	0	0	2	3	10	15	90.7	1	1	5	4	5	15	71.67	6	64.98	2
3.	1	1	7	2	4	15	69.3	49	3	5	7	0	15	56.67	40	39.29	45
4.	1	2	2	4	6	15	76.0	14	3	7	2	3	15	58.33	31	44.33	24
5.	2	2	2	3	6	15	72.0	32	3	4	7	1	15	60.00	26	43.20	27
	Project related causes								Project related causes								
6.	2	1	0	5	7	15	78.7	10	1	4	7	3	15	70.00	9	55.07	9
7.	3	3	1	3	5	15	65.3	67	5	6	2	2	15	51.67	55	33.76	64
8.	5	4	2	4	0	15	46.7	84	5	6	1	3	15	53.33	51	24.89	83
9.	6	4	3	2	0	15	41.3	85	6	7	1	1	15	45.00	76	18.60	85
10.	2	1	7	5	0	15	60.0	78	4	5	5	1	15	55.00	46	33.00	66
11.	2	3	5	5	0	15	57.3	80	2	10	2	1	15	53.33	51	30.58	72
	Client related causes								Client related causes								
12.	0	1	4	4	6	15	80.0	7	1	2	4	8	15	81.67	1	65.33	1
13.	0	0	5	5	5	15	80.0	7	2	7	5	1	15	58.33	31	46.67	17
14.	1	1	2	9	2	15	73.3	28	3	3	5	4	15	66.67	16	48.89	16
15.	0	1	3	5	6	15	81.3	3	2	1	9	3	15	71.67	6	58.29	3
16.	1	2	4	6	2	15	68.0	54	2	8	3	2	15	58.33	31	39.67	43
17.	1	2	4	6	2	15	68.0	54	3	5	4	3	15	61.67	20	41.93	36
18.	1	1	1	10	2	15	74.7	22	1	4	3	7	15	76.67	3	57.24	6
19.	2	2	3	7	1	15	64.0	70	2	5	7	1	15	61.67	20	39.47	44
20.	1	1	6	7	0	15	65.3	67	2	5	7	1	15	61.67	20	40.29	40
21.	2	1	7	4	1	15	61.3	77	4	8	2	1	15	50.00	64	30.67	71
22.	3	2	1	1	8	15	72.0	32	8	4	3	0	15	41.67	81	30.00	74
23.	2	2	2	7	2	15	66.7	62	4	4	5	2	15	58.33	31	38.89	46
	Contractor related dela								Contractor related delay								
24.	0	1	1	6	7	15	85.3	2	7	7	0	1	15	41.67	81	35.56	57
25.	1	1	1	6	6	15	80.0	7	4	10	0	1	15	46.67	70	37.33	50
26.	1	1	1	5	7	15	81.3	3	6	7	1	1	15	45.00	76	36.60	54
27.	2	1	3	5	4	15	70.7	38	2	8	4	1	15	56.67	40	40.04	41
28.	1	3	2	4	5	15	72.0	32	3	9	2	1	15	51.67	55	37.20	51
29.	2	4	0	4	5	15	68.0	54	5	7	2	1	15	48.33	68	32.87	68
30.	2	2	2	4	5	15	70.7	38	4	7	3	1	15	51.67	55	36.51	55
31.	2	2	2	4	5	15	70.7	38	5	8	1	1	15	46.67	70	32.98	67
32.	4	2	0	6	3	15	62.7	74	5	8	1	1	15	46.67	70	29.24	76
33.	3	3	3	5	1	15	57.3	80	5	9	0	1	15	45.00	76	25.80	82
34.	1	3	0	8	2	14	70.0	48	8	6	0	1	15	40.00	84	28.00	77
35.	3	1	2	6	3	15	66.7	62	6	3	5	1	15	51.67	55	34.44	61

Summary of Responses and computation of severity, frequency of occurrence, important index and ranking of variables - Contractor

No	Degree of impact					Total responses	Severity Index %	Rank	Frequency of Occurrence				Total responses	Frequency Index	Rank	Importance Index	Rank
	None	Neutral	Moderate	High	Very high				Never	Low	Medium	High					
	1	2	3	4	5				1	2	3	4					
36.	2	1	3	4	5	15	72.0	32	4	7	3	1	15	51.67	55	37.20	51
37.	2	1	2	7	3	15	70.7	38	4	6	3	2	15	55.00	46	38.87	47
38.	2	1	2	3	7	15	76.0	14	4	6	2	3	15	56.67	40	43.07	29
39.	2	1	3	5	4	15	70.7	38	4	7	3	1	15	51.67	55	36.51	55
40.	3	1	2	6	3	15	66.7	62	5	6	3	1	15	50.00	64	33.33	65
41.	0	1	4	7	3	15	76.0	14	0	2	10	3	15	76.67	3	58.27	4
42.	0	2	3	8	2	15	73.3	28	0	3	7	5	15	78.33	2	57.44	5
43.	0	1	4	7	3	15	76.0	14	0	6	4	5	15	73.33	5	55.73	7
44.	1	2	5	2	5	15	70.7	38	2	6	3	4	15	65.00	17	45.93	19
45.	2	3	1	7	2	15	65.3	67	4	5	4	2	15	56.67	40	37.02	53
46.	2	0	4	3	6	15	74.7	22	4	6	2	3	15	56.67	40	42.31	34
	Consultant related causes								Consultant related causes								
47.	0	2	1	6	6	15	81.3	3	2	9	3	1	15	55.00	46	44.73	23
48.	1	2	5	3	4	15	69.3	49	2	3	9	1	15	65.00	17	45.07	21
49.	1	3	2	7	2	15	68.0	54	2	2	9	2	15	68.33	13	46.47	18
50.	1	0	4	7	3	15	74.7	22	1	4	7	3	15	70.00	9	52.27	11
51.	1	1	4	7	2	15	70.7	38	1	8	5	1	15	60.00	26	42.40	32
52.	0	2	2	7	4	15	77.3	11	0	6	5	4	15	71.67	6	55.42	8
53.	1	3	1	9	1	15	68.0	54	1	7	5	2	15	63.33	19	43.07	28
54.	1	3	2	2	7	15	74.7	22	2	8	3	2	15	58.33	31	43.56	26
55.	0	2	2	8	3	15	76.0	14	1	7	2	5	15	68.33	13	51.93	13
	Material related causes								Material related causes								
56.	1	0	7	5	2	15	69.3	49	1	8	4	2	15	61.67	20	42.76	31
57.	1	4	1	4	5	15	70.7	38	3	4	7	1	15	60.00	26	42.40	32
58.	0	2	2	9	2	15	74.7	22	1	5	5	4	15	70.00	9	52.27	11
59.	0	1	4	6	4	15	77.3	11	1	4	7	3	15	70.00	9	54.13	10
60.	1	1	4	5	4	15	73.3	28	3	5	6	1	15	58.33	31	42.78	30
	Equipment related causes								Equipment related delay								
61.	1	3	5	1	5	15	68.0	54	3	8	4	0	15	51.67	55	35.13	58
62.	2	5	2	1	5	15	62.7	74	6	8	1	0	15	41.67	81	26.11	80
63.	0	3	6	2	4	15	69.3	49	4	11	0	0	15	43.33	80	30.04	73
64.	1	5	0	5	4	15	68.0	54	8	6	1	0	15	38.33	85	26.07	81
	Labour related causes								Labour related delay								
65.	1	2	1	6	5	15	76.0	14	2	8	3	2	15	58.33	31	44.33	24
66.	1	1	4	3	6	15	76.0	14	2	8	2	3	15	60.00	26	45.60	20
67.	0	3	5	2	5	15	72.0	32	2	9	4	0	15	53.33	51	38.40	49
68.	1	2	5	3	4	15	69.3	49	3	10	1	1	15	50.00	64	34.67	59
69.	1	1	5	2	6	15	74.7	22	0	11	2	2	15	60.00	26	44.80	22
70.	1	3	4	4	3	15	66.7	62	4	9	1	1	15	48.33	68	32.22	69
71.	2	1	2	6	4	15	72.0	32	3	7	2	3	15	58.33	31	42.00	35
72.	3	3	3	5	1	15	57.3	80	5	8	1	1	15	46.67	70	26.76	79
73.	1	1	3	4	6	15	77.3	11	3	10	0	2	15	51.67	55	39.96	42

Summary of Responses and computation of severity, frequency of occurrence, important index and ranking of variables - Contractor

No	Degree of impact					Total responses	Severity Index %	Rank	Frequency of Occurrence				Total responses	frequency Index %	Rank	Importance Index	Rank
	None	Neutral	Moderate	High	Very high				Never	Low	Medium	High					
	1	2	3	4	5				1	2	3	4					
	External delay causes								External delay causes								
74.	2	1	7	3	2	15	62.7	74	3	6	6	0	15	55.00	46	34.47	60
75.	2		2	7	3	14	72.9	31	4	5	4	2	15	56.67	40	41.29	38
76.	0	1	5	5	4	15	76.0	14	1	3	10	1	15	68.33	13	51.93	13
77.	3	2	4	4	2	15	60.0	78	6	6	3	0	15	45.00	76	27.00	78
78.	2	5	5	2	1	15	53.3	83	4	9	2	0	15	46.67	70	24.89	83
79.	2	1	5	4	3	15	66.7	62	3	8	4	0	15	51.67	55	34.44	61
80.	1	2	7	3	2	15	64.0	70	3	9	3	0	15	50.00	64	32.00	70
81.	2	2	2	6	3	15	68.0	54	2	7	3	3	15	61.67	20	41.93	36
82.	2	2	3	7	1	15	64.0	70	3	7	5	0	15	53.33	51	34.13	63
83.	1	1	4	7	2	15	70.7	38	2	8	3	2	15	58.33	31	41.22	39
84.	3	0	2	6	4	15	70.7	38	5	4	4	2	15	55.00	46	38.87	47
85.	4	0	2	7	2	15	64.0	70	7	4	3	1	15	46.67	70	29.87	75
	Factors Causing Cost Overrun								**Factors Causing Cost Overrun**								
1.	1	2	2	8	2	15	70.7	8	2	7	5	1	15	58.33	7	41.22	7
2.	0	1	2	4	8	15	85.3	1	0	7	3	5	15	71.67	1	61.16	1
3.	0	2	2	3	6	13	80.0	3	0	8	4	1	13	61.54	5	49.23	5
4.	1	3		2	8	14	78.6	5	3	4	3	5	15	66.67	2	52.38	2
5.	0	1	4	2	8	15	82.7	2	1	8	4	2	15	61.67	4	50.98	3
6.	1	3	7	2	2	15	61.3	9	3	10	1	1	15	50.00	9	30.67	9
7.	3	0	1	2	9	15	78.7	4	6	5	1	3	15	51.67	8	40.64	8
8.	0	2	2	6	4	14	77.1	6	0	8	5	2	15	65.00	3	50.14	4
9.	0	1	5	5	4	15	76.0	7	1	8	5	1	15	60.00	6	45.60	6

Severity Index (S.I) (%) = $\left(\frac{\sum_{i=1}^{5} A_i N_i}{5 \sum_{i=1}^{5} N_i} \right)$ *** 100%**

Frequency Index (F.I) (%) = $\left(\frac{\sum_{i=1}^{4} B_i N_i}{4 \sum_{i=1}^{4} N_i} \right)$ *** 100%**

Importance Index (I.I) (%) = $[S.I\,(\%) \ * \ F.I\,(\%)\ ]/100$

APPENDIX: C

Computation of Kandall Coefficient of Concordance (W) and level of Significance (p) - for causes of delay

No	Clients' Rank	Consultants' Rank	Contractors' Ra nk	R_1	R_1-Mean	$S=(R_1\text{-Mean})^2$
	Design related					
1.	34	69	15	118	-23.26	540.97
2.	82	71	2	155	13.74	188.82
3.	88	77	48	213	71.74	5146.80
4.	87	72	27	186	44.74	2001.77
5.	74	90	30	194	52.74	2781.63
	Project related causes					
6.	67	57	9	133	-8.26	68.21
7.	53	80	70	203	61.74	3811.97
8.	62	86	91	239	97.74	9553.34
9.	93	94	93	280	138.74	19249.11
10.	86	87	72	245	103.74	10762.23
11.	85	55	79	219	77.74	6043.69
	Client related delay causes					
12.	12	8	1	21	-120.26	14462.18
13.	56	60	19	135	-6.26	39.17
14.	33	25	16	74	-67.26	4523.75
15.	9	24	3	36	-105.26	11079.42
16.	17	41	46	104	-37.26	1388.22
17.	20	46	39	105	-36.26	1314.70
18.	16	29	6	51	-90.26	8146.66
19.	63	88	47	198	56.74	3219.56
20.	51	59	43	153	11.74	137.86
21.	52	67	78	197	55.74	3107.08
22.	81	93	81	255	113.74	12937.06
23.	57	36	49	142	0.74	0.55
	Contractor related delay causes					
24.	2	9	63	74	-67.26	4523.75
25.	1	1	55	57	-84.26	7099.55
26.	3	3	59	65	-76.26	5815.41
27.	5	5	44	54	-87.26	7614.10
28.	14	6	56	76	-65.26	4258.71
29.	41	17	74	132	-9.26	85.73
30.	49	39	60	148	6.74	45.44
31.	63	63	73	199	57.74	3334.04
32.	30	44	84	158	16.74	280.27
33.	37	56	90	183	41.74	1742.33
34.	83	82	85	250	108.74	11824.64
35.	44	40	67	151	9.74	94.89
36.	45	50	56	151	9.74	94.89
37.	28	16	50	94	-47.26	2233.40

Computation of Kandall Coefficient of Concordance (W) and level of Significance (p)-

No	Clients' Rank	Consultants' Rank	Contractors' Rank	R_1	R_1-Mean	$S=(R_1 - Mean)^2$
38.	31	60	32	123	-18.26	333.38
39.	35	34	60	129	-12.26	150.28
40.	23	48	71	142	0.74	0.55
41.	36	14	4	54	-87.26	7614.10
42.	27	31	5	63	-78.26	6124.44
43.	45	38	7	90	-51.26	2627.47
44.	25	4	21	50	-91.26	8328.17
45.	77	45	58	180	38.74	1500.88
46.	25	53	37	115	-26.26	689.53
	Consultant/Engineer related delay causes					
47.	92	62	26	180	38.74	1500.88
48.	79	73	23	175	33.74	1138.47
49.	70	68	20	158	16.74	280.27
50.	58	65	11	134	-7.26	52.69
51.	55	78	35	168	26.74	715.09
52.	61	75	8	144	2.74	7.51
53.	68	91	31	190	48.74	2375.70
54.	66	85	29	180	38.74	1500.88
55.	31	75	13	119	-22.26	495.46
	Material related delay causes					
56.	41	49	34	124	-17.26	297.87
57.	11	35	35	81	-60.26	3631.13
58.	8	33	11	52	-89.26	7967.14
59.	15	12	10	37	-104.26	10869.90
60.	6	11	33	50	-91.26	8328.17
	Equipment related delay causes					
61.	40	28	64	132	-9.26	85.73
62.	47	32	88	167	25.74	662.61
63.	71	51	80	202	60.74	3689.49
64.	60	70	89	219	77.74	6043.69
	Labour related delay causes					
65.	4	23	27	54	-87.26	7614.10
66.	13	10	22	45	-96.26	9265.76
67.	50	42	54	146	4.74	22.48
68.	19	7	65	91	-50.26	2525.95
69.	38	18	24	80	-61.26	3752.64
70.	21	15	76	112	-29.26	856.08
71.	10	13	38	61	-80.26	6441.48
72.	59	74	87	220	78.74	6200.17
73.	7	19	45	71	-70.26	4936.30
	External delay causes					
74.	48	21	66	135	-6.26	39.17
75.	23	20	41	84	-57.26	3278.57
76.	75	47	13	135	-6.26	39.17
77.	69	66	86	221	79.74	6358.66
78.	91	92	91	274	132.74	17620.22

Computation of Kandall Coefficient of Concordance (W) and level of Significance (p)-

No	Clients' Rank	Consultants' Rank	Contractors 'Rank	R_1	R_1-Mean	$S=(R_1 - Mean)^2$
79.	73	89	67	229	87.74	7698.51
80.	80	84	77	241	99.74	9948.30
81.	76	83	39	198	56.74	3219.56
82.	89	64	69	222	80.74	6519.14
83.	84	52	42	178	36.74	1349.91
84.	43	2	50	95	-46.26	2139.88
85.	90	37	82	209	67.74	4588.87
			Total	**12007**	Sum	**350978.31**
			Mean	**141.26**		
			DEVSQ	**350978.31**		
			W	**0.76**		
			CHIDST	**192.05**		
			P	**0.00000000019**		

$$W = \frac{12S}{m^2(n^3 - n)}$$

$$\chi_r^2 = m(n-1)W$$

m=3 & n=85

Computation of Kandall Coefficient of concordance (W) and level of significance (p)-for causes of Cost Overrun

No	Clients' Rank	Consultants' Rank	Contractors' Rank	R_1	R_1-Mean	$S=(R_1 - Mean)^2$
1.	7	4	7	18	3.00	9.00
2.	2	1	1	4	-11.00	121.00
3.	8	6	5	19	4.00	16.00
4.	3	3	2	8	-7.00	49.00
5.	1	2	3	6	-9.00	81.00
6.	9	9	9	27	12.00	144.00
7.	5	7	8	20	5.00	25.00
8.	6	8	4	18	3.00	9.00
9.	4	5	6	15	0.00	0.00
			Total	**373010.38**	**sum**	**454.00**
			Mean	**15**		
			DEVSQ	**454**		
			W	**0.841**		
			CHIDST	**20.18**		
			p	**0.009683982**		

$$W = \frac{12S}{m^2(n^3 - n)}$$

$$\chi_r^2 = m(n-1)W$$

m=3 & n=9