AN INVESTIGATION INTO FACTORS CAUSING CONSTRUCTION PROJECT DELAYS IN KENYA

Case Study of High Rise Building Projects in Nairobi

Alfred Atsango Talukhaba

B.A.(Bld.Econ.) Hons, M.A.(Bld. Mgt.), MAAK(QS)

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DECLARATION

I hereby declare that this thesis is my original work and has not been presented for a degree in any other university.

Talukhaba, Alfred Atsango

DECLARATION OF THE SUPERVISORS

This thesis has been submitted for examination with our approval as University supervisors

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Prof. P. M. Syagga, PhD

Dr-Ing. C. M. Mbatha, PhD

Dr. I. M. Mbeche, PhD

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ABSTRACT

Construction project delay is a widespread phenomenon in Kenya and reflects poor project time management practices. Project delay frustrates the process of development. In addition, scarse funds are tied in unfinished projects, and cause problems of mortgage servicing. Consequently, viable projects are rendered not viable due to lost opportunities occasioned by changing market conditions. Besides, the cost to society and loss of reputation of the parties involved in the concerned projects is immeasurable.

The significance of the factors that cause project delays in Kenya unknown. This has created a vacuum in the efficiency with which projects are managed with respect to project planning and control. Hence, this study sought not only to identify and establish the significance of the factors that cause project delays but also investigated the influence of project characteristics on the delay causing factors. It was hypothesized that the factors that cause project delays are associated with the project participants, the process and the environment of project implementation, and that project characteristics of client and size influence the occurrence of these factors. Ninety variables were identified through literature review and pilot interviews. A random sample of 40 high rise buildings, ranging in cost between Ksh. 45 million to Ksh. 200 million was used in the study. A rating scale was used to identify the significant variables. Those that emerged significant were subjected to Chi-square test for the purpose of establishing the influence of project characteristics on the variables. The regression model was used to identify the variables that are most significant.

It was observed that client's payment and architect's instructions (in that order of merit) are the most significant contributors to delays accounting for 70.6% of variations in percentage of delay. Other 22 factors which include rock, rain and client's instructions were also found to be significant contributors to delays but with minimal effect. Delay in payment was found to be influenced by project client and size characteristics. Financial difficulties are caused by project financiers, inaccurate estimates, variations and price increases. Architect's instructions on the other hand, was found to be influenced by project size characteristics but not by client. Architect's instructions come about due to redesign, client interference and change of mind. These observations are however interpreted to mean that they are only symptoms of the underlying real causes of project delays. The real causes were observed to be poor financial management by clients, inadequate designs and poor management of the construction process by the parties involved in project implementation. These are compounded by poor resource management such as materials and equipment by contractors, inadequate recognition and response to project risks inherent in both the physical and socio-economic environments of the project, and inadequate regard for the role of project stakeholders by the parties involved in the project implementation process.

These pointed to lack of awareness by project management of the seriousness of the problems of delays, inadequate knowledge about and sensitivity to the factors causing projects delays, and lack of updated skills for tackling the diverse risks experienced during project implementation.

The findings of this study point to the problem areas in project implementation process and are useful to project management and others for identifying particular areas of concern in order to minimize project delays. This study therefore recommends that project management should be concerned mostly with client's project financing and efficient and workable project designs. In addition, efficient construction process management is necessary. Hence, efficient structures of project management should be recognised in the infrastructure of project implementation process. This requires a total reform of the construction industry in Kenya with specific emphasis on review of the existing infrastructure, promotion of continuous research for new and better methods and techniques in project management, training of industry participants to impart new and updated skills and development of support programmes by the allied industries to assist in the development of the construction industry.

This is an enormous task that requires government support in terms of formulating policies for developing an efficient construction industry by focusing on research, training, review and allied industry support. The policies will guide and direct the development of the construction industry towards efficiency and good practices and enhance the construction industry's partnership in Kenya's socio-economic development process. An agency that can guide this reform process is proposed.

Talukhaba, A. A.

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CHAPTER ONE

INTRODUCTION

1.1: Background to the Study

Conventional project procurement in Kenya is achieved through the traditional system. It is a characteristic of the traditional system that all project implementation activities revolve around the project architect who is expected to manage the design and the construction processes of the project on behalf and to the satisfaction of the client. This is done with the assistance of other professionals such as engineers and quantity surveyors who are all commissioned by the client at a fee to offer their professional services. Together the professionals constitute the design team. Essentially the system requires that the design process is complete and sufficient information is made available before the commencement of construction.

The traditional system is founded and supported by an infrastructure that is equally traditional. The infrastructure is in the form of recognised methods, rules and procedures used for project implementation. This infrastructure allows limited flexibility in project procurement. For instance, the appointment of the design team is mainly done through personal contacts. In most cases there is no formal and elaborate contract signed between the client and the parties that constitute the design team. The letter of commissioning is therefore the basis of the contractual relationship between the client and the design team. Basically the contract is based on trust with the client relying on the supposed integrity of the design team; hence it is assumed that no elaborate formalities are needed in the contractual relationship. Likewise members of the design team have no reason to doubt the commitment of the client in deciding to build.

The architect receives a brief from the client and proceeds to develop the design. This is followed by the preparation of tendering documents, if the client is satisfied, to enable the tendering process to begin. Contractors are pre-qualified on the basis of experience, work capacity and past performance. Consequently, contracts are awarded mostly on the basis of the lowest bidder. A standard form of contract is signed between the client and the contractor. The conditions and articles of agreement in the current standard contract used in Kenya are a replica of similar old British standard contracts such as the Joint Contracts Tribunal (JCT) of 1963. The standard form of contract in use for instance, was first drafted in 1970. The first revision was carried out in 1991. The revision, however, did not take into account the changes that have occurred in the construction industry since the 1970s. The revision only managed to rationalise inefficiency in the construction process and transferred more risks inherent in construction to the disadvantaged parties, that is, the client and the contractor. For example, despite the universal need to recognise and involve project managers in the implementation of projects, the revision failed to put this fact into consideration. This has caused various problems to some clients who may have wished to involve project managers in their projects. They have realised that project management is not recognised in the local instruments of operation in the construction process. In project works where project managers have been involved, they find it difficult to operate because architects retain their traditional powers in the project process (Adwera, 1993).

To assist in the day to day supervision of the project, the architect employs the clerk of works. The clerk of works in essence acts as the architect's or client's representative on site, to monitor the day to day activities of the contractor. Subcontractors on the other hand are appointed by the client with the assistance of the design team. The contractor and subcontractors sign a similar agreement (the agreement and schedule of conditions of building subcontract). The main contract empowers the contractor to manage the work of the subcontractors on behalf of the client. This arrangement has been criticised on the grounds that subcontractors tend to be loyal to the architect who has a say in their appointment rather than to the main contractor, resulting in adversarial relationships on site (Franks, 1982a).

The architect with his team carry out monthly inspections and hold site meetings at which problems arising out of the construction process are sorted out and may issue instructions as the situation demands. The site meetings become a routine process until the practical completion of the project is achieved. At this stage the last inspection is carried out and the project handed over to the client for use, with the provision of a six months defects liability period in which the contractor is expected to make good defects.

The traditional project procurement system has evolved for over two centuries. It has passed the test of time, and is responsible for most of the buildings seen today (Young, 1971; Franks, 1982a). However, this system was introduced in Kenya during the colonial period and is based on technologies that are foreign to Kenya. The technology is applied in climatic, social and cultural conditions that are different from the country of origin. Habitat (1982) has stated that some of the problems experienced in the construction industry are attributed to the traditional system, when they pointed out that;

> "-- the construction sector in developing countries is beset by serious difficulties ---- aggravated by adoption of designs, technologies and standards that are inappropriate to local conditions".

However there is nothing inherently wrong with the concepts on which the traditional system is based. It is the static and inflexible principles on which it is based that make it unsuitable in a dynamic environment as that of construction. The needs of the construction industry have been changing from time to time and thus past approaches may not necessarily be appropriate in a changed environment. The construction industry is faced by scarcity of required resources such as limited access to construction finance, increasing prices of materials, labour and plant. Despite these challenges, construction projects are expected to be managed efficiently. These pressures when exerted on the present construction industry, complicate the construction process. Construction facilities are expected to be viable in the light of these difficult circumstances, demanding that a high degree of efficiency be achieved in the construction process. The characteristics of the industry and projects are always changing, necessitating flexibility and amorphous systems of project delivery which can adapt to differing project circumstances (Sidwell, 1990)

The methods, rules and procedures in the traditional system of project procurement do not meet this criteria of flexibility and efficiency. They have no in-built sensors of flexibility and efficiency as well as a mechanism of accountability for the actions and omissions of the parties involved. For example, to employ contemporary project procurement systems such as package deals, management contracting and project management, that may be suitable in certain project situations, can be achieved by enormous resistance. On the other hand, it is surprising that in the history of construction in Kenya, cases of professional negligence are rare when they should be widespread due to the magnitude of negligence problems currently faced in the construction industry. Efficiency and accountability are subjected to trust and integrity of the concerned parties with the hope that they will do their best for the success of the project with the interests of the client in mind. The professional participants (architects, engineers and quantity surveyors) are supposed to be guided by good conduct and ethics in the performance of their duties, as emphasised in their rules of professional conduct. This philosophy is not sustainable and may no longer work due to the erosion of ethical and moral norms in the fabric of the wider society. This is evidenced by the widespread inefficiency in the Kenyan construction industry, according to studies done in Kenya on the performance of construction projects such as that of Mbaya (1984), Mbatha (1986), Kithinji (1988), Khang'ati (1986) and Mbeche and Mwandali (1996).

1.2: Statement of the Problem

In the last fifty years Construction projects have advanced to higher levels of complexity. For instance, recently quite complex projects have been initiated in Kenya. These Projects cost millions of shillings, take longer periods to accomplish and involve diverse expertise[1]. Complexity is defined by size, cost, time and intricacy of construction, when these attributes seem to be larger than usual (Sidwell 1990, Gidado 1996). The National Social Security Fund (NSSF) complex cost Ksh. 2.5 billion compared to the estimated cost of Ksh. 600 million, it took five years to complete as opposed to the original estimate of two years. The Migori District Headquarters which was initially planned to be completed in two years has since stalled, and it is not known when it shall be completed. The original contract sum was Ksh. 518 million but now it is projected to cost Ksh. 1.5 billion on completion.

The huge and challenging projects notwithstanding, the construction industry in Kenya has not kept pace with this advancement to be able to effectively handle complex situations. Whereas the projects mentioned above could be termed complex by virtue of their shear size and hence suitable candidates for use of more advanced project procurement systems, they were still implemented using the traditional project procurement system. Similar cases are common in Kenya where projects are experiencing time and cost overruns, falling quality standards and increased litigation. These are

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[1] Complexity in this case is linked to shear size, cost, time and intricacy of construction, which are interrelated. However, Gidado (1996) defines complexity as the measure of the difficulty of implementing planned production work flow in relation to a number of quantifiable managerial objectives. Sidwell (1990) describes it as the diversification of the operating environment, which of course is influenced by size, cost and intricacy.

manifestations of serious problems of project management in the construction industry.

Mbatha (1986), Talukhaba (1988) and Mbeche and Mwandali (1996) established that time and cost performance of construction projects in Kenya are poor to the extent that over seventy percent of projects initiated in Kenya are likely to escalate in time with a magnitude of over fifty percent. In addition, over fifty percent of projects are likely to escalate in cost with a magnitude of over twenty percent. Although cost performance is not any better, the studies showed that time performance is comparatively the worst. This suggests that within the existing project management procedures, cost management and control is perhaps given more emphasis compared to time management and control. However, despite the importance of project cost management in the construction process, it is not combined with project time management in this study. Such a broad scope is likely to limit the analysis each factor requires with respect to the two attributes of time and cost within the respective conceptual framework. Hence the concentration of this study on time only. However, causes of escalation in project cost is an area needing a study of its own.

The seemingly poor control of project time as manifested in the poor time performance has reached unprecedented levels. It is a commonly reported phenomenon in the construction industry as attested by the following excerpts:

> "--- MPs and Ministers ------ vowed to revive the construction of Kanyakine hospital abandoned five years ago (The Daily Nation, April 26, 1992)"
>
> "--- a --- library project estimated to cost Ksh. 20 million has stalled ----- the library was expected to be completed in November 1989 but the completion time has now been extended to September 1991 (The Kenya Times, May 13, 1991)".

The above cases and many others reported frequently show that project delays need to be tackled urgently. For a developing country like Kenya the problem of project delays frustrates the process of development. In every five year development plan in Kenya, major projects are planned to be accomplished in the planned period. Delayed projects therefore render the effort of drawing up development plans futile and yet it costs a lot in terms of money and intellectual input.

On the other hand, major development projects are financed by international bilateral aid and loans. Financial aid by donors is increasingly being tied to efficiency in the Kenyan society and the need for more transparency and accountability in the way things are done. The current government policy of promoting foreign investment is not supported by the inefficient construction industry. This is because foreign investors are sensitive to and attracted by efficient infrastructures that support profitability of their investments. Project delays are manifestations of inefficiency in the construction industry and this makes it difficult to finance projects either through aid or loans. Delays in projects however should be minimised for the following reasons:

* Construction finance is loaned for a fixed period of time during which repayment has to be made. This requires that delays be minimised so that investors may receive returns on their investment as soon as possible to be able to service their loans when they become due.
* Time is an important parameter in the feasibility analysis of projects. It is however assumed to be constant in the analysis. As projects delay, the exposure to more and greater risks increases, such as, material price increases and higher interest rates[2]. These risks increase project cost and may render what would have been a viable project become unviable.
* For public projects in a developing country, the cost to society is immeasurable when projects planned to offer health, education, and security services to the community delay. The total cost of delays, assessed by not only the consideration of the total increase in capital expenditure due to delay, but also the opportunity cost to the community for not utilizing the project in good time, becomes an enormous task to quantify.

The occurrence of delays in the construction industry seems to suggest that the participants in the sector are unaware and insensitive to time as one of the important facets of the industry's efficiency. It also suggests that there

[2] Prices of materials are unstable in Kenya, due to a weaker local currency viz a viz the international currencies. Some of the construction materials such as cement, steel, ceramics and electrical components have a high import component (Wells, 1993) and therefore their prices are vulnerable to the performance of the Kenya shilling against the international currencies. Material prices can increase drastically without warning when the Kenya shilling falls. Likewise interest rates are not only high, but also increase frequently.

are difficulties in the estimation of construction time. Mbatha (1986), Talukhaba (1988), and Mbeche and Mwandali (1996) found that among other factors, underestimation of project time was a contributor to time overruns. The major difficulties associated with project time estimation by whatever method relate to the assumptions made about the factors that influence project time, and the process of project time planning and control. The factors that influence project time are basically project time risks. Initially, the project planning and scheduling process needs to take into account these risks. Consequently, control of project time plan, requires information on these risks. The four important facets of efficient project time management namely; sensitivity, estimation, planning and control, require that the risks that influence construction time be known. The greatest success in project time management is likely to be achieved if the risks that influence time can effectively be identified, quantified and managed.

Project time estimate ideally should emanate from the project planning and scheduling technique adopted for the project, such as the Bar Chart, Critical Path Method (CPM) and Programme Evaluation and Review Technique (PERT), among others. In which case the duration of each activity is estimated by the following formula (Calvert, Bailey and Coles 1995):

$$\text{Duration} = \frac{\text{Scope}}{\text{Rate of Output}}$$

Scope is a function of the size of the activity, which can be expressed in volume, area, or unit. This is subject to design decisions arising from the project brief. The rate of output is influenced by the productivity of workers in a gang and the number of gangs deployed on an activity. A contingency time is assessed and added to cater for worker absenteeism, learning time and other factors that impede activity progress. The total project time is arrived at by summation of the durations of all critical activities in the project.

Several problems are associated with time estimation. The first is that, the Bar Chart and the CPM assume a static project environment and therefore the time estimate derived is deterministic. The contingency time added to cater for uncertainty is based on subjective judgement. PERT on the other hand attempts to account for the effect of uncertainty by basing the activity time estimate on three estimates using the probability theory. Thus estimates are made of the optimistic time (a), the most likely time (m) and the pessimistic time (b). The expected time (te) is derived by the following formula (Thierauf and Klekamp, 1975: p. 125):

$$te = \frac{a + 4m + b}{6}$$

This formula assumes that the optimistic and the pessimistic time estimates have an equal chance of achievement and therefore fit in the normal distribution curve, with the most likely time being the modal time, hence weighted by a factor of four. However, although PERT attempts to measure uncertainty in project time, the assumptions made about the optimistic, most likely and the pessimistic times are still based on subjective judgement.

Thus whether the project time estimate is based on the deterministic methods or the probabilistic method, sufficient information must be available about the importance of the factors that may influence project time. The accuracy of the estimated time will, among other things, depend on the level of accuracy of the information used in making such assumptions.

The above argument portrays the ideal situation about project time estimation. However, these methods are rarely used in the construction industry (Mbatha, 1986). The most commonly method used is the Bar Chart, but not much attention is paid to its accuracy (Wachira, 1994).

In the construction process, time estimation is done at the project tendering stage and submitted along with the project cost estimate. At this stage most of the project details may not be available as some of the sections of the project may still be under design. In the absence of guidelines and uniformity in time estimation, contractors practically use intuition to estimate project time. On the other hand, clients may dictate a project time frame by intuition without sufficient regard for the technicalities involved in the project. The intuition method cannot be relied upon for project time accuracy because it is based on subjective judgement and in some circumstances could be responsible for some cases of project delay.

It is not the intention of this study to evaluate the accuracy of the methods used for project time estimation. It would be difficult to undertake such a study without first identifying the risks that impact on project time. However, such a study would be a suitable follow up of this study.

Although studies by Mbatha (1986), Mbeche and Mwandali (1996) and Baradyana (1996) identified factors such as subcontractors, weather, materials, underestimation of project time, variations, equipment, incorrect design drawings and slow process in decision making among others, as causes of delays, the significance of each these factors as causes of delays was not established. Hence very little information has been generated which can be used to develop strategies that can effectively address the problem of delays. The presence of some factors in the project process may not necessarily result in project delay since activity floats may be utilised to recover lost time to keep the project on schedule.

Another useful aspect of project planning and scheduling is the ranking of the diverse factors with respect to their influence on project time for the purpose of factor prioritisation. Although some factors may be known to cause delays, it becomes difficult to know the differences between factors with respect to causing delays. Consequently, project management may have difficulties with strategizing for the purpose of controlling delays when faced with diverse factors.

On the other hand, projects are implemented under different circumstances. Two attributes which have been found to profoundly affect project performance are the project size and client (Mbatha 1986; Sidwell 1984, 1990). These factors also influence project planning and control because of the unique environments they create. The influence of project size and client on the behaviour of delay causing factors is also not known. Yet it is important to make project planning decisions based on these important different project characteristics.

It is therefore the proposition of this study that the problem of project delays relates to lack of information on project time risks, the project characteristics that influence the significance of these risks and lack of skills to utilize the information for risk quantification in the light of time estimation and management. Hence the difficulty in modelling time using appropriate techniques in the process of project planning. The task of project time control is also difficult because it is not easy to anticipate the likely risks and their impact on project progress. This limits the application of appropriate measures to control delays. This necessity inspired the choice of this study.

1.3: Objectives of the Study

This study aims at addressing four main objectives. These are to:-

* Identify significant factors that cause delays in construction projects.
* Assess the influence of project size and client on delay causing factors.
* Rank the significant factors with respect to contribution to delays.
* Propose a strategy that can minimise delays in construction projects.

1.4: Conceptual Framework

It is difficult to find information in literature that can be termed as delay theory. The word delay has both noun and verb usage. As a verb it means to postpone or to be late. It is used as a noun to mean the time lost by the act of postponement or being late (Tullock 1996). The latter is the meaning adopted in this study. However, for the purpose of this study, project delay is defined as the extra period incurred to complete the project over and above the agreed and binding contract period. It is assumed that the period the parties to the contract commit themselves to is adequate for the completion of the project, since it is arrived at by methods acceptable in the construction industry.

Therefore, theories related to time management form the foundation of explaining and understanding delays. On the other hand, delay can be termed as a construction risk. Risk according to Toakley (1990) is an unwanted negative consequence of an event. Since project delay is negative and unwanted in the construction process, it fits Toakley's definition of risk. The risk management theory therefore forms a basis on which to examine the problems of delays. The concepts of time and risk management are within the domain of construction project management theory. The aim of construction project management theory is to develop a knowledge base for efficient management of projects with the objective of achieving efficiency in time and quality at minimum cost (Abbott, 1987: p.706).

Concepts in this study are derived from the construction project management theory which in turn derives its concepts from the general management science. Construction project management is practically as old as the beginning of construction, but theoretically it is relatively new. The theory emphasises those tenets of management science that are relevant to the management of construction projects.

However the specific theories that relate to the subject of time management and ultimately delays in construction are project time planning and control. These set the construction time frame and ensures its achievement. The systems theory assists in understanding complexity of projects by offering some explanations regarding interacting project forces and their risks. The risk management theory offers solutions on how uncertainty can be quantified and minimised.

The planning and control theories as they relate to construction projects with the aim of minimising delays should take into account the ideas proposed in systems and risk management theories. This means that delays should be addressed from a wider perspective covering project planning and control, systems and risk management theories to embrace a whole spectrum of management related theories. This is necessary because the theories form a foundation upon which project delay theory can be developed as discussed in chapter three of this study.

1.5: Location and Type of Projects of Study

To achieve the study objectives high-rise building projects in Nairobi are used as a case study. Nairobi is located in the middle of the corridor that stretches from Mombasa at the coast to Busia at the border with Uganda. This is the most active area in Kenya economically and in which there will be continued development of high rise buildings. Climatic conditions to the South and North of this region where Nairobi is economically dominant are different. Labour supply to the North and South of the region is limited because of sparse population and harsh climatic conditions. The entire region therefore experiences comparatively limited economic activity. Although the results of this study are primarily applicable to Nairobi, they can form a reasonable basis on which to project construction activities in the economically active region.

Technically, the study is concerned with high rise buildings. First, in recent years, the city of Nairobi has experienced an increase in the construction of high rise buildings. The high cost of land in the city and the zoning regulations adopted by the Nairobi City Council (NCC) compel developers to maximise the use of their sites. Plot ratios are higher in the city centre and so are the rates paid to the NCC. The emergence of high rise construction is therefore a phenomenon that is expected to increase in the future. Already older buildings are being demolished to give way to modern skyscrapers. It is the primary interest of the study to understand how best to manage the construction of high rise buildings. The study results could also be extended to the understanding of how to efficiently manage other building projects with similar characteristics. While it is acknowledged that all construction work is challenging, most challenges are likely to be encountered in high rise buildings due to the following characteristics:

* The repetitive nature of construction in typical floors, beams and columns require intricate planning if the process is to be efficient. This requires use of advanced skills such as the multiple activity chart for efficient utilisation of resources.

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* The repetitive nature of construction in typical floors, beams and columns require intricate planning if the process is to be efficient. This requires use of advanced skills such as the multiple activity chart for efficient utilisation of resources.

* The shear volumes of materials such as steel and concrete that are used in a single high rise building are enormous compared to single low rise building except in special cases.
* The type of equipments used in high rise construction such as excavators, compressors, cranes, cement silos and concrete mixers are more sophisticated and require efficient planning to achieve economic utilisation. They also need to be frequently maintained if they have to give efficient service.
* Craft workers are exposed to more risks as they work at high heights. Falling objects increase the incidence of accidents in high rise construction. The risk of accidents increases even higher if the contractor does not take adequate safety measures for the protection of the workers.

High rise buildings therefore have more logistical problems, hence this study is expected to bring out most of the factors that cause project delays. Perhaps, some of the factors are unlikely to be manifested in other forms of construction (Forster, et al, 1977).

1.6: Operational Definitions

For the purposes of this study the following terms are used in the following context:

Project Delays: The extra time incurred over and above the originally set project contract period.

High Rise Building: A building with five or more storeys above ground level (Abbott, 1987:p.413)

Project Management: The organisation of resources required for a project in terms of materials, equipment and skills so that the requisite items are available at the right time in the right place, and that the project can be carried out with the maximum efficiency at minimum cost (Abbott, 1987).

Project Time Performance: The eventual time achieved at the completion of the project as compared to the originally set target.

Project Cost Performance: The eventual cost achieved at the completion of the project as compared to the originally set target.

Project Procurement: A process of acquiring services and other resources for implementation of the project.

Traditional Project Procurement: A method of implementing projects with a set of rules and procedures that require sufficient project details and recognise the architect or engineer as the project leader to oversee the provision of services and other resources for the whole process of project implementation including design, construction and commissioning.

Project Planning: The process of gathering and organising information and other details necessary for implementation of a project to the set objectives of time, cost and quality.

Project Control: The process of monitoring and comparing the achieved and planned performance for the purpose of detecting and correcting deviations.

1.7: Study Assumptions

It is assumed that there is homogeneity in the management of projects under study and therefore project management as a factor has a constant and equal impact on project delays since all the projects were implemented using the traditional procurement system.

It is also assumed that there are no differences in the traditional procurement system that can be attributed to the process such that projects implemented using the system have an equal chance of showing similar characteristics in performance.

Another assumption is that productivity of workers within Nairobi is the same, hence variation in delays due to differences in worker productivity is negligible.

It is assumed that the project contract period the parties agree to adhere to is adequate for the completion of the project, and therefore the delays observed by the projects in the sample were not as a result of contract time underestimation.

1.8: Significance of the Study

Construction project management is a relatively new discipline and has evolved for the purpose of improving efficiency in the construction industry. A study on project delays is relevant because it touches on the very essence of construction project management which aims at improving construction industry efficiency. To improve efficiency, it is necessary to understand what contributes to inefficiency. A study on project delays is therefore useful in creating an insight into the understanding of the factors that contribute to time efficiency. It is also expected to expand the theory of construction project management, particularly, in the area of project time management. This will ultimately contribute to efficient management of construction resources.

Efficiency in the management of construction resources is perhaps needed more in a developing country like Kenya where the construction industry is still an important partner in the development process. Pressure is placed on the construction industry for the realisation of development facilities such as educational, health and transport facilities. The provision of these facilities in Kenya is far from adequate. For instance, the need to construct more schools, hospitals and housing is great in every part of Kenya. This is evidenced by the many children who miss to go to school because of lack of classroom spaces, the many people who have no access to health care because of limited health centres and the acute shortage of housing in urban centres. Below are excerpts to support this observation.

> "--- the registration of standard one pupils in Nairobi begins ------ amid shortage of vacancies owing to the high population of school going children (The Daily Nation, June 13, 1992)"

> "--- provision of workshops, home science rooms, laboratories --- has proved formidable in rural areas. The situation is so bad particularly at primary level where 95% of the schools do not have these facilities --- and pupils learn under trees (The Daily Nation, April 12, 1992)"

> "--- rapid population growth coupled with increased rural-urban migration, among other factors has considerably strained the provision of decent housing, leading to slums in most urban areas (Development Plan 1994-1996:p.35)"

These needs have exerted high pressure on the construction industry and this pressure is likely to increase as the population continues to increase. This demands that the industry be more efficiently managed to deliver the expected development facilities.

The present methods of project management and the infrastructure in place have proved to be inadequate to tackle the present problems of construction. Some of the methods and procedures have outlived their usefulness. Furthermore, future construction projects will be more complex as the Kenyan society strives for higher levels of development. If the current methods are inadequate at present, there is no guarantee that they can handle the complex construction problems of the future.

The ongoing structural changes in the Kenyan society on political and economic liberalisation have exposed the Kenyan economy to competition both locally and internationally. For the construction industry to compete in this new environment, it has to be more efficient. The procedures and techniques in use have to measure up to benchmarks of international standards. Hence the need for the construction industry in Kenya to develop efficient ways of managing projects not only for local use but also for international competition. One way of contributing to this much needed efficiency is to establish the significance of the causes of project delays and how they can be minimised.

1.9: The Scope and Outline of the Study

While the study acknowledges that decisions made earlier during the project design stage may later affect the construction process (Bromilow, 1974). the study is restricted only to the construction phase of the project. The conditions prevailing during design can be controlled by the parties involved, because unlike construction, design occurs in an enclosed environment which can be controlled. During construction, the largest number of participants at any one given time of the project process interact and it may not be easy to control some prevailing conditions. For instance, it may not be easy to control rain or shortage of materials. Such factors can only be managed. Therefore the greatest challenges in implementation of projects are likely to be experienced during the construction phase. A study of the design phase can however be useful in explaining project performance. In situations where the causes of delay are known it is possible to link specific design decisions to factors that cause delays. When the significant factors are unknown, it is usually impossible to link particular delays to specific design decisions.

Conceptually therefore the study is concerned with the delays observed during the construction process. Such delays eventually result in the overall delay at the completion of the project. The delays that occur during the design process are not part of this study. However, it is necessary that a study of the delays occurring during the design phase and how design decisions can contribute to project performance be undertaken.

This study is presented in eight chapters. Chapter one discusses the background to the study, the problem statement, the study objectives and sets the conceptual framework and scope of this study. The significance of the study is also presented.

Chapter two discusses the concepts in project management theory advanced for the improvement of project time performance. The previous work done in this area both in Kenya and abroad is also discussed. It is shown that past research in Kenya basically established that projects were performing poorly but the significance causes were not established.

In chapter three, the strategies of good project management practice which if employed should minimise the problem of delays are discussed. The strategies recognise the importance of systems and risk management theories applied within the context and functions of management such as the planning and control techniques. These set the ground rules for sound project time management practices. It forms the theoretical framework in which efforts to minimize delays are founded.

Chapter four sets the hypothesis of the study and discusses the methods of data analysis

Chapter five discusses the potential variables that cause delays. By testing the hypothesis the significant variables are identified.

In chapter six there is a discussion regarding the influence of project size and client on variables that cause delays. The factors that contribute most to delays are also identified.

Chapter seven interprets the results of both chapters five and six by linking the significant variables to specific origins in the project management process. The main argument is that the actions and omissions of the project participants and the application of one set of rules and procedures for every project situation does not promote sound project management and could be a recipe for delays.

A summary of the findings and conclusions drawn as well as recommendations made based on strategies for minimising delays are presented in Chapter eight. The recommendations focus not only on the project participants training needs, and the review of the ground rules for project implementation to allow for flexibility in procurement, but also on investment in research to guide the development of the construction industry so that its competitiveness can be increased locally, regionally and internationally. Areas of further research are also suggested.

CHAPTER TWO

CONCEPTS FOR IMPROVING PROJECT PERFORMANCE

2.1: Introduction

This chapter discusses arguments advanced for improving efficiency in the construction industry in general with particular emphasis on time efficiency. The arguments are diverse, and reflect lack of focused effort in tackling the problems of time. The discussion focuses on specialisation that evolved to deal with complexity, application of management functions in the construction process, technical advancements in methods and techniques of construction to improve construction efficiency and project performance.

2.2. Specialisation

From time immemorial, the need to minimise delays in the construction industry has pre-occupied construction professionals throughout the world. Diverse efforts have therefore been made to improve the performance of the construction industry. Two noticeable turning points towards improving performance in the construction industry can be identified. The recognition of the master-builder from the general public as a person with skills to design and construct buildings was a major achievement for improving efficiency in the construction industry. The move recognised skill, expertise and experience as useful in the promotion of efficiency. As buildings became complex, this resulted in specialisation of skills originally performed by the master-builder into distinct and interrelated disciplines. Thus, increased complexity of buildings resulted into the need for specialisation. Specialisation was indirectly influenced by increased demand for buildings and an increase in awareness for the need for efficient services by clients. The professions of architecture, engineering, quantity surveying and contracting evolved over time because of specialisation to improve on efficiency in the construction industry. These culminated into the traditional project procurement system along with the procedures and rules that support its operation (Sandstrom, 1970; Young, 1971; Franks, 1982a).

Specialisation offered improvement in efficiency in project implementation within certain limits of technology and project complexity. However, project demand and complexity has increased over time owing to the advances in civilisation and has exerted more pressure on the construction industry in terms of the need for the provision of more efficient services. This has been accentuated by commercial construction activities. Building for commercial purposes has presented new challenges in terms of speed of construction and change in tastes. Specialisation has further increased the need to add new skills on to existing expertise in the construction industry. For example, within the architectural professions, other expertise in the area of interior design and landscaping have emerged. Although specialisation is advantageous in improving both the trade and professional skills in the construction industry, the present challenges of the construction industry are not so much in trade and skill performance. The challenges are rather in the finesse with which the organisation of the many and varied skills required in the project implementation can be carried out for a focused and successful project attainment.

Thus specialisation has increased within the traditional system at the expense of the development and acquisition of managerial techniques in project planning and organisation. The various distinct and yet interrelated professionals specialised in different aspects of the project realisation and implementation have to be organised efficiently if project objectives have to be met. The existence of limited integration has been identified as the cause of some of the problems experienced in the construction industry (Mbaya 1984; Walker 1989). They have argued that a major problem exists in the construction industry which is related to the organisation of the diverse and yet interrelated contributors to the construction process in order to ensure that their skills are used for the benefit and achievement of efficiency in the project implementation process.

2.3: The Traditional Construction Infrastructure

Despite its past success, the traditional project procurement system has its own shortcomings. The greatest deficiency in the traditional approach to project implementation is the application of outdated management concepts in the project procurement process. Mbatha (1993) observed that it is lack of application of advanced project management principles in the construction process that is causing most of the problems encountered in the Kenya's construction industry.

The underlying philosophy in the traditional approach is based on the notions borrowed from the Industrial Revolution manufacturing practices (A.D. 1760-1840). During this period, it was believed that inventors were the best managers of the production of their inventions. This notion characterised manufacturing industries and engineers doubled as engineer-executive and doers. The notion was borrowed by the construction industry and likewise, architects were regarded as the best managers of construction projects. This philosophy worked well when projects were simpler. The projects encountered in this age require a combination of engineering and technology prowess and therefore need diverse expertise. The manufacturing sector, was the first to move away from this notion. It was later recognised in the manufacturing sector that although managers were expected to understand the principles of the design process and the organisations they manage, managing and design required different skills. The mastery of design alone was not enough to successfully manage the realisation of design. The resources needed for designing are not the same as those required for design realisation. Therefore, the skills of managing the design may not necessarily be appropriate in the process of managing the design realisation.

The above argument applied to the construction process from the conceptualisation of the project, to inception, design and construction enable it to be viewed as a large organisation. The tasks of implementing the project can be grouped into different departments such as the policy formulation and overall project management department, the design department, and the construction department - represented by the client, the design team and the contractor, respectively. These departments are related for the purpose of successfully completing the project. Although the cooperation of the different departments is comparatively conspicuous in the manufacturing industries, it best managers of the production of their inventions. This notion characterised manufacturing industries and engineers doubled as engineer-executive and doers. The notion was borrowed by the construction industry and likewise, architects were regarded as the best managers of construction projects. This philosophy worked well when projects were simpler. The projects encountered in this age require a combination of engineering and technology prowess and therefore need diverse expertise. The manufacturing sector, was the first to move away from this notion. It was later recognised in the manufacturing sector that although managers were expected to understand the principles of the design process and the organisations they manage, managing and design required different skills. The mastery of design alone was not enough to successfully manage the realisation of design. The resources needed for designing are not the same as those required for design realisation. Therefore, the skills of managing the design may not necessarily be appropriate in the process of managing the design realisation.

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The construction industry has been slow to appreciate that design and construction process need different approaches. In recent years however, there has been debate about the introduction of project managers in the construction process. Although project managers are recognised in some countries as useful contributors to the construction process, they have not been adequately recognised in Kenya. However, it does not necessarily mean that the introduction of project managers in the construction process will solve all the problems in the construction industry. It is the functions and tools of project management such as project planning and control that, if applied effectively should result into significant changes in the way projects are managed and hence improve project performance. On the other hand, the functions of project management must be recognised within the construction industry infrastructure to support effective operation of project managers.

2.3.1: Variations Within the Traditional System

The need to achieve efficiency in the construction industry resulted in the development of alternative systems of project procurement within the traditional system. For example, instead of accurate bill of quantities, the bill of approximate quantities has been used. Contracts have been based on schedule of rates and specifications. Furthermore cost reimbursement, target cost and package deals types of contracts have also been applied. These non-conventional systems have been applied in an effort to reduce the design and documentation process, enable fast tracking, and hasten project delivery.

In addition, there have been attempts to minimise time taken for the tendering process. A choice has to be made between competition and negotiation when selecting a suitable contractor for the project. Negotiation is the earliest known method of contractor selection. Negotiated contracts were found to perform better and could minimise tendering time if the negotiations do not collapse. This is because negotiation introduces the contractor in the project early enough. Contractors are familiar with the technicalities of projects and their input at this stage may improve constructability. Competitive tendering is used for the purpose of ensuring that accountability, transparency and best value for money are achieved. This method, however has its unique problems. For instance, competition was found not to offer any advantages in both time and cost performance of projects. At the same time it takes unnecessarily too long to select a contractor in addition to being costly (Talukhaba, 1988).

Package deals or turnkey contracts are applied in the same way to improve project time performance. The single point responsibility concept that the package deal system entails, improves project integration. In studies to compare the time in which projects are implemented between competitive tendering and package deal, Harris (1976) and Sidwell (1984) found out that at all the project stages from design to construction, the package deal ended up being more time efficient. This is because package dealers frequently use proprietary building systems or modular building forms which are familiar to them. This reduces design and approval time of building components with vast opportunities of fast tracking (Franks, 1982b). However, it has to be realised that package deals are suitable for what may be referred to as "mass production" in the construction industry. Mass production is a characteristic of speculative property developers, hence may not be suitable for different project characteristics. The package deal system therefore cannot be relied upon to solve all the problems of the construction industry.

The alternatives that developed within the framework of the traditional system were due to the specific needs of individual clients. The needs of clients are particularly more faster and efficient ways of project implementation. The alternatives are specifically developed to solve specific problems and may not necessarily be suitable for general industry application. On the other hand, whereas new systems aimed at minimising construction time exist, some tend to increase risks in the contract for the other project participants. For example, attempts to implement a project with less design details increases risks in scope and specification to the contractor. This is a characteristic of the cost reimbursement contract. Contractors respond to increased risks by increasing the cost to the client. Reduced competition encourages contractors to bid highly, whereas increased competition encourages contractors to submit low and unrealistic bids with the hope of later capitalising on contract loopholes to recover costs.

These arguments support the fact that although some of the new concepts introduced in the construction industry have offered some advantages, they have on the other hand, complicated project management processes.

2.3.2: Procedures and Rules

Procedures and rules generally establish the infrastructure of project implementation. There have been reviews of some of the procedures and rules used in the construction industry. For example, standard designs and their documentation were developed for public buildings such as schools, hospitals and houses. It was believed that this exercise will save on construction time by reducing design detailing, documentation and approval. This however, did not achieve any advantages as found out by various studies. In particular Mbatha (1986) and Talukhaba (1988) revealed that there existed poor project time and cost performance and yet some of the standard designs were part of the samples used in the studies.

There were also revisions of some specific clauses of the Agreement and Schedule of Conditions of the Building Contract. For example, in 1991, the clause on payment certificates was revised to increase the period of preparation and honouring certificates from 14 days to 28 days. The other change was to allow interest on delayed payments to the contractor. This was because most clients in the past were unable to honour payment certificates within 14 days and the conditions did not allow interest on delayed payment.

Extending the period of honouring certificates meant that clients were offered free credit using the contractor's money[3].

Another revision increased the amount of bond from 7.5% to 10% of the contract value with an additional provision for the client to provide bond to the contractor for the performance of his obligations in the contract. This was in response to the high rate of default in construction contracts by both clients and contractors. The contract for government projects, which is similar to the private sector contract, has not been revised in the same way.

Since the fundamental issues that involve project procurement and which influence efficiency were not addressed, the revisions only institutionalised and rationalised the inefficiency inherent in the construction industry. At best, the revisions can be termed as a risk re-distribution exercise. While risk distribution is healthy for the construction industry, it has to be fair to all the parties concerned. Such a desperate exercise is a reflection of lack of knowledge about the causes of inefficiency in the construction industry by the industry's players[4]. This further justifies the need for further studies on the causes of inefficiency in the construction industry.

There exist however, a strong resistance for change to other forms of project procurement by some members of the design team. Mbatha (1993) found out that architects are more resistant to change because they fear that

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[3] The changes were done on the conditions of contract for building works which is commonly used in the private sector. By allowing interest on delayed payment and doubling the period of honouring certificates, contractors were the losers; a case of giving with one hand and taking with the other.

[4] An example of a case of the blind leading the blind.

they may loose the power that they currently enjoy under the traditional system if new systems of procurement are to be introduced.

A procurement system that encourages better project performance and effective project management recognises the role of project planning and control. Project planning and control are key factors for successful project implementation. They set a strong infrastructure for project implementation. The other essential functions of project management such as organising, directing, staffing, leading, coordinating and motivating become therefore easy to apply. They must however be recognised within the rules and procedures of project implementation if they have to be enforced.

Poor project time planning and control practice contribute significantly to project delays. In addition, other factors collectively and individually contribute to good project planning. One such factor is that the plan must be accurate and take into account not only the scope and intricacy of the project, but also the uncertainty that surround the project. This can be made possible if the project risks are recognised and quantified. The second important factor is that during project implementation, the plan must be interpreted correctly. This depends on the clarity of the plan and the persons interpreting it. It is important to appreciate that since a plan is only a forecast of the likely course of project implementation events, it is inaccurate in the first place. Therefore, every step in the project implementation process must be monitored carefully for the purpose of controlling any deviations from the original estimated course. This requires that risks that cause deviations are known. It is expected that reviews to procedures and rules in the construction industry aimed at improving efficiency should emphasise these important facts.

2.4: Non Traditional Procurement Systems

The infrastructure for the overall project management process varies and is determined by the project procurement system. Those who criticise the traditional project procurement system cite the inherent fragmentation of the project implementation team, low level of management, poorly defined relationships and poor communication channels as the mitigating factors against attempts to improve project implementation efficiency. This is worse in a complex and uncertain environment experienced in the very large projects (Kettle, 1986). Team-work is necessary for solving complex project problems. However, fragmentation (as defined by specialisation), compounded by the rivalry and antagonisms between project professionals and their allegiances to their specific professional institutions inhibit team-work. This results in many serious managerial problems in project implementation process, hence the need to introduce in the project process management concepts that have worked in other sectors. The success achieved by alternative forms of contract, tendering, and procurement is attributed to some measure of integration entailed in these systems. However, the integration is not sufficient to the levels expected. The introduction of management principles in the construction process has been proposed by Sidwell (1984) as one of the ways of improving integration in the construction industry. He argues that management is one factor which is essential for the success of the project, more particularly, when projects have problems of size, speed and complexity. He further argues that the reason why the traditional procurement system has performed poorly in complex situations is due to the lower level of management it entails. The problem is compounded by the division of design and construction, which does not encourage a unified approach to the implementation of the project. The following management oriented procurement systems have been proposed with the aim of improving efficiency and performance in the construction industry.

2.4.1: The Management Contracting System

The main characteristic of the management contracting system is that the contractor is incorporated early in the project and becomes part of the design team. His role therefore is that of a management consultant. Thus the contractor is able to offer technical advice on areas such as construction cost, materials and methods of construction, manpower utilisation, and scheduling of work. This ensures that the essential and difficult aspects are set right at the design stage of the project to facilitate immediate feedback during construction. Furthermore, the system allows early incorporation of the latest construction technologies in the design, and allow activities with large time lags such as excavations, foundations and securing of materials to begin under a fast track approach. The result may be savings in time. In this way the designers are allowed to devote their energies to those activities for which they are trained and experienced. The client on the other hand is relieved of many anxieties usually besetting him particularly those concerned with adequate project financing. Sidwell (1984) compared the traditional and management contracting systems, and found out that management contracting achieved shorter total project time. However, it is not known whether this system can reduce delays to acceptable levels in the construction industry in Kenya because it has not been applied. Therefore a study in this respect is necessary.

2.4.2: The British Property Federation System

The British Property Federation system (BPF) introduced the concept of client representative in the whole project process. The role of the client representative is to oversee the needs of the client from the clients point of view at all the stages of the project. In this case, the client has an opportunity to be represented and makes a contribution during the design and construction processes of the project. This enables a knowledgeable client representation at all the stages in the project and gives the client representative overall authority of managing the project. This system is an improvement on the management contracting system.

The BPF system also encourages team-work and attempts to avoid the entrenched antagonistic relations between the professionals so often experienced under the traditional system. It also makes individual consultants directly responsible for managing their respective works through the binding consultancy agreements between them and the client. In an attempt to find a suitable system for application in the Kenyan construction industry, Mbatha (1993) found out that the BPF system has characteristics which could accommodate most of the problems experienced in the Kenyan construction industry. This system, however, has not been applied in Kenya. Its potential as a solution to the problems of delays in the Kenyan construction industry remains largely unknown.

2.4.3: The Project Management System

The project management system introduces the concept of the project manager in the construction process. The role of the project manager is to represent the client's interests at all stages of the project. The project manager's position in the project process is recognised as the manager of the entire process of construction and not only as a representative of the client or a manager of only one aspect of the process as is the case with management contracting and BPF systems. The project manager's involvement emphasises the commitment of the project team to the control of time, cost and quality and offers the managerial support for such a control to be realised. The potential of the project management system to assist in solving the problems of the construction industry in Kenya was recognised by Mbatha (1993). He analyzed the traditional, management contracting, the BPF and project management systems with the aim of establishing the levels of commitment of delegation of client's responsibility, team spirit and reduction of adverse relationships, constructability enhancement and reduction of uncertainty. These were seen to enhance project performance. The management contracting and the BPF systems possess some measure of commitment of these essential ingredients. With regard to successful implementation of projects, none of the systems possesses all the requirements to satisfactory levels. The project management system maximises the use of the success ingredients in the project procurement process and was found to be the alternative that could be suitable for solving the problems of inefficiency in the Kenya's construction industry. However, the model developed by Mbatha (1993) has not been applied to establish how efficient it is in reducing delays.

2.4.4: Performance of Non Traditional Project Procurement Systems

The move towards management oriented systems of project procurement (management contracting, BPF and project management) has been described by Young (1971) as going back to the Middle Ages (A.D. 400-1500). He argues that by embracing the project management system the separate roles of the architect and the builder are merged again in the same way as they were in the Middle Ages[5]. This is not advocating for the application of Middle Ages techniques of construction but rather to emphasise that the designer of the Middle Ages had considerable expertise in construction methods and techniques. It is only meant to illustrate the importance of early contractor involvement in complex projects and having a client representative that is knowledgeable in the technicalities of the project. The two have something to offer in the project process which the traditional procurement system ignores. Studies done to compare the performance of projects implemented under the management contracting, project management and

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[5] In the 14th century, Master-builders designed and built castles and churches for Kings and Bishops (Sandstrom, 1970; Young, 1971)

traditional systems found that while project delays were not eliminated entirely, comparatively, the projects implemented by adapting the non traditional concepts performed better (Krantz, 1976; Levido, et al, 1981). This creates hope that the new concepts have a chance of improving performance if further developed. They have therefore to be applied in an infrastructure that is supportive of their development and application.

2.5: Construction Methods and Techniques

Construction methods and techniques adopted for any given project vary depending on the type of project, the availability of and accessibility to a given type of technology, and the availability of skilled personnel capable of utilising the preferred technology. However, construction technologies such as the traditional construction techniques, mechanisation, systems building, industrialised construction techniques and/or combination of these techniques are used in various circumstances.

2.5.1: Traditional Building Trades

Traditional building trades have been used for a long time in the construction industry with considerable success. However, there are inherent inefficiencies in the traditional construction techniques of stone laying, plastering, tiling and carpentry when carried out in a sequence of trades. A considerable amount of fabrication and assembly of parts involving combining many small units take place on site in-situ. The method is slow because sometimes much of the work is done under bad working conditions. For example, hot or cold temperatures, wind and heavy rains may prevent continuity of work. Some work, such as concrete, must be allowed time to cure and gain strength before continuity of work. Plaster has to set and dry out before it can be painted. There is also the possibility of materials and work being damaged by exposure to weather. For example, dampness may cause warping of timber and destroy cement. On the other hand, due to the difficulties of supervising various trades on site, some of the work may be below standard but pass unnoticed especially in large projects. The traditional building trades are labour intensive and may lead to problems associated with labour such as low productivity and poor precision and workmanship. These increase delays. In addition, the increasing cost of labour may require that alternative techniques be applied to keep the cost of buildings low.

The traditional building methods have been undergoing change by introduction and development of new components and techniques of construction to minimize the problems cited. By examining the traditional techniques of construction using work study techniques, inefficient practices are identified and better techniques introduced to reduce costs and increase speed of construction. This ensures that buildings are ready for use in a shorter time that is commensurate with cost.

2.5.2: Standardised Components

The use of standardised components is evident in joinery, metalwork and sanitation. It reduces construction time as opposed to fabricating such components on construction sites. Other components such as standard staircases and standard wall cladding are presently being developed and introduced into the market. In this way, the amount of on-site fabrication is reduced with off-site fabrication increasing. Site assembly by operatives with specialised skills distinct from the old crafts increases and improves the speed of construction. At the same time other industries develop as sub-systems of the construction industry to produce the new products and contribute to economic growth and employment creation. Component manufacturing and assembly is therefore one way of improving efficiency in construction. However, the level of efficiency achieved by this method is largely unknown.

2.5.3: Mechanisation

Replacement of unskilled labour with mechanical plant is another way of improving efficiency. The rationale behind this move is to reduce labour costs and increase speed of construction. In some situations, construction operations cannot be done either economically or physically by manual labour. Such operations require mechanical plant to be performed. In Kenya, construction plant is applied in but not limited to operations such as mass excavations, rock excavations, concrete mixing, and hoisting. The machines used are mostly imported and are sometimes plagued with problems of maintenance and lack of spare parts. The other problem associated with construction plant is the optimisation of labour/plant ratios. The labour/plant ratio analysis and logistical plant utilization problems may inhibit efficient and economic utilisation of the mechanical plant. This is a problem associated with lack of efficient methods of resource management. This is another area that has not been explored by research in the construction industry in Kenya.

2.5.4: Systems Building

Systems building utilises dimensionally integrated components joined together to form the structure of the building. The dimensional discipline ensures that the components relate to each other as part of the single integrated system for specific building type such as housing and schools. The component parts are factory produced and site assembled. The essential point in adopting systems building is that the system first governs the basic design of the building, and then the pattern of its constituent parts on plan and elevation. It is also concerned with the component manufacturing in the factory, transport to site, and consequent assembly. Thus an interface is developed between design and construction. Systems building removes fabrication from site and only leaves assembly operations to be performed. Thus it reduces the number of traditional skilled labour required on site and the time spent on site operations. This is expected to improve efficiency in construction time. This is a concept that cannot be found in the traditional methods and their subsequent improvements. It is also not found in the other hybrid systems of project procurement. However, the hybrid systems are likely to recognise its potential faster than the traditional system.

Systems building, however, requires thorough coordination of design, factory production, and site assembly process. It necessitates intricate planning. Thus the more system building is applied, the more the need for efficient project management systems.

Fisher (1974) argues that systems building has generally not shown itself to be cheaper either in initial cost or total cost including subsequent building maintenance costs. However, it certainly offers advantage in reduced construction time. A combination of factory produced components with in-situ construction is widely applied in high rise construction especially in developing countries. The problems of economic combinations and planning of the interface between component manufacture and in-situ operations do arise. This in essence complicates the process and negates the advantages gained by adopting system building techniques. In addition, system building may not be readily available in Kenya, because of limited investment in this area. Imported systems may require payment of royalties increasing the cost of this technology.

2.5.5: Industrialised Construction

Systems building and mechanisation globally constitute the industrialised construction methods. As more and more of the building components become factory made, either for conventional or systems construction, the process of construction resembles that of the manufacturing industries, hence the organisational techniques used in manufacturing industries become applicable. The increased complexity and size of buildings result in more intricate construction processes. The demand for more buildings of various types and the need to reduce costs, require that construction techniques should change to those that can not only reduce costs but also increase productivity. This means that the planning of the construction processes should move away from the traditional approaches to new approaches. This requires that there should be an integrated system of design and construction that can lead to continuity in all the construction operations. Thus work is planned to ensure that all operations fit into a continuous time sequence so that construction proceeds as a continuous operation. It becomes necessary that the organisation of the whole construction process be efficient to ensure a coordinated flow of labour, materials and plant, resulting into minimal material shortages and hold-ups as well as delays.

Standardisation and prefabrication of components as far as possible together with the introduction of construction plant aimed at achieving continuity, reducing labour costs, and achieving time efficiency are necessary to enhance project performance. To this end, design of the building and construction operations have to be considered together at the design stage as a way of achieving continuity and rationalisation of construction. This continuity can only be to achieved within the flexible procurement systems.

2.5.6: Performance of Industrialised Techniques

The pace of applying industrialised methods in construction in developing countries is slow compared to the developed countries. One reason for this state of affairs is lack of accessibility to technology. Some of the technologies in the developed countries are patented and are not readily available. Differences in prices of labour and capital and the consequent differences in factor productivity across the economy also hinders adoption of some of the technologies. For example, the high unemployment rate coupled with cheap labour would mitigate against adoption of mechanised methods of construction.

Systems building, though has problems of weather, sound and fire insulation, was instrumental in alleviating problems of housing in Europe. This was particularly so after the second world war. It is largely still unavailable in Kenya. It should be noted that the main problem encountered in Europe after the second world war was an enormous shortage of labour. Thus systems building resulted from an effort to reduce the use of labour in construction. The present building by-laws in Kenya do not accommodate new technologies. New concepts such as "systems" building encounter problems of social acceptability (Waithaka, 1988). Although industrialised methods have offered advantages where they have been applied, for such methods to be applied successfully in Kenya, they require a supportive infrastructure that recognises their potential and an analysis for their suitability.

2.6: Project Time

In addition to the need to emphasise the systems that can improve efficient time management, there has to be a sensitivity to time. This is regardless of the system in which the project is implemented. Bromilow

(1969) attributed the tepid approach to time to lack of serious treatment of time during project implementation when he observed the following:

> "insufficient regard was paid to the importance of time and its proper use in all aspects of the project, from the clients original decision to build, through the design stages, up to the final completion".

This observation also applies to the Kenyan construction industry. The traditional approach to project implementation lacks sensitive approach to time management in its rules and procedures. It does not emphasise project planning and control in some of its documents. For instance, the bill of quantities which at best is a cost model of the project, is recognised in the schedule of agreement and conditions of building contract as a contract document. The project time model which should be in the form of a bar chart or a network schedule, has no similar recognition. Besides, project planning and control has been found not to be seriously applied in the project implementation process (Mbaya, 1984; Khang'ati, 1986; Kithinji, 1988). This can be explained partly by the fact that the culture to plan meticulously and commitment to controlling the project has not entrenched itself in the construction industry in Kenya, largely due to the application of the traditional system of project procurement.

2.6.1: Project Time Estimation

Project time estimation is a factor that has been cited as responsible for the poor time performance (Bromilow, 1971; Mbatha, 1986; Talukhaba, 1988; Mbeche and Mwandali, 1996). Mbatha (1986) and Talukhaba (1988) found out that there was no universally recognised method for construction time estimation in Kenya. Although project time estimation methods exists, such as the Bar Chart, CPM and PERT, their application or lack of it is the major problem.

The greatest challenge to time estimation is perhaps the assumptions it is based on. The assumptions must be realistic by assessing the correct environment in which the project is to be implemented. The arguments advanced for the problems experienced with time estimation are two pronged. The first argument is that the methods used to estimate project time may not be accurate on account that they do not adequately consider the parameters that influence project time, such as scope, methods of construction, style of management, and the productivity of the workers. Secondly, the assumptions made about the likely risks influencing project time, if any, may be wrong. In other words the risks that are likely to cause project delays are not correctly quantified due to inaccurate assumptions and lack of application of updated techniques of risk measurement[6]. The result is optimistic or pessimistic time estimates.

Project contract time estimation is done by either the client or the contractor depending on what the client's terms are. If the client fixes the contract time, this is done on the advice of the consultants. Thus an inadequate time is a product of the consultants. It is therefore the client's

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[6] Assumptions are based on the information available on the effect, magnitude and frequency of the foreseeable risks in construction. This information is lacking in kenya's construction industry. Mathur (1987) has demonstrated how monte carlo simulation can be used to measure risk.

consultants who may be suffering from lack of application of updated methods of time estimation and time risk quantification. On the other hand, the client may insist on a construction time as dictated by the investment needs. For instance, a project could be initiated to be completed within a certain fixed time frame to take advantage of a certain expected business opportunity. In such a situation, it is crucial that the project be completed within the fixed time. An example of such a project is the Kasarani Sports Complex that was initiated to capitalise on the All Africa Games held in Kenya in 1987. The risks associated with such a time may not be adequately quantified by both the consultants and the contractor. Bromilow (1974) argues that to seek faster time involves substantial risk and should be attempted only when all the necessary conditions surrounding the project are thoroughly understood.

In a situation where time estimation is left to the discretion of the contractor, it is often part of the competition for the contract. In this type of scenario, the contractor may offer inadequate time due to his own poor estimate and assumptions about the project. This may also be as a result of lack of application of updated skills in time estimation. On the other hand, the contractor may deliberately offer an attractive time for the purpose of winning the contract, with the knowledge that once on site he can request for time extension to complete the project[7]. Since tendering conditions do not require detailed analysis and estimation of time, which can equally be verified,

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[7] There is no way of verifying the time offered by the contactor at the tender stage in the same way the cost is scrutinised(see Cowell, 1974). In the current practice, unlike elsewhere(see Franks, 1982a), contractors are for example, not asked to produce a programme of work at the tender stage. But if they win the contract, they are asked to produce it later, and this may be more for decorating the site office than for controlling the project (Wachira, 1994).

contractors exploit the loopholes in the schedules of agreement and conditions of contract to get time extension without tangible, quantifiable and empirical assessment.

Accurate project time estimate must be supported by effective time control, so that the project may be accomplished within the original time estimate. The two (time estimation and control) require different methods and approaches. However, although time estimation should take into account project risks, time control should largely involve identifying and containing the negative effects of the project time risks during project construction.

Models of ascertaining the cost of the project such as cost estimation based on units, area, or volume; standard method of measurement, cost planning, bills of quantities, and fluctuation formulae for assessing cost increases or reductions are more developed and articulated. Some of these techniques are recognised and enforced by the standard forms of contract. Comparatively, models of time are not equally recognised in project contracts.

2.6.2: Project Time Planning

Although project time planning models exist such as the bar chart and the critical path method (CPM), they are not given the emphasis they deserve in the existing infrastructure for project implementation. Neither are there specialists for time estimation recognised in the same way are the quantity surveyors, whose role is to estimate and control project cost. Cowell (1974) argues that it is desirable that when dealing with time, judgment on the programmes should be logical and equitable, requiring that ground rules be provided to assist in uniformity of time estimation and interpretation. The ground rules must be set and be effective before the event rather than after it. This is self evident if uniformity of interpretation is to be realised. At present, even within the time estimation models, there are no rules for deriving the project programme which can be authenticated by interested parties. Hence, there is no basis of deciding whether the project time is adequate or not except by intuition. For instance the Standard Method of Measurement was developed so that measurement of building works can be standardised. It is desirable that similar documents be developed for time estimation and submission of construction programmes which can be evaluated uniformly during the project tendering process.

2.6.3: Systems and Contingency Approach for Time Planning

The concerns of Mbaya (1984) was poor time performance of projects when he examined the possibility of extending systems and contingency theory to the management of the construction process as one way of explaining the complex nature of project implementation. He defined a project in terms of three major sub-systems, design, design realisation and construction, against the background of the traditional project procurement system. This revealed a glaring gap in relation to coordination, integration and control of the three sub-systems all viewed as important to project implementation. He emphasised that project participants should take into account the environmental factors that influence the construction process. This is particularly useful in understanding the influences on construction time.

Kithinji (1988) examined the systems approach to project management with specific reference to resource planning, project control, communication, authority, accountability and coordination for projects implemented in the districts of Kenya. He argued that the mode for project implementation process in the district was more complicated and often brought together strange parties which presented unique problems that compounded the problems of the tasks involved in project implementation. The problems presented could therefore not be tackled effectively by the traditional approaches. The heavy dependence of the industry on other sectors increased the problem of complexity and dynamism, thus the problems experienced by the projects could not be solved by focusing management effort on the construction industry only. The systems concept had the philosophy of management that could improve project time performance in the districts if applied.

This analysis demonstrates the difficulties of implementing projects in Kenya. The infrastructure that exists at the district level is worsened by the parties who are ignorant about construction processes[8]. Systems management is a function of project management theory. Systems theory enables a clear description of projects and the project process for easy identification of the problem areas, which can aid time estimation and management.

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[8] District Commissioners, who are government appointees and may have no training in construction make decisions on government projects implemented in the districts, about contractor selection, contract sum and time with disastrous consequences.

2.7: Project Performance and Size, Location and Variations

Project size has always been suspected to have an influence on project performance. Sidwell (1984) argued that size is a function of complexity and a major cause of poor project time performance. He identified some causes of complexity as the need for many subcontractors in large projects, that create sequencing problems and hold-ups. In a study to establish time performance of projects in Kenya, Mbatha (1986) found out that project time performance was not a function of size and location. Whilst project time is obviously a function of size, size may not necessarily influence performance. Project time performance, assuming an accurate time estimation, can be influenced by project management. Size related factors have been found to be predictors of time with a high degree of correlation (Nkado 1992; Chan and Kumaraswamy 1995). This does not necessarily mean that they can also be predictors of time performance as well, or delays.

However project size can influence time performance indirectly due to the problems associated with it, causing a different kind of relationship. Bromilow (1970) found out that both the value and number of variations occurring on a contract were functions of size. Sidwell (1984), on the other hand, argued that complexity is a contributor to variations. A large number of variations were found to influence time performance (Bromilow, 1970; Talukhaba, 1988). The occurrence of variations is a reflection of incompetence in design, lack of application of constructability and poor project planning and control. Hampton (1994) attributed this phenomenon to the procurement process that does not allow a suitable criteria for consultant selection, giving rise to the appointment of a design team not best qualified to provide the services. This again is encouraged by the traditional procurement system.

2.8: Project Performance with Respect to Management

The problem of delays has been linked to management related factors and incompetent design team. Bromilow (1971) argued that poor organisation of the design stage result in lack of identification of objectives and the sequence of timing events to attain the set objectives. This problem was compounded by tardiness in making decisions and deficiencies in contract documents such as the forms of contract agreement, specifications and bills of quantities (Baldwin and Manthei, 1971).

Walker (1995) confirmed this argument by emphasising that project characteristic factors have no significant impact on construction time performance because they are subject to management planning and control. Challenges associated with them can therefore be compensated for by employing good risk assessment and management practices. Sidwell (1984) while comparing projects implemented under different client characteristics, that is, private and public clients linked time performance to management. The result was that public clients including the central government, local authorities and public corporations built more costly projects which at the same time took long to design and construct. This was verified by studies by Mbatha (1986) and Talukhaba (1988). The studies found out that, although there was generally poor time performance observed in all the projects undertaken by different clients, there was a difference in magnitude of severity of the poor performance by different types of clients. Government projects were found to be the poorest in time performance. This difference can only be attributed to differences in management styles. In Kenya, government employees are known to have apathy towards work because of low pay and lack of motivation, which in itself is a sign of poor management practice.

Nkado (1995) in an effort to prioritise the time influencing factors from the point of view of those involved with construction activities on site, found out that the most important factors with respect to time performance included clients specified sequence of completion, contractor's programming of construction work, form of construction, client's and designers priority on construction time, project location, constructability of design, availability of construction management team and the completeness, and timeliness of the project information. Other factors are financial penalty or bonus in the contract, motivation of site management team, and the influence of external pressure groups. All these factors put together, except for the external pressure groups which is a problem of the environment, can be tackled by the project management which is also expected to devise methods of dealing with the influence of the external pressure groups.

Walker (1995) classified the factors affecting construction time in two broad categories namely, the client's representative team effectiveness and the construction management team's effectiveness. These define the project into two broad phases of design and construction. From a managerial point of view, the client representative is important to the success of project time and has to deal with the risk of incompetent design team. The construction process management has to deal with challenges of construction complexity and scope and other outside challenges. Thus project success with respect to time is seen to be within the control of the client with both the contractor and the design team as factors to be controlled.

2.9: Project Infrastructure with Respect to Performance

From a developing country's point of view, the problems of project delays have been seen in different perspectives. One perspective is represented by the framework and procedures in project implementation. The framework is a legacy left behind by former colonial powers, currently outdated. Aniekwu and Okpala (1988) and Dlakwa and Culpin (1990) argued that deficiencies in these framework arises from the existence of a gap between the basic premises on which the arrangements are based and the prevalent situation that is peculiar to developing countries.

The other perspective was advanced by Ofori (1991) and Ogunlana, Promkuntong and Jearkjirm (1996) when they argued that it is the limited technical and managerial skills among clients, consultants and contractors in the construction industry that is the cause of problems of delays in developing countries. The professionals in the industry have continued to learn and apply traditional skills with little development towards new skills and methods that are better suited to tackle the challenges of present day construction. Such skills and methods include project management, industrialised building, and risk management among others. These are some of the tools to be applied under different project circumstances.

2.10: Conclusion

The concepts reviewed so far allude to the fact that delays is a world wide problem, but perhaps only worse in developing countries. The characteristics of the construction industry in developing countries as well as the level of project time performance is similar to the characteristics of construction industries in developed countries in the 1960s.

Piecemeal reviews to the documents in use in the construction industry without a comprehensive study to identify the problem areas and without the input of all the actors and stakeholders has provided a simplistic and short sighted approach to the problems of the construction industry. It has managed only to shift risks to the disadvantaged parties, thus highlighting the existence of the problem.

The evolution of package deals, management contracting and project management systems of project procurement came as a result of specific needs of the construction industry. The needs included single point responsibility, constructability enhancement, integration, and informed client representation. Although the results show that projects implemented under such new systems have performed better, the systems have not altogether eliminated the problem of delays. They however form the basis upon which suitable solutions can be developed further to tackle the problem of delays. The new systems have to be recognised and nurtured by the construction industry infrastructure.

The methods that have been developed to improve construction operations efficiency and techniques such as systems building, mechanisation, and industrialisation, whilst aimed at improving efficiency, initially developed as a result of specific needs in the construction industry. Shortages of labour and increased demand for housing soon after the Second World War were instrumental in influencing the development of industrialised construction methods. Such methods have found general application in the construction industry, not specifically as a means of eliminating delays, but as an addition to the pool of techniques available to be used in the industry for efficiency. Intricate project planning and control techniques are necessary to realise the full potential of systems and mechanised construction techniques.

The project specific variables such as complexity and location, and the uncertainty that they present, are challenges of project management which should be faced with elaborate, updated and flexible techniques.

So far the significance of the various causes of project delays in Kenya is unknown. The analyzed concepts are generalised and do not give a set of rules that can minimise delays. It is also not known where to concentrate efforts in order to minimise delays. The specific problem areas of project management that contribute to delays, and the skills that need to be emphasised to minimise delays are largely unknown. The knowledge gap in this area is therefore still wide. Chapter three discusses the relevant management theories that can be applied to improve efficiency in the construction industry. It sets the foundation for the theoretical framework in which the problems of delays can be understood.

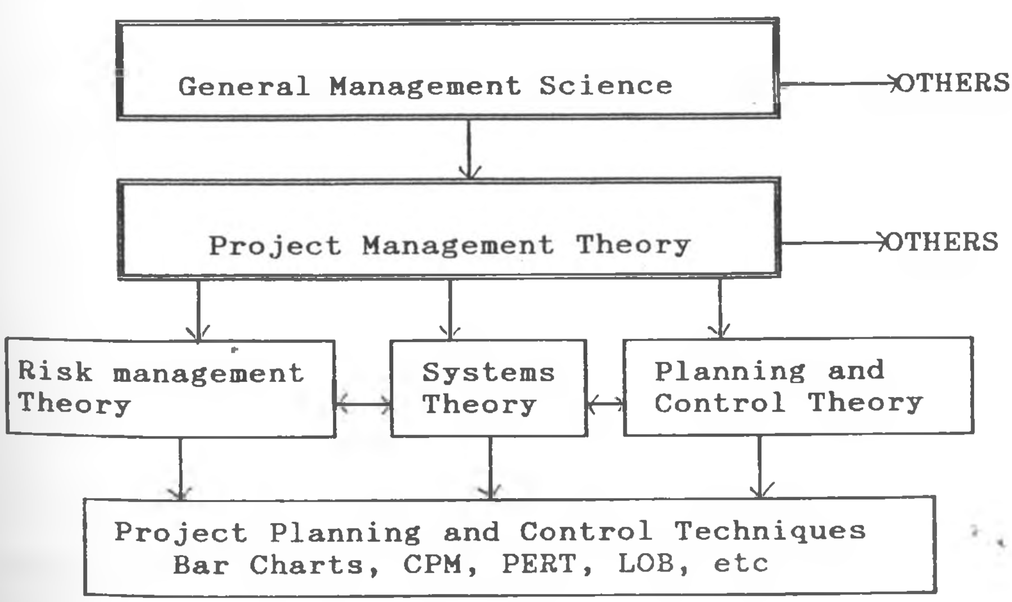
CHAPTER THREE

PROJECT TIME PLANNING AND CONTROL STRATEGIES

3.1: Introduction

This chapter discusses the concepts that have a bearing on project construction time and its performance. Time is modelled by using planning and control techniques. Delay is measured in terms of time and can therefore be explained in the same context. Figure 3.1 shows the interrelationships between the various theories as discussed in this chapter. Time planning techniques must be applied within the universal planning and control theory and recognise the importance of risk and systems theories. Planning and control, systems and risk theories are all part of the general project management theory which in turn is part of the wider general management science.

Figure 3.1: Conceptual Interrelationship Model

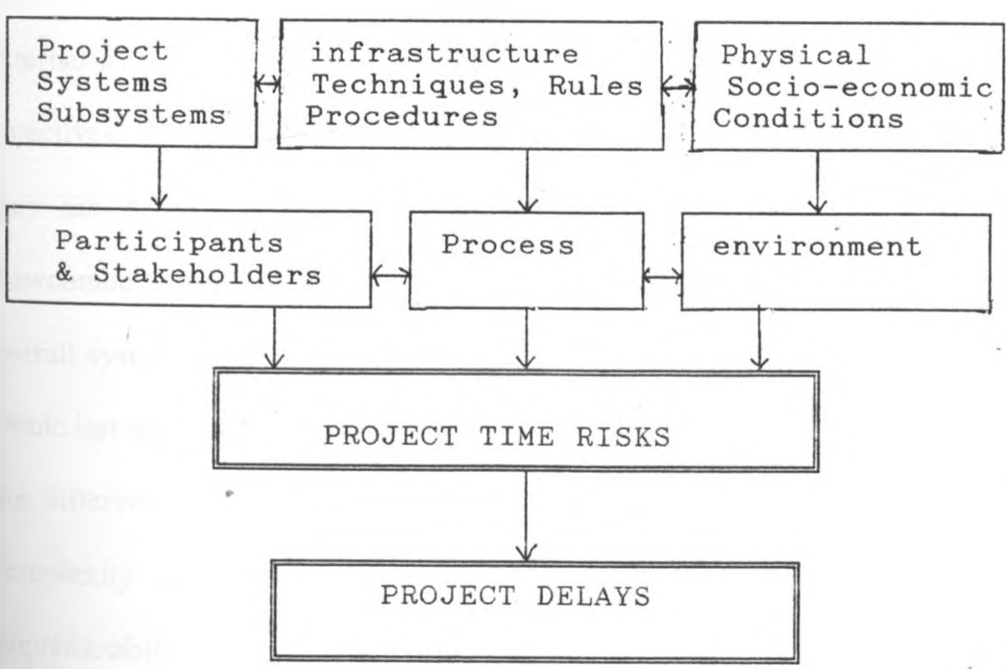


Source: Author's own construct

3.2: Conceptual Delay Model

Figure 3.2 shows the conceptualisation of the causes of project delays with respect to the construction process in relation to the conceptual interrelationship model. Project subsystems generate risks by virtue of their influence on the project. They could also generate risks due to deficiency in the pertinent concepts of sound project management, with regard to project planning and control. The process of construction is defined by the infrastructure of project implementation as represented by the techniques, rules and procedures. It should be noted that the non or wrong application of management oriented techniques also generates other risks.

Figure 3.2: Conceptual Delay Causal Model



Source: Author's own construct

The other potential cause of delays is both the physical and socio-economic environments as represented by sites, weather conditions, and the economic situation, among others. These makes the problem of delays to be looked at in the context of the participants and stakeholders, the process, and the environment as discussed within the framework of the relevant time planning and control concepts.

3.3: Project Management

Project management draws its theories from pure management science and aims at coordinating and controlling all the relevant actors and stakeholders in the project to achieve the desired project objectives. The need for project management arises out of the need to efficiently manage complex projects. Construction projects are complex because of the many parties, external as well as internal to the project, that interact to realise the project objectives. It is possible to appreciate construction projects as complex when they are defined as systems (Cleland and King 1985; Walker 1989; Newcombe, Langford and Fellow 1990). The construction process as an overall system comprises of interactive forces which are related together as a whole but separated and influenced by the environment. The relationships of the different intérrelated forces create complexity. Beishon (1980) defines complexity as a characteristic that has a wide range of behaviour, unpredictable or both. This definition suits construction projects because of the limitation hitherto to predict with certainty the time, cost and quality achieved at project completion.

Complexity is best understood by analyzing the many forces that act in the construction process and their interactions. It provides an analytical framework of the design of construction project organisations. In addition, it creates an insight into the effect of the interacting forces on the outcome of the project, thus enabling the identification of the project environment and the interactive relationship between the project and its environment. This enables focus to be directed not only at the project but also on external influences of the project.

Two main broad systems in a project namely, the operating system and the managing system have been identified (Walker,1989). The operating system possesses the necessary professional and technical skills to realise the project. This includes broadly the design consultants, the contractor and subcontractors who also represent the functional specialists. The managing system is charged with the responsibility of decision making, maintenance and regulatory activities that keep the operating system performing its functions consistent with the objectives of the client.

The main concern of the managing system is harnessing the functional resources in order to meet the utility objectives of the client in terms of function, quality time and cost. The project management system must have a strategy that can achieve these objectives to the satisfaction of the client, by utilising planning, control and co-ordination of the project from inception to completion. Morris(1986) argues that since project management has to deal with factors external to the project as well as within it and factors of institutional nature which are at the same time tactful, they have to be equipped with the tools of risk management. This is because they are faced with a wide range of risks.

Sidwell (1990) argues that given the complex and dynamic nature of the project environment, project management must be equipped with different approaches at different project stages. For instance, the approach at the inception stage should be outward looking because issues external to the project to be dealt with are more crucial at this stage. The issues at this stage are government policies, project approvals, and pressure groups. This suddenly changes to centralised interactive process during design and documentation, and focuses on the various consultants involved in the design process. A sequential approach is needed during the construction process to follow the sequential nature of activities. This gives way to a focused approach during commissioning. The approach at this stage is mainly inward looking because attention shifts to the finished project. The relationships and problems emerging in the different situations can be complex. It is argued that a matrix approach to project management is more suited in this type of situation during the life cycle of the project (Walker, 1989; Sidwell, 1990; Pilcher, 1992). The matrix structure attempts to place equal emphasis on the technical expertise as well as supervisory techniques to ensure that responsibility is shared by the two authorities. It allows a combination of management theories and technical knowledge in a harmonious way.

The project management strategy should provide the enabling environment in which the functions of management can be exercised in project implementation. It has been established that project goal understanding, the level of authority given to project management, problem handling by the project team, communication and team support have significant influence on project success (Conillard, 1995). These attributes require efficient human relationships in order to achieve efficient project implementation.

3.4: Project Environment

The concept of project environment can be understood within the context of the systems theory. The interaction of the project system and its environment has been covered in various studies (Cleland and King 1985; Walker 1989; Newcombe, Langford and Fellow 1990; Kithinji 1988 and Hughes 1989). The influence of the environment on the project has two facets. The conception of the project is determined by environmental forces of demand for buildings and the services that they offer. On the other hand, the environment provides the inputs necessary to realise the project. It also receives the project as a product. The description and identification of the environment is therefore an important step in understanding influences on the project. The project environment can be classified and analyzed in a variety of ways. One way is to identify the influences on the project. The influences may vary depending on the geographical and social locations of the project. Political, legal, institutional, sociological, technological and economic factors can affect the project in different ways.

The environmental forces acting directly on the project design and construction processes may affect the ability of the process to achieve the project objectives. For instance, the political forces which include the influence of government policy on the control of the economy through monetary and fiscal policies, may influence the availability of finance and exert pressure on the labour market through wage guidelines and employment levels. Educational policy usually affects availability, the type and quality of skilled labour. Political stability influences economic activity. High economic activity produces a high level of demand in the construction industry. This may lead to shortages of materials and cause delays in projects. On the other hand. demand stimulates growth and development in the construction industry.

Legislation affects the clients activity by acting directly on the process of construction. Legislation such as the building code, safety rules, planning laws, and zoning ordinances, land and taxation laws do influence among others. the availability of land for construction. the technology to be used and the cost of construction[9].

The institutional forces include the influence of institutions on the activities of their members through rules of conduct, education, conditions of engagement, and fee scales[10]. These largely affect the performance of professional consultants such as architects, quantity surveyors and engineers.

Trade associations have influence on the wage rates and the working conditions in construction and hence the cost of construction. They can also influence industrial action and labour availability and affect project progress.

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[9] The Kenya Building Code has been criticised for not reflecting the current technological development in the construction industry and hence needs review. On the other hand it is one thing to have regulatory legislation and another to enforce it. The mushrooming of illegal structures is a common phenomenon in Nairobi, some posing safety hazards.

[10] Some of the rules are not supportive of the competitive spirit and promotion of efficiency. For instance, the architects and quantity surveyors code of conduct and that of engineers prohibit advertising and charging less fees than stipulated. Problems arise when clients wish to appoint consultants through competition, especially when one aspects of competition is fees.

In case of disputes these could lead to strikes which may hamper project progress. The employer's organisations also have an influence on projects by way of resisting the demands of trade unions and can exert pressure on the activities of their members. This may lead to protracted negotiations causing project delay. This problem can affect contractors, especially if they attempt to heap all their risks in the project on the workers.

The acceptability of specific activities by the general public, particularly as reflected by the local workforce, is an example of a social force which may affect construction projects. This includes issues such as customs, beliefs and attitudes to work as well as the pressure groups including environmentalists who may oppose the development of the project for environmental reasons[11].

The technological forces include the influence of technology on the construction process through the development of new materials, techniques and ideas. Other aspects of importance are the range of construction methods available such as in-situ, precast concrete or systems building, the range of materials available, and the type and availability of plant in use.

A high level of uncertainty regarding inflation can make estimating and cost control difficult. The economic environment though influenced largely by government policy, is also dependent on other forces such as the level of general world economic situation, the country's exports verses imports, foreign exchange reserves, and the stability and demand of the local currency

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[11] A case in mind was the proposed 60 storey Kenya Times Media Trust project at Uhuru Park which could not take off because of strong opposition by the Green Belt Movement.

against major world currencies. Other factors include social vices such as corruption. Apart from increasing the tax burden, corruption increases project costs in addition to loss of reputation of the project participants.

The physical environment has an influence on the performance of projects by way of unsuitable sites and bad weather conditions, and hence increased project cost and time of construction.

The interaction of the environmental forces and their consequent effect on the project participants and stakeholders including the construction process, determine the total sphere in which the project is implemented. An inactive project environment leads to a relatively stable construction atmosphere, whereas an active environment, on the other hand, leads to an uncertain atmosphere of project implementation. The process of construction exists in an uncertain environment due to the fact that the environment is always active (Newcombe, Langford and Fellow, 1989),

Both the project environmental analysis and systems analysis assist in identification of factors that present risks to the construction process. Betts and McGeorge (1988) argue that the best approach to risk identification in the construction process is likely to require a diagnosis of the particular problem through the development of an understanding of the project nature and structure. The isolation of the various project subsystems and their likely influences, and identification of the environmental forces and their likely influences enable the identification of factors or features that could represent risk. The factors that could cause risk are not necessarily single independent and quantifiable variables but are complex interrelationships between subsystems of the construction process.

3.5: Project Risk Management

Risk management concept is applied in the construction industry for the purpose of understanding and explaining uncertainty. It has to be recognised that like any other human activity construction projects create risks. Toakley (1990) asserts that risk is an inherent characteristic of the construction process and therefore should be expected in every project. Van Houtte (1988) defines construction risk as the probability of occurrence of a hazard in the construction process. It is implied in this definition that the likely measure of risk is probability. The arguments support the proposition that project delay is a risk which can be measured in terms of probability. During project implementation, some subsystems support the objectives of the project while others, by design or default, have the opposite effect. The recognition of uncertainty is likely to influence the outcome of projects lays the foundation for the concept of risk management (Uher and Levido, 1992; Van Houtte, 1988). Systematically, the concept looks at areas of risk and consciously determines how each should be treated. By identifying sources of risk and uncertainty and determining their impact, appropriate responses can be developed. Thus delays, among others, is undesirable consequence of the construction process and lends itself to the application of risk identification and analysis.

The entire process of construction including inception, planning and design, estimation, tendering and construction is prone to risk differing only in the types (Toakley 1990, 1995b; Zhi, 1995). Addou (1996) observes risk from the point of view of the contractual relationships, especially involving the functionaries and their relationships. He further argues that it is the contractual relationships that present the risks in the way they are distributed. The construction phase has more risks ranging from poor planning and management and poor industrial relations to poor safety and communications. Toakley (1990), however, argues that it is the result of poor initial planning during the early stages of the project that results in greater risks later.

Since construction projects are inherently prone to risks, it requires project management to have considerable skills in handling the anticipated problems that may arise in connection with the project to minimize their effect. Despite the importance of risk management, lack of knowledge in fundamental principles, lack of data and uniformity of classifying identified risks, and the absence of the general risk classification model are some of the factors responsible for its limited use in construction (Uher, 1994). Consequently, problems such as delays remain largely unresolved mainly because of lack of skills.

3.5.1: Risk Identification.

Risk identification is an important function in project risk management process. It is not easy to act on project risks before they are identified. Berkley, Humphrey and Thomas (1991) and Toakley (1990) argue that it is easy to identify project risks at each project stage by breaking up the project into phases of conception, design, procurement and construction. A detailed examination of the phases during project planning is likely to identify potential risks in order to ensure adequate design of possible responses. Another approach proposed by Betts and McGeorge (1991) and Komela, Olomolanje and Harris (1996) is to analyse the systems involved in the project such as the client, the consultants, the contractor, and the project environment.

Uher and Levido (1992) and Isaac (1995) advocate for the need for a systematic approach to risk identification. They identified some main methods that include financial statement and flow charts of construction process that are required to identify possible areas of risk. The questionnaire and check-list approach to risk identification involve making a check-list of risks and asking people involved in construction to rate their importance. Risk can also be identified by past experience. It has however to be recognised that different projects may present different risks. Therefore, relying on past experience alone as influenced by subjectivity may lead to some risks being unnoticed.

3.5.2: Risk Analysis

Risk analysis is a systematic evaluation of the effect of risk on the project using appropriate techniques. Once the risk has been identified it must be analyzed to quantify its probability of occurrence and impact on the project. In this respect more importance is attached to the impact rather than the probability of occurrence. It may not be prudent to concentrate on counter measures on a risk whose probability of occurrence is high when its impact on the project is negligible. Thus any measure to address risk must look at its benefit verses cost. Toakley (1995a) and Uher and Levido (1992) identified risk analysis techniques including the elementary approach which utilises subjective but also experienced judgment to identify those areas of risk requiring focus. The spider diagram, through subjectivity also identifies the most sensitive risks. Other methods include the sensitivity analysis, utility theory, and fuzzy set theory. The fuzzy set theory has been applied directly to planning for risk minimisation (Ayyub, et al 1984). The decision tree analysis which is a geometrical method shows the structure of the decision problem. The tree is made up of a series of nodes and branches with each branch representing an alternative course of action in the face of the risk anticipated. It is however, not within the scope of this study to discuss in detail the risk analysis techniques as they are already adequately covered (Toakley 1995a; Uher and Levido 1992; Ayyub et el 1984; Yeo 1990 and Newton 1992).

According to Uher and Levido (1992) the two important considerations that influence the selection of the technique of risk analysis are the nature of the technique to be used, and the appropriateness of the technique to the decision context as influenced by the risk anticipated in the project. A highly risky project requires more superior methods of risk analysis. A common practice in the construction industry is to assess a single value of estimate of risk using a contingency (Newton, 1992; Uher, 1996). The contingency approach does not adequately measure risk. Since risk is associated with uncertainty, the known method of measuring uncertainty is probability. The application of probability oriented risk analysis techniques assumes that the uncertain data can take on a range of different values. The likely values can be considered over a range within which the decision maker believes they are likely to lie. Thus the data is represented by probabilistic distribution. Project parameters which lend themselves to risk analysis application are time and cost among others. A project time estimate with risk in mind will express the probability of achieving the time estimated.

According to Yeo (1990), Newton (1992), Uher and Levido (1992) and Uher (1994, 1996) the method which seems to offer the best analysis of risk is the probability analysis. The use of the computer based stochastic Monte-carlo simulation makes the assumption that parameters such as construction time and cost are subject to risk. The Monte-carlo technique uses probability distributions to generate a number of simulations of the desired estimate.

3.5.3: Response to Risk

Risk response is the action or series of actions taken by project management to avert the impact of the presence of risk in the project (Uher and Levido, 1992). Methods of risk response have been identified to include avoidance, reduction, transference and absorption (Betts and McGeorge, 1988). The method adopted for each area of risk depends on the nature of risk. The nature of risk is determined by the probability of occurrence and the impact of risk on the project. Avoiding or reducing risk is difficult, and may mean reassessing strategy, developing alternatives, redesigning the project or abandoning the idea of the project altogether (Uher and Levido, 1992). Risk transfer means shifting risk from one party to the other. However, the parties to whom the risk is transferred may respond by instituting an appropriate risk allowance. This happens only when the parties are able to recognise the fact that risk is transferred to them. Bhuta (1992) prefers risk apportionment, arguing that it is capable of benefiting all members of the project team. The other alternative is to minimise and absorb the risk residue with an allowance for contingency. This is possible only when the risk is known and an appropriate party best suited to absorb the residue is identified. The other method of risk response is subcontracting to parties which are best suited to handle the identified risk due to their skills, equipment and experience. Subcontracting is widely used in the construction industry. But it is not appreciated in this context by both parties. Alternatively the risk can be transferred to an insurance company. In this way, the real cost of the risk is known. The present contract documents in Kenya recognise only damage to property as the only risk that can be transferred to an insurance company. Other risks such as price escalations, faulty designs, and mistakes made by consultants are not recognised in the same way. However, in recent years, some clients have demanded that their consultants be covered by professional indemnity insurance. This is a way of transferring some of the risks.

3.6: Project Planning

The most important managerial function that influences the success of projects is planning. This is in turn influenced by staffing. The staff must be conversant with planning techniques. A fundamental approach to planning defines the scope of the project, its goals and the means of attainment. It identifies also their limitations, and develops a course of action most suited to the attainment of set goals. Koontz et al, (1984) define planning as a decision making process performed in advance of action which endeavours to design a desired future and an effective way of bringing it about. The objective and its accomplishment need to be rationalized to avoid haphazard situations. Thus setting project objectives must precede planning. This is followed by a synthesis of solutions to achieve the objectives or goals while satisfying a set of possible constraints or risks. To satisfy the constraints there has to be an anticipation of the probable effects of events that may change the activities and objectives, demanding that the objectives be clear. There should be both awareness of alternatives and an ability to analyze alternatives in the light of goals sought and the risks anticipated. This means that information must be available regarding the possible constraints and risks to aid the derivation of possible alternatives.

This approach to planning is necessary for a meaningful influence and control of the nature and direction of things and for effective determination of the actions necessary to bring about the desired results (Cormican, 1985: p.4). It is therefore necessary to have ample time for planning. Planning needs to take place sufficiently ahead of action to allow for gestation of the decision process to enable effective decision making and the refinement of the planning process. This is only possible if planning is taken seriously in any given project situation.

Some of the broader planning goals to be accomplished in construction projects are the scope, cost, time, quality and function as portrayed by contract documents, drawings, and technological constraints which form the criteria for planning (Laufer, 1990). All these are set during the pre-tender stage. The time objectives span the entire construction process and vary as the project progresses through the different stages. The design, construction and commissioning stages have different set time objectives. In all these stages, very intricate decisions which are intertwined and interrelated have to be made about the objectives to be achieved. Quality, function and time affect cost the cost in turn affects time, quality and function. When decisions are highly interrelated as is typical in construction projects, ample time for planning is justifiable as well as design of upgraded project organisational structures. Thus serious approach to planning prior to the beginning of the execution of the project is necessary.

Planning cannot be effective unless it is known how well the plans are working. This necessitates the task of control, requiring the follow up of plans during project implementation to ensure their success. The procedures followed in effective planning enable overall control to be maintained by carefully monitoring objective accomplishment and enable decisions taken earlier to be monitored throughout the process. Therefore during planning, realistic standards against which performance can be compared to must be established. This becomes the first step towards realistic project control.

Planning in construction project is wider than most people in the construction industry in Kenya have imagined. It is a known fact that most of those involved in construction projects begin to regard planning at the site operations stage (a task carried out by the contractor) at a time when many decisions have already been made. This is another shortcoming of the traditional procurement system. From the foregoing discussion, construction project planning ideally should start at the inception stage and be a commitment at all the stages of the construction process. It has to involve all participants in the project. At the inception stage most objectives are broad. These gradually broaden as demanded by the roles of the various levels of management in the project process. Typically, the client together with the top management construction team need to be represented by the project manager or the lead consultant and his team in setting the project goals of time, cost, and quality. Contractors and subcontractors, are concerned with selection of the means and resources to accomplish the goals set. The Clerk of Works and trade foremen assist the contractor in selecting and devising the solutions and methods of meeting the goals set.

The feasibility report is a good source of objective setting information. It may deal with the economic, financial, commercial, technical and environmental objectives to be accomplished in the project. Gibson, Kaczmarowski and Lore (1995) argue that the feasibility report provides sufficient strategic information for the project since it addresses risks, and forms a basis upon which decision to proceed with the project is based. The broader objectives are translated further into sub-objectives by defining the project more precisely into the scope in the form of the concept including a detailed spatial and technological design.

The sub-objectives are defined further by production of such other supplementary plans such as the bills of quantities, specification, detail drawings, estimates, cash flows, preparation of schedules and milestones, and the contractors plan of assembly operations on site. The seriousness and importance attached to global planning at the initial stages subsequently influences the success of the medium and short term planning stages which in most cases are closer to project realisation (Hendrickson, 987: p.253).

The planning process of the project production stage ensues as more details of the project are developed. The level of planning shifts from development of the project concept to the design of organisational structures that are best suited to handle the problems of the project. The contractual strategies to be adopted, staffing and team assembly necessary, information gathering, analysis and dissemination are developed to aid in the project control. Other pertinent issues such as procurement structures, quality and safety control are also devised. Site planning differs as there are likely to be planning problems of site layout, provision of temporary facilities, transportation, labour camps, communication, utilities and labour relations and site safety. These should be linked to all the stages of the project. At all the stages of project planning the impact of the risks of the external environment likely to affect the project should be assessed and incorporated in the planning decisions of the project.

Planning as exercised by clients, project managers, designers, contractors and subcontractors, and those in the project hierarchy in each respective group is different. The objectives at each stage or level and group are also different with each group's objective limited to specific scope. However, each objective supports the overall objective of the project in terms of projected time, cost and acceptable quality standards. The project management's planning strategy is wide and concerned mainly with milestones and budget achievement results. The clients objectives and the subsequent supplementary objectives as generated by designers, contractors and subcontractors define the nature, role, and breadth of planning. These are influenced by the degree to which project management embraces planning. Since the client or his representative is expected to direct others, the commitment and seriousness to planning should start with the client and/or his representative. Planning is not likely to be effective if the client does not encourage it and make the necessary decisions that will compel all the parties to effectively plan.

Laufer and Howell (1993) argue that uncertainty is the greatest challenge to effective planning regardless of whether or not there is commitment to planning. Unfortunately, uncertainty is part and parcel of the construction process. The environmental factors that affect construction project, such as the weather, market conditions, clients, designers, suppliers, contractors, subcontractors and resource inputs pose problems of uncertainty. This can better be understood if risk management is applied in planning. The longer the time interval between planning and implementation, the higher the uncertainty regarding the planned activities. Since the future is inherently uncertain, the gap between available information and needed information widens with the extension of the time span of planning and action. This also influences the environmental factors that cause greater risks, particularly in an unstable economic environment like Kenya. It is therefore important to gather information to keep track of the changing events. The more available the information on the environmental influences, the more uncertainty is reduced.

3.6.1: The Planning Infrastructure

The planning infrastructure refers to the rules and procedures of project implementation that support planning culture. One of the fundamental and basic principles of effective planning is the development or recognition of the planning policy in any organisation. Planning like any other discipline must take place in the context of fundamental theories, principles and techniques which can develop adequately within a supportive environment. A planning policy creates the atmosphere for planning which is expected to guarantee the existence, and development of fundamental theories and techniques of planning.

In construction project implementation, a number of policies should be in place at different stages influencing different participants. It is a well known fact that among the policies that exist in a construction project organisation, planning policy receives the lowest rating in terms of priority. Koontz et al (1984) argue that many failures in planning are caused by lack of understanding of fundamental principles and the necessary planning atmosphere. Lack of planning policy and culture in the traditional procurement system is evident. This is worsened by the unique socio-cultural environment in Kenya.

Another cause of failure in construction planning has been attributed to production of support plans. The master plan may not be of any meaning if the support plans are not developed accurately. For instance, the medium and short term plans must be produced to amplify the master plan. There is a tendency to rely on the master plan for project implementation without further amplification.

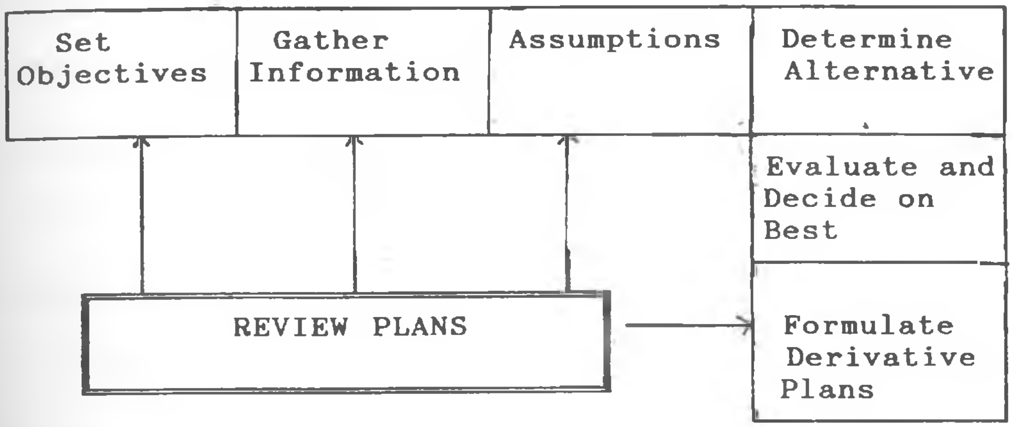
3.6.2: The Planning Process

Project planning is a process involving of several pertinent tasks which are interrelated as shown in Figure 3.3. These include objective formulation, information gathering, formulation of alternatives, analysis and evaluation of alternatives to enable appropriate decision making, and the implementation of the plan. Plan review is also an important and should be a continuous task to be performed during both the planning and plan implementation stages. These have been discussed by Laufer, et al (1987), Ahuja (1985) and Koontz et al (1984) who emphasize that the larger the presence of the above tasks in project planning process, the more the process is recognised as planning. This increases the chances of its effectiveness.

3.6.2.1: Project Objectives

The first important step is to set objectives stating the end result desired. Cost and time are the objectives at a broader planning level and are set by the client's advisers. The objectives must be set in the light of economic, technological, social, political and ethical elements of the project environment which in themselves pose risks to objective attainment. The risks in planning represent constraints to plan implementation. Clarity of objectives is the greatest problem encountered in setting project objectives.

Figure 3.3: The Planning Process



Source: Adopted from Koontz et al, 1984

3.6.2.2: Project Information

The second most important step is to gather information surrounding the project objectives and on how they can be achieved. The information aids in the development of strategies that may be adopted for successful accomplishment of the objectives. It can also be used in refining and resetting objectives to ensure that they are realistic and clear. There should be re-evaluation of the feasibility and appropriateness of the project objectives on a continuing basis. This enables setting objectives which are clear, easily understood, and attainable. Information gathering also ensures that the objectives are defined in the light of the strengths and weaknesses of the project team, with respect to technology, expertise and financial resources necessary to achieve the objectives. This is viewed in the light of the many external and internal forces which may influence their attainment. This information may be in the form of risk analysis, statistical analysis, research findings and work study results. Laufer et al (1985) assert that more information reduces planning uncertainty and improves the degree to which planned values correspond to eventual actual values.

3.6.2.3: Planning Assumptions

The information gathered is used for making assumptions. Assumptions are important to the planning process because they involve making decisions about both the external and internal environments in which the project plan is to operate. The fundamental aspects of planning must take account of interactions with the project environment in every respect of the planning objectives. The risks posed by the project environment, if known, assist in making assumptions about the project plan.

Alternative plans are developed when assumptions have been put in place depending on the information available on the project risks. This reduces the risks involved in future uncertainties and enables contingency planning by having alternative plans based on them. This also enables flexibility and navigational change to be instituted right from the beginning, ensuring that unexpected circumstances can readily be reflected in planning by producing various plans for the same objective.

Drawing on the already existing alternative plans shortens the time for plan review. Koontz, et al (1984) argue that there is seldom a plan for which reasonable alternatives do not exist. Incidentally, an alternative that is not quite obvious proves to be the best.

Constructability enhancement in the project design is one way of ensuring contingency planning (Tatum, 1987; Mbatha, 1993). Constructability reduces uncertainty and enhances planning, thus making assumptions realistic. Evaluation of alternatives enables choice of the best, based on time efficiency and cost as well as recognising the risks involved in terms of finance, labour, weather and technology among others.

3.6.2.4: Plan Review

Plan review is an important exercise in planning. This is necessary to maintain a course toward a desired goal, in recognition of the principle of navigational change and contingency planning. The more the planning decisions consider the future, the more important project management is expected to periodically check on events and expectations, followed by redrawing plans as necessary to maintain a course toward the desired goal.

3.6.2.5: The Planning Paradigm

The concerns and emphasis of project planning change as the project moves nearer to execution as well as during execution. Plans must be updated and worked over in greater detail, against new and better information. This further supports the idea that planning should be a continuous process from project inception to commissioning. It is a well known fact in Kenya that once the initial schedule of the project has been approved, nobody ever cares to look at it again, perhaps until things are out of control.

The whole process of planning is futile if the plan is not supported by integrated and other better management functions. For example, better organisation should ensure the best structure suited to implement the plan. The structure must be tailored reflect the attainment of the desired objectives and plans. It needs to reflect on the responsiveness to the environment with suitable spans of control for effective staff management. In addition, the staff should be carefully selected and trained to ensure that they have the skills for the job for which they are selected. From a project team point of view, it requires that the selected team should have the right skills to face the challenges of construction. The project leader should possess good leadership qualities and be able to incorporate sound communication and motivation structures to ensure support for the fulfilment of project objectives. Thus requiring that there is a specific project procurement structure designed for each project situation.

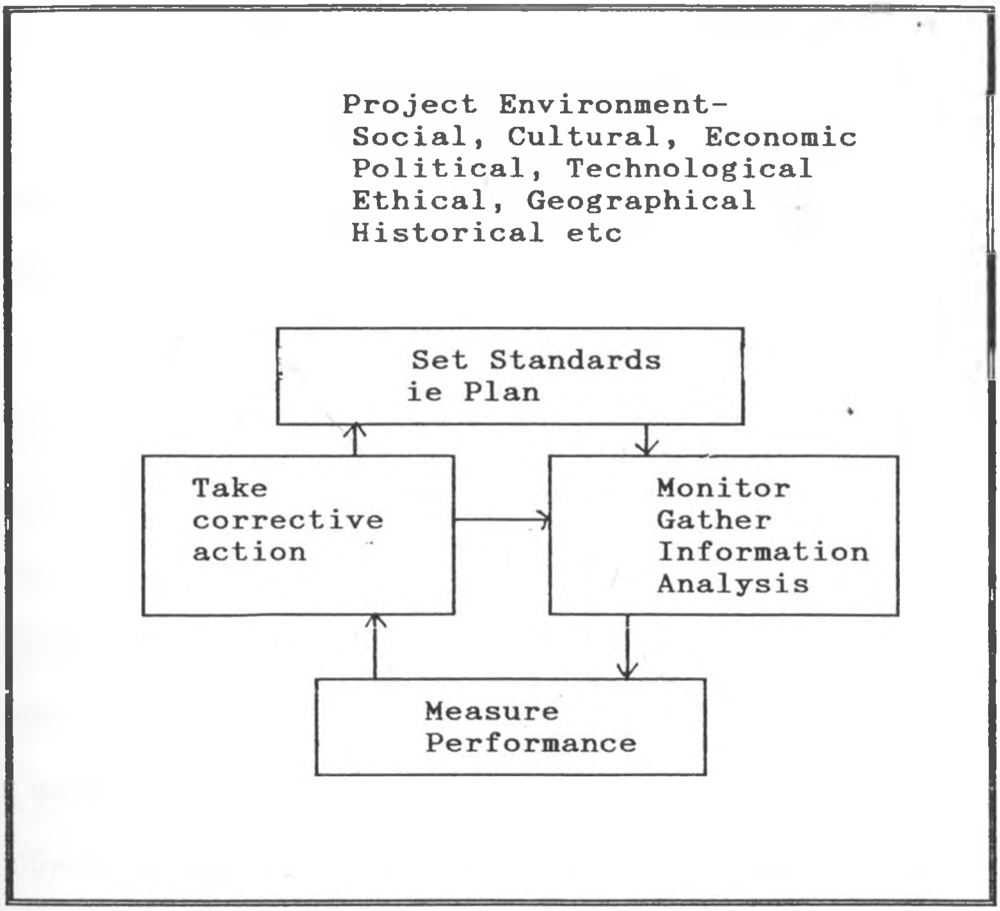
3.6.3: The Control Process

The project control process consists of several steps as shown in Figure 3.4. The first step is the process of planning which puts in place the control mechanisms. It sets the performance yardsticks upon which the control mechanisms can be exercised in terms of milestones, targets and budgets. Control is complimentary to planning and its mode and intensity depends on the defined objectives of the project plans, schedules and estimates and how they are integrated with external factors. In construction, the overall objective of delivering a project within time and cost framework is the yardstick of planning against which control can be devised.

The control technique adopted varies with the project objectives set during the planning stage. The mechanisms of control in terms of cost, duration and quality, change to cost control, time control and quality control, respectively. The approach to each type of control differs but the basic principles of control remain the same. Thus in construction projects, the cost plan, the contract sum, the contract period and specifications form the basis of project control. The control mechanism should be tailored to the plans and positions created to implement the plan.

A form of measurement is necessary to institute the control mechanism. The measure is evaluated and compared to the expected standards to reveal the project state during the execution of the plan. This is possible by monitoring every step of the construction process. Koontz, et al (1984) argue that it is better if this measurement can be done on the basis of a forward forecasting, so that deviations may be detected in advance of their actual occurrence and be avoided by taking appropriate action. This means that there has to be an element of predictability and forecasting of probable departures from standards, requiring that project monitoring should be a continuous process.

Figure 3.4: The Control Cycle



Source: Adapted from Koontz, et al, 1984

Project monitoring should be achieved by gathering information about the actual performance of the project. The first step of monitoring is the measurement of the results achieved. This information can be obtained from various sources including periodic information on cost, time and quality. This information that needs careful interpretation, can be presented in the form of historical or forecast data.

Results from monitoring exercises are reports on plan implementation. In construction projects, site meeting reports and clerk of works daily, weekly and monthly reports are good sources of control information. Other sources of control information are productivity rates, s-curves, elemental budgets, and progress reports. Some of the information collected may touch on the resources consumed against the goals achieved.

Once the deviations are noted or anticipated, corrective action must be taken. This may be done in different ways such as reviewing plans or modifying the goals. Reviewing the other management functions such as the project structure through reassignment and clarification of duties may also be necessary. Control can also be effected by other actions such as additional staffing, better selection and training of subordinates, and restaffing or firing. It could also be corrected through more effective directing, leading, motivation, and communication. The corrective measure adapted depends on the nature of risk observed or anticipated as explained in section 3.5.3.

However, effective planning and control procedures depend on the recognition that they are systems of a project. As already demonstrated, procedures normally extend to various project subsystems and various factors in the environment affect the project. Therefore control tasks should not be carried out in isolation. Effective control mechanism is the one that can therefore focus on managing the risks.

3.7: Construction Planning Techniques

The planning principles set the general and universal rules of planning. In practice a hierarchy of plans and schedules is required for a project to satisfy the various levels of planning and scheduling. Different details are required at each stage of the project. This is necessary to put the plan more in perspective and also for monitoring and control of activities during the different phases of the project. The actual planning activities involve the use of appropriate techniques of planning. This begins by developing an overall long term plan indicating the overall strategy for the project, and its main stages from inception to completion. It establishes the basis for more detailed planning. Medium term plans are more detailed and are based on a three to six months period. Short term plans may span for a week and include resources such as plant, labour and materials. The weekly plans are supported by daily schedules which depict day to day programmes for critical trades. These may further be supported by hourly schedules depending on the task involved. Plans are developed by using programmes and schedules which are graphical documents that communicate the plan to interested parties.

The conceptual assertion that delays are a function of the participants, the process and the environment implies that during planning the stakeholders should not be ignored. Some pertinent questions have to be asked regarding the three. For example, the project participants have to be clearly defined; the process of construction has to be clearly articulated in terms of procurement and technology, and the project environment must be well defined. It is important to depict the resources used such as labour, materials, plant, finance and time. It may however not be easy to produce a plan that can depict the utilisation of all these resources in a project. One type of plan may not depict all the resources because the parameters of measurement are different. However, by use of a series of programs and schedules, the various attributes can be planned. A hierarchy of planning utilises various techniques to model project parameters without losing sight of the importance of the participants, the process and the environment at all levels of the project. The Bar Chart, the CPM network, Line of Balance (LOB), PERT network, Multiple Activity Charts, Material Schedules, Equipment schedules, Labour Schedules and Cash Flow Schedules may all be used at different stages for various purposes.

3.7.1: The Bar Chart

The Bar Chart is used mainly to plan construction time. It consists of a chart divided into columns and rows. The first column lists the activities while the first row lists the time scale. Construction activities are displayed on a horizontal time scale in a line or bar beginning at the activity start and ends at the activity finish. Activity descriptions and resource requirements of labour, materials and plant may be shown on the bar chart. A linked Bar Chart shows how the activities are logically related. As a control devise, a bar of the actual progress can be plotted alongside the scheduled progress. This makes it possible to see the progress achieved and enables project monitoring. It may not be easy to show the influence of the participants, the process and the environment on the Bar Chart. These could be catered for by allowance in calculations of activity time. However, if it is established that any of the three attributes has a special case that needs to be considered, then this may be shown as an activity in the Bar Chart. For example, an approval by the client or a rainy season may be shown in the Bar Chart. This enables special attention on these activities in the control of the construction process. Construction time is calculated by dividing the quantity of work by the crew size and rate of output. It is influenced by the quantity of work, the rate of output of the workers and the number of workers. In a particular project the quantity may be more or less constant unless there are variations. The rate of output may be varied by other factors such as working conditions, incentives and level of management. These may be achieved at extra cost. The crew numbers can also be varied appropriately to maintain a specified productivity rate.

When calculating time for activity duration, the quantities of work are obtained either from drawings or bill of quantities. The rates of output may be obtained from synthesised data of work study, or from standards based on historical experience. They could also be derived from personal experience or merely guesstimates. All estimates must bear some relationship to the resources likely to be available because work load, time, and output are interdependent. However, the time estimate assessed in this way does not include unproductive time such as time lost due to absenteeism, learning and idle time. The acts and omissions of participants, the inappropriateness of the process chosen, and the influence of the environment may not be included. The use of synthesised data (which is rare) may take care of this situation to some extent. To estimate for such time the estimator will rely on past performance or personal experience to include a contingency in the time estimated[12].

The Bar Chart suffers also from other limitations. The scope of activities tend to be large, normally comprising many operations with a great deal of overlapping start and end times. The relationships that exist between these activities cannot be accurately shown. Though the linked Bar Chart tends to improve on this, it produces a confusing chart. As a control devise, the bar chart shows the activities that are behind schedule. It does not show the effect of such delays on the subsequent activities and on the overall project duration. On the other hand, the estimate for activity duration is deterministic, and does not take into consideration the effect of uncertainty and risks associated with construction projects (Carr, et al, 1974; Ayyub et al, 1984; Uher and Levido, 1992). Some of these risks are generated by the participants, the process and the environment. These shortcomings make the Bar Chart an inferior method of programming for large projects compared to other methods available. However, it is a suitable technique for long term

[12] In Kenya there is no data on the productivity of workers. Most of what may be applied is from foreign textbooks. Such data can only be used as a guide because of the differences in the conditions (cultural, climatic and labour legislation) in which they were developed and those of Kenya. However productivity parameters are in many situations guesstimated.

planning, weekly and daily planning of activities, and resource levelling and smoothing.

3.7.2: The Critical Path Method(CPM)

The critical path method is a method of programming work in a logical manner by linking activities that have some relationship in the way they are constructed on site. It seeks to show graphically how these activities follow one another in the process of construction. It is not the intention of this study to explain the production of a CPM network because this has been done explicitly by many writers (Antill 1982; Oxley and Poskitt 1986; Uher and Levido 1992; Calvert, Bailey and Coles 1995; Pilcher 1992; Harris and McCaffer 1989; Clough and Sears 1991; Harris 1978; and Ahuja 1974; 1976). However it is important to note that whether one is using the arrow method or the precedence method, the duration of the project is determined by the Critical Path in the diagram. One advantage of the critical path method in relation to time control is that one is able to manipulate the floats in the activities so as to keep the project on course and minimise deviation from the original project time. The floats enable resource levelling and smoothing by possibly shifting resources from uncritical activities with high float to critical activities.

The CPM has the same limitations with activity time as is the case with the Bar Chart. It is difficult to account for the roles of the participants, the process and the environment in the CPM network except by way of contingencies. When using the CPM, it is assumed that reasonably accurate information is available on the duration and cost of activities. In many construction projects sufficient information on issues affecting the project may not be available. This is in most cases an erroneous assumption. Thus CPM relies on deterministic expression of the time duration by adding together the time duration of critical activities. This means that activity durations are assumed to be uncertain when they are not.

3.7.3: Programme Evaluation and Review Technique (PERT)

The Programme Evaluation and Review Technique is produced in the same manner as the CPM network. However, this method mainly utilises the arrow network. It is therefore event oriented while CPM network is activity oriented. The differences of PERT with the CPM lies in the activity duration estimate which also determines the total project time estimate. Scheduling with PERT takes account of uncertainty as it follows a probabilistic or stochastic model to estimate activity time, taking into consideration all the influences on the project time both internal and external.

Three time estimates are made instead of one. The optimistic estimate is arrived at by assuming that the activity or project will be subjected to minimum risks and therefore the shortest possible duration is derived. The most likely estimate is based on the analysis of previous project experience and judgement. The pessimistic time estimate is based on the assumption that the project will encounter all foreseeable risks and derives the maximum time expected on the activities. The most likely time is weighted by a factor of four by the beta distribution formula that is derived. The optimistic time, most likely time, and pessimistic time cannot be determined accurately and therefore are considered as random variables with the estimated values taken as the mean values for the three distributions. These three estimates are assumed to fall on the beta distribution curve which resembles the normal curve and may be described by its mean and standard deviation. The formula derived as discussed in chapter one section 1.2, has been demonstrated by Pilcher (1992); Oxley and Poskitt (1986); Sasieni (1986) and Cox (1995)

The advantage of PERT is that it attempts to take into account the risks of project time as generated by the participants, the process and the environment as well as ascertain the possibility of finishing the project at a given level of probability. However, for reasonable judgement to be made, the significance of the risks that influence project duration should be known.

3.7.4: Line of Balance Method (LOB)

The Line of Balance method was developed to programme work of repetitive nature such as housing units, roads and high rise buildings. In these types of construction the application of other methods may be cumbersome requiring each unit to have its own programme. This produces a confusing chart. The main feature of repetitive work is that the identical operations are carried out repeatedly on successive units by the same operatives or different gangs of the same operatives. The analysis of the LOB technique has been demonstrated by Pilcher (1992) and Harris and McCaffer (1989).

The main features of programming a repetitive process are to ensure that advantage is taken of repetitive working for efficient use of resources by minimising unproductive time, and maximising continuity of work of committed resources. Thus targets and programmed rate of output are set with efforts geared towards meeting and maintaining them. The objective is to utilise resources to move through the project in a continuous manner. Consequently, a balanced labour force is maintained and fully employed, enabling an efficient use of labour. The objective is to utilise resources to move through the project in a continuous manner. Consequently, a balanced labour force is maintained and fully employed, enabling an efficient use of labour and other resources.

This achieves savings in cost and time of construction through the benefit of repetitive working and avoidance of idle time thus reducing construction delays. The resource multiplication factor is necessary to multiply the resource so as to maintain the set rate of output. It is important for it to be noted in the LOB charts. Control is achieved by looking at the chart and comparing it with the planned progress. However, this technique has been criticised by Kartam (1990) and Laufer (1990) for its erroneous assumption of linearity. This is on account that, the construction process is non linear. Besides, the estimates for activity duration is deterministic ignoring the influence of the participants, the process and the environment.

3.8: Conclusion

An effective project management system is one that recognises and embraces updated management skills which set the ground rules for tackling the challenges of construction projects. It attempts to quantify the project risks and devises appropriate methods of response. Project planning defines the project more clearly for implementation. It also assists in identifying the response to risks in addition to reducing uncertainty in the construction process, both at the initial planning stage and during the process of construction. Planning must be supported and amplified by updated control mechanisms and the choice of techniques and methods of planning appropriate to the specific project planning needs and the risks involved. Flexibility in the choice of project planning techniques is necessary because the risks vary and require the application of different approaches.

The project participants, project infrastructure and project environment all generate risks which cause project delays. This may be due to deficiency in management skills. These important variables should be seen as important surrogates of project planning and control. Thus focus on planning and control should be directed not only on the project scope but should incorporate the three surrogates. A culture of good project planning and control practices that embraces a wider perspective at all levels of the project should be encouraged. This may take care of the use of appropriate methods and techniques by all the project stakeholders in recognition of the risks generated by themselves and the project environment.

Each of the techniques of project planning and scheduling has its own limitations. For instance, the Bar Chart, the CPM and LOB methods when deriving project time, place emphasise on the scope of the project, labour and plant productivity with insufficient regard for the project subsystems and the dynamic project environment. Hence the influence of project risks on time is not given adequate emphasis. These methods quantify time risks by using a contingency to cater for uncertainty. The problem lies in the assessment of the contingency. A suitable contingency can be assessed if the risks can be quantified. To quantify the risks needs information about the factors that affect project time. That is however lacking. This requires the application of risks management techniques in project planning and implementation.

Restricting attention only on the scope and resource inputs assumes a static project environment. When a contingency is added to the time estimate, the assumption is that the risks have a constant and static influence on construction time. While this may be true in some cases, in most cases, the project environment is always changing. Therefore the contingency approach does not sufficiently deal with construction dynamism and risks. A technique that tries to measure project time risk is PERT. However, this is also hampered by lack of information. Thus a study into the significant factors that cause project delays is the first step towards identifying the construction project time risks, a prerequisite for effective project planning and control, and in a holistic perspective, management.

CHAPTER FOUR

RESEARCH DESIGN AND METHODOLOGY

4.1: Research Design

The research strategy used to accomplish the study objectives conformed to ethical standards and legal safeguards for research participants. Construction projects involve a wide spectrum of clients who include the government, private individuals, public and private organisations. Information relating to project delays is usually sensitive and therefore it was necessary to assure the respondents that the information given was to be treated with confidentiality.

One of the criteria for engaging consultants and other key participants in projects is their integrity. Integrity is therefore crucial to consultants and other participants. Information on project delays may lower the integrity of these parties. Thus such information may not be easily divulged to outsiders. It was necessary that the issue of confidentiality be emphasised in the letter seeking permission to obtain information on projects.

The research utilised both survey and statistical designs Both these methodologies were necessary in order to achieve the objectives of this study. Refer to chapter one section 1.5 on the justification of the study of high rise buildings in Nairobi. The details of the research design are discussed in the subsequent sections of this chapter.

4.2: The Population

Evidence shows that construction industry activities in developing countries are concentrated in capital cities, and most firms involved in construction activities locate in the capital cities (Habitat, 1982:p.iv-31).

The population of projects was within the geographical boundaries of the city of Nairobi. This became necessary because Nairobi is the capital city of Kenya, and compared to any other part of Kenya, Nairobi has the highest concentration of high rise buildings. In addition, for the purpose of holding certain parameters such as climate constant, it was necessary to confine the study to one geographical area.

The study adopts the definition given by Abbott (1987: p.413) for high rise building as any building with five or more storeys above ground level. Thus buildings above five storeys became the target population. The focus of the study on high rise buildings is due to the established fact that they present more technological and logistical problems during construction and therefore are likely to reveal most of the factors that cause project delays compared to other type of buildings (Forster et al, 1977). Refer to chapter one section 1.5.

The Nairobi City Council (NCC), has a jurisdiction over all development projects within the city boundaries, hence a natural starting point for identifying projects to be used in the study. All project plans are supposed to be approved by NCC to ensure that they conform to their by-laws. This is regardless of whether they are developed by the government, public, or private organisations. When construction work commences, the NCC personnel are expected to inspect and approve the construction especially with regard to setting out, access roads, foundations and reinforcement, to ensure that standards are met. This is done in order to safeguard the safety and health of the users. It is therefore unlikely that a building would be constructed in Nairobi and miss to be recorded in the NCC's project approval records.

The sample frame was therefore obtained from the NCC's project approval records. A perusal of these records revealed that there were 256 approved projects which had commenced construction in the recent past.

4.3: The Sample

Out of the 256 projects, 79 were classified as high rise as per the criteria already set. The study confined itself to recent projects because of the difficulties experienced in obtaining information on past projects. Since the 79 high rise buildings constituted, incidentally, a small population, there was no need for sampling. However, these reduced to 40 projects for various reasons. Some of the reasons responsible for attrition were: decline to participate for sensitivity and security of the project; lack of information needed in the research because such information had not been kept; some of the projects had not commenced although the NCC records showed that they had been approved; some projects were non-existent and therefore, it could not be established whether they had not commenced or had altogether been shelved; and non response for purely uncooperative reasons. The attrition therefore occurred for reasons beyond the control of the research team.

The 40 high rise building projects further reduced to 38, because two of the projects did not portray the problem of delays and were regarded as not useful to the study. A pilot study involving project participants established that the two projects had not experienced delays. It is only those projects that had experienced delays that were useful to the study.

However, researches on construction projects have in many cases worked with relatively small sample sizes for various reasons. For example, Nkado (1992) investigated information system for the building industry with a sample of 29 cases; Ogunlana, et al (1996) investigated the causes of delay in projects in Thailand basing their research on a sample of 12 projects and Uher (1996) investigated the cost estimating practices in Australian construction industry using a sample of 10 projects. The sample of 38 projects used in this study is therefore well above what has been used in other studies in the construction industry elsewhere. On the other hand, the sample size determines the type of statistics to be applied. Therefore, by using a suitable statistical tool, some of the problems that could be associated with the sample size are minimised (Gall, et al, 1996; Lapin, 1982).

The inherent attrition is therefore assumed not to be a cause for concern since the non responding projects were unlikely to have a remarkably different data from responding projects. That could have been the case if only the differences in project characteristics as differentiated by strata were not represented in the sample. Gall, et al (1996) argue that the non responding data represents bias if they are in some measurable way different from the responding one. Such differences could normally be associated with the project characteristics of size and client. This is however not the case with this sample because the different project characteristics identified are represented.

The sample of 38 projects was stratified by client and size. The client attribute was important to test whether differences in client characteristics such as public and private had an influence on the factors that cause project delays, as discussed in chapter six. Government, Local Authority and Parastatal projects were grouped together under public projects.

It also became necessary to test whether differences in project size strata had any significant influence on either the variable occurrence or its significance. Size in this regard referred to project cost, which is influenced by the scope of the project. The different sample size strata were set with the assistance of construction industry participants during the variable identification exercise. It was their view that, projects costing between Kenya shillings (Ksh) 20-50 million may not show remarkable differences in terms of challenges to management. Those costing in the ranges of Ksh 50-100 million and Ksh. 100-200 million may show similar challenges to management. The sample of projects in the stratum of over Ksh. 200 million in cost was small. They were therefore combined to form one stratum of projects exceeding Kshs 100 million in cost. The stratification was necessary because of the non homogeneity of the sample, by size and by client. This is recommended in situations of non homogenous data (Lapin 1982; pp.88-89).

4.3.1: Sample Characteristics

All the 38 cases produced 100% positive response. The representation in the sample by strata is as shown in Table 4.1. In terms of cost, the sample size reflected 36.5% of cost up to Ksh. 50 million, 34.5% of cost between Ksh 50 and 100 million and 29% costing over 100 million.

Private projects represented 71% of the sample compared to 29% of public projects, confirming the increasing role played by the private sector in the construction industry.

The general technological characteristics of the project were reinforced concrete construction in foundations as well as frame with standard finishes. The other characteristics of the sample are shown in Tables 4.2 and 4.3. The number of floors varied between 5 - 24 with the majority of floors lying in the 5 - 14 floors range. While the number of basements ranged from 0 - 4 with the majority of cases having 0 - 2 basements.

Table 4.1: Client and Cost Strata.

Cost/ Client	<Ksh 50M		Ksh 50-100M		>Ksh 100M		Totals	
Public Private	4 10	10.5% 26%	4 9	10.5% 24%	3 8	8% 21%	11 27	29% 71%
Totals	**14**	**36.5%**	**13**	**34.5%**	**11**	**29%**	**38**	**100%**

Source: Field survey, 1994

Table 4.2: Number of Floors per Project

No. of Floors	No. of Projects	Percentage
5 - 9	16	42%
10 - 14	13	34%
15 - 19	5	13%
20 - 24	4	11%
Totals	38	100%

Source: Field survey, 1994

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Totals	38	100%

Source: Field survey, 1994

Table 4.3: Number of Basements

No. of Basements	No. of Projects	Percentage
0	14	37%
1	13	34%
2	6	16%
3	4	11%
4	1	3%
Totals	38	100%

Source: Field survey, 1994

4.4: Identification of Variables

Most of the variables were identified through literature review[13] specifically variables relating to the participants, the process and the project environment. The researchers own experience and involvement in the implementation of construction projects in both government and private sectors of over ten years was also useful in the identification of some of the variables. More variables were identified through unstructured interviews with architects, engineers, quantity surveyors and contractors. The interviews aimed at identifying some of the factors that cause project delays based on the experiences of members of the construction team. These approaches resulted into an initial total of 76 variables that were thought to be significant causes of delays in projects. In addition five more variables were identified through

[13] See, Aniekwu and Okpala (1988); Baldwin and Manthei (1971); Bresnen and Haslam (1991); Bromilow (1969, 1970, 1971, 1974); Clough and Sears (1991); Cormican (1985); Dlakwa and Culpin (1990); Franks (1982a, 1982b); Hughes (1989); Imbert (1990); Kithinji (1988); Laufer (1990); Mbatha (1986); Mbaya (1984); Newcombe, Langford and Fellow (1990); Ofori (1991); Nkado (1992); Sidwell (1994); Talukhaba (1988); Toakley (1990); Uher (1988, 1991); Walker (1989) and Young (1971)

pre-test of questionnaires. The open ended questions identified an additional nine variables. In total, 90 variables were finally identified.

The 90 variables were grouped into 19 broad categories to ensure easy analysis. The grouping considered variable relationships with each other as well as similarity in characteristics. For example, variables such as the client instructions, architect instructions, contractor's and sub-contractor's suggestions, all for changing design, were grouped together under the broad category of design changes. Each of the 90 variables became a sub-variable within the 19 broad category groups. The variables identified were thus grouped under, design changes, subsoil conditions, subcontractors, contractual disputes, industrial disputes, approval of materials and work samples, weather, material and equipment shortages. Other variables included finance, local authorities, labour, accidents, politics, manufactured components, permits and licenses, shop drawings, and material and work sample tests. Other variables were included in the questionnaire for the purpose of identifying the project strata of the client and project size in terms of cost. A copy of the questionnaire showing how the broad categories of variables and their sub-variables were structured is shown in the Appendix "A".

4.5: Questionnaire Design

The questionnaire was designed in such a way that the stratification of the data was easy for analysis. The questions involved recording the number of days that each variable caused delays in the project. These were later ranked on a rating scale.

The questions were both closed ended and open ended. The open ended questions were for the purposes of harnessing the variables that may have been missed out. They were also helpful in cases where there was need for further clarification about the variables. The questions concentrated on past phenomena on the project. The interest was to show how the past events had affected the projects.

4.5.1: Pilot Testing of the Questionnaire

The first draft of the questionnaire was given to supervisors and colleagues for their comments. Their comments were incorporated into the second draft which was then pre-tested on three respondents that were involved in managing construction projects. They were drawn from samples of those involved in projects as listed in the Nairobi City Council's (NCC) project records. The aim was not only to receive comments and suggestions on additional questions from prospective respondents but also to get an indication of expected responses with the view of scrutinising and detecting ambiguities either in the asked questions or in the given answers. The final version of the questionnaire was prepared by taking into account the comments of the pre-test questionnaire.

4.5.2: Administration of the Questionnaire and Data Collection

At the beginning of data collection the project participants were approached for permission to collect the necessary data. Letters requesting for permission to gather information about the project were delivered by hand to the personnel in-charge of the projects. The letters also explained the purpose and usefulness of the research and the type of information that was needed.

Data collection was done by using a questionnaire with the help of four research assistants. The questionnaire was the most suitable method of data collection because of the nature of the data. Gall, et al (1996) recommend the questionnaire as a convenient and the most suitable instrument for data collection in survey as well as statistical research especially regarding social issues. The characteristic of the data was predominantly quantitative, and this needed a method of recording to avoid loss or forgetting the data. The objective of the questionnaire was to solicit information from project records regarding the causes of project delays.

The research assistants were trained for two days on how to fill in the questionnaire to be able to record data carefully in the same way the researcher himself would have done. They were also trained on how to conduct a successful research interview. The survey involved visiting each project site and examining site weekly reports, site diaries and site meeting minutes with the guidance of the researcher. The extracted information was then filled into the questionnaire. The site personnel, including site agents and clerks of works were also interviewed for clarification of some information. Two methods were employed simultaneously namely, observation and interview. This approach was necessary because of the nature of some of the data encountered. Some data were kept in a haphazard way, which is a common characteristic of the construction industry in Kenya. Harper (1994:26) recommends observation as the most fruitful method of data collection because it reduces the chances of incorrect data being recorded by respondents. This is the main reason why this method was preferred.

4.5.3: Validity and Reliability of the Data Collected

The time performance of all the collected data was compared for the purpose of detecting those that appeared to the odd ones. The percentage time overrun magnitude ranged between 30 and 70 (see Table 5.1). This range of performance was seen to be normal as previous studies had found more or less similar results (Mbatha, 1986; Talukhaba, 1988; Mbeche and Mwandali, 1996). Hence on the basis of this account, all the data collected were assumed to be valid and none was discarded.

4.6: Data Measurement

The standard measure of the data was the number of days the variable delayed the progress of the project. However, the variables attribute varied, some attributes being qualitative while others were quantitative. For example, the data varied from subsoil conditions, such as rock, an attribute that is physical and measurable by volume, to the political situation, an attribute that is social, and with no known unit of measurement. It was therefore necessary to design a common unit of measurement that could be used for all variables despite their differences to ensure the use of a common method of analysis. The appropriate unit of measurement for all these varied variables was found to be the number of days the project delayed due to the occurrence of the variable. This information was obtained from the site weakly reports, site diaries and site meeting minutes.

The second stage involved designing a rating scale on which to rate the variables. Rating scales are devices which enable quantification of judgement. This was necessary because the mere fact that there was information about how many days the project delayed due to the occurrence of a variable was not in itself enough to make judgement about the significance of the variables. Lang and Heiss (1991: p.107) argue that rating can be done by either the respondent or the observer. This research opted for the latter because it was felt that the observer may not be influenced by the prejudices acquired during the implementation of the project. It may not be possible for some of the project participants to admit that delays occurred due to their acts or omissions. Thus they would most probably blame someone else, resulting in distortion of data. At the same time it was a way of ensuring that the data were as primary as possible. However, the challenge was to develop a suitable system of rating in order to identify the significant variables in relation to the number of delay days caused in the project.

A numerical scale was developed to quantify judgement. An interview with randomly selected key construction industry participants, who included two clerk of works, two architects and two quantity surveyors revealed that any factor that causes the project to delay for one hour was a reason for concern in project implementation due to the interrelationships within project operations. This could spark a chain of other hold-ups and it may take a considerable time and effort to revert the project back on course. They were also of the opinion that any factor that caused over two weeks in project delay could easily cause havoc in the project schedule and was very critical to the successful and timely completion of the project. On the basis of these views a scale defining the two extreme positions was developed as follows: A score of 1- represented the opinion that the variable was not important and 4- that the variable was very important and critical to the timely completion of the project. Based on these two extremes, the next step was to develop the range in which the number of days of delay would qualify a variable to fit in a certain score on the continuum of the scale. This was designed as follows:

1 - The variable did cause noticeable delay

2 - Delay of 1 - 7 days was observed

3 - Delay of 8 - 14 days was observed

4 - Delay of 15 and more days was observed

This scale was shown to different groups of two clerk of works, two architects and two quantity surveyors who were also randomly selected to corroborate the opinions of the first group. The general observation from the respondents was that the scale was adequate enough to capture most of the possible variables that could significantly cause delays in projects.

Having developed the scale, the observation of the researcher was done for each variable as recorded in the questionnaire. The variables scored between 1 and 4 depending on the number of days they caused project delays.

The descriptive phrases to define the scores on the scale were developed as follows:

1 - Not significant

2 - Less significant

3 - Significant

4 - Very significant

This scale was used for evaluating and placing a value of judgement upon the outcomes of the questionnaire.

This procedure was preferred because the information from the project reports was not structured. For example, the delay by rain was noticed at different stages of the project with the reporting being done as it occurred. It became necessary to sum up the periodic delays caused by rain by perusing through the project reports to be able to arrive at the total number of days of delay caused by rain in the project. This exercise which involved a lot of work could not have been effectively done by the project personnel, thus the data were first structured and later rated.

4.7: Study Hypothesis

It was hypothesised that delays are caused by exogenous as well as endogenous factors to the project and therefore are a function of the following factors.

(a) The actions and omissions of the project participants and other stake holders. These include the client, the design team and the contractor, among others.

(b) The uncertainty arising from the project process leading to problems associated variations and improper financial planning.

(c) The uncertainty associated with both the physical and socio-economic environments in which the project is implemented, leading to problems associated with weather, subsoils, materials supply, strikes and politics, among others.

4.7.1: Testing the Hypothesis Using the Mean Score

All the 90 variables had two hypotheses. The Null Hypothesis (Ho) was that the variables were not significant causes of project delays. The Alternative Hypothesis (Ha) was that the variables were significant causes of delays. The rejection of the null hypothesis meant accepting the alternative hypothesis.

It became necessary to set the decision point, a point at which to accept or reject the null hypothesis based on the mean variable score. Since it was assumed that the population was normally distributed, the four possible scores had an equal chance of occurring and therefore the mean score was 2.5 on the rating scale. This is a point higher than less significant on the decision scale.

The second stage was to set the lower limit of the sample mean at which the variable could be classified as significant. This involved a one tailed lower limit test because any score above the mean was already significant. The decision rule was evaluated by establishing the probability of committing a type 1 error, that is, concluding that a variable is significant when it is not. Lapin (1982) and Harper (1994) argue that type I error can be avoided by setting a lower confidence level at 95%. In this situation committing type I error was viewed to be less harmful than committing type II error especially in an environment of construction project management. Type II error is committed when it is concluded that a variable is not significant when it is. The variables in the study at one particular time caused problems of delays in projects at various stages. Owing to the fact that a construction project brings together many and diverse factors during its implementation, project management must be aware of any variable that could possibly cause interference. Therefore, it was more important to avoid committing type II error. Lapin (1982) and Harper (1994) argue further that type II error can be avoided by setting a higher confidence level. The confidence level set was therefore 99%. This means that any variable that scored a sample mean within three standard deviations from the asserted population mean at the lower tail of the distribution was regarded as a significant cause of delay. The upper tail limit was not necessary because a score above the lower critical value was already significant.

4.8: Methods of Data Analysis

Three methods were used for data analysis. These are the Z and student t tests, Chi-square test and Regression analysis. The justifications for the application of each are discussed in detail in the subsequent sections of this chapter.

4.8.1: Z and Student t Tests

The basic assumption was that the variable score distribution in the sample reflected what could be expected from the population distribution. Hence the statistics calculated from the sample, such as the mean variable score, were estimates of the variable parameters in the population of projects.

Descriptive statistics were used to observe some properties of the sample and its strata. These are the mean, frequency, the standard deviations, and the standard error of the estimate. These were generated by the SPSS PC+ computer programme.

The mean was used for calculating the average scores on the rating scale, whereas the frequency was calculated to show the rate at which the variables occurred. The standard deviation and the standard error of estimate were useful in calculating the critical values.

The data were assumed to be normally distributed. The data were standardised by using the normal deviate, that is Z values. This was used in sample strata of more than 30 case studies. The Z values were obtained by the following formula:

$$Z = x - X/sx$$

Where, x = Sample mean

X = Population mean

sx = Standard error of estimate

The student t distribution was used for sample strata with less than 30 cases. The student t distribution has a relative frequency curve like the normal curve but its shape is determined by the number of degrees of freedom(df).

The df is calculated by subtracting one from the sample size. The formula for calculating the t distribution values is as follows:

$t = x - X/sx$

Where, x = Sample mean

X = Population Mean

sx = Standard error of estimate

Sub-samples stratified by clients and project cost were below 30 cases. This necessitated the use of the student t test. The critical values were compared to the mean scores to enable decision to be taken on whether a variable was significant or not. These were derived from the student t statistic formula as follows:

$x = X - t_{0.01}\, sx$

Where, x = Critical value

X = Asserted population mean score (2.5)

sx = Standard error of estimate

$t_{0.01}$ = The student t test confidence interval at appropriate degrees of freedom

The decision as to whether or not a variable would be significant depended on the variable mean score. For all the mean scores greater than the critical value (x) led to the rejection of the null hypothesis. The mean values less than (x) led to the acceptance of the null hypothesis.

The overall sample had many case studies and therefore utilized the normal deviate. The critical values at 99% confidence level were calculated using the following formula:

$$x = X - Z_{0.01} sx$$

Where, x = Critical value

X = Asserted population mean score (2.5)

sx = Standard error of estimate

$Z_{0.01}$ = Z value at the decided confidence interval

These values were calculated individually for each variable. This exercise facilitated the isolation of significant variables that cause project delays from those that were not significant.

4.8.2: Chi-Square Test

In the previous analysis, although the test isolated the significant variables, it was not apparent whether the significant variables were influenced by different project characteristics. It was therefore necessary to subject the data to other tests to bring out this important fact in project management. The chi-square test was found suitable for this exercise. It was used to test whether or not differences in project size and nature of client influenced the occurrence of the significant variables identified. The null hypotheses was that the variable occurrence was independent of differences in the characteristics of the two attributes.

The chi-square test compared the actual frequencies (fa) and the expected frequencies (fe). The actual frequencies were recorded as observed in rows, reflecting the different sample characteristics, and in columns indicating the different strata characteristics. The expected frequencies were calculated using the following formula:

fe = Row total x column total/n

where, n = number of observations

The actual and expected frequencies were compared for the purposes of making a decision about the null hypothesis. This was done by measuring the amount of deviation between the actual and the expected frequencies for each variable. The formula for calculating the chi-square statistic (X^2) is as follows:

$$X^2 = \Sigma(fa - fe)^2/fe$$

where, fa = actual frequencies

fe = expected frequencies

The decision rule for determining independence was arrived at by providing a desirable balance between the probability of committing the type 1 error, that is, rejecting independence when it actually exists, or type 11 error of accepting independence when it does not exist. The confidence level of 99% was used.

The chi-square distribution is described by the number of degrees of freedom (df). As the number of the df increase the chi-square approaches the normal distribution. The number of df is obtained by the formula:

$$df = (r - 1) \times (c - 1)$$

where, r = number of rows

c = number of columns

The critical value of the chi-square ($X^2_{0.01}$) was obtained from the chi-square distribution table and compared to the sample chi-square statistic (X^2). If X^2 was greater than $X^2_{0.01}$, the null hypothesis was rejected and vice versa.

4.8.3: Regression Analysis

Another very important exercise in the study was to rate the significance of the variables with regard to their contribution to delays. Both the mean score and the chi-square tests had not brought out this important fact. It is important that project management be aware of the factors that contribute most to delays so that they know where to direct more efforts in managing projects. The most suitable test for this was found to be the regression analysis test.

This was done by utilising step-wise regression analysis. In the regression analysis the basic assumption was that a linear relationship exists between the dependent variable and the independent variables. The dependent variable was the percentage of overall delay in the project. The independent variables were the significant variables identified as measured by the number of days they individually caused projects to delay.

The step-wise method begins with no independent variable in the regression model. It picks variables one at a time, starting with the most promising variable, in reducing the unexplained variation in the dependent variable. It then adds to the model one variable at a time from a pool of remaining variables depending on whether it passes an F test at the specified significance level, which was set at 99%.

However the variables do not necessarily stay in the model in the subsequent steps. After a variable is entered, the step-wise method looks at the variables already in the model and deletes any variable that does not produce a significant F statistic. The correlation analysis was used to test the existence of multicollinearity. A print-out of the result of the stepwise regression analysis is shown in Appendix "C".

One level of the test of significance involved the use of the squared moment correlation coefficient, the R square, as a measure of significance. The coefficient is a standard measure of an assumed linear relationship between variables. A coefficient of value between (+ve) 0.5 and (-ve) 0.5 or higher indicates a strong relationship and by extension a significant variable in influencing the trend of the dependent variable.

The other level of testing significance involved the calculation of the probability that the sample R is different from zero. If the sample R is zero it signifies that a linear relationship exists. The calculated probability was compared to the value of F corresponding to the given degrees of freedom at 99% significant level. Beta coefficients were also calculated for each significant variable.

4.9: Conclusion

The three tests were necessary so that conclusions could be made about the variables. The mean was necessary to isolate the variables that are significant in causing project delays from those that are not significant. The chi-square test was important to test whether the frequency of occurrence of the significant variable was influenced by the differences in sub-sample characteristics. This was important to establish whether certain sub-sample characteristics were important in encouraging the occurrence of significant variables. The step-wise regression analysis was important for determining the contribution of various variables to delays.

This information is important for project management personnel, to be aware of the variables that cause projects to delay. This can be useful in the designing, planning and controlling of project implementation structures. The results of hypothesis testing are discussed in the preceding chapters.

CHAPTER FIVE

FACTORS CAUSING PROJECT DELAYS AND THEIR SIGNIFICANCE

5.1: Introduction

This chapter discusses, in detail, the 90 variables identified under 19 broad variable categories. The discussions refer to the observed frequency of variable occurrences and the mean scores on the rating scale in comparison with the critical values[14]. This is with respect to the identified overall sample and the sample strata. These included public projects, private sector projects, and projects costing less than Ksh 50 million, between Ksh 50 - 100 million, and exceeding Ksh 100 million. This was done in order to make inferences about the significance of the variables causing project delays.

5.2: Delay Characteristics

The costs of the projects in the sample varied between Ksh. 45 million to Ksh. 200 million. Tables 5.1 and 5.2 show the sample delay characteristics. The overall mean percentage of delay in the sample is 44%. The highest mean percentage delay was observed in public projects and projects costing over Ksh 100 million. These recorded 61% and 65% respectively.

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[14] Refer to chapter four on how critical values were computed

Table 5.1: General Sample Delay Characteristics

Sub-sample	% Magnitude of Delay
Overall, n = 38	44
Public, n = 11	61
Private, n = 27	29
<Ksh 50M, n = 14	38
Ksh 50-100M, n = 13	31
>Ksh 100M, n = 11	65

Source: Field Survey 1994

Table 5.2: Delay Characteristic by Cost Strata

Sub - sample	% Magnitude of Delay
<Ksh. 50 M	
Public, n = 4	51
Private, n = 10	25
Ksh.50-100M	
Public, n = 4	47
Private, n = 9	15
>Ksh. 100M	
Public, n = 3	85
Private, n = 8	45

Source: Field Survey 1994

The analysis presented in Table 5.2 points out that public and larger projects suffer more from delays. The public and large projects portray the worst situation in terms of both the frequency and magnitude of delay. Private and smaller projects show comparatively better results. From the observation it can be inferred that management and control of delay causing variables in public and large projects is the poorest.

5.3: Delay Causing Variables

This section presents a discussion on each individual variable with respect to their significance in causing delays. The discussion highlights the circumstances that could influence variable significance, the incidence and magnitude of the of the variable in causing delays, and the result of hypothesis test using Z and student t values.

5.3.1: Design Changes

Design change refers to modification or addition of new works to the original design. These changes may be done by the project team for reasons such as unworkable designs, change in ideas, taste or market conditions. The sub-variables under design changes are, client's and architect's instructions, contractors and subcontractors suggestions among others.

Table 5.3 shows the percentage of occurrence of the various design change sub-variables and their mean scores, in the overall sample and in the sample strata. It is shown that generally, client's and architect's instructions are the most common causes of design changes. Both have an incidence of 60%. Client's instructions, occurring in 69% of the projects, were most prominent in private sector projects. Architect's instructions were more frequent in public projects as well as in projects exceeding Ksh. 100 million in costs. On the other hand, the two sub-variables achieved the highest mean scores in all the sample strata. They occurred in 82% and 90.9% of the projects, respectively. Design changes caused by contractors and subcontractors were not frequent, thus show low level of percentage of occurrence.

Table 5.3 : Percentage of Design Change Occurrence and Mean Scores on the Rating Scale.

Design Change	Over n=38	Pub n=11	Priv n=27	Ksh. <50M n=14	Ksh. 50-100M n=13	Ksh. >100M n=11
Client's % **Mean**	**60.0** **2.4**	**27.0** **1.7**	**69.0** **2.6**	**56.3** **2.3**	**61.5** **2.8**	**63.6** **2.4**
Architect's **Mean**	**60.0** **2.9**	**82.0** **3.4**	**51.7** **2.7**	**50.0** **2.5**	**46.2** **2.4**	**90.9** **3.5**
Contractor's Mean	17.5 1.5	18.0 1.5	17.2 1.5	18.8 1.6	15.4 1.4	18.2 1.5
Subcontr. Mean	7.5 1.2	0.0 1.0	10.3 1.3	12.5 1.4	0.0 1.0	9.1 1.3
Others Mean	0.0 1.0	0.0 1.0	0.0 1.0	0.0 1.0	0.0 1.0	0.0 1.0

Source: Field Survey 1994.

Abbreviations: Over = Overall, Pub = Public, Priv = Private.

This points out that private sector clients interfere more in their projects. Similarly, in public and large projects, architects change their designs more frequently.

To test the null hypothesis that the variables are not significant, the critical mean score using the normal deviate (Z) for the overall sample and the student test (t) for the sample strata are calculated at 99% confidence level. Only the subvariables that emerged significant are shown in Table 5.4, with the rest of the result appearing as Appendix "B".

The mean scores for both client's and architect's instructions are greater than the critical values in all the sample strata. Consequently, the null hypothesis that clients and architects instructions are not significant in causing project delays is rejected. This confirms that client's and architect's instructions are significant causes of delays. The null hypothesis for the other variables under design changes is accepted, meaning that they are not significant causes of project delays.

Table 5.4: Design Changes: Critical Values Compared with Mean Scores.

Design changes	Confidence Interval 99%	Critical Value	Mean Score	Decision
Client's Instructions				
Overall	n=38	2.026	2.350	Reject Ho
Public	n=11	1.440	1.727	,,
Private	n=27	1.918	2.552	,,
<KSh. 50M	n=14	1.653	2.313	,,
Ksh 50-100M	n=13	1.475	2.385	,,
>Ksh. 100M	n=11	1.365	2.364	,,
Architect's Instructions				
Overall	Ditto	2.059	2.875	Reject Ho
Public		1.730	3.364	,,
Private		1.924	2.690	,,
<KSh 50M		1.643	2.500	,,
Ksh 50-100M		1.582	2.769	,,
>Ksh 100M		1.927	3.545	,,

Source: Field Survey 1994

5.3.2: Sub-soil Conditions

Sub-soil Conditions is an identifiable variable in a project's physical environment. It describes the conditions prevailing below ground on the site where the project is constructed. Subsoil conditions vary significantly depending on the natural soil characteristics. It may be in the form of rock, black cotton soil, red coffee soil or loose sandy soils. In some situations, underground water may be encountered during excavations. These subsoil characteristics are frequently encountered in most parts of Nairobi.

Sub-soils pose various problems. They affect the construction of foundations. For example, black cotton soil is not a suitable supporting material for foundations. It has to be removed before construction can commence resulting in loss of time. Depending on its extent, the removal process involves a lot of time and cost. Rock is an excellent material for foundations. However, it poses difficulties during excavation. It is naturally hard. Depending on its nature and extent, specialized equipments are needed for its removal. The problem of time may be compounded if the excavation has to be very deep, often a requirement in high rise buildings.

Underground water is encountered in situations where excavations touch the water table. This causes water pools in excavation, requiring pumping before work can proceed. On the other hand, heavy rain causes either flooding in the excavations or raising of the water table level.

Other factors include soils that are loose and prone to collapse during the excavation thus necessitating re-excavation. Loose soils need also side support to prevent collapse. Other site conditions include some objects which may be found underground such as water pipes and electrical cables. These may require removal, re-routing or protection before commencement of work.

The condition of the subsoil is established during site investigations. This is carried out not only to have some knowledge about the sub-soil but also to provide useful information for design of foundations. Unfortunately, quite a number of building failures have been attributed to lack of information on sub-soil conditions. This is due to the fact that site investigation is not always carried out and some construction work has often started without the slightest idea about the conditions of sub-soils (Holmes, 1983).

Table 5.5: Subsoil Conditions: Percentage of Variable Occurrence and Mean Scores on the Rating Scale.

Subsoil conditions	Over n=38	Pub n=11	Priv n=27	<Ksh 50M n=14	Ksh 50-100M n=13	>Ksh 100M n=11
Black cotton %	19.0	27.3	17.2	25.0	23.0	9.1
Mean	1.4	1.5	1.4	1.4	1.5	1.3
Rock	**62.5**	**63.6**	**62.1**	**43.8**	**46.2**	**90.1**
Mean	**2.5**	**2.5**	**2.5**	**2.1**	**1.9**	**3.5**
Normal Soils	0.0	0.0	0.0	6.2	7.7	0.0
Mean	1.0	1.0	1.0	1.1	1.2	1.0
Undergr.Water	**57.5**	**63.6**	**58.6**	**50.0**	**38.5**	**81.8**
Mean	**2.2**	**2.2**	**2.2**	**1.1**	**1.5**	**3.0**
Loose Soils	0.0	0.0	0.0	6.2	0.0	0.0
Mean	1.0	1.0	1.0	1.1	1.0	1.0
Break Concrete	2.5	0.0	0.0	0.0	7.7	0.0
Mean	1.0	1.0	1.0	1.0	1.2	1.0
Electr. Cables.	7.5	0.0	10.3	6.2	7.7	9.1
Mean	1.2	1.0	1.2	1.1	1.1	1.3
Others	0.0	0.0	0.0	0.0	0.0	0.0
Mean	1.0	1.0	1.0	1.0	1.0	1.0

Source: Field Survey, 1994.

As shown in Table 5.5 rock and underground water were the most frequent causes of delays. The two sub-variables were most frequent in projects exceeding Ksh. 100 million in cost, with an incidence of 90.1% and 81.9% occurrence, respectively. The influence of rock and underground water were significant in both public and private sector projects, indicating that sub-soil investigation is not given serious thought in the two strata. The mean scores for rock and underground water, as expected, are comparatively high, in all the strata. The highest mean scores, however, are achieved in projects exceeding Ksh.100 million.

Table 5.6 shows the result of the null hypothesis test for the subvariables that produced significant results. At 99% confidence level, the null hypothesis for rock is rejected in all the sample strata. This is expected because these sizes of projects are likely to have expansive and deep foundations which may involve large volumes of rock excavation. The hypothesis for underground water is also rejected in all the sample strata except in projects costing between Kshs. 50 - 100 million.

Table 5.6: Subsoil Conditions: Critical Values Compared with Mean Scores.

Subsoil Conditions	Confidence Interval 99%	Critical Value	Mean Score	Decision
Rock				
Overall	n= 38	2.009	2.525	Reject Ho
Public	n= 11	1.360	2.545	,,
Private	n= 27	1.880	2.517	,,
<KSh 50M	n= 14	1.662	2.063	,,
Ksh 50-100M	n= 13	1.566	1.923	,,
>Ksh 100M	n= 11	1.637	3.545	,,
Underground Water				
Overall	Ditto	2.046	2.175	Reject Ho
Public		1.527	2.182	,,
Private		1.917	2.241	,,
<KSh 50M		1.648	2.125	,,
Ksh 50-100M		1.526	1.462	Accept Ho
>Ksh 100M		1.446	3.000	Reject Ho

Source: Field Survey 1994

The acceptance of the null hypothesis for underground water in projects costing Kshs. 50-100 million and not projects costing less than Kshs. 50 million is surprising. There is no explanation for this result other than perhaps, a sampling error. If underground water can be a significant cause of delays in projects costing less than Ksh 50 million, it is likely to be the same in larger projects as well, unless the variation is due to unique site conditions. The null hypothesis for the other subvariables is accepted as shown in appendix "B". This means that they are not significant causes of delays.

5.3.3: Subcontractors

Subcontractors are engaged in projects to carry out specialized works such as electrical, plumbing, lifts and air conditioning. Some of these works may be concealed in the main contractor's works such as concrete walls and floors. Therefore, the subcontractor's work must closely follow the main contractor's work. Delay in subcontractors work may subsequently cause delay in main contractor's work.

Subcontractors are often appointed after the appointment of the main contractor and at a time when some of the preliminary works are already done. Their appointment may delay due to delay in tendering for subcontract works. They are usually paid for work done through the main contractor. There are situations when main contractors delay in paying subcontractors, thus causing problems related to the payment to workers, materials and equipment purchase. In essence main contractors resort to this action to have free credit from the subcontractors. Alternatively, main contractors can delay paying subcontractors due to non payment by the client. Other problems experienced by subcontractors include poor workmanship, industrial problems and materials availability. Table 5.7 presents the percentages of variable occurrence and mean scores as they relate to subcontractors.

Table 5.7: Subcontractors: Percentage of Variable Occurrence and Mean Scores on the Rating Scale.

Subcon-tractors	Over n=38	Pub n=11	Priv n=27	<ksh 50M n=14	Ksh 50-100M n=13	>Ksh 100M n=11
Late Nom. %	**55.0**	**81.8**	**37.9**	**50.0**	**46.2**	**72.7**
Mean	**2.3**	**3.2**	**1.8**	**2.1**	**2.1**	**2.6**
PoorWork	12.5	18.2	6.9	18.9	6.3	0.0
Mean	1.3	1.5	1.2	1.5	1.3	1.0
Labour Prob.	0.0	0.0	0.0	0.0	0.0	0.0
Mean	1.0	1.0	1.0	1.0	1.0	1.0
Materials	**75.0**	**81.8**	**68.9**	**81.3**	**61.5**	**81.8**
Mean	**3.0**	**3.1**	**2.8**	**3.0**	**2.5**	**3.5**
Late Payment	**77.5**	**90.9**	**68.9**	**61.3**	**61.5**	**90.9**
Mean	**2.9**	**3.5**	**2.5**	**3.1**	**2.4**	**3.1**
Absconded	2.5	9.1	0.0	0.0	0.0	0.0
Mean	1.1	1.2	1.0	1.0	1.0	1.0
Others	0.0	0.0	0.0	0.0	0.0	0.0
Mean	1.0	1.0	1.0	1.0	1.0	1.0

Source: Field Survey 1994.

Late nomination, material problems and late payment were the most frequent causes of delays both in the overall sample and in the sample strata, recording 55%, 75% and 77.5% incidence of occurrence respectively. The highest incidence of 90.9% was achieved in public projects and projects exceeding Ksh 100 million in cost. These subvariables also recorded high scores on the rating scale, suggesting that the three subvariables could be significant causes of delays.

Table 5.8 shows part of the result of the null hypotheses test. The null hypothesis for the overall sample, and in all the sample strata is rejected for late nomination, materials problem and late payment, except for late nomination in private projects.

Table 5.7: Subcontractors: Percentage of Variable Occurrence and Mean Scores on the Rating Scale.

Subcon-tractors	Over n=38	Pub n=11	Priv n=27	<ksh 50M n=14	Ksh 50-100M n=13	>Ksh 100M n=11
Late Nom. %	**55.0**	**81.8**	**37.9**	**50.0**	**46.2**	**72.7**
Mean	**2.3**	**3.2**	**1.8**	**2.1**	**2.1**	**2.6**
PoorWork	12.5	18.2	6.9	18.9	6.3	0.0
Mean	1.3	1.5	1.2	1.5	1.3	1.0
Labour Prob.	0.0	0.0	0.0	0.0	0.0	0.0
Mean	1.0	1.0	1.0	1.0	1.0	1.0
Materials	**75.0**	**81.8**	**68.9**	**81.3**	**61.5**	**81.8**
Mean	**3.0**	**3.1**	**2.8**	**3.0**	**2.5**	**3.5**
Late Payment	**77.5**	**90.9**	**68.9**	**61.3**	**61.5**	**90.9**
Mean	**2.9**	**3.5**	**2.5**	**3.1**	**2.4**	**3.1**
Absconded	2.5	9.1	0.0	0.0	0.0	0.0
Mean	1.1	1.2	1.0	1.0	1.0	1.0
Others	0.0	0.0	0.0	0.0	0.0	0.0
Mean	1.0	1.0	1.0	1.0	1.0	1.0

Source: Field Survey 1994.

Late nomination, material problems and late payment were the most frequent causes of delays both in the overall sample and in the sample strata, recording 55%, 75% and 77.5% incidence of occurrence respectively. The highest incidence of 90.9% was achieved in public projects and projects exceeding Ksh 100 million in cost. These subvariables also recorded high scores on the rating scale, suggesting that the three subvariables could be significant causes of delays.

Table 5.8 shows part of the result of the null hypotheses test. The null hypothesis for the overall sample, and in all the sample strata is rejected for late nomination, materials problem and late payment, except for late nomination in private projects.

Table 5.7: Subcontractors: Percentage of Variable Occurrence and Mean Scores on the Rating Scale.

Subcon-tractors	Over n=38	Pub n=11	Priv n=27	<ksh 50M n=14	Ksh 50-100M n=13	>Ksh 100M n=11
Late Nom. %	**55.0**	**81.8**	**37.9**	**50.0**	**46.2**	**72.7**
Mean	**2.3**	**3.2**	**1.8**	**2.1**	**2.1**	**2.6**
PoorWork	12.5	18.2	6.9	18.9	6.3	0.0
Mean	1.3	1.5	1.2	1.5	1.3	1.0
Labour Prob.	0.0	0.0	0.0	0.0	0.0	0.0
Mean	1.0	1.0	1.0	1.0	1.0	1.0
Materials	**75.0**	**81.8**	**68.9**	**81.3**	**61.5**	**81.8**
Mean	**3.0**	**3.1**	**2.8**	**3.0**	**2.5**	**3.5**
Late Payment	**77.5**	**90.9**	**68.9**	**61.3**	**61.5**	**90.9**
Mean	**2.9**	**3.5**	**2.5**	**3.1**	**2.4**	**3.1**
Absconded	2.5	9.1	0.0	0.0	0.0	0.0
Mean	1.1	1.2	1.0	1.0	1.0	1.0
Others	0.0	0.0	0.0	0.0	0.0	0.0
Mean	1.0	1.0	1.0	1.0	1.0	1.0

Source: Field Survey 1994.

Late nomination, material problems and late payment were the most frequent causes of delays both in the overall sample and in the sample strata, recording 55%, 75% and 77.5% incidence of occurrence respectively. The highest incidence of 90.9% was achieved in public projects and projects exceeding Ksh 100 million in cost. These subvariables also recorded high scores on the rating scale, suggesting that the three subvariables could be significant causes of delays.

Table 5.8 shows part of the result of the null hypotheses test. The null hypothesis for the overall sample, and in all the sample strata is rejected for late nomination, materials problem and late payment, except for late nomination in private projects.

Table 5.8: Subcontractors: Critical Values Compared with Mean Scores.

Subcont-ractors	Confidence Interval 99%	Critical Value	Mean Score	Decision
Late Nomination				
Overall	n = 38	2.032	2.250	Reject Ho
Public	n = 11	1.537	3.182	,,
Private	n = 27	1.925	1.793	Accept Ho
<KSh. 50M	n = 14	1.648	2.125	Reject Ho
Ksh 50-100M	n = 13	1.518	2.077	,,
>Ksh. 100M	n = 11	2.198	2.636	,,
Poor Workmanship				
Overall	ditto	2.187	1.300	Accept Ho
Public		1.488	1.545	Reject Ho
Private		2.202	1.172	Accept Ho
<KSh 50M		1.788	1.500	,,
Ksh 50-100M		1.881	1.331	,,
>Ksh 100M		2.500	1.000	,,
Materials Problem				
Overall	ditto	2.026	2.975	Reject Ho
Public		1.482	3.091	,,
Private		1.875	2.828	,,
<KSh 50M		1.712	3.000	,,
Ksh 50-100M		1.466	2.538	,,
>Ksh 100M		1.488	3.455	,,
Late Payment				
Overall	ditto	2.056	2.850	Reject Ho
Public		1.722	3.545	,,
Private		1.944	2.483	,,
<KSh. 50M		1.696	3.063	,,
Ksh 50-100M		1.515	2.385	,,
>Ksh. 100M		1.713	3.091	,,

Source: Field Survey 1994

The null hypothesis for the other subvariables is accepted except for poor workmanship in public projects, suggesting that late nomination and poor workmanship are not causes of delay in private projects. However, materials and late payment problems are experienced in all the strata.

5.3.4: Contractual Disputes

The client and the contractor enter into a contract by signing a Standard Form of Contract. The standard form of contract spells out the conditions under which the contract is to be executed. The client commits to pay the contract sum in exchange for the contractor's services in accordance with the design and specifications as shown in drawings, bill of quantities and other supportive documents supplied to the contractor.

However, in the process of construction, disagreements may occur over issues such as poor quality of work and variations to design, quality or quantity of the work (Trickey, 1983: p. 66; Ramus, 1981: pp.77-90). Disagreements may therefore arise due to differences in cost and extent of these changes. Contractors often submit claims to clients on issues they feel they need compensation such as on extra works, and loss and expenses incurred. Such items include extended preliminaries, idle plant and labour, loss of profit, increased prices of materials, wages and liquidated damages.

The claims may not present difficulties in the contractual relationship if the client were to approve them without queries. The client often queries such claims on account of either their legality or evaluation. Clients also make counter claims against the contractor. However, client's claim may not be a significant cause of delays because this is often submitted towards the end of the contract.

Table 5.9 shows that the frequency of occurrence of all the subvariables under contractual disputes was low. This suggests that contractual disputes in general may not be a significant cause of project delays. This observation is confirmed by the low mean scores of the subvariables.

Table 5.9: Contractual Disputes: Percentage of Variable Occurrence and Mean Scores on the Rating Scale.

Contractual Disputes	Over n=38	Pub n=11	Priv n=27	<Ksh 50M n=14	Ksh 50-100M n=13	>Ksh 100M n=11
Poor Workmanship %	10.0	0.0	13.8	12.5	0.1	18.2
Mean	1.2	1.0	1.3	1.3	1.0	1.5
Variations	17.5	18.2	17.2	18.8	15.4	18.2
Mean	1.5	1.5	1.5	1.6	1.4	1.5
Claims	22.5	18.2	24.2	31.3	15.4	18.2
Mean	1.6	1.5	1.6	1.8	1.5	1.5
Others	0.0	0.0	0.0	0.0	0.0	0.0
Mean	1.0	1.0	1.0	1.0	1.0	1.0

Source:Field survey 1994

Part of the results of the hypothesis test are as shown in Table 5.10. The rest appearing as appendix "B". At 99% confidence level, the result is that the hypothesis for variations in public projects and in projects exceeding Kshs. 100 million in cost is rejected. Likewise, claims in public projects and in projects costing less than Ksh 50 million is rejected. The null hypothesis for the rest of the subsamples for variations and claims as well as for other subvariables in all subsamples is accepted, suggesting that variations and claims are significant causes of contractual disputes and delays in the three strata.

Table 5.10: Contractual disputes: Critical Values Compared with Mean Scores.

Contractual Disputes	Confidence Interval 99%	Critical Value	Mean Score	Decision
Variations				
Overall	n= 38	2.093	1.500	Accept Ho
Public	n= 11	1.488	1.545	Reject Ho
Private	n= 27	2.000	1.483	Accept Ho
<KSh 50M	n= 14	1.714	1.563	,,
Ksh 50-100M	n= 13	1.751	1.385	,,
>Ksh 100M	n= 11	1.488	1.545	Reject Ho
Claims				
Overall	ditto	2.078	1.600	Accept Ho
Public		1.488	1.545	Reject Ho
Private		1.975	1.621	Accept Ho
<KSh 50M		1.670	1.813	Reject Ho
Ksh 50-100M		1.662	1.462	Accept Ho
>Ksh 100M		1.637	1.455	,,

Source: Field Survey 1994

5.3.5: Industrial Disputes

Industrial disputes arise between the contractor and workers. Certain rules and legislation regulate the contract of engagement between the contractor and workers in order to promote industrial peace. For example, the construction industry is governed by the Factories Act, Cap 514 of the Laws of Kenya which stipulates among other things, the conditions to be met by the employer to ensure that work is done for a reasonable time and workers have the necessary leaves and other entitlements. The Factory's Act further outlines the conditions to be adhered to by employers to ensure a good working environment and that health and safety hazards to workers are reduced. For instance, under different job environments contractors are supposed to provide protective gear to workers, such as helmets, goggles and boots. Most contractors compromise on the safety and health of workers in order to maximise their profits. This may lead to industrial disputes.

Contractors are also expected to adhere to the conditions set in the Regulation of Wages and Conditions of Employment Act, Cap 229 of the Laws of Kenya. This is to ensure payment of reasonable wages to workers. The wages for unskilled workers are determined by the Joint Building Council (JBC) on a periodic basis. Those for skilled workers are negotiated directly between the contractor and workers. In addition, it is mandatory that contractors insure workers under the Workmen's Compensation Act, Cap 236, against injuries occurring in their normal course of duty. Contractors may decide to ignore their obligations as required by the various regulations. This may lead to strikes or disputes which may involve the industrial court and hence impair work progress.

The results of the subvariable occurrence and their mean scores are shown in Table 5.11. It shows that disputes over payment of wages, compared to other variables were quite frequent. A percentage of 55% in the whole sample is achieved. The highest percentage of 75% is observed in projects costing less than Kshs. 50 million. This suggests that delays caused by industrial disputes are likely to be due to payment of wages and the problem is pronounced in smaller contracts. This is expected because smaller projects are likely to be undertaken by smaller and inexperienced contractors who may not be sensitive to the grievances of workers. The other possible cause of disputes such as safety, welfare, refusal to work on Saturday and laying off of workers were not frequent in occurrence and are unlikely to be causes of significant project delays.

The mean scores reflect higher values for wages compared to the other subvariables under industrial disputes with the highest mean score of 2.9 points recorded by projects costing less than Kshs. 50 million.

Part of the result of the hypothesis test is shown in Table 5.12. As expected, the null hypothesis for the payment of wages is rejected. The null hypothesis for the other subvariables is accepted as shown in Appendix 'B'. This confirms that payment of wages to workers is a significant cause of delays.

Table 5.11: Industrial Disputes: Percentage of Variable Occurrence and Mean Scores on the Rating Scale.

Industrial Disputes	Over n=38	Pub n=11	Priv n=27	<Ksh 50M n=14	Ksh 50-100M n=13	>Ksh 100M n=11
Wages % **Mean**	**55.0** **2.3**	**36.4** **1.9**	**43.3** **2.1**	**75.0** **2.9**	**46.2** **2.0**	**36.4** **1.9**
Safety Mean	5.0 1.1	0.0 1.0	6.9 1.1	0.0 1.0	7.7 1.1	9.1 1.3
Welfare Mean	2.5 1.1	0.0 1.0	0.0 1.0	0.0 1.0	0.0 1.0	0.0 1.0
Ref.Work sat. Mean	2.5 1.1	9.1 1.3	0.0 1.0	0.0 1.0	7.7 1.2	9.1 1.3
Sack workers Mean	2.5 1.0	0.0 1.0	2.5 1.1	0.0 1.0	0.0 1.0	0.0 1.0
Others Mean	0.0 1.0	0.0 1.0	0.0 1.0	0.0 1.0	0.0 1.0	0.0 1.0

Source: Field Survey, 1994

Table 5.12: Industrial Disputes: Critical Values Compared with Mean Scores

Industrial Disputes	Confidence Interval 99%	Critical Value	Mean Scores	Decision
Wages				
Overall	n = 38	2.019	2.325	Reject Ho
Public	n = 11	1.417	1.904	,,
Private	n = 27	2.042	2.103	,,
<KSh.50M	n = 14	1.683	2.875	,,
Ksh 50-100M	n = 13	1.598	2.000	,,
>Ksh. 100M	n = 11	1.417	1.909	,,

Source: Field Survey 1994

5.3.6: Weather Conditions

Weather is a natural phenomenon and may have far reaching effect on construction projects. Weather elements that affect construction work are rain, hot and cold temperatures, and to some extent, wind. These weather elements can sometimes be very extreme in some parts of Kenya. Rain interrupts construction in areas prone to high levels of downpour. In Kenya, the long rains season starts in April and ends in August. The short rains season occurs between October and November. Nairobi Province is located within the Kenya highlands which is one of the high rainfall areas of Kenya receiving up to 2,000 millimetres of annual rainfall (Statistical Abstract, 1995). Hot weather in Nairobi is experienced between October and April with daily temperatures averaging between 12 -28 degrees centigrade. The cold season on the other hand, is experienced between May and September with temperatures ranging between 12-23 degrees centigrade (Statistical, Abstract, 1995).

Rain may cause stoppage of construction works such as in situ concreting and soil compaction especially if work places are exposed. When concreting, rain may interfere with the water/cement ratio and affect its design strength. Rain also interferes with the moisture content of the soil and the expected degree of soil compaction may not be achieved. Thus, if it starts raining, concreting and soil compaction must stop and be protected. On the other hand, rain makes structural steel slippery and hazardous, warps wooden forms, and creates havoc with finishing and electrical materials. Rain also turns construction sites into mud seas and slows the movement of materials and personnel.

Strong winds, on the other hand, may topple unfinished walls, blow away materials that are not securely fastened, and makes it difficult to construct works such as sidings and precast units. Lost or destroyed items must be replaced resulting in increased costs.

Table 5.13: Weather: Percentage of Variable Occurrence and Mean Scores on the Rating Scale

Weather	Over n=38	Pub n=11	Priv n=27	>Ksh 50M n=14	Ksh 50-100M n=13	<Ksh 100M n=11
Rain % **Mean**	**77.5** **3.0**	**45.5** **2.2**	**86.2** **3.2**	**87.5** **3.3**	**84.6** **3.2**	**54.5** **2.5**
Hot Temp. Mean	0.0 1.0	0.0 1.0	0.0 1.0	0.0 1.0	0.0 1.0	0.0 1.0
Cold Temp. Mean	2.5 1.0	9.1 1.1	0.0 1.0	6.3 1.1	0.0 1.0	0.0 1.0
Wind Mean	0.0 1.0	0.0 1.0	0.0 1.0	0.0 1.0	0.0 1.0	0.0 1.0
Others Mean	0.0 1.0	0.0 1.0	0.0 1.0	0.0 1.0	0.0 1.0	0.0 1.0

Source: Field survey 1994

Cold weather requires that personnel wear protective warm clothing. This may be heavy and may slow workers productivity. On the other hand, high temperature reduces the effectiveness of the workers. It also reduces the quality of concrete due to rapid evaporation of moisture during the curing process. In some situations, it causes rapid deterioration of some materials.

Table 5.14: Weather Conditions: Critical Values Compared with Mean Score.

Weather	Confidence Interval 99%	Critical Value	Mean scores	Decision
Rain				
Overall	n = 38	2.041	3.025	Reject Ho
Public	n = 11	1.274	2.182	,,
Private	n = 27	1.688	3.241	,,
>KSh.50M	n = 14	1.730	3.250	,,
Ksh 50-100M	n = 13	1.706	3.154	,,
<Ksh. 100M	n = 11	1.243	2.545	,,

Source: Field Survey 1994

Table 5.13 shows the percentage of occurrence of weather elements and their mean scores. It can be seen that it is only rain that was a frequent cause of delays. Hot and, cold temperatures, wind and others are not frequent. Rain scored highly on the rating scale in all the sample strata, suggesting that it is a significant cause of delays in projects. The other subvariables score very low and are not expected to be significant contributors to project delays.

Table 5.14 shows part of the result of the hypothesis test. At 99% confidence level, the null hypothesis for rain is rejected, while the null hypothesis for the other weather elements is accepted as shown in Appendix 'B'. This confirms the significance of rain as a cause of delays.

5.3.7: Sample of Materials and Work Approvals

In project implementation process, many decisions may not be made during the design process. Decisions on both qualities and standards of materials as well as work may be deferred during the design process, particularly where the design process is separated from the construction process, with the deferred decision being made during the actual construction process. Similarly, the contractor and subcontractors are monitored to ensure that their work conforms to the required standards. It is therefore necessary that the contractor submits materials or work samples for approval before proceeding with the rest of the work. The approvals are done by the architect for architectural work, by the client for taste, and by the engineer for engineering works such as structural, mechanical and electrical.

The concerned parties may delay to approve work or samples thereby retarding the work progress by the contractor. The cause of these approval delays may be indecisiveness, laxity or procrastination, a problem that is inherent in the rules and procedures in the construction process. However, this type of problem should not be confused with unsatisfactory work done by the contractor.

The variable occurrence in the sample and the mean scores are shown in Table 5.15. The percentage of occurrence of the subvariables in all the sample strata and their mean scores are quite low, indicating that they may not be serious causes of delays. However, the result shows that architects and engineers are likely to be the originators of this problem.

Table 5.15: Sample of Materials and Work Approvals: Percentage of Variable Occurrence and Mean Scores on the Rating Scale.

Approval of materials and samples	Over n=38	Pub n=11	Priv n=27	<Ksh 50 M n=14	Ksh 50 - 100M n=13	>Ksh 100M n=11
Architect %	20.0	27.3	17.2	12.5	15.4	36.4
Mean	1.5	1.8	1.3	1.3	1.3	1.8
Client	5.0	9.1	3.4	6.3	7.7	0.0
Mean	1.1	1.3	1.0	1.2	1.1	1.0
Engineer	22.5	27.2	20.7	31.3	15.4	18.2
Mean	1.6	1.5	1.6	1.9	1.3	1.4
Others	0.0	0.0	0.0	0.0	0.0	0.0
Mean	1.0	1.0	1.0	1.0	1.0	1.0

Source: Field Survey 1994.

Table 5.16: Sample of Materials and Work Approvals: Critical Values Compared with Mean Scores.

Materials/Work Approvals	Confidence Interval 99%	Critical Value	Mean Scores	Decision
By Architect				
Overall	n = 38	2.148	1.450	Accept Ho
Public	n = 11	1.332	1.818	Reject Ho
Private	n = 27	2.174	1.310	Accept Ho
<KSh.50M	n = 14	1.932	1.313	,,
Ksh 50-100M	n = 13	1.864	1.308	,,
>Ksh. 100M	n = 11	1.527	1.818	Reject Ho
By Engineer				
Overall	Ditto	2.102	1.550	Accept Ho
Public		1.637	1.545	,,
Private		1.986	1.552	,,
<KSh 50M		1.615	1.875	Reject Ho
Ksh 50-100M		1.864	1.308	,,
>Ksh 100M		1.826	1.364	,,

Source: Field Survey 1994

Table 5.16 shows part of the results of the critical mean values compared to the mean scores. The null hypothesis at 99% confidence level for architect's approval in public projects and in projects exceeding Ksh 100 million in cost, and engineer's approval in all the project cost strata is rejected. This suggests that architects approval of materials and work samples is a significant cause of delays in public and large projects. It is significant for the engineers in smaller and larger projects. The null hypothesis for the other strata and subvariables is accepted as shown in Appendix 'B', suggesting that they are not significant causes of delays.

5.3.8: Construction Equipment

Construction equipment is one of the most important resources necessary to carry out construction work, with its problems possibly linked to the participants, especially the contractor and the socio-economic environment. The type of equipment required for the construction of a project vary depending on the nature, type and size of the project as well as on the methods of construction, whether labour or capital intensive. In labour intensive techniques of construction, some form of equipment is still necessary to improve the productivity and efficiency of workers.

The equipment needed in construction projects include tractors, bulldozers and graders for excavation work; hoists, cranes and winches for hoisting materials; compacting machines and rollers for compaction work; mixers and vibrators for concrete work; and dump trucks, lorries and pick-ups for transport. These equipments may either be owned or hired by the contractor.

However, the pertinent issue is that the equipment must be available when needed and must be in sound mechanical condition to provide continuous service. Constraints experienced by contractors and which hamper equipment ownership are high cost of importation and the high level of inflation and taxation. Equipment hiring is constrained by the fact that there are few companies that own equipment for hire. In addition, hire charges are high and the equipment are poorly maintained. Poor maintenance is compounded by lack of spare parts. Lack of policy on maintenance of equipment by contractors and equipment hirers compounds the problem. This causes frequent equipment breakdowns and contributes to problems of equipment acquisition and use (Habitat, 1982, IV - 114).

Table 5.17: Equipment: Percentage of Variable Occurrence and Mean Scores on the Rating Scale

Equipment	Over n=38	Pub n=11	Priv n=27	<Ksh 50M n=14	Ksh 50 - 100M n=13	>Ksh 100M n=11
Crane %	**27.5**	**27.3**	**34.5**	**6.3**	**23.1**	**81.8**
Mean	**1.7**	**1.5**	**1.8**	**1.1**	**1.7**	**2.7**
Mixer	**50.0**	**63.6**	**41.4**	**37.5**	**69.2**	**45.5**
Mean	**2.0**	**2.4**	**1.7**	**1.5**	**2.5**	**1.9**
Excavator	12.5	27.3	6.9	18.8	7.7	9.1
Mean	1.2	1.5	1.1	1.3	1.2	1.2
Vibrator	5.0	9.1	3.4	12.5	0.0	0.0
Mean	1.1	1.1	1.0	1.4	1.0	1.0
Transport	12.5	9.1	13.8	2.5	0.0	9.1
Mean	1.2	1.1	1.2	1.1	1.0	1.1
Hoist	2.5	0.0	3.4	0.0	7.7	0.0
Mean	1.1	1.0	1.1	1.0	1.2	1.0
Others	0.0	0.0	0.0	0.0	0.0	0.0
Mean	1.0	1.0	1.0	1.0	1.0	1.0

Source: Field Survey 1994.

Equipment availability and poor maintenance are two attributes that could have far reaching effects on work progress. If the required equipment is not available construction work may not progress. In addition, poorly maintained equipment is prone to frequent breakdowns.

Table 5.17 shows the occurrence of the subvariables under equipment and their mean scores. It can be seen that crane and the mixer were frequent in causing delays. The greatest problems with crane were observed in projects exceeding Ksh 100 million in cost with a frequency of 81.8% and a comparatively higher mean score. This is expected because crane is mostly utilised in this type of projects. The mixer seems to be a problem in all the sample strata, with relatively high variable score.

Table 5.18: Equipment: Critical Values Compared with Mean Scores

Equipment	Confidence Interval 99%	Critical Value	Mean Scores	Decision
Crane				
Overall	n = 38	2.083	1.700	Accept Ho
Public	n = 11	1.637	1.545	,,
Private	n = 27	1.957	1.759	,,
<KSh.50M	n = 14	2.337	1.063	,,
Ksh 50-100M	n = 13	1.521	1.692	Reject Ho
>Ksh 100M	n = 11	1.507	2.721	,,
Mixer				
Overall	Ditto	2.094	1.950	Accept Ho
Public		1.428	2.364	Reject Ho
Private		2.044	1.724	Accept Ho
<KSh 50M		2.012	1.500	,,
Ksh 50-100M		1.609	2.538	Reject Ho
>Ksh 100M		1.482	1.909	,,

Source: Field Survey 1994

Part of the result of the hypothesis test is shown in Table 5.18. The null hypothesis for crane in projects costing Ksh 50-100 million and projects with cost exceeding Ksh 100 million is rejected. So is the null hypothesis for mixer in public projects, projects of Ksh 50-100 million, and projects with cost exceeding 100 million. This is not surprising because the two strata are likely to rely and utilise more of these equipment, hence non availability or breakdown could cause serious delay problems. What is surprising is the significance of mixers in public projects. The only explanation for this could be sampling error or perhaps the contractors chosen for public projects have problems with mixers. The null hypothesis for the rest of the strata and the subvariables is accepted as shown in Appendix 'B', meaning that they are not significant causes of delays.

5.3.9: Construction Materials

Materials is another important resource in the construction process. Its problems may be linked to the participants as well as the socio-economic environment. The magnitude of materials in the total value of the building structure ranges between 68 - 76 percent (Habitat, 1982 p. IV - 43 - 44). The types of materials used in construction are sand, aggregate, cement, timber, steel, roofing materials such as tiles, plumbing and sanitation fixtures, and electrical fittings. Some of the materials are obtained from natural sources. For instance, sand is used in its natural form. Others are manufactured or need some form of conversion. For example, aggregates need to be converted to different sizes for various uses. Cement, steel, roofing tiles, electrical fittings and plumbing and sanitary fittings are manufactured in factories under different conditions, requiring various inputs.

Some materials are produced locally while others are imported. Materials such as sand, aggregate, natural stone, cement and timber are produced locally in Kenya and some are exported to neighbouring countries.

Table 5.19: Material Shortages: Percentage of Variable Occurrence and Mean Scores on the Rating Scale

Material Shortage	Over n=38	Pub n=11	Priv n=27	<Ksh 50M n=14	Ksh 50 - 100M n=13	>Ksh 100M n=11
Cement %	**62.5**	**54.5**	**65.5**	**62.5**	**53.8**	**72.7**
Mean	**2.6**	**2.4**	**2.7**	**2.5**	**2.4**	**3.0**
Steel	**55.0**	**45.5**	**58.6**	**56.3**	**38.5**	**72.7**
Mean	**2.3**	**2.2**	**2.3**	**2.2**	**1.8**	**2.9**
Timber	**45.0**	**27.3**	**48.3**	**75.0**	**38.5**	**18.2**
Mean	**2.1**	**1.5**	**2.3**	**2.9**	**1.8**	**1.5**
Sand	2.5	0.0	3.4	6.3	0.0	0.0
Mean	1.1	1.0	1.1	1.1	0.0	1.0
Aggregate	10.0	0.0	13.8	6.3	7.7	18.2
Mean	1.2	1.0	1.3	1.1	1.2	1.5
Clay Tiles	7.5	0.0	3.4	6.3	13.8	9.1
Mean	1.2	1.0	1.1	1.1	1.2	1.3
Elect.Fittings	2.5	9.1	6.9	6.3	7.7	0.0
Mean	1.1	1.3	1.2	1.2	1.2	1.0
Ceramic Tiles	2.5	0.0	3.4	0.0	0.0	9.1
Mean	1.1	1.0	1.1	1.0	1.0	1.2
Marble	10.0	0.0	3.4	0.0	15.4	0.0
Mean	1.1	1.0	1.1	1.0	1.4	1.0
Roofing Tiles	7.5	9.1	3.4	0.0	7.7	0.0
Mean	1.2	1.3	1.1	1.0	1.2	1.0
P.V.C. Tiles	2.5	9.1	0.0	0.0	7.7	0.0
Mean	1.1	1.3	1.0	1.0	1.2	1.0
Facing Tiles	2.5	0.0	3.4	0.0	0.0	0.0
Mean	1.1	1.0	1.1	1.0	1.0	1.0
Imp. Materials	2.5	0.0	3.4	6.3	0.0	0.0
Mean	1.0	1.0	1.1	1.2	1.0	1.0
Others	0.0	0.0	0.0	0.0	0.0	0.0
Mean	1.0	1.0	1.0	1.0	1.0	1.0

Source: Field Survey 1994.

Other materials such as, steel products, electrical and plumbing fittings, which form a sizeable amount of consumption in construction, are imported (Habitat, 1982:p.IV - 46). However, Syagga (1985) observes that the use of locally available materials should be encouraged for easy maintainance and promotion of local production which will improve the national economy.

The availability and supply of materials present some constraints to the construction process. Locally available materials can be faced with problems of shortages which could be caused by lack of sufficient quantities to meet the demand. Material problems can also be caused by poor planning of construction activities where work scheduling fails to ensure that materials are delivered on site at the time when needed. Some delivered materials may not meet the expected standards and cause rejection. Imported materials may cause constraints due to payment of duties, clearance from customs and the problem of ascertaining the time lags needed between import placement and delivery.

The percentage of occurrence of materials shortages and the mean scores are shown in Table 5.19. The table shows that cement, steel and timber were the most frequent causes of delays. Cement and steel shortages occurred more frequently in projects exceeding Ksh 100 million in cost, while timber caused delays in projects of lesser cost. The mean scores for cement, steel and timber in the overall sample are high, an indication that they could be significant causes of project delays.

Table 5.20: Materials: Critical Values Compared with Mean Scores

Materials	Confidence Interval 99%	Critical Value	Mean Scores	Decision
Cement				
Overall	n = 38	2.003	2.600	Reject Ho
Public	n = 11	1.365	2.364	,,
Private	n = 27	1.875	2.690	,,
<KSh.50M	n = 14	1.611	2.500	,,
Ksh 50-100M	n = 13	1.469	2.385	,,
>Ksh. 100M	n = 11	1.382	3.000	,,
Steel				
Overall	ditto	2.009	2.275	Reject Ho
Public		1.888	2.182	,,
Private		1.887	2.310	,,
<KSh 50M		1.627	2.250	,,
Ksh 50-100M		1.633	1.769	,,
>Ksh 100M		1.354	2.909	,,
Timber	ditto			
Overall		2.010	2.100	Reject Ho
Public		1.639	1.545	Accept Ho
Private		1.852	2.276	Reject Ho
<KSh 50M		1.662	2.938	,,
Ksh 50-100M		1.547	1.846	,,
>Ksh 100M		1.637	1.455	Accept Ho

Source: Field Survey 1994

Part of the result of the null hypothesis test is shown in table 5.20. The null hypothesis for cement, steel and timber in all the sample strata is rejected at 99% confidence level, except for timber use in public and large projects. The explanation for large projects with respect to timber could be that they are not large consumers of structural timber, except for formwork. However, formwork could be substituted for, perhaps by steel. That is true for single large units.

The possible explanation for the insignificance of timber in public projects, is that, the government controls the exploitation and use of some timber species. This is either for environmental reasons or control of over-exploitation of certain tree species. This can cause problems for projects in which the government has no interest, especially, the private sector. However, due to the social nature of public projects they may benefit from waivers. Another reason could be sampling error. The hypothesis for other materials is accepted, suggesting that they are not significant causes of delays.

5.3.10: Construction Finance

Finance in construction is a very important resource. Finance is used to purchase other resources such as labour, equipment and materials. Availability of finance is therefore crucial to the success of projects. This variable is linked to the participants, their financial procurement techniques and the socio-economic environment.

Finance in construction projects is needed for both client and contractor financing. Client financing is necessary and crucial for payment of consultancy services offered by architects, project managers and engineers. This is paid for by way of professional fees, usually approximated at 15% of the total cost of the project. The other payment to be made by the client is the interim periodic payments to the contractor for work done on the project. Other client payments may include payment of insurance premiums and performance bond.

It is necessary that the client is endowed with adequate financial resources to meet financial commitments as they accrue. This requires intricate financial estimating and planning with respect to sourcing and cash flow forecasts. This is a potential cause of financial difficulties in projects.

The other level of financial needs are the contractors finances. Contractors need both working and investment capital. Working capital covers payments for labour, subcontractors, materials suppliers, equipment rentals and overhead expenses. Contractors are almost universally paid through monthly instalments over the construction period on the basis of work done. A portion of the contractor's payments is always withheld as a guarantee against poor workmanship, hidden defects and similar faults which may be observed only after project completion. Similar arrangements are usually made between the contractor and the subcontractor with the subcontractor generally supposedly receiving payment shortly after the contractor has received his own from the client.

Clients obtain their finance from building societies and commercial banks and, on a limited scale, from savings and retained profits. Contractors use bank loans as a source of funds for working capital and to a large extent the material suppliers credit. However, clients may have financial problems due to inaccurate estimates and poor financial planning and control. Due to some of these reasons, payment from the client to either consultants or the contractor may be subject to unreasonable delays.

Contractors, on the other hand, may also have financial problems such as failing to obtain short term credit for lack of collateral, underquoting the cost of the project, and managing financial resources poorly. For instance, cases of funds received for construction being diverted to other uses other than the project are a frequent cause of contractor's difficulties with finances (Habitat, 1982: p.IV - 115). Another frequent source of financial problem in projects is failure by the architect or engineer to release the periodic payment certificate to enable the client to pay the contractor. This may be due to poor quality work, strained relations between the contractor and the client's representative and laxity or procrastination.

Table 5.21 shows the occurrence of the subvariables in the sample and their mean scores. It can be seen that client payment is the most frequent cause of financial problems in projects. The problem is severe in public projects and in projects exceeding Ksh 100 million in cost. The rest of the subvariables score relatively low and are unlikely to be significant causes of delays. Part of the result of the hypothesis test is shown in Table 5.22.

Table 5.21: Construction Finance: Percentage of Variable Occurrence and Mean Scores on the Rating Scale.

Finance	Over n=38	Pub n=11	Priv n=27	<Ksh 50M n=14	Ksh 50-100M n=13	>Ksh 100M n=11
Client Payment %	**60.0**	**90.9**	**44.8**	**43.8**	**53.8**	**90.9**
Mean	**2.8**	**3.7**	**2.4**	**2.8**	**2.6**	**3.1**
Arch.Cert.	10.0	0.0	13.8	12.5	0.0	18.2
Mean	1.3	1.0	1.4	1.3	1.0	1.5
MCs.cash flow	17.5	9.1	20.7	25.0	12.5	9.1
Mean	1.4	1.3	1.5	1.6	1.5	1.1
Others	0.0	0.0	0.0	0.0	0.0	0.0
Mean	1.0	1.0	1.0	1.0	1.0	1.0

Source: Field Survey 1994.

The null hypothesis for client's payment in all the sample strata and architects certificate in projects exceeding Ksh 100 million is rejected at 99% confidence level. This suggests that project delays attributable to finance are caused by both delay in payment by the client, and in the issuance of architects certificate in large projects. The null hypothesis for the rest of the strata and subvariables is accepted as shown in Appendix 'B', suggesting that they are not significant causes of delays.

Table 5.22: Construction Finance: Critical Values Compared with Mean Scores

Finance	Confidence Interval 99%	Critical Value	Mean Scores	Decision
Client Payment				
Overall	n = 38	1.985	2.775	Reject Ho
Public	n = 11	1.961	3.727	,,
Private	n = 27	1.834	2.414	,,
<KSh.50M	n =.14	1.540	2.750	,,
Ksh 50-100M	n = 13	1.425	2.615	,,
>Ksh. 100M	n = 11	1.667	3.091	,,
Architect's Certificate	Ditto			
Overall		2.189	1.275	Accept Ho
Public		2.500	1.000	,,
Private		2.052	1.378	,,
<KSh 50M		1.932	1.313	,,
Ksh 50-100M		2.500	1.000	,,
>Ksh 100M		1.488	1.545	Reject Ho

Source: Field Survey 1994.

5.3.11: Local Authorities

Local authorities have influence on construction activities by way of regulation and control of development in their jurisdiction. During project construction, local authority personnel have to approve sections of work to ensure that it is done in accordance with the rules and regulations and conform to the standards of specification and requirements as approved. The approval at this stage relates more to the building code, zoning ordinance, subdivision regulations, planning laws and safety legislation. The approval process is a potential cause of delays, as a result of either laxity or unsatisfactory work. Table 5.23 shows the percentage of occurrence of the variables in the sample and their mean scores. The subvariables under local authority approvals do not seem to be significant causes of delays. However, approval of foundations in projects exceeding Ksh 100 million seems to be significant.

In addition, Table 5.24 shows part of the results for the significance test. The null hypothesis for the approval of foundations in projects exceeding Ksh 100 million is rejected, meaning that it is a significant cause of delays in large projects. The null hypothesis for the rest of the strata and subvariables is accepted as shown in Appendix 'B'.

Table 5.23: Local Authority Approvals: Percentage of Variable Occurrence and Mean Scores on the Rating scale

Local Authority Approval	Over n=38	Pub n=11	Priv n=27	<Ksh 50M n=14	Ksh 50-100M n=13	>Ksh 100M n=11
Foundation % **Mean**	**22.5** **1.4**	**18.2** **1.2**	**24.1** **1.4**	**12.5** **1.1**	**23.1** **1.3**	**36.4** **1.8**
Steel Mean	2.5 1.0	0.0 1.0	3.4 1.0	6.3 1.1	0.0 1.0	0.0 1.0
Dump.Ex.Mat Mean	5.0 1.1	0.0 1.0	3.4 1.0	0.0 1.0	0.0 1.0	0.0 1.0
Access Road Mean	2.5 1.1	0.0 1.0	6.9 1.2	6.3 1.1	7.8 1.1	9.1 1.3
Others Mean	0.0 1.0	0.0 1.0	0.0 1.0	0.0 1.0	0.0 1.0	0.0 1.0

Source: Field survey, 1994

Foundations in large projects are usually expansive and costly, involving deep excavations and heavy reinforcement. In the central business districts, as required by the Nairobi City Council by-laws, foundations are supposed to have underground basements for car parking. It is for these reasons that foundation approval could be a potential source of delays.

Table 5.24: Local Authority: Critical Values Compared with Mean Scores

Local Authority Approval	Confidence Interval 99%	Critical Value	Mean Scores	Decision
Foundations				
Overall	n = 38	2.206	1.375	Accept Ho
Public	n = 11	2.162	1.182	,,
Private	n = 27	2.083	1.448	,,
<KSh.50M	n = 14	2.278	1.125	,,
Ksh 50-100M	n = 13	2.032	1.308	,,
>Ksh. 100M	n = 11	1.458	1.818	Reject Ho

Source: Field Survey 1994

5.3.12: Labour Availability

Labour is an important resource in the construction process for carrying out actual operations of various construction activities. Both skilled and unskilled workers are required in construction. Skilled workers are people who have acquired certain specific skills in various trades. For example, masons, carpenters, painters, plumbers, electricians, steel erectors and roof tilers are skilled workers. Other necessary workers are those skilled and experienced in the trades to be deployed for supervision. The other cadre of workers are the unskilled workers, who possess no skills, and are deployed to do work requiring no special knowledge of the trades. For example, the tasks of excavating and assisting skilled workers with their work normally utilize unskilled workers.

Table 5.25 shows the percentage of labour shortage occurrence and mean scores in the sample. It can be seen that the scores are low. The null hypothesis that labour shortage is not a significant cause of delays is accepted for all the subvariables in all the subsamples as shown in Appendix 'B'. This suggests that labour availability is not a significant cause of delays in projects.

Table 5.25: Labour Availability: Percentage of Variable Occurrence and Mean Scores on the Rating Scale

Labour Availability	Over n=38	Pub n=11	Priv n=27	<Ksh 50M n=14	Ksh 50 - 100M n=13	>Ksh 100M n=11
Skilled % Mean	5.0 1.1	0.0 1.0	6.9 1.1	12.5 1.3	0.0 1.0	0.0 1.0
Unskilled Mean	2.5 1.1	0.0 1.0	3.4 1.2	6.3 1.2	0.0 1.0	0.0 1.0
Others Mean	0.0 1.0	0.0 1.0	0.0 1.0	0.0 1.0	0.0 1.0	0.0 1.0

Source: Field Survey 1994.

5.3.13: Accidents

The occurrence of accidents in construction is within the domain of site safety. It is a requirement of the Factories Act, Cap 514, that the contractor should take the necessary steps to ensure that the general site environment is safe and healthy for the welfare of the workers. This may not be easy to achieve on a construction site.

However, steps such as provision of safety devices to workers, well constructed and secured scaffolding, and protection against falling objects by use of barriers may assist in alleviating accidents. In addition, the general site tidiness and orderliness assists to reduce accidents to workers and passers-by.

Although site welfare was found not to be a significant cause of delays, it is one of the factors that may cause industrial disputes(see 5.3.5). The Ministry of Labour Inspectorate may either not inspect or may neglect some issues which could easily be safety risks to the workers.

When safety issues are overlooked, the incidence of accidents is likely to increase. The occurrence of accidents interrupts the progress of work. It further causes panic and fear in workers thus reducing the tempo of working. Three subvariables identified under accidents are fatal, serious injuries, minor injuries and others. Table 5.26 shows the occurrence of the variables in the sample and their mean scores.

Table 5.26: Accidents: Percentage of Variable Occurrence and Mean Scores on the Rating Scale

Accidents	Over n=38	Pub n=11	Priv n=27	<Ksh 50M n=14	Ksh 50-100M n=13	>Ksh 100M n=11
Fatal %	0.0	0.0	0.0	0.0	0.0	0.0
Mean	1.0	1.0	1.0	1.0	1.0	1.0
Serious Injury	0.0	0.0	0.0	0.0	0.0	0.0
Mean	1.0	1.0	1.0	1.0	1.0	1.0
Minor Injury	12.5	9.1	13.8	12.5	7.7	18.2
Mean	1.1	1.1	1.1	1.1	1.2	1.1
Others	0.0	0.0	0.0	0.0	0.0	0.0
Mean	1.0	1.0	1.0	1.0	1.0	1.0

Source: Field Survey 1994.

It can be seen that the subvariables under accidents are unlikely to be significant causes of project delays given the low level of incidence and mean scores. Fatal and serious injuries were not observed in the sample. Minor injuries occurred but at a very low rate. Minor injuries were, however, comparatively high in projects exceeding Ksh 100 million in cost. This is confirmed by the acceptance of null hypothesis in all the subvariables and in all the sample strata as shown in Appendix "B".

5.3.14: Politics

Political activities affect many issues in society. Political interference in projects is caused by opposing political forces. Cases where projects initiated by opposition politicians usually do not have government blessing are common. A case in mind is the moribund Kisumu Molasses Plant. On the other hand, government initiated projects may be opposed by opposition politicians as was the case with Eldoret Airport on account that it was not viable.

Another possible source of political interference in projects is wrangling as were the politically instigated tribal clashes. Cases of workers clashing over their political differences are common. A site with workers of different political divide is a potential cause of wrangling. Political directives may outlaw the construction of a project or use of certain materials such as the ban on sand harvesting in Machakos.

Table 5.27 shows the occurrence of the subvariables under politics and their mean scores. They are relatively low. The results are confirmed by acceptance of the null hypothesis of all the subvariables in all the sample strata as shown in Appendix 'B'. This is an indication that the subvariables under politics are not significant causes of project delays.

Table 5.27: Politics: Percentage of Variable Occurrence and Mean Scores on the Rating Scale.

Politics	Over n=38	Pub n=11	Priv n=27	<Ksh 50M n=14	Ksh50 -100M n=13	>Ksh 100M n=11
Political Interference	2.5	9.1	0.0	6.3	0.0	0.0
Mean	1.1	1.3	1.0	1.2	1.0	1.0
Political Wrangle	20.0	9.1	24.1	18.8	0.0	0.0
Mean	1.2	1.1	1.2	1.2	1.0	1.0
Political Decrees	0.0	0.0	0.0	0.0	0.0	0.0
Mean	1.0	1.0	1.0	1.0	1.0	1.0
Hawker&Askari	2.5	0.0	20.7	6.3	0.0	0.0
Mean	1.0	1.0	1.2	1.1	1.0	1.0

Source: Field Survey, 1994.

5.3.15: Manufactured Components

Building construction makes extensive use of manufactured components. These include doors, windows, sanitary ware and precast concrete products. Non availability of these components can cause the project to delay. However, the question regarding manufactured components was open ended.

The percentage of occurrence and the mean scores of the subvariables identified are shown in Table 5.28. The percentage of occurrence of the subvariables are low. The null hypothesis in all the subvariables and in all the sample strata is accepted as shown in Appendix 'B'. This is a confirmation that manufactured components are not significant causes of delays in projects.

Table 5.28: Manufactured Components: Percentage of Variable Occurrence and Mean Scores on the Rating Scale.

Manufactured Components	Over n=38	Pub n=11	Priv n=27	<Ksh 50M n=14	Ksh50-100M n=13	>Ksh 100M n=11
Clay Products %	2.5	0.0	3.4	6.3	0.0	0.0
Mean	1.0	1.0	1.0	1.1	1.0	1.0
Lifts	2.5	0.0	3.4	0.0	7.8	0.0
Mean	1.1	1.0	1.1	1.0	1.1	1.0
Windows	2.5	0.0	3.4	0.0	7.8	0.0
Mean	1.1	1.0	1.1	1.0	1.1	1.0
Doors	2.5	2.5	0.0	0.0	7.8	0.0
Mean	1.0	1.1	1.0	1.0	1.1	1.0
Roof Girders	2.5	0.0	3.4	0.0	0.0	0.0
Mean	1.1	1.0	1.1	1.0	1.0	1.0
Sanitary Ware	2.5	0.0	3.4	0.0	0.0	0.0
Mean	1.1	1.0	1.1	1.0	1.0	1.0
Imported Prod.	2.5	0.0	3.4	6.3	0.0	0.0
Mean	1.0	1.0	1.0	1.1	1.0	1.0

Source: Field Survey, 1994.

5.3.16: Permits and Licenses

In some situations, during the process of construction, permits and licenses may be needed from relevant authorities to enable certain kinds of work to be done. These permits may be issued by the government, local authorities or other organisations that have control over certain issues pertaining to construction projects. The use of cedar, for example, is prohibited by the government, and hence a licence from the forest department is required for its use. Local authorities have jurisdiction over water resources and its reticulation, sewer lines and city roads. It may sometimes be necessary to relocate these facilities to allow construction work to proceed. This requires a permit from the local authority.

The Kenya Power and Lighting Company controls the electricity supply network. Project sites traversed by power lines and cables may need relocation. Likewise, Kenya Posts and Telecommunications Corporation controls telephone cables and may also be required to provide a permit for diversion of telephone lines or cables.

Table 5.29: Permits and Licences: Percentage of Occurrence and Mean Scores on the Rating Scale.

Permits and Licenses	Over n=38	Pub n=11	Priv n=27	<Ksh 50M n=14	Ksh 50-100M n=13	>Ksh 100M n=11
Government %	2.5	0.0	3.4	0.0	7.8	9.1
Mean	1.1	1.0	1.1	1.0	1.2	1.3
Lo. Auth.(NCC)	20.0	9.1	24.1	25.0	15.4	27.3
Mean	1.4	1.2	1.4	1.4	1.3	1.5
KPLC Ltd	17.5	0.0	24.1	25.0	15.4	9.1
Mean	1.5	1.0	1.6	1.5	1.4	1.3
KPTC	2.5	0.0	3.4	0.0	0.0.	0.0
Mean	1.1	1.0	1.1	1.0	1.0	1.0
Others	0.0	0.0	0.0	0.0	0.0	0.0
Mean	1.0	1.0	1.0	1.0	1.0	1.0

Source: Field Survey, 1994.

Obtaining a license from these authorities may be quite difficult. Some of the difficulties could be caused by bureaucracy, laxity and lack of prompt requisition for licenses by those involved in the project. Table 5.29 shows the percentage of variable occurrence in the sample and their mean scores. The scores are generally low. The null hypothesis is accepted in all the sample strata as shown in Appendix "B". This suggests that this variable is not a major cause of project delay.

5.3.17: Shop Drawings.

In certain construction works such as steel construction, details of design and construction may need to be prepared by the contractor. This is usually on the understanding that it is the contractor who has the know-how of the design of such details. The details prepared by the contractor, however, are subject to approval by the architect and engineer.

Table 5.30: Shop Drawings: Percentage of Variable Occurrence.

Shop Drawings	Over n=38	Pub n=11	Priv n=27	<Ksh 50M n=14	Ksh50-100M n=13	>Ksh 100M n=11
Preparation %	15.0	9.1	17.2	12.5	12.5	18.2
Mean	1.4	1.2	1.4	1.3	1.2	1.5
Approval	2.5	0.0	3.4	6.3	0.0	0.0
Mean	1.0	1.0	1.0	1.1	1.0	1.0
Others	0.0	0.0	0.0	0.0	0.0	0.0
Mean	1.0	1.0	1.0	1.0	1.0	1.0

Source: Field Survey, 1994.

There are two main problems that arise due to shop drawings namely; contractor causing delay in preparing shop drawings due to lack of expertise, and the architect or engineer causing delay to approve the drawings due to incompetence or laxity.

The percentage of subvariable occurrence and mean scores are as shown in Table 5.30. Generally, the occurrence of the subvariables and their mean scores are low. However, shop drawing preparation comparatively shows a frequent occurrence.

Table 5.31: Shop Drawings: Critical Values Compared with Mean Scores.

Shop Drawings	Confidence Interval 99%	Critical Value	Mean Score	Decision
Preparation				
Overall	n = 38	2.172	1.350	Accept Ho
Public	n = 11	1.997	1.182	,,
Private	n = 27	2.049	1.414	,,
<KSh. 50M	n = 14	1.932	1.313	,,
Ksh 50-100M	n = 13	2.055	1.231	,,
>Ksh. 100M	n = 11	1.488	1.545	Reject Ho

Source: Field Survey, 1994

Part of the results of the hypothesis testing is shown in Table 5.31. The null hypothesis for shop drawing preparation in projects exceeding Ksh 100 million, is rejected. The null hypothesis for the rest of the strata and subvariables is accepted as shown in Appendix 'B'. This suggests that although the variable shop drawings is generally not a significant cause of project delays, it however causes delays in large projects. This result is not surprising because it is in large projects that structural steel is mostly used requiring preparation of shop drawings.

5.3.18: Materials Testing

Materials for construction work require laboratory tests and are frequently tested to ensure that they meet the required specification and standards. This is an important part of the construction process.

Sand may be tested to determine its silt content and coarseness. Silt in sand affects negatively the strength of concrete. Aggregate, likewise, may be tested to determine whether it meets the size specification. Subsoils may be tested to determine moisture content, soil type and expected load bearing capacity. Steel, concrete and timber are also tested to determine the expected compressive and tensile strengths.

Samples of affected materials are tested in laboratories equipped with specialised equipment. The Ministry of Works has materials testing laboratories located in various parts of the country, such as Nairobi, Kisumu, and Mombasa. Other private laboratories also exist.

Table 5.32: Materials Testing: Percentage of Variable Occurrence and Mean Scores on the Rating Scale

Materials Testing	Over n=38	Pub n=11	Priv n=27	<Ksh 50M n=14	Ksh 50-100M n=13	>Ksh 100M n=11
Sand %	0.0	0.0	0.0	0.0	0.0	0.0
Mean	1.0	1.0	1.0	1.0	1.0	1.0
Aggregate	0.0	0.0	0.0	0.0	0.0	1.0
Mean	1.0	1.0	1.0	1.0	1.0	0.0
Soils	0.0	0.0	0.0	0.0	0.0	1.0
Mean	1.0	1.0	1.0	1.0	1.0	0.0
Steel	0.0	0.0	0.0	0.0	0.0	1.0
Mean	1.0	1.0	1.0	1.0	1.0	0.0
Concrete	10.0	0.0	13.8	12.5	7.7	1.0
Mean	1.3	1.0	1.3	1.4	1.2	9.1
Timber	0.0	0.0	0.0	0.0	0.0	1.2
Mean	1.0	1.0	1.0	1.0	1.0	0.0
Others	0.0	0.0	0.0	0.0	0.0	1.0
Mean	1.0	1.0	1.0	1.0	1.0	0.0

Source: Field Survey, 1994.

Before any material requiring testing can be used, the results of the laboratory test must be obtained to enable the architect or engineer make a decision on whether to approve or condemn the material. In the event that the material is condemned, the contractor must obtain suitable samples for further testing. The results of laboratory tests may delay because the time lag between delivery of samples and obtaining the results may be underestimated by the parties. In addition, the laboratory staff may be lax.

Table 5.32 shows the percentage of occurrence of the subvariables in the sample and their mean scores on the rating scale. The result shows that all the materials except concrete tests were not a cause of delay in the sample. The occurrence of delays caused by concrete test is however low. The null hypothesis that materials testing is not a significant cause of project delays is accepted at 99% confidence level in all the subvariables and all the sample strata as shown in Appendix "B". This suggests that materials testing is not significant in causing project delays.

5.3.19: Other Factors

The variable "other factors" was included in the questionnaire as an open ended question to capture any other variable that may have been overlooked. This open ended variable produced eight other subvariables as shown in Table 5.33. The variables percentage of occurrence and the mean scores are low.

The null hypothesis is accepted as shown in Appendix "B". This suggests that the subvariables are not significant causes of project delays. Consequently, there may not be any other cause of delay that was overlooked.

Table 5.33: Other Factors: Percentage of Variable Occurrence and Mean Scores on the Rating Scale.

Other Factors	Over n=38	Pub n=11	Priv n=27	<Ksh 50M n=14	Ksh50 -100M n=13	>Ksh 100M n=11
Underpinning %	2.5	0.0	3.4	6.3	0.0	0.0
Mean	1.1	1.0	1.1	1.2	1.0	1.0
Survey Maps	2.5	0.0	3.4	6.3	0.0	0.0
Mean	1.0	1.0	1.0	1.1	1.0	1.0
Theft	5.0	0.0	6.9	6.3	7.7	0.0
Mean	1.1	1.0	1.1	1.2	1.1	1.0
Noise	2.5	9.1	0.0	0.0	7.7	0.0
Mean	1.1	1.2	1.0	1.0	1.3	1.0
Site Clearance	5.0	9.1	3.4	0.0	15.4	0.0
Mean	1.1	1.3	1.0	1.0	1.3	1.0
Exter. Works	5.0	9.1	3.4	0.0	15.4	0.0
Mean	1.1	1.3	1.1	1.0	1.3	1.0
P. Negligence	2.5	0.0	3.4	6.3	0.0	0.0
Mean	1.1	1.0	1.1	1.1	1.0	1.0

Source: Field Survey, 1994.

5.4: Summary

This chapter has presented the result of the hypothesis test to identify the significant variables causing delays in projects. Out of a total of 90 such variables, only 24 are found to be significant causes of delays. These are architect's and client's instructions; rock and underground water; late nomination, material, payment and poor workmanship; cement, steel and timber; variations and claims; wages; approvals; rain; crane; mixer; architect's certification; local authority approvals, and shop drawings. However the non significant variables should not be ignored in project management. They should only be given less emphasis, because in a dynamic environment as construction, it may be unwise to ignore any variable.

CHAPTER SIX

THE RELATIONSHIP BETWEEN PROJECT CHARACTERISTICS AND CAUSES OF DELAYS

6.1: Project Characteristics

This chapter attempts to examine how differences in project characteristics influence the occurrence of the significant variables.

Project characteristics were differentiated by client and cost. The clients were differentiated further by public and private. There is a marked difference in the internal organisational structure of these two strata in terms of styles of management and commitment to the running of their affairs. Elements of client characteristics which affect their approach to building are, for instance, the procedures used for project funding, approvals and project monitoring. These issues may be quite involving and time consuming in public organisations, giving rise to delays (Sidwell, 1984).

The public client is known to be plagued with bureaucracy which hinders faster and effective communication resulting in delays in decision making. For example, there is always need for many signatories for payments to be made by public organisations. This is due to the need to satisfy public accountability. Public projects on the other hand, are subjected to parliamentary scrutiny and auditing by both the Public Accounts Committee (PAC) and Public Investments Committee (PIC). Due to these requirements, public projects usually utilize competitive methods of procurement as well as other bureaucratic procedures of project implementation. They predominantly use traditional in house design teams and are usually difficult to change to new methods of project management. Staff in public organisations are known to be demoralised because of low pay and poor working conditions. These affect their efficiency.

Private clients are highly motivated by profit as they are business oriented. They are likely to be more efficient in their dealings. They have less bureaucracy because of the narrow spans of management control in their organisational structures which improves on their decision making process. The staff on the other hand, are highly motivated because of better pay and working conditions. In most cases the private sector relies substantially on private consultants who are also expected to be more efficient in the implementation of projects. This is because private consultants are expected to be endowed with new and better techniques and can easily adapt to changing project conditions. The differences in the ways in which public and private sectors are organised and managed are likely to manifest themselves in differences in the occurrence of the significant variables.

Project size has been identified as a key and significant variable in the performance of projects. In addition, it influences project complexity (Sidwell, 1984). It is in larger projects that diversification is likely to be more profound because of the increased number of interacting forces exerted by consultants, contractors, subcontractors and suppliers which make the operating environment more complex (Sidwell, 1990). The sheer volumes of work involved in large projects, such as, excavations, concrete and steel, are large and therefore require complex decisions to be made by project management.

Thus problems of planning, organisation and control are likely to be more challenging in large projects.

The differences in the discussed characteristics could be responsible for the occurrence of some of the significant variables, or could influence differences that affect some of the significant factors. In the previous analysis carried out in Chapter Five, some significant variables were identified with particular project characteristics. They did not need any further tests. For instance, late nomination of subcontractors, disputes over variations and claims, delays caused by architects failure to approve samples and delays caused by concrete mixer, were found to be significant in public projects only. Delays caused by shortage of timber were only found to be significant in private sector projects. Likewise, disputes over variations, architects failure to approve samples, local authority approval of foundations, and delays caused by shop drawing preparations, were only found to be significant in large projects. These findings supported suspicion that different project characteristics may influence the significance of some variables. Thus the other significant factors which were observed to be significant in two or more sample strata needed further analysis. It became necessary to investigate whether there are differences in the occurrence of significant variables attributed to project characteristics according to the defined sample strata. This called for the use of chi-square test.

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6.2: Client's Instructions

This variable was found to be significant in all the sample strata. Powys (1981) observed that senior executives in an organisation tend to have a hand in the project, thus give the architect conflicting and confusing instructions. In such situations the architect may not be in a position to know what to accept or discard. Table 6.1 shows the results of the Chi-square test for clients instructions with respect to project characteristics. The null hypothesis tested is that the occurrence of clients instructions is not influenced by differences in project client and size.

Table 6.1 : Client's Instructions and Project Characteristics

Clients Instructions	Chi-square Test		
	$X^2_{0.01}$	X^2	Decision
Client (Public, Private) df = 1	6.635	<6.773	Reject Ho
Size <KShs. 50m, KShs. 50-100m, >KShs. 100m df = 2	9.210	>0.152	Accept Ho

Source: Field Survey, 1994.

The null hypothesis for client is rejected at 99% confidence level with one degree of freedom, suggesting that the occurrence of clients instructions as a cause of project delays is associated with differences in client attributes. It was observed in Chapter Five Table 5.3 that private projects had the highest incidence of client interference (69%) compared to public projects (27%).

This supports the fact that the project team should be wary of client interference when dealing with private projects.

The null hypothesis for project size is accepted suggesting that differences in project size do not influence the occurrence of client interference in projects. This means that the private sector client interferes with projects regardless of size. The conclusion is that the more interest shown by private sector clients in their projects does not support efficient project implementation.

Table 6.2 : Architect's Instructions and Project Characteristics.

Architect's Instructions	Chi-square Test		
	$X^2_{0.01}$	X^2	Decision
Client (Public,Private df = 1	6.635	>3.672	Accept Ho
Size: <KShs. 50m, KShs. 50-100m, >KShs. 100m df = 2	9.2101	<10.43 2	Reject Ho

Source: Field Survey, 1994.

6.3: Architect's Instructions

Architects instructions were also found to be significant in causing projects delays in all the sample strata. Table 6.2 shows the results of the null hypothesis test. The null hypothesis for client is accepted at 99% confidence level and one degree of freedom. This suggests that delays caused by architect's instructions are independent of whether the project is public or private. This finding is surprising because it is expected that architects in the private sector, who are mainly private consultants, should contribute less to projects delays by way of instructions. This therefore means that the approach to design and commitment to management of projects both in public and private sectors by architects is the same.

The null hypothesis for project size and architect's instructions is rejected, suggesting that project size influences the issuance of instructions by architects. The percentage of variable occurrence in Chapter Five Table 5.3 showed that the incidence of architect's instructions was highest in larger projects by 90.9%, compared to smaller projects. This suggests that larger and complex projects suffer more from delays caused by architects instructions. The conclusion is that architects could be having problems of designing and managing larger projects.

6.4: Rock

Rock was found to be significant in all the sample strata. It is however, not known whether the problems it causes in projects are independent of the differences in project characteristics. Since rock occurs naturally, there is no way different project characteristics can influence its occurrence. Occurrence of rock in this respect refers to knowledge of prior information about rocks presence on site, and the use of that information in project implementation. This information is obtained from site investigation reports. The differences in commitment to project implementation can determine the availability of that information. Information on the presence of rock can be used for project planning to avoid surprise encounters with rock during project implementation. The hypothesis test for rock is therefore a test of whether the parties take steps to ascertain the presence of rock, and whether they take adequate measures to counter its effect on project progress.

Table 6.3 : Rock and Project Characteristics

Rock	Chi-Square		
	$X^2_{0.01}$	X^2	Decision
Client (Public, Private) df = 1	6.635	>0.016	Accept Ho
Size: <KShs. 50m, KShs. 50-100m, >KShs. 100m df = 2	9.210	<10.947	Reject Ho

Source: Field Survey, 1994.

Table 6.3 shows the result of the null hypothesis test with respect to project client and size. The critical chi-square value for client at 99% confidence level and one degree of freedom is greater than the value of chi-square calculated from the sample and therefore falls within the acceptance region. Thus the null hypothesis that the significance of rock is independent of differences in client characteristics is accepted. This suggests that for both public and private sector projects, inadequate steps are taken to ascertain the presence of rock on site. Subsequently, there is inadequate information about the sub-soil conditions. On the other hand, it means that even if the information is available, it is not effectively used for project planning and control. The null hypothesis for project size is rejected, suggesting that project size influences the significance of rock in causing project delays. Previous analysis in Chapter Five Table 5.5 shows that rock was a frequent cause of delays in larger projects with an incidence of 90%. This suggests that the possibility of the presence of rock is not given the emphasis it deserves in the planning of foundation work in large projects.

Table 6.4 : Underground Water and Project Characteristics

Underground Water	Chi-Square Test		
	$X^2_{0.01}$	X^2	Decision
Client (Public, Private) df = 1	6.635	>0.084	Accept Ho
Project Size <KShs. 50m, KShs. 50-100m, >KShs. 100m df = 2	9.210	>4.794	Accept Ho

Source: Field Survey, 1994.

6.5: Underground Water

Underground water, another subsoil characteristic, was found to be a significant cause of project delays in all the sample strata. Like rock, it occurs naturally, hence its occurrence is not expected to be influenced by any project characteristics. However, the argument advanced for rock also applies in the case of underground water. The test is about prior knowledge regarding the existence of ground water. This knowledge also is obtainable from site investigation reports. Table 6.4 shows the result of the chi-square test.

The null hypothesis is accepted. This suggests that in all the sample strata of client and size, inadequate effort is taken to address the influence of underground water on project delays. This suggests that the approach to this problem is the same whether in public or private sector. It does not seem to matter to those involved in the implementation of projects that large projects could be vulnerable to the problem of underground water. It is also not an issue in smaller projects.

6.6: Subcontractor's Late Nomination

This variable is significant in only public projects and in all the project size strata. Therefore, it is not necessary to test for differences in clients attributes. Subcontractor's late nomination is attributed to late decision making which is a symptom of bureaucracy, laxity and procrastination. It is not surprising that it is a significant cause of delays in public projects. It became necessary to investigate whether differences in project size influence its occurrence. Table 6.5 shows that the null hypothesis is accepted. The conclusion is that late subcontractor nomination is independent of differences in project size. Since this problem is associated with public projects, it means that the problem is no less significant in both smaller and larger projects.

Table 6.5 : Subcontractor's Late Nomination and Project Size

Subcontractor's Late Nomination	Chi-square Test		
	$X^2_{0.01}$	X^2	Decision
Size: <KShs. 50m, KShs. 50-100m, >KShs. 100m df = 2	9.210	>1.969	Accept Ho

Source: Field Survey, 1994.

Table 6.6 : Subcontractor's Material Problems and Project Characteristics

Subcontractor's Materials	Chi-square Test		
	$X^2_{0.01}$	X^2	Decision
Client (Public, Private) df = 1	6.635	<6.844	Reject Ho
Size: <KShs. 50m, KShs. 50-100m, >KShs. 100m df = 2	9.210	>1.862	Accept Ho

Source: Field Survey, 1994.

6.7: Subcontractor's Material Problems

Subcontractor's material problems was tested to find whether or not its occurrence is influenced by differences in client and project size. As shown in Table 6.6, the null hypothesis for client is rejected, suggesting that the client characteristics have an influence on subcontractor's material problems.

This variable had the highest incidence of occurrence in public projects with 90.9% occurrence rate. This variable is closely linked to late payment.

Delayed payment to subcontractors was found to affect their cash flow. They may not therefore have the necessary finance to purchase materials needed for the work. The null hypothesis for project size with respect to subcontractor's materials problems is accepted, indicating that differences in project size have no effect on the occurrence of subcontractor's material problems. The conclusion is that material problems by subcontractors are experienced mostly by subcontractors in public projects regardless of whether the projects are small or large.

6.8: Late Payment to Subcontractors

Late payment to subcontractors was found to be significant in all the sample strata. It therefore became important to ascertain whether or not the differences in project characteristics influence its occurrence.

The result of the Chi-square test for late payment to sub-contractors with respect to different clients and project sizes is shown in Table 6.7. The null hypothesis is accepted in all the subsamples, an indication that subcontractors, whether involved in public or private projects, smaller or larger contracts, equally experience problems of late payments. However, since subcontractors receive their pay from main contractors, this may not be entirely a problem of the client. The main contractor may partly be the cause of this problem. Clients may be involved indirectly if they delay payments to the main contractor, who consequently delays in effecting payment to subcontractors.

Table 6.7 : Late Payment to Subcontractors and Project Characteristics.

Late payment to subcontractors	Chi-square Test		
	$X^2_{0.01}$	X^2	Decision
Client (Public, Private) df = 1	6.635	>2.048	Accept Ho
Size: <KShs. 50m, KShs. 50-100m, >KShs. 100m df = 2	9.210	>3.356	Accept Ho

Source: Field Survey, 1994.

Table 6.8: Wages and Project Characteristics.

Wages	Chi-square Test		
	$X^2_{0.01}$	X^2	Decision
Client (Public, Private) df = 1	6.635	>0.4573	Accept Ho
Size: <KShs. 50m, KShs. 50-100m, >KShs. 100m df = 2	9.210	>4.540	Accept Ho

Source: Field Survey, 1994.

6.9: Wages

Non payment of wages is a problem of the contractor and his workers. It is linked to the contractor's project management policies. This factor was found to be significant in all the sample strata. It is however, not known whether or not it is influenced by differences in project characteristics.

Table 6.8 shows the result of the null hypothesis test. The null hypothesis is accepted, indicating that the occurrence of non-payment of wages is independent of client and project size. To some extent, the problem of wages could be linked to payment to contractors by the client. However, the results in Table 6.8 show that this may not be necessarily the case. It appears that contractors will delay to pay wages regardless of whether their own payment is effected or not. It was observed in Chapter Five Table 5.21 that private clients comparatively honour payments on time. This is not consistent with this result. The problem of wages is thus more of industrial relations between contractors and workers. This is influenced by the rules and legislation governing their relationship and the sensitivity of the workers and contractors to matters that affect this relationship.

6.10: Rain

Rain occurs naturally, and therefore it is not expected that either the client or the project size can influence its occurrence. However, the test of rain with regard to differences in characteristics of the project is supposed to gauge the response to the risk posed by rain in construction, under different project characteristics.

Table 6.9 : Rain and Project Characteristics

Rain	Chi-square Test		
	$X^2_{0.05}$	X^2	Decision
Client (Public, Private) df = 1	6.635	>1.338	Accept Ho
Size: <KShs. 50m, KShs. 50-100m, >KShs. 100m	9.210	>4.619	Accept Ho

Source: Field Survey, 1994.

The risk of rain as a cause of delays can be minimized if the weather patterns as produced by the Meteorological Department are studied and used in project planning and control. The knowledge and understanding of the rainy seasons can assist planning of site operations to avoid interruption by rain. The significance of rain as a cause of delays means that weather data is not used in project planning. However, it is not known whether the non use of weather data in project planning is common in the project characteristics under consideration.

Table 6.9 shows the result of the null hypothesis test. The null hypothesis for both client and project size is accepted, indicating that differences in project client and size do not influence the significance of rain as a cause of delays. This means that, in all the sample strata, information on the occurrence of rain is not used in project planning. Subsequently, there is no difference in commitment to the problem of rain by consultants and contractors, whether working in public or private sector and whether involved in different project sizes.

6.11: Crane and Mixer

Crane and mixer are the only items of equipment that significantly cause delays. This is only in projects exceeding KShs. 50 million. It is, however, not known whether the differences in the two size strata have an influence on their occurrence. Table 6.10 shows the result of the null hypothesis test. The null hypothesis for crane is rejected at 99% confidence level, suggesting that the differences in the two project size strata influence the occurrence of the problems caused by crane.

Table 6.10 : Crane and Mixer and Project Size

Project Size KShs. 50-100m, >KShs. 100m	Chi-square Test		
	$X^2_{0.01}$	X^2	Decision
Crane df = 1	6.635	<8.223	Reject Ho
Mixer df = 1	3.841	>1.387	Accept Ho

Source: Field Survey, 1994.

In the previous Chapter, Table 5.17 showed that crane was a dominant cause of delays in projects exceeding KShs. 100 million with 81.8% incidence. This points out that as projects become larger. the availability and planning of crane utilization is not given the emphasis it deserves.

The null hypothesis for mixer is accepted, suggesting that the problems associated with the mixer are not influenced by the differences in the two sample size strata. This means that the mixer has more problems than the crane as its problems are not influenced by size. The problems of the mixer are also related to its acquisition and planning for usage, which seem not to be emphasized in larger projects.

6.12: Cement

Cement was observed to be significant in all the sample strata. The test aims at finding out whether differences in project characteristics influence its occurrence as a cause of delays.

Table 6.11 : Cement and Project Characteristics

Cement	Chi-square Test		
	$X^2_{0.01}$	X^2	Decision
Client (Public, Private) df = 1	6.635	>0.40	Accept Ho
Size: <KShs. 50m, KShs. 50-100m, >KShs. 100m df = 2	9.210	>0.90	Accept Ho

Source: Field Survey, 1994.

Table 6.12 : Steel and Project Characteristics

Steel	Chi-square Test		
	$X^2_{0.01}$	X^2	Decision
Client (Public, Private) df = 1	6.632	>0.55	Accept Ho
Size: <KShs. 50m, KShs. 50-100m, >KShs. 100m	9.210	>3.39	Accept Ho

Source: Field Survey, 1994.

The result of the hypothesis test is as shown in Table 6.11. The null hypothesis is accepted for both client and project size, pointing out that shortage of cement is not influenced by differences in project client or size. However, shortage of cement can be caused by market conditions such as under-capacity, hoarding and smuggling, thus project characteristics may have nothing to do with it. On the other hand, cement shortage or any other material could be caused by poor planning of material deliveries. This may be caused by lack of planning skills and underestimation of time lags between placing material orders and deliveries on site. The problem of cement shortage is, however, no less severe in public or private projects and in projects of different sizes. The deficiencies in planning and underestimation of time lags are experienced in all the project strata.

6.13: Steel

Steel was also found to be significant in all the sample strata. This test aims therefore at finding out whether its significance is influenced by differences in project client and size.

The null hypothesis is accepted as shown in Table 6.12. This points out that steel shortage is a problem that is independent of differences in project client or size. One would perhaps expect that project size could have an influence on account that larger projects consume large quantities of steel and hence most likely to experience steel shortage. As in the case of cement, the problem of steel is related to procurement planning.

Table 6.13 : Timber and Project Size

Timber	Chi-square Test		
	$X^2_{0.01}$	X^2	Decision
Project Size <KShs. 50m, KShs. 50-100m df = 1	6.635	<6.948	Reject Ho

Source: Field Survey, 1994.

6.14: Timber

Timber is a significant cause of delays in private sector projects, in projects costing less than KShs. 50 million and projects costing between KShs. 50-100 million. It is however not known whether there is any statistical difference in the significance of timber as a cause of delays on account of the differences in project size.

The results of the hypothesis test are shown in Table 6.13. The null hypothesis is rejected at 99% confidence level and one degree of freedom, indicating that shortage of structural timber is influenced by the differences in project size. It was observed in the previous chapter (Table 5.19) that the greatest incidence of shortage of timber was in projects costing less than KShs. 50 million, possibly the strata in which structural timber is most used.

6.15: Delayed Payment by Client

Delayed payment by client is the only element of finance that significantly cause delays in all the sample strata. The test, however, aims at ascertaining whether this variable is influenced by differences in project characteristics.

Table 6.14 : Delayed Payment by Client and Project Characteristics.

Late payment by client	Chi-square Test		
	$X^2_{0.01}$	X^2	Decision
Client (Public, Private) df = 1	6.635	<10.115	Reject Ho
Project size: <KShs. 50m. KShs. 50-100m, >KShs. 100m df = 2	9.210	<9.344	Reject Ho

Source: Field Survey, 1994.

Table 6.14 shows the result of the null hypothesis test. The null hypothesis for clients is rejected at 99% confidence level, pointing out that differences in clients have an influence on the occurrence of late payment by clients. An observation of the percentage of occurrence in Table 5.21, in the previous Chapter shows that public projects had the highest incidence of late payment by client, accounting for 90.9% compared to 44.8% in private sector projects. This means that there is a difference in approach to project financing by the two types of clients.

The null hypothesis for project size is also rejected, indicating that late payment by client is influenced by differences in project size. Table 5.21 in chapter five showed that the incidence of client delay in payment was highest in projects exceeding Ksh 100 million in cost with a 90.9% incidence. This means also that there are differences in approach to project financing by virtue of project size. The cause of financial problems is poor financial planning of procurement, expenditure and control. The conclusion is that this problem is worse in larger projects.

6.16: Significant Factor Contribution to Delays

The results from the data analysis discussed so far do not show which factors among the 24 are more important in causing delays. To answer this question, it became necessary to use correlation coefficients and step-wise regression analysis. The dependent variable is the percentage of delay achieved in each project in the sample. The independent variables are the 24 variables found to be significant using the rating scale analysis. These are the client's instructions, architect's instructions, rock, underground water, late nomination of subcontractors and poor workmanship. Others are subcontractors material problems, subcontractors late payment, dispute over variations, dispute over claims, payment of wages, architects approval, engineers approval, and rain. The rest included crane, concrete mixer, cement, reinforcement steel, timber, clients payment, architects certificate, NCC approval and preparation of shop drawings. All these were regressed against project delay at 99% confidence interval.

6.16.1: Correlation Coefficients

Interpretation of the multiple regression model depends on the assumption that the independent variables are not themselves strongly interrelated. A correlation analysis was carried out for the 24 variables in the model at 99% confidence level, giving a probability significance (p) of p = 0.01. The variables that produced a coefficient of determination of over 0.5 with a probability significance of p = 0.0000 were classified as strongly correlated. This exercise was aimed at identifying the existence of multicollinearity. Twenty two factors were found to be strongly correlated as per the set criteria. These were Wages with Architects Instructions, Rain and Client's Instructions, Client's Payment and Late Nomination, Variations and Claims and Engineers approval and Architects Approval. Others were Rain and cement, Cement and Reinforcement, Architects Certificate and Engineers Approval, Shop Drawings and Cement, Poor Workmanship and Variations and Shop Drawings and Steel.

However, most of the variables identified with strong correlations did not make any sense in terms of project management. For example, there is no logical connection in influence between Clients Instructions and Rain or Cement and Shop Drawings as would be expected between Client's Payment and Wages or Architects Instructions and Variations.

The strongly correlated variables that seemed to have a logical connection were Variations and Claims, Cement and Rain, Engineers Approval and Architects Approval and Architects Certificate and Engineers Approval. The logical connection is that Variations inevitably cause claims, too much rain may cause shortage cement due to transport problems, what is not approved by the engineer may not be approved by the architect and non approval by the engineer may cause delay in payment certificates.

However, the strongly correlated and logically related variables were eliminated from the regression model and were therefore assumed not to have any meaningful influence in the model. It was therefore concluded that although multicollinearity existed to some extent, it did not have a direct impact on the result of the analysis in such a way as to affect the outcome of the model. Multicollinearity was therefore ignored.

6.16.2: Regression Analysis

For the step-wise regression analysis the results were as in following discussion. The first variable to be picked is clients payment (JI), showing that clients payment was the most promising contributor to reducing unexplained variation in the percentage of delay. The result of the first run is as follows:

Delay = 20.2 + 0.718 (JI)

t = 3.125 t = 7.997

sig t = 0.0034 sig t = 0.000

R square = 0.62727

Adjusted R square = 0.61746

F(calculated) 1,36 = 63.95, Sig F = 0.000

The above result shows that client payment is a highly significant variable in causing project delays. The Adjusted R Square of 0.61746 indicates a high correlation, hence the equation easily passes the F test at 99% confidence level. The result obtained from step one shows that clients promptness or otherwise in payment to the contractor accounted for 0.617 or 61.7% of the variations in delay.

In the second run, the second most significant variable entered is architects instructions (A2). The Architect's instructions as a cause of delay increased the R^2 to 0.70638, that is, it accounted for (0.70638-0.62727)= 0.0791 or 7.91% of the variations in delay. The equation changes as follows:

Delay = 10.358 + 0.738 (JI) + 0.389 (A2)

t = 1.565 t = 5.107 t = 3.157

Sig t = 0.126 Sig t = 0.000 Sig t = 0.032

R Square = 0.70638

Adjusted R Square = 0.69057

F(calculated) 2,35 = 44.506, Sig F = 0.000

Thus the two variables accounted for 70.6% of the delays in the 38 projects at 99% confidence level. Approximately 29.4% variations in delays are accounted for by other variables which are either not included in the equation or those included but not significant at 99%.

These results, to a large extent, confirm the result, in Tables 5.3 and 5.4 regarding the influence of architect's instructions on all projects, whether public or private, and large or small. Thus the extent of architect's detailed drawing at the time of awarding project to a contractor is very important. Similarly, Tables 5.21 and 5.22 in the previous chapter support the major role client's payment has on progress of construction whether by main contractor or subcontractors(Tables 5.7 and 5.8). The overall predictive equation is given as:

Delay = 10.365 + 0.389 A2 + 0.738 J1

The beta coefficients are coefficients that result when the regression is carried out with standardised dependent and independent variables, using the Z scores for all the variables. It has been shown that beta coefficients can be used to compare the importance of each independent variable in relation to the dependent variable (Crockett, 1988).

Table 6.15: Beta Coefficients

Variable	Beta coefficient
Clients payment	0.813672
Architect's instructions	0.282092

Table 6.15 shows that clients payment has more influence on delays than architects instructions. The conclusion is that the most significant variables that cause delays in projects are clients payment and architects instructions in

that order of importance, hence requiring more effort in terms of control. The other 22 significant variables, however, cannot be ignored. They can only be comparatively given less emphasis in project implementation.

6.17: Conclusion

The result of the analysis shows that in some incidences there are remarkable differences in the influence of project characteristics on delay causing variables. Clients instructions, subcontractor's late nomination, subcontractor's material problems, delayed payment, poor workmanship and claims seem to be influenced by differences in client characteristics. Project size has an influence on architect's instructions, crane, timber, rock, local authority approvals and client payment. Variables that are not influenced by either project client or size include underground water, subcontractor's late payment, payment of wages to workers, rain and shortage of cement and steel.

The step-wise regression analysis shows that, out of the 24 significant variables, clients payment and architects instructions cause most delays, accounting for up to 70.6% of the variations in delays. Hence, these two variables need more attention during project implementation. On the other hand, project management has to approach each project situation differently depending on its characteristics. Chapter Seven discusses the implication of these results in the context of project implementation and management against the background of the participants, the process and the environment.

CHAPTER SEVEN

DISCUSSION AND INTERPRETATION OF RESEARCH FINDINGS

7.1: Introduction

The hypothesis tests have shown the specific variables that significantly cause delays. These variables are largely associated with the participants, the process, and both the physical and the socio-economic environments of the project. These "stakeholders" inevitably interact to achieve a project. For example, the client, the design team, the contractor and subcontractors constitute the participants. Disputes, claims, approvals, and payment certificates are associated with the process whereas the materials, finance, and equipment constitute the socio-economic environment. Rock, underground water, and rain are attributes of the physical environment.

7.2: Interpretation of the Research Findings

The interpretation of the research findings is that the variables found to be significant are only symptoms of problems associated with project implementation. They take the form of acts and omissions of the participants, the process and the environment which ought to be addressed by the project implementation team at various stages of the construction process. The variables are significant causes of delays because of poor project management practices. The client, design and construction teams are responsible for the success or failure of the construction process. The interface of the three in the project process, between themselves, and with respect to the project's physical and socio-economic environment ensure that project risks are identified and planned for and remedial measures taken when need arises to ensure that the project remains on course. This is crucial for the timely completion of the project.

The infrastructural framework for project implementation, in the form of the procurement process, the design team's rules and ethics, the design process, tendering rules, and conditions of contract, set the ground rules for project implementation and determine the interface and effectiveness of all concerned parties. The infrastructure, however, can be manipulated by the key players, on account of their interests in the project to the detriment of others, especially when the risks are poorly distributed. The infrastructure is also largely influenced by the wider society's economic, legal and cultural conditions. For instance, although the standard building contract is used in the construction process, it is governed by the general contract law. Deficiency in the general law may be reflected in the applied law. The awareness and commitment with which the construction team handles the issues of project implementation are reflected and underpinned in the infrastructure. The infrastructure is expected to support sound project management practices in order to enhance efficient practices by the parties.

7.3: The Participants

The contribution of the four groups of participants to project delays were identified. They are examined with respect to their links with the significant variables.

7.3.1: Client's General Project Management

Sidwell (1990) observed that active involvement of clients in projects improves performance. However, this does not seem to be the case because client interference in the project has been found to be negative. This can be attributed to the level of awareness by clients in technical aspects of the project. Compared to the clients in Sidwell's study, the clients of this study seem to be deficient in technical matters of the project.

Client's deficiency with regard to the technicalities of project implementation necessitates strong and informed client representation in the project process by project managers (Mbatha, 1993; Morris, 1986; Walker, 1989). In this respect, project managers are expected to advise the client on aspects such as project planning and control, design team selection and control, contractor selection, and project finance. Informed client representation in projects would greatly assist in minimising the problems associated with clients such as instructions and late payment.

7.3.2: Client's Instructions

Client's instructions are problems associated with the development of project briefs. In most cases project briefs are not well developed before the commencement of design and construction. There is also a possibility that clients are not aware of the implications of issuing instructions even if the brief is well developed. For example, in some projects in the sample the client issued instructions because of change of mind. In one instance, the client requested for the incorporation of a basement when the contractor had already started work. This necessitated the re-design of the whole foundation layout, causing the revision of many other drawings. In another project, the client requested that the number of floors be increased from the planned 18 to 20. This was in the middle of the construction process. This ultimately caused the design to be revised.

These kinds of instructions reflect lack of proper advice from the client's consultants. A good advice would result in clearer briefs with development of possible design alternatives. In addition, clients would be advised on the implications and effects of issuing unnecessary instructions.

7.3.3: Client's Financial Management

The problem of late payment by clients is a major cause of project delays. This points to several issues. One is that clients are not able to adequately provide enough funds for the project and prepare accurate project cash flows. For example, where some projects in the sample had late client payment problems, it was because clients faced liquidity problems. For instance, in one particular project, every payment to the contractor delayed by between one to two months. In addition the client could not afford to pay the full amount of the certificate at once. The client paid in instalments, attracting an interest of over Ksh 3.7 million.

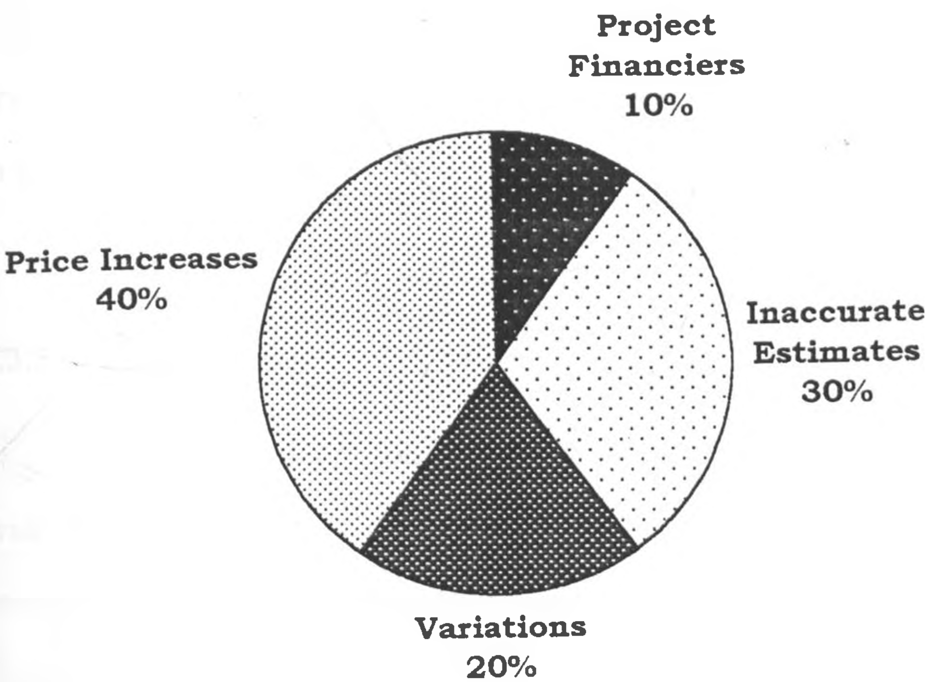
7.3.3.1: Problems of Project Financiers

In ten projects there was a response to the question seeking to find out why projects had liquidity problems. The responses are as shown in Figure 7.1. Problems between the client and the project financier accounted for 10% of liquidity problems. These arose because clients did not furnish financiers with the relevant information necessary for financiers to make project financing decisions. In some cases, there were complaints that financiers had difficult conditions to be met before agreeing to funding projects, such as security guarantees and deposits.

7.3.3.2: Inaccurate Estimates

Inaccurate estimates accounted for 30% of the problems of client's project financing. There were complaints by the clients about discrepancies between the submitted estimate by the quantity surveyor and the tender sum. The causes of inaccurate estimates were cited as lack of information on prices and cost indices for materials, labour, and equipment. This problem was compounded by failure of the estimates to take into account the risks that may increase the project's final construction cost.

Figure 7.1: Causes of Financial Difficulties



Source: Field Survey, 1994

Low and inaccurate estimate led to under-funding of the project. Consequently resulted in the need for extra funding to complete the project. Time was lost during application, justification and negotiations for extra funds. Application for extra funds portrays incompetence, on the part of the consultants, leading to loss of reputation.

7.3.3.3: Variations

Variations caused by the architects and clients instructions increased the scope of the project and also contributed to financial difficulties in projects. This accounted for 20% of the responses. These variations were issued without regard to the original project budget, and hence affected the project cash flow. The problem of variations can be attributed incomplete briefs and lack of application of risk management and constructability concepts in project implementation.

7.3.3.4: Price Increases

The most frequent reason cited for financial difficulties was however price increases which accounted for 40% of the responses. This was blamed on unstable economic conditions. High interest rates and inflation contribute to instability in pricing. However, these problems can be minimised by application of risk management and updated concepts in project cost estimating such as probabilistic estimating methods. It has been argued that inaccurate and incomplete contracts, specifications, plans and untimely information on aspects of feasibility, estimates, and costs, if not addressed at the project design phase, may eventually lead variations and cause severe financial problems later in the project (Sanvido and Norton 1994; Al-Hammad A. and Al-Hammad I. 1996; Janney, Vince and Madsen 1996). The implication is that most clients are not well advised on project cost and financing and hence not able to identify reputable financiers for the project during the feasibility stage, as well as control it.

7.3.4: The Design Team

Architects instructions, late approval of samples and work by architects and engineers, and delay in releasing architects certificate are problems associated with the design team. It should be noted that architects instructions is the second most important contributor to delays. Six respondents answered the question as to why architects issued instructions. The responses are shown in Figure 7.2.

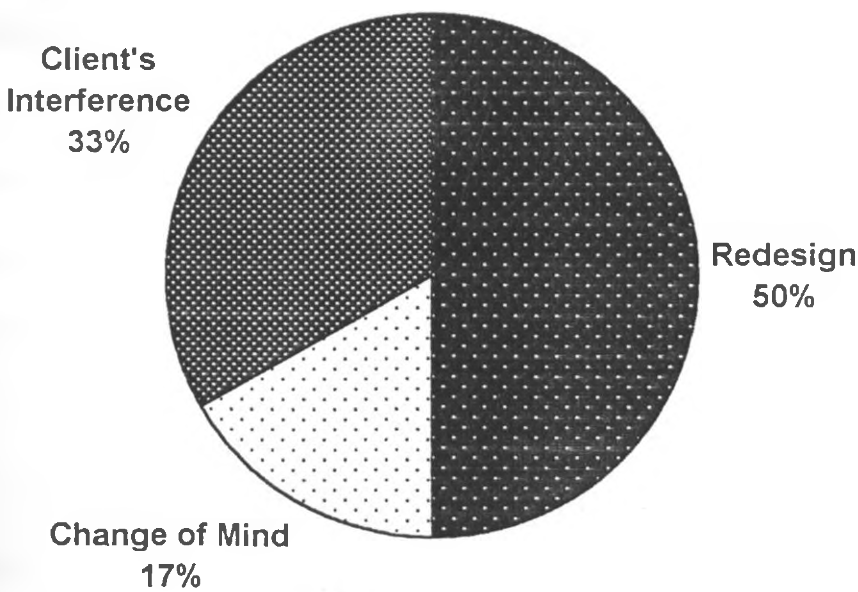
7.3.4.1: Redesign

Architects instructions arose due to lack of informed and firm decisions about the design. For example, in 50% of the responding cases, architects revised drawings when work had already commenced for reasons such as wrong positions of certain facilities and dimensions, such as the lift pit and windows. This is attributed to lack of commitment by designers to produce buildable designs. Once again it shows that constructability concepts are not applied in the project implementation process.

7.3.4.2: Client Interference and Change of Mind

In 33% of the cases, architects issued instructions due to client interference and in 17% of the cases, it was due to change of mind. These necessitated changes in the design. Once again these problems point to lack of thorough briefs, skilful designs and specifications. In addition, they reinforce the observation that there is lack of the application of constructability concepts in the design process, which can reduce changes in design.

Figure 7.2: Causes of Architect's Instructions



Source: Field Survey, 1994

Glavinich (1995) argues that architects and engineers are not experts in construction means and methods. Their designs are usually performance oriented, leaving methods of achieving the design to the contractor. In most cases designs are produced which can be built without difficulties. Most of the difficulties encountered with designs can be reduced if constructability enhancement is carried out.

Other design team oriented problems are late approval of samples and work as well as delay in releasing certificate to the contractor. These are problems associated with laxity and procrastination on the part of the design team. This indicates weakness in the contractual relationships that exist between the design team and the client, and the design team and the contractor. Essentially, they are problems of management because management is supposed to detect those deficiencies and institute appropriate instruments that govern the relationships between all the parties and about who pays for procrastination and laxity. Presently, it is the client who pays for the inefficiency of others.

The underestimation of the project cost by the design team as discussed in 7.3.3.1 is attributed to lack of updated skills and information which can be used for accurate cost estimation.

7.3.5: The Contractor's General Management Approach

The contractors general approach to project management is important for achieving project goals. It is largely influenced by company's practices with regard to management of projects. The effectiveness of the practices is portrayed by the level at which management functions of planning, control, organising, and directing are embraced. The company's practices on these key management functions determines the structure and commitment of the contractor regarding the site, materials, plant, finance and labour management.

7.3.6: The Contractor's General Site Management

Efficient site management was lacking in several of the projects studied. For instance, theft of materials was reported in several projects, causing shortage of materials. In other cases, site congestion was reported and this caused materials and equipment movement problems, resulting in delays in materials reaching work places. It was also observed that site managers lacked basic managerial skills.

Site management is a great contributor to the overall project success. Most of the significant delay causing factors such as materials and plant are to some extent influenced by the contractor's site management practices. However, project site management is influenced by the general management structure of the contractor. Walker (1990) argues that effective site management structure is influenced by factors such as contractors management practice, client characteristics and influence, and the industrial relations climate existing at the time of construction. The significant causes of delays attributable to the contractor fall to some extent within issues related to site management. Walkerdine (1982) maintains that successful site management is largely influenced by deployment of a good site manager whose character can determine the success or failure of the project. The site manager is responsible for the management of the construction process and makes decisions on site layout, plant deployment, materials, and labour motivation, and the planning and control of subcontractors. These attributes need careful consideration to achieve successful project implementation.

7.3.7: The Contractor's Materials Management

The problem of cement, steel and timber in projects is attributed to poor contractor's materials management practices. In some projects, for instance cement and steel were in short supply because of delays in placing orders. In several projects contractors purchased the materials in small quantities whereas in other projects, materials shortage was caused by delay in delivery by the supplier. For example, it was observed in one project that the supplier of cement always supplied less quantities than ordered.

The problems are pointers to the practice of inaccurate estimates for material requirements necessary to maintain the tempo of work, and inadequate regard for the time lags needed between placing orders and material deliveries. These are a reflection of poor skills in materials management by contractors. The other cause was attributed to the socio-economic conditions, especially in cases where material shortages were reported to be due to market conditions.

The structure of the company's practices on material purchases and its management can have a far reaching effect on the efficiency of the material purchases and subsequent availability on site. Thomas, Sanvido and Sanders (1989) argue that an investment in materials management can result in considerable profit to the contractor as well as improving performance of projects. Lack of this will produce the opposite effect.

Two aspects of the contractors materials management practices were noticed. The practice of purchasing materials for several sites or for one site at a time, and the practice with regard to credit with materials suppliers. In many of the projects studied, the company's head office was empowered with the role of making decisions on material purchases for all projects. This contributed largely to delays in material purchases. In only a few projects, the site offices were empowered with the roles of making their own decisions about the purchases of materials without having to wait for orders from the head office. This resulted in comparatively efficient materials purchasing system.

A basic materials management function is to ensure that required materials are available at the work place at the right time (Birdsall and Woodhead 1978). In situations where the head office was responsible for acquisition of materials, there were problems of communication between the head office and the site office. Information on the required materials took time before it was received and acted upon by the head office. Communication between work places and site management and the movement of materials from storage to the workplace on site also presented problems. In some cases, stock depletions on site took time before they could be detected because of poor inventory control system. The problem was compounded by the time lags between placing orders for materials and their delivery. The purchasing, expediting, and delivery of materials system is an important component in the efficient materials flow process. Communication between site and head office and within site are also critical to the success of the materials management process (Lansford and Skukhart, 1986; Abdul-Rahman and Alidrisyi, 1994).

An integrated materials system utilising material schedules as a tool for materials planning and control was evidently lacking. This caused problems to site management to establish and schedule work place materials demand. The handling system also had shortcomings. It could not be harnessed to meet demands by focusing on supply to site, its site movement, and subsequent work place consumption. Consequently, the integrated management of storage, forward orders and assessment of work place requirements suffered.

In support of the above initiatives is the general site layout with particular reference to material entrance points to the storage locations and the workplace. This was observed to be poor. It was evident that issues such as the specific physical location, dimension and shape of access, which are important in establishing an efficient flow of materials on site were overlooked. The access design did not allow for smooth flowing operation by considering the width, height, weight and manoeuvrability of delivery vehicles. Similarly, crane and hoist locations were not established in relation to delivery zones and the equipment load radii. The equipment seemed not to be of the right capacity in relation to the materials to be handled.

Birdsall and Woodhead (1978) and Lansford and Skukhart (1986) argue that the materials management should be approached seriously in order to alleviate some of the causes of delays attributed to materials such as irregular materials deliveries (a problem of scheduling, purchasing and expediting), inadequate planned materials movement (a sign of poor storage and distribution) and inadequate equipment capacity.

7.3.8: Management of Subcontractors

Delay in payment to subcontractors is linked to the main contractor's management practices. Weaknesses in contractual relationships between contractors and subcontractors may result into the main contractors using money due to subcontractors as a source of free credit. However, in many cases contractors delayed payment to the subcontractor because of delay of client payment.

Adverse relations between the main contractor and subcontractors was found to cause problems in several projects. For instance, in one project subcontractors boycotted site meetings to avoid meeting with the main contractor due to strained relations. The main contractor retaliated by delaying payment to subcontractors.

7.3.9: Contractor's Equipment Management

Crane and mixer are important plants in the construction of high rise buildings. They have a strong relation with materials because they are used for either mixing materials or transporting materials to work places. The problems identified with crane and mixer were the contractor's practices on plant acquisition and maintenance and the efficient planning of equipment utilisation in the construction process.

The contractor's practices with regard to equipment were influenced by the availability of the equipment, whether for purchase or hire. In several cases studied, contractors hired cranes. This was because, it would not have been economical to purchase crane due to considerable amount of capital required. Vorster and Sears (1977) advise that the objective for the management of construction equipment should be set so as to maximise construction profits rather than minimise equipment costs.

Factors that influenced the selection of the type, size and capacity of the equipment according to respondents included job factors, quantity of work, and the productive utilisation of the equipment. Job factors were influenced by the size of the project and the desired technology. In several projects there were indications that contractors had not paid attention to the issues of quantity of work with respect to equipment productivity. For instance, in one project, concreting delayed due to the under capacity of the concrete mixer. The mixer was size 10/7 cubic feet when obviously it should have been of a larger capacity.

Equipment productivity is important and is determined not only by the design efficiency of the equipment but also the contractors own planning of the utilisation of the equipment. These two factors could be within the control of the contractor (Hinze and Ashton 1979). However, contractors complained about the conditions imposed by equipment dealers, financiers and taxation rules which hampered the acquisition, utilisation and maintenance of the equipment.

Equally important is the equipment costs which include both the acquisition of an equipment and the maintenance expenses. The costs, vary, by rising or descending annually as the machine ages. Although the purchase price is important, it is rather the total life cycle cost of the machine that really counts. The costs are divided into ownership and operation costs (Douglas 1978; Vorster and Sears 1987). Ownership costs usually include those that occur regardless of whether or not the equipment is operated and cover transactions such as purchase, finance, and resale. These costs are incurred with the passage of time. Similarly, annual costs incurred with respect to depreciation, interest on investment, insurance, security, storage and licenses must be accounted for. However, depreciation consideration must take cognisance of the physical deterioration resulting from wear and tear and obsolescence as the economic usefulness of the machine declines.

The operating costs are variable and depend on the number of hours of operation rather than calender time. These are necessary in order to maintain the economic levels of equipment utilisation. Effective maintenance is expensive and requires financing. In many projects studied, contractors spent the minimum on maintenance, resulting into frequent breakdowns. The problems were further compounded by lack of spare parts for the equipment that had broken down. In one project, the equipment was too old and kept breaking down even after repairs, pointing to the fact that the contractor had not considered the issue of replacement.

Equipment replacement was a difficult issue faced by most contractors. Schexnayder and Hacher (1981) argue that machine utilisation time and maintenance costs should guide this decision, requiring proper record keeping about the costs of utilizing the equipment. It was found out in many projects studied that the contractor's equipment practices were based on intuitive judgment for lack of factual information and of managerial knowledge concerning proper economic analysis techniques. Use of old equipments, some of which had outlived their usefulness was evident in most sites.

It is not enough to make wise decisions on equipment acquisition and maintenance. It is equally very important to manage the equipment efficiently so that it gives maximum benefits to the firm. One important aspect in this regard is to plan equipment use to ensure that it is fully employed during its utilisation. In quite a number of projects cranes were on site and yet their services were not needed at the material time. There are costs associated with the fact that equipment often performs less than expected and thereby influence many aspects of the construction process. This is compounded if the equipment utilisation is not properly planned.

If all these factors are taken into account with regard to the contractors equipment management practices, it is expected that contractors will take rational decisions about investment in equipment, its maintenance, and efficient use. Eventually equipment can be a contributor to the contractors profits rather than his problems.

7.3.10: Payment of Wages

Disputes over wages arise out of the relationship between the contractor and the workers. However, if the risks are tilted against the contractor in the contractual arrangements, some of the risks are transferred to subcontractors and workers. This could result in increased disputes. The greatest influence on the occurrence of disputes arose out of the contractor's personnel management practices. The practices hinged on management styles, and the treatment of workers regarding level of payment. In several cases workers were not paid the recommended wages, payments were irregular, there was no payment of overtime, provision of leave, housing and other incentives.

These problems were linked to personnel management deficiency, lack of sensitivity of the contractors to the workers problems, problems inherent in the machinery of resolving contractor worker disputes, and problems in the legislation that regulates the worker-contractor relationships. There were also problems with worker-trade union relationships, and how they could press for workers rights without harming the project. In several sites, contractors avoided hiring union workers. The relations that exist between the trade unions and the employer organisation is also important in resolving any explosive situations.

Diekmann and Girard (1995) identified some aspects of characteristics of projects which could have a bearing on industrial peace on people, the process and the project itself. The people issues involve the relations, roles, and responsibilities, and the many different kinds of expectations that affect the people. The process issues include the manner in which the contract and the building process is carried out, which includes the planning of the project, financial and scope definition, contractual obligations, contract administration procedures, quality of construction documents used, and the use of dispute litigation techniques. The project issues include the characteristics that define the technical nature of the work, such as type and complexity of the project, the limitation of the site, and the environment in which the project is implemented. All these indicate the risks faced in the projects.

The people characteristic was identified as affecting the projects dispute performance to a great extent. The project and process variables did not affect the project performance greatly. It is the actions and omissions of the people that influence the project and the process. In several cases contractors hindered the process of settling disputes with workers by not cooperating and giving lame excuses. Contemporary thinking about dispute reduction has concentrated on the client, design team and contractor relationships by embracing the partnering concept. Partnering should be applied in a wider context, to extend to the contractor, subcontractor and worker relationships.

7.4: The Construction Process

Some of the significant variables identified such as late subcontractor nomination was linked to the practice adopted in the process of construction. The problems were rooted in the process of appointing subcontractors. In several cases studied concreting delayed due to late appointment of subcontractors by the client. The subcontractors work was necessary to lay service pipes and conduits before concreting. This was attributed to the practice that subcontractors should be appointed after the main contractor. The problem of late nomination can be reduced if all contractors were appointed at the same time.

The problem of variations and claims are related more to the process of assessing variations and claims in the projects. In one project, a claim was logged very late and it was not easy to authenticate most of the items because they were already covered. In another project, there was no proper documentation of changes in the project and when the contractor eventually brought claims, these were denied by the client and it became difficult to verify them.

These problems could be avoided if there is a proper practice of record keeping through project implementation. These have to be supported by the instruments that support the practice in terms of contracts, rules, and procedures. It is also necessary that universally accepted rules of assessing variations and claims should be developed and adhered to. Incompetence and lack of skills in the management of the contract by the client, the design team and the contractor was observed.

In large projects local authority approvals was a problem observed on the side of the construction team as well as the NCC. For instance, in many cases the application for approval was logged late by the design team. In other situations however, there was laxity on the part of NCC personnel. Some projects were plagued with both problems. This again was a reflection of poor procedures in the process of work supervision and approvals.

The shop drawing preparations problems in most projects studied were attributed to lack of skills. For instance, in one project, the contractor took too long to prepare the drawings. This was a reflection of incompetence on the part of the contractor as there were no technically qualified people to do this type of work.

The architect delayed the contractor's payment as a way of punishing the contractor because they had personal differences. This was observed to be due to the contract arrangements. Adversarial relationships in contracts may not promote team spirit in the project. This is another attribute requiring the application of partnering concept. Risk distribution in the contract documents contributed to this. This pointed to weaknesses in the instruments that govern the construction process, specifically relating to the relationship that exists between the architect and the contractor, which were observed to be weak.

Poor workmanship by subcontractors was observed to be caused by poor quality control and management practices. For instance, in one project, it was reported that the subcontractor used unqualified workers to reduce costs. This situation arose because of weaknesses in procurement processes and contract administration by the subcontractor. Whereas the contractor is responsible for the subcontractors work on behalf of the client he has no say over the hiring and firing of subcontractor's workers. Thus, the instruments that define the relationships that exist between the main' contractor, subcontractors and the design team were also observed to be weak in this respect.

7.5: The Socio-Economic Environment

This relates to two variables namely; materials and equipment. Although contractors contributed to materials shortage by their materials management practices, there were some aspects which were beyond their control. For instance, in several projects, the materials needed were not available in the market with some projects experiencing shortage of timber, cement and steel. In one project, materials shortage was caused by derailment of the Kenya railways wagons. In another, the contractor was unable to purchase materials because of sudden increase in material prices. Thus, events in the wider society which were directly unrelated to the project affected the project materials supply system. It was therefore observed that the socio-economic environment has some risks which bear on the project in various ways.

7.6: Site Investigation

The physical environment presented problems of rock, underground water, and rain. It is always desirable and good practice that clients acting on the advice of the design team, should institute site investigation to explore the features of the site and gather information required to enable economical design to take place, taking into consideration the design features and in addition, expose any risks which the site could pose. In a number of projects, site investigation was not done to ascertain the nature of the subsoil. In projects where site investigation was done, it was observed that the information was not used in project management. In majority of projects, site investigation was not ever envisaged prior the beginning of the work. It was therefore treated as a variation when the contract documents were already complete and the contract duly signed. It is the contractor who dug the trial pits when such work should have been done during the contract documentation. It is not surprising that in quite a number of projects unexpected rock and underground water caused delays. This is a problem attributed to the design team and the client's representative.

In addition, most clients did not see the need for site investigation and consultants did not wish to emphasise its importance. Hence there were hardly any finances allocated for site investigation activities as the clients did not see the need for such allocation. However, no savings were achieved because many variations arose out of excavation in unexpected rock and escalated the project cost.

7.7: Weather

In a number of projects too much rain prevented work to continue. In one project, for example, basement work delayed because of rain. The basement had to be covered by polythene sheets as an after thought to prevent accumulation of water. The occurrence of rain may not be easily controlled. It can only be managed. The real cause of the problem of rain was management. The contractors planning practices were not sensitivity to weather problems. Provisions were not made for the rainy seasons in contractor's project planning.

The contractor can manage the risk of rain by proper programming of work. This may include covering exposed areas so that work can proceed even during rain. Some completed works can provide cover for outstanding work. The problem of rain reflected lack of use of information on weather patterns and data in project planning.

7.8: Conclusion

The results of the study and the conclusions arising from it show that the problems of delay are not confined to one sector of the construction industry. The whole spectrum of the construction industry including all the stake holders whether directly or indirectly contribute to delays in one way or another. However, two major factors which contribute most to the problems of project delays are client's financial management practices and the design teams project management practices. The problems of client financial management practices are compounded by project financiers, inaccurate estimates, variations and price increases. The design teams problems emanate from redesign, client interference and change of mind. The other problems are secondary.

These problems narrow down to deficiency in project management practices by the client, design team and the contractor. This deficiency is due to lack of appreciation of the project environment, poor planning and control practice, lack of risk management practice and lack of application of advanced skills in tackling some of the problems encountered in project implementation. These deficiencies have more impact on the seven major factors that cause project delays.

In some situations, different project characteristics do not seem to influence different approaches to project implementation. Public and larger projects seem to suffer more from lack of efficient project management approaches.

Other problems relate to the instruments that are used in the process of construction in terms of rules, procedures, and contractual relationships. These instruments define the infrastructure of the construction process and show some weaknesses by not being explicit on certain issues and not emphasising good practices in project implementation.

Some of the problems are also influenced to some extent by other factors that may not have a direct stake in the project such as government policies and the general economic environment, which in themselves are the problems of the wider society. However, efficient project management would address the problems of the wider society.

CHAPTER EIGHT

SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

8.1: Summary

This study set out to investigate the factors that cause construction project delays in high rise building projects. An analysis of the actual problems that occur at the construction site has revealed that clients payment and architects instructions are the most significant causes of delays, accounting for 70.6% of the variations in delays experienced in projects. Within these main variables, seven subvariables are isolated as responsible for the delay in projects. Client's payment problems are caused partly by project financiers, inaccurate estimates, variations and price increases. The Architects instructions on the other hand are caused by the need for redesign, client interference and change of mind. This means that if effort is concentrated on the seven areas of project implementation, about 70% of the problems of delays can be minimized. This is a fairly large margin of success.

Other 22 variables including, client's instructions, rock, underground water, late nomination of subcontractors, poor workmanship, material problems by subcontractors, late payment to subcontractors, disputes over variations, disputes over claims, payment of wages, architect's approval, engineer's approval, rain, crane, concrete mixer, cement, reinforcement steel, structural timber, architect's certificate, local authority approvals, and shop drawings preparation were also found to be causes of project delay in. These variables, possibly with others not in the study, could be accounting for the remaining 29.4% of variations in delays.

Some project characteristics were found to influence the occurrence of some of the delay causing variables. For example, client's instructions, subcontractor's late nomination, subcontractor's material problems, client's delay in payment, poor workmanship and claims are influenced by client characteristics. On the other hand architect's instructions, crane, timber, rock and local authority approvals, and delayed payment are influenced by project size. Other variables were found to cause delays regardless of differences in client or project size. These are underground water, late payment to subcontractors, payment of wages, rain, and shortage of cement and steel.

8.2: Conclusions

The two most significant factors that cause delays are related both to the client and the architect. The two are key project participants. In addition, the other significant factors can as well be linked to actions and omissions of the project participants because they are subject to sound project planning and control. The problem of project delays in Kenya is therefore linked to deficiency in major managerial skills by the key parties involved in the project implementation process. The poor project management practices are observed to be inherent in the client's, design team's and contractor's organisations. The specific areas of deficiency are resource planning and control, estimating, and risk estimation and management.

The construction environment also has an influence on project delays, as evidenced by price changes that affected project cash flows. This calls for the understanding and management of the characteristics of the construction environment by the parties concerned to minimize their negative influence on projects. The significance of both the physical and socio-economic construction environment implies that the parties are ill equipped with relevant knowledge and skills to understand and manage the risks posed by the project environment with respect to the implementation of projects.

The other pertinent factor is the infrastructure which regulates the project implementation. The infrastructural deficiency stems from the fact that it is not flexible to accommodate different project situations, and thus unable to support efficient project implementation systems. The use of archaic procedures and rules, techniques, and documents, some of which have outlived their relevance, compounds the problems of delays.

The objectives of this study have therefore been substantially accomplished. The significant delay causing variables have been identified and analyzed in view of the different project characteristics. The factors that contribute to most delays have also been identified. The hypothesis that the significant delay causing factors are associated with the players and stakeholders in the project process is supported, although not by all the variables identified. The influence of the factors identified in terms of causing delays is understood within the context of project management practices that emphasize, planning and control, systems theory, and risk management theory. A theory that borrows from and combines the three important project management areas has emerged. This theory can explain the problems of efficient project management with regard to time if developed further.

8.3: Recommendations

To minimise delays more efforts should be directed at the key participants in project implementation, the process and infrastructure, and the environment. The seven main causes of project delays namely financing, estimates, variations, price changes, redesign, client interference and change of mind fall in these three major areas of project implementation.

However, the problems of the environment can be addressed by the parties and the infrastructure because they are subject to the acts and omissions of the two.

Advanced skills for participants and a set of good ground rules for sound project management practices in the infrastructure are therefore necessary. This will ultimately require changes in attitude, procedures and rules used for project implementation.

Since it is the actions and omissions of people that bring about the problems of delays, the greatest impact in minimising delays and achieving efficiency in the construction process is likely to be achieved by focusing effort on the participants. Imbert (1990) points out that, the factors affecting the construction process are human. It is, therefore, the underdevelopment of the human resource which is inhibiting effective implementation of projects. Thus the recommendations of this study focus on the following aspects: clients, design team, contractors and subcontractors and the construction infrastructure.

8.3.1: Client Strategies

(1) Clients should demand better services from their agents and consultants, by insisting on good practice in areas of project planning and control, estimating, tendering, and contract administration. The participants who include designers, contractors and subcontractors, have to use advanced methods. This calls for client awareness regarding the existing good practices in the project process through training programmes such as workshops, seminars and refresher courses. The training areas should emphasise alternative project procurement, project planning and control, financing, risks and constructability enhancement.

(2) Client representatives should be made knowledgeable in the above areas.

(3) The client representatives must have authority derived from the contract relationships to demand and compel good practices from the design team, and other participants.

(4) Clients should seek adequate funding for their projects, with the issue of project finance being adequately addressed at the feasibility stage of the project.

(5) Project funding should be given an equal treatment as the design process. The design team should therefore be equally concerned about how the project will be financed by identifying interested financiers and their terms. Project financial identification and negotiation should be part of the package of services to be offered by the design team if that role is not played by the project manager or the client.

(6) The client should be encouraged and be convinced of the need for a comprehensive site investigation where necessary. The information obtained from site investigation should be used for the purpose of project documentation and also be availed to the contractor for project planning and control of site operations.

(7) The client or his representative should give clear and thorough project briefs and be able to evaluate the design proposals arising from them to select the one that best meets project goals and objectives in terms of cost, value and constructability.

(8) Clients or his representative should be responsible for the formulation of policies and guidelines in all areas of the project which determine and improve good practice and performance. Areas of concern are planning and control, information gathering to establish good data

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bases on which plans, estimates, and benchmarks of good practice can be based, and the utilisation of advanced and updated skills and methods developed to deal with the vagaries of construction.

8.3.2: The Design Team Strategies

(1) The design team should perfect their basic skills as well as master their professional skills and be able to adapt quickly to the ever changing and dynamic environment in the construction industry. This means that, in addition to practising what they profess to know meticulously, they should be able to continuously acquire new skills, in the spirit of continuous professional development.

(2) Some of the consultants in the construction industry should devote time to develop new techniques for solving the problems of the construction industry such as current project planning and control techniques, decision making techniques in uncertain circumstances and the use of computer as a tool to improve performance of manpower, versatility and familiarity with the various procurement systems.

(3) The design team should be able to prepare good feasibility studies, accurate estimates, and realistic plans utilising the current concepts such as simulation and probabilistic methods.

(4) The design team should be able to recognise and quantify project risks, calling for more attention in this area[15].

(5) The design team should be able to embrace constructability concept during design phase by being ready and receptive to the views expressed by those with construction experience who may be partners in the team in order to minimise later changes to design, and hence minimise design team risks.

(6) Constructability exercises should not only look at the efficiency of the design, by paying all the attention to the plans and specifications, but also further look at other aspects such as the contract conditions and other instruments in use as they relate and enhance project implementation, as well as team building.

(7) Design phase scheduling should be carried out early to schedule the work as expected to be done by the contractor, and also have some thoughts on such issues as procurement of materials and equipment, and identification of long lead items.

(8) There is necessity of programmes to train participants in the design process, whether architects, engineers or quantity surveyors to equip themselves with the advanced techniques of project design and management. This should be accomplished through seminars,

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[15] Some of the problems observed such as inaccurate estimates, reflect an obvious lack of mastery of the basics. If designers can take their work seriously and reduce this problem, which is within their control, time and effort can be directed to fighting the uncertain (the risks).

workshops and professional refresher courses with appropriate evaluation and certification.

(9) The other training needs should be directed at the future designers, engineers and project managers in colleges and universities. This should be done through review of the curricula being offered to include the upgraded techniques. Emphasis should, however, be placed on management related subjects, basic professional requirements, and relevant industrial training.

8.3.3: Contractors and Subcontractors Strategies

(1) Contractors should appreciate and apply advanced management methods and techniques in construction.

(2) The use of Bar Charts, Critical Path Method, PERT, Line of Balance and Multiple Activity Chart, as techniques of project planning and control should be very basic practice for the contractors project management. They should be able to exercise choice for the planning and control methods most suitable and appropriate for the tasks, depending on whether they are planning for longer time, medium or short time. This means that there is need for personnel in construction firms with planning and control skills, devoting time and effort to planning and controlling of the project.

(3) The ability to plan by contractors should not just be confined to the planning and control of operations but should also encompass such areas as finance, materials, equipment and labour. This should be enhanced by application of advanced techniques such as cash flows using S-curves, materials inventory control, efficient utilisation of the equipment, and worker motivation.

(4) Contractors should be equipped with risk management concepts.

(5) The risk of weather should be addressed adequately by liaising with the meteorological department, and utilising the weather information for project planning and control, and utilize this knowledge to identify and respond effectively to the risks. They should also be able to detect efforts by other project team members to transfer all the risks to their side at various project stages such as project documentation, design, site, contracts, tendering procedures, and also in the physical environment.

(6) Contractors in the field need training in areas such as project management, planning and control, risk management, estimating, value engineering, construction techniques, partnering, materials management, plant management, financial management, and labour resource management. The training should be carried out through, seminars, workshops, and short and refresher courses.

(7) Future contractors should be trained at both university and college levels with a comprehensive curricula emphasising the above training

needs. Alternative existing programmes should be reviewed to allow for flexibility for interested students to have an inclination towards construction.

(8) Contractor registration should be stricter, requiring contractors to have extra qualities alongside sound equipment and finances, to employ competent managers at various levels of the project organisation, extending to the project site. In addition, they should have technically qualified employees with proven skills.

(9) There should be a body established to regulate the activities of contractors, independent of the Ministry of Works. The body can also be responsible for contractor registration, and develop guidelines that can suit all types of clients.

(10) Suppliers, plant hirers, financiers and local authorities, among others, should support the improvement in performance of the construction industry. They should be sensitised to be aware of the mechanisms, needs and problems of the construction industry. They could be encouraged to develop policies that could suit the needs of the construction industry in such areas as project funding, equipment acquisition assistance, material supply and transport.

8.3.4: The Construction Infrastructure

(1) The appointment of consultants needs to be standardised to take into account the risk of engaging incompetent consultants. The procedure should be able to detect incompetence in consultants and to satisfy a set scale of necessary skills and expertise for the works needed to be carried out. Appointment of consultants should not only emphasise the professional expertise but also further demand good managerial skills in specialised areas of planning and control, and risk management. Further reference on the success of the consultant based on experience should be emphasised by scrutinising past project success in terms of cost, time and quality performance.

(2) A mechanism should be developed for client evaluation with respect to their commitment to project implementation and performance. For example, the history of client payment default can be detected at this stage and the necessary action taken.

(3) A procedure should be developed on the evaluation of the best suited and alternative procurement systems with respect to a given project. This should assist in providing flexibility in project procurement for different project circumstances as opposed to the current monopolistic traditional approach.

(4) There is a great need for the revision of the scale of fees charged by consultants to be based on output rather than a percentage to avoid rewarding consultants for their inefficiency. This would greatly

encourage good practice so that consultants can share in the project risk including those generated by them.

(5) Formal and standardised contracts should be signed between clients and consultants, with articles and conditions of agreement including issues such as the expected services and output required, mode of payment and dispute resolution spelt out. Such a contract should envisage the risks that clients and consultants are exposed to in their relationship, and assist to develop a system of apportioning the risks in the most appropriate manner.

(6) A system should be developed for evaluation of the various tendering procedures and allow clients and consultants flexibility in the choice and usage of the options available to them. A comprehensive guide to tendering should be produced advising clients and others on the choices available, and the merits and demerits of each, and set out the best practice with each option.

(7) There is need to develop elaborate and clear guidelines on the pre-qualification of contractors which should be used by clients, designers and project managers. These guidelines should incorporate work experiençe, work force, equipment, financial stability, managerial capabilities, organisational skills, purchasing and material handling, scheduling, safety, and quality control. Past performance of the contractors and the quality of staff employed are also important. The

analysis should emphasise staff managerial skills, particularly, planning and control, and good industrial relations record among others.

(8) The methods of evaluating contractors bids need to be reviewed to consider more than the lowest bidder and should be tied to the accuracy of the tender in pricing and time estimation.

(9) The contract between clients and contractors needs review to apportion the risks appropriately and the conditions to reflect the current changes in the construction industry, by considering general current good construction practice.

(10) Relationships between consultants and contractors should be more clearly defined in the conditions of contract and be enforced to enable a level playing field in the project by all the parties.

(11) There is need to review construction related legislation governing practice of consultants. For example. the cap 525 and the Ministry of Public Works schedule of fees need review to bring them in line with the expected changes in the industry. Also requiring review are the established institutions for consultants and contractors such as the Architectural Association of Kenya (AAK), Institute of Engineers of Kenya (IEK), Institute of Quantity Surveyors of Kenya (IQSK) and Kenya Association of Building and Civil Engineering Contractors (KABCEC). They should redefine their objectives and aims, restructuring them to conform to changes in the industry. They will

also be expected to play a leading role as instruments of change, for training, good practice and professional ethics.

(12) Post completion analysis of projects is important to gain a better understanding of performance level achieved in projects and the means used to achieve that level. This will provide information for data bases for future reference. This should be emphasised in the contracts and be enforced.

(13) There is need for change in the culture and attitudes of the construction practitioners as well as the general public. The first and important step is for the parties to realise their limitations and problems of the current practice and be willing to learn and change to new ideas which are for the good of the industry. This change can be facilitated by the socio-cultural change in the wider society. The society should embrace a culture of excellence and be sensitive to anything that is to the contrary.

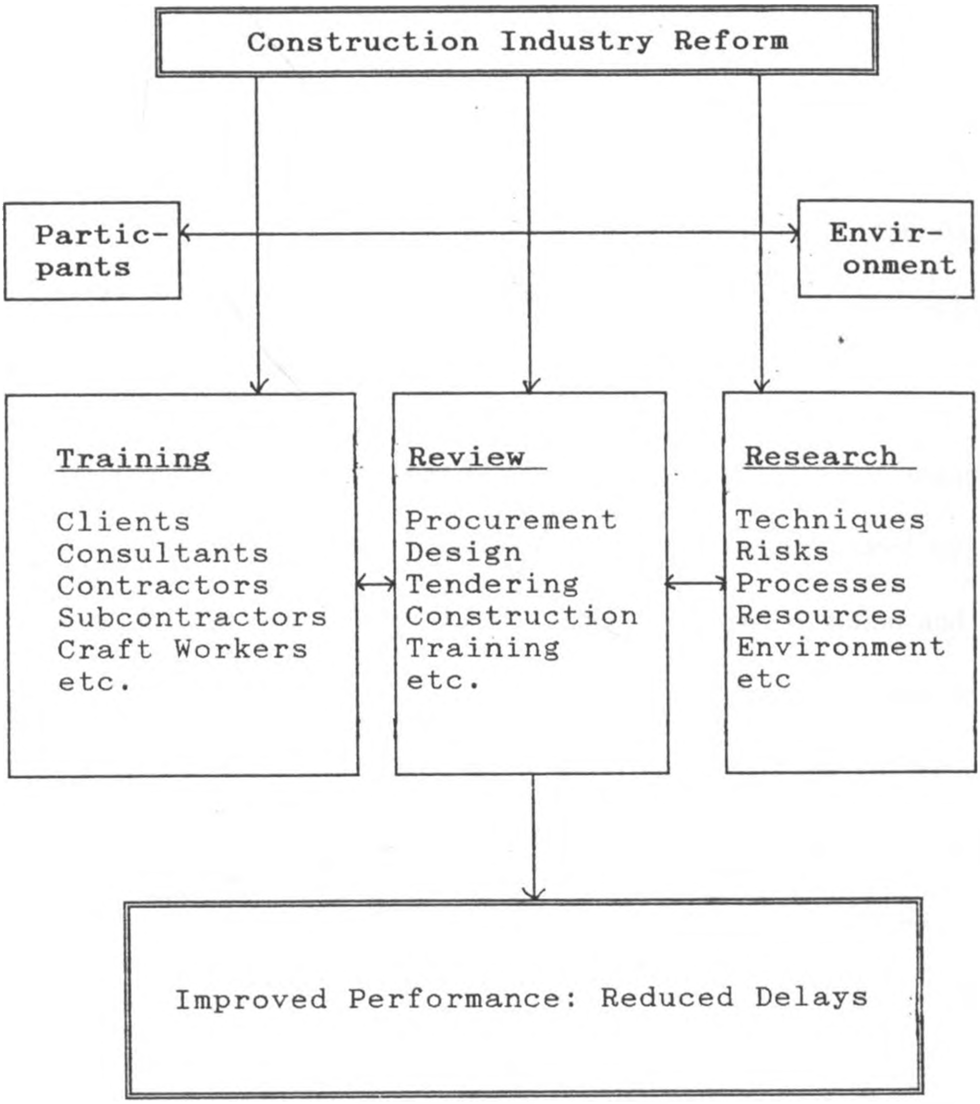
(14) The government should focus attention on the needs of the construction industry by formulating policies through its development programmes and other instruments geared towards the development of the industry through research and education.

8.3.5: Construction Industry Reform Model

An overview of the recommended changes in the construction industry is depicted in Figure 8.1. The recommended changes call for a reform in the construction industry in Kenya. The first attribute focuses on training at all levels of the construction industry. The training should aim at upgrading the skills for better and advanced methods of project management as well as efficient performance of trades. The other attribute focuses on the review of the existing rules, procedures and institutions in the construction infrastructure to embrace good practice and reflect the expected continuous developments in the construction industry. An element inherent in this review is the review of the existing curricula for training personnel in the construction industry at all levels, starting at the trades to the institutions of higher learning.

The other facet is the promotion of research interest in the construction industry in Kenya. The research attribute will provide the training and review attributes with the necessary findings and recommendations that will form a basis for implementation in those areas. The research should be continuous and to cover all areas of project and construction management including procurement, methods and techniques, resources, risks and environment.

Figure 8.1: Construction Industry Reform Model



Source: Author's Own Construct

The training and review areas will provide the research aspect with the required research problems.

8.3.6: Construction Industry Research and Development Institute(CIRDI)

The recommendations discussed in the foregoing are quite widespread in the construction industry as they have far reaching implications, and may encounter resistance by some of the project participants.

The expected changes can be realised more appropriately by a concerted effort of not only the Kenyan public, government and social institutions in Kenya, but may involve international institutions who may be holding a stake in some of the projects implemented in Kenya.

The construction industry in Kenya needs reorganisation in an ordered direction with guidance from one focal point. There is therefore need for an agency whose main objective will be to bring order and direction and to promote development in the construction industry. A government sponsored agency supported by all the industry participants, and which can oversee and guide review, research, training and development in the construction industry needs to be formed. Other countries of the world have seen the need for such agencies. These include the Construction Industry Development Board (CIDB) of Singapore, the Construction Industry Board (CIB) of United Kingdom and the Construction Industry Board (CIB) of Malaysia. These agencies, and many others around the world have been responsible for the success of the construction industries in the countries in which they are formed. A similar agency in Kenya will formulate policies to assist the government for long term planning of the national economy with the recognition of construction as a distinct sector and key player in the socio-economic development process. The agency is expected to work with participants in the construction industry, in a participatory manner for the purpose of establishing their needs and formulating solutions for their problems. The agency will also be charged with the task of developing, improving and expanding the construction industry through the development of guidelines and benchmarks for good practice, and promotion of training programmes at all levels of the industry. It will also initiate reviews to the existing procedures and practices with a view of continuously bringing them in line with established benchmarks of good practice.

The agency will coordinate research in all areas of the construction industry, collaborate and network with other research institutions and similar organisations both locally and internationally for exchange of information and establishment of its benchmarks for training and practice in the construction industry.

8.4: Areas of Further Research.

(1) Further research needs to be carried out on client project financing, to find out how it is done and establish whether it meets the universal project financing theory and the international project financing practice. The influence of the construction external players, such as financiers and suppliers needs to be studied so that it is understood, and recommend suitable modes of relationships with the construction industry which can harmonise these interrelationships.

(2) Research is necessary to develop a model of using constructability in the design and construction processes to improve the quality of design.

(3) There is need for research in the areas of project estimating and price changes to develop surrogates of measurement of these factors.

(4) It is necessary to device units of measurement that can quantify the delay causing factors, especially financing and constructability, and establish the optimum required for project success. This may form a basis for developing a benchmark not only for project funding and constructability enhancement but for updated project time management.

(5) The proposed agency needs research to establish its nature, composition, and legal stature in the construction industry and also in the national economy.

(6) Areas needing reviews, such as procurement, tendering, contracts, risk redistribution and training, need further research to establish how best they should be carried.

The future and improvement of the performance of the construction industry in Kenya with respect to the time management and indeed any other aspect of construction lies in research. This study has proposed the spectrum and direction of research in the construction in industry. The challenge ahead is to make research part and parcel of the process of construction, and to utilize the result therefrom for the benefit of the construction industry.

REFERENCES

Abbott, D., (1987), **Encyclopedia of Real Estate Terms,** Gower Technical Press Ltd, Hants

Abdou, O. A., (1996), "Managing Construction Risk", **Journal of Architectural Engineering, ASCE**, Vol.2, No.1, pp.3-10

Abdul-Rahman, H., and Alidrisyi, M. N., (1994), "A Perspective of Materials Management Practices in a Fast Developing Economy: A case of Malaysia", **Construction Management and Economics**, Vol.12, pp. 413-422

Adwera, L.A., (1991), "Construction and Project Management Practices in Kenya, An Exploratory Study", Unpublished BA Project, Department of Building Economics and Management, University of Nairobi.

Ahuja, H. N. (1976), **Construction Performance Control by Networks**, Wiley, New York.

Ahuja, H. N. et al, (1985), "Simulation model to forecast project Completion Time" **Journal of the Construction Division, ASCE,** Vol.III, No.4

Ahuja, H. N., (1984), **Project Management: Techniques in Planning and Controlling Projects**, Wiley, New York.

Al-Hammad, A. M. and Al-Hammad,I.,(1996)."Interface Problems Between Building Owners and Designers", **Journal of Performance of Constructed Facilities**, Vol.10. No.3, pp.123-126

Aniekwu, A. N. and Okpala, C .D., (1988), "The Effects of Systematic Factors on Contract Services in Nigeria", **Construction Management and Economics**, Vol.6, pp.171-182

Antill, J.M. and Woodhead, R.W.,(1982), **Critical Path Methods in Construction Practice**, Wiley, New York

Ayyub, B.M., et al, (1984), "Project Scheduling Using Fuzzy Set Concepts", **Journal of the Construction Division, ASCE**, Vol.110, No.2, PP. 132 - 145

Baldwin, J.R., and Manthei, J. M.,(1971), "Causes of Delay in the Construction Industry", **Journal of the Construction Division, Proceedings of the American Society of Civil Engineers**, Vol. 97, No.C02, pp.177-187.

Baldwin, M. and Barry, A. J., (1974), "Site Investigation and Laboratory Testing of Soils", **Build International**, Vol.7,pp.424-450

Baradyana, J.S. (1996), "Delays: A Major Management Problem for Construction Projects in the East African Region: The case for Tanzania", Paper presented at the regional conference on construction project management, 20th-23rd November, Garden Hotel, Machakos

Beishon, J., (1980), **Systems Organisations : The Management of Complexity**, The Open University Press, Milton Keynes

Berkeley, D., Humphrey, D. C., and Thomas R. D., (1991)," Project Risk Action Management", **Construction Management and Economics**, vol. 9, pp3-17.

Betts, M., and McGeorge, D., (1988), "A Systems Approach to Life Cycle Costs Appraisal", **Australian Institute of Building Papers**, vol.3

Bhuta, C. J., (1992), "Management of Risks in Projects", **The Chartered Builder**, August p.25.

Birdsall, G. C., and Woodhead, R. W., (1978),"An Integrated Approach to Materials Handling", **Chartered Builder**, Vol.21 Dec/Feb, pp.25-29

Bowen, P. A., (1981),"Problems in Econometric Cost Modelling", **The Quantity Surveyor**, May.

Bresnen, M. J. and Haslam, C. O., (1991), "Construction Industry Clients : A Survey of Their Attributes and Project Management Attitudes", **Construction Management and Economics**, Vol.9, pp.327-342

Bromilow, F. J.,(1969),"Contract Time Performance: Expectation and the Reality", **Building Forum**, Sept, pp.70-80

Bromilow, F. J., (1970) "The Nature and Extent of Variations to Building Contracts," **The Building Economist,** November, pp.93-94

Bromilow, F. J., (1974), "Measurement and Scheduling of Construction Time Performance in the Construction Industry", **Official Journal of the Australian Institute of Building**, June, pp.57-65

Bromilow, F. J., (1971),"Contracts as Waste Generators", **Building Forum,** March, pp.5-11

Bubshait, A. A. and Al-Gobali, K. H.,(1996), "Contractor Prequalification in Saudi Arabia", **Journal of Management in Engineering**, Vol.12, No.2, April, pp. 50 -54

Calvert, R. E., Bailey, G., Coles,D. (1995), **Introduction to Building Management, 6th edition,** Butterworth-Heinemann Ltd, Oxford, pp.206-287

Carr, et al, (1974), "Planning Construction of Repetitive Building Units", **Journal of the Construction Division, ASCE**, Vol.100, No.C03, pp. 156-179

Ceran, T. and Dorman, A. A., (1995),"The Complete Project Manager", **Journal of Architectural Engineering**, June, Vol.1, No.2, pp.67-72

Chan, A. P. C., Yeung, C. M and Tam, C. M.,(1995),"Effective Measures of Reducing Variations: An Australian Perspective", **Australian Institute of Building Papers**, Vol.6, pp.113-120

Chan, D. W. M., and Kumaraswamy, M. M.,(1995), "A Study of Factors Affecting Construction Durations in Hong Kong", **Construction Management and Economics**, Vol.13, pp.319-333

Cleland D. I. and King, W. R. (1985), **Systems Analysis and Project Management,** McGraw Hill, New York

Clough, R. H. and Sears G. A., (1991), **Construction Project Management, 3rd edition**, John Wiley and Sons, Inc., New York, pp. 53-113.

Conillard, J., (1995), "The Role of Project Risk in Determining Project Management Approach",**Project Management Journal**, December, pp.3-15

Cormican, D., (1985), **Construction Management: Planning and Finance**, Longman group Ltd, London, Cowell, A. S. T. (1974), "How We Shall Tell the Time", **Building Technology and Management**, March, pp.12-14

Cox, M. A. A., (1995), "Simple Normal Approximation to the Completion Time Distribution for a PERT Network", **International Journal of Project Management**, Vol.13, No.4, pp.265-270

Crockett, V. G., (1988), **An Introduction to Statistical Techniques in Social Sciences Using SPSS(x)**, Roleystone, Western Australia, Quoll Enterprises

Crowley, L. G. and Karim, M. A., (1995), "Conceptual Model of Partnering", **Journal of Management in Engineering**, Vol. 11, No.5, Oct., pp.40-44.

Daily Nation, April 26, 1992

Daily Nation, June 13, 1992

Daily Nation, April 12, 1992

Diekmann, J. E., and Girard, M.,(1995), "Are Contract Disputes Predictable?", **Journal of Construction Engineering and Management**, ASCE, Vol 121, No.4, Dec. pp.355-363.

Dlakwa, M. M., and Culpin, M. F., (1990), "Reasons for Overruns in Public Sector Construction Projects in Nigeria", **International Journal of Project Management**, Vol.14, No.1, pp.237-241

Douglas, J., (1978),"Equipment Costs by Current Methods", **Journal of Construction Division, Proceeding of the American Society of Civil Engineers**, ASCE, Vol.104, No. C02, June, PP.191-205.

Eldin, N. N., (1988), "Constructability Improvement of Project Designs", **Journal of Construction Engineering and Management, ASCE**, Vol. 114 No. 4 , pp. 631- 640

Fisher, D., Miertschins, S, Pollock D. R, (1995), "Benchmarking in the construction industry", **Journal of Management in Engineering**, Vol.11, No.1, pp.50-57

Fisher, G. J., (1974), "Industrialization and Dimensional Coordination in Building", **The Quantity Surveyor,** October, pp. 66-69.

Forster, J. S., Harington, R.,(1977), **Structure and Fabric Part 2,** B. T. Batsford Limited, London

Franks, J., (1982a), "The Traditional System of Managing the Building Process", **Building Trades Journal**, November, pp.50-52

Franks, J., (1982b), "The Package-deal System Has All the Client's Building Needs", **Building Trades Journal,** December, pp.22 - 28.

Gall, M.D., Borg, W.R., Gall, J.P., (1996), **Educational Research, 'An Introduction, Sixth edition**, Longman Publishers, New York

Gates, M., and Scarpa, A., (1980), "Criteria for Selection of Construction Equipment", **Journal of Construction Division, Proceedings of the American Society of Civil Engineers**, Vol.106 No.c03 June, pp.207-219

Gibson Jr., G. E., Kaczmarowski, J. H., Lore jr. H. E., (1995), "Project Planning Process for Capital Facilities", **Journal of Construction Engineering and Management**, Vol.121, No.3, pp. 312-318

Gidado, K. I., (1996), "Project Complexity: The Focal Point of Construction Production Planning", **Construction Management and Economics**, Vol.14. pp.213-225

Glavinich, T. E., (1995), "Improving Constructability During Design", **Journal of Construction Engineering and Management, ASCE**, Vol. 1, No. 2 , June , pp.73-76

Habitat, (1982), **Role and Contribution of the Construction Industry to Socio-economic Growth of Developing Economies**, GMT, inc, Cambridge

Hamiton M. R., and Gibson, Jr., G.E., (1996), "Benchmarking pre-project Planning Effort", **Journal of Management in Engineering,** Vol.12, No.2

Hampton, D., (1994), "Procurement Issues", **Journal of Management in Engineering**, Vol.10, No.6, pp.45-49

Harding, P., (1980), "Why Organisation can be Disjointed and Bewildering", **Building Trades Journal,** April, pp. 56 - 59.

Harper, W.M., (1994), **Statistics, sixth edition**, M&E Handbook Series, Pitman Publishing, London

Harris, F. and McCaffer, R. (1989), **Modern Construction Management, 3rd Edition**, BSP professional books, London.

Harris, R. (1978), **Precedence and Arrow Networking Techniques for Construction**, John Wiley and Sons,Inc, New York

Harris, R. P., (1976), "The Time Element (Part 1)", **The Quantity Surveyor**, pp. 49-53.

Hendrickson, C. et al, (1987) "Construction Expert System for Construction Planning", **Journal of Computing in Civil Engineering,** vol.1, No.4, P.253.

Hinze, J., and Ashton, W. B., (1981), "Financial Management Practices in Utility Construction Firms", **Journal of the Construction Division, Proceedings of the American Society of Civil Engineers, ASCE,** Vol.107, No.co3, Sept. pp.469-485

Hinze, J., and Ashton, W. B.,(1979), "Construction Equipment Policies of Utility Contractors", **Journal of Construction Division, Proceedings of the American Society of Civil Engineers, ASCE**, Vol.105, No.C03, Sept, pp.225-235

Holmes, R., (1983), **Introduction to Civil Engineering Construction**, College of Estate Management, Reading.

Hughes, W. P., (1989),"Identifying the Environments of Construction Projects", **Construction Management and Economics**, vol 7, PP.

Imbert, I. D. C., (1990),"Human Issues Affecting Construction in Developing Countries", **Construction Management and Economics**, Vol.8, pp.219- 228

Isaac, I., (1995), "Training in Risk Management", **International Journal of Project Management**, Vol.13, No.4, pp.225-229

Janney, J. R., Vince C. R., and Madsen, J. D., (1996), "Claims Analysis from Risk Retention Professional Liability Group", **Journal of Performance of Constructed Facilities**, Vol. 10, No.3, pp.115-122

Kartam, N. A. et al, (1990), "Intelligent Planning of Construction Projects" **Journal of Computing in Civil Engineering,** Vol. 4, No.2

Kenya Times, May 13, 1991

Kettle, K. A., (1976), "Project Delivery Systems for Construction", **Journal of the Construction Division, Proceedings of the American Society of Civil Engineers, ASCE**, Vol.101, No. C04, December, pp.575-585.

Khang'ati, A.,(1986),"The Implementation of Public Building Projects. A case Study of Ministry of Public Works. Housing and Physical Planning", Unpublished MA Thesis, University of Nairobi

Kirby, J. G., Furry, D. A. & Hicks, D. K.,(1988),"Improvement in Design Review Management", **Journal of Construction Engineering and Management**, ASCE , Vol.114, No.1 March. pp.69-82

Kithinji, N. B, (1988), "Systems Approach to Building Project Management: Experience from Kenya", Unpublished M.A Thesis, University of Nairobi

Kometa S. T., Olomolanje, P. O, and Harris F. C., (1996), "Validation of the Model for Evaluating Client Generated Risks by Project Consultants", **Construction Management and Economics**, Vol.14, pp.131-145

Koontz, et al, (1984), **Management** McGraw-Hill, Singapore

Krantz, L. G., (1976), "Management in High Risk Areas" **The Quantity Surveyor,** September, pp. 26-29.

Lang, G., Heiss, G.D., (1994), **A Practical Guide to Research Methods**, Fifth Edition, University Press of America Inc. Lan Ham

Lansford, B., and Skukhart, G.,(1986), "Attributes of Materials Management Systems", **Journal of Construction Engineering and Management, ASCE**, Vol.112 No.1, march. pp.14-21

Lapin, L.L., (1982), **Statistics for Modern Business Decisions**, Third Edition, Harcourt Brace Jovanovich, Inc., New York

Laufer, A. and Howell, G. A., (1993), "Construction Planning: Revising the Paradigm", **Project Management Journal**, Vol.xxv, No.3, pp.23-32

Laufer, A., (1990), "Essentials of Project Planning: Owners Perspective", **Journal of Management in Engineering,** Vol.6, No.2, PP. 107-119

Laufer, A., et al, (1987),"Is Construction Project Planning Really Doing its Job? A Critical Examination of Focus, Role and Process", **Construction Management and Economics**, pp 243-266.

Lema, N. M. and Price, A.D.F.(1995), "Benchmarking Performance Improvement Towards Competitive Advantage", **Journal of Management in Engineering**, Vol.11, NO.1, PP.28-37

Levido, G. E., et al,(1981), "Contract Performance with Various Non Traditional Forms of Contract", Report on a Research Project on the Project Managers Forum, School of Building, University of New South Wales, November.

Mathur, K. S., (1987),"Simulation Applied to Cost Prediction", **Australian Institute of Building Papers**, Vol.2, pp.13-29

May, G. J.,(1982), "Project Planning and Progress Control: An Overview of the Problems Related to the Implementation of Planning"., Unpublished Msc. Thesis, University of New South Wales.

Mbatha, C. M.,(1986), "Building Contract Performance, A Case Study of Government Projects, Kenya", Unpublished MA Thesis, University of Nairobi

Mbatha, C. M., (1993), "The Management of Building Projects, Analysis of Building Procurement Systems, Features, and Conception of an

Appropriate Project Management System for Kenya", PhD Thesis, Wuppertal University, Germany

Mbaya, J. S., (1984), "The Management of Public Sector Construction Projects in Kenya: A Systems and Contingency Approach", Unpublished Msc. Thesis, University of London

Mbeche, I. M. and Mwandali, D. N. , (1996), "Management by Projects", Paper presented at the regional conference on construction project management, 20th-23rd November, Garden Hotel, Machakos

Morris, P. W. G., (1973),"An Organisation Analysis of Project Management in the Building Industry", **Build International**, Vol.6 pp.595-616

Morris, W. G.,(1986), "Project Management : A View from Oxford, **International Journal of Project Management and Technology**, vol.1 no.1, pp 36-52.

Mwangi, C. M.,(1986),"The Bill of Quantities as a Means of Communication in the Construction Industry", Unpublished BA Project Report, University of Nairobi.

Mwangi, C. M, (1988), "Safety Management on Construction Sites in Kenya", Unpublished MA Thesis, University of Nairobi

Newcombe, R., Langford D. and Fellow R., (1990), **Construction Management**, Mitchel, London

Newton, S.,(1992), "Methods of Analysing Risk Exposure in the Cost Estimate of High Quality Offices", **Construction Management and Economics**, Vol. 10, pp.443-449

Nkado, R. N.,(1992), "Construction Time Information System for the Construction Industry", **Construction Management and Economics**, vol.10, pp.489-509.

Nkado, R. N.,(1995), "Construction Influencing Factors: The Contractors Perspective", **Construction Management and Economics**, Vol.13, pp.81-89

O'connor, J. T., and Davis, V. S., (1988)," Constructability Improvement During Field Operations", **Journal of Construction Engineering and Management**, ASCE, Vol.114, No.4 Dec. pp. 548-564

Ofori, G., (1991), "Programmes for Improving the Performance of Contracting Firms in Developing Countries: A Review of Approaches and Appropriate Options", **Construction Management and Economics**, Vol.9, pp.19-38

Ogunlana S.O., Promkuntong, K. and Jearkjirm V.,(1996), "Construction Delays in a Fast Growing Economy: Comparing Thailand with other Economies", **International Journal of Project Management**, Vol.14 No.1, pp.37-45

Oxley, R. and Poskitt, J., (1986), **Management Techniques Applied to the Construction Industry**, Crosby Lockwood, London

Pilcher, R., (1992), **Principles of Construction Management, 3rd Edition**, McGraw Hill Book company, London, pp.272-373

Powys, R.O. (1981),"Improving Communication in the Construction Industry, Communication Affacting the client", **The Building Economist**, June, pp.9-11

Ramus, J.W., (1981), **Contract Practice for Quantity Surveyors**, Heinemann, London

Republic of Kenya, (1995), **Statistical Abstract**, Government Printers, Nairobi

Republic of Kenya, (1994), **Development Plan**: 1994-1996, Government Printers, Nairobi.

Russel, J. S., et al, (1996), "Development of a Predictive Tool for Continuous Assessment of Project Performance", Seminar Paper, 4[TH] June, University of New South Wales.

Sandstrom, G. E.,(1970), **Man the Builder**, McGrawhill Book Company, New York

Sanvido, V. E., and Norton, K. J., (1994), "Integrated Design Process Model", **Journal of Management in Engineering, ASCE**, Vol. 10 No. 5, pp. 55-62

Sasieni, M. W., (1986), "A Note of PERT Time", **Management Science**, Vol.32, No.12, pp.1652-1653.

Schexnayder, C. J., and Hancher, D. E.,(1981),"Contractor Equipment Management Practices", **Journal of the Construction Division, Proceedings of the American Society of Civil Engineers, ASCE**, Vol.107, No.c04 Dec. pp.619-627

Sidwell, A. C.,(1984),"The Time Performance of Construction Projects", **Architectural Science Review**, Vol. 27, No. 4, pp.85-87

Sidwell, A. C., (1990), "Project Management Dynamics and Performance", **Construction Management and Economics,** Vol.8, pp.159-178

Stevens, J. D., and Al-Dulaijan, S. U.,(1989),"Contractor Financing Public Works in Saudi Arabia", **Journal of Construction Engineering and Management**, Vol.115, No.1, March, pp.1-14

Syagga, P. M.,(1985),"The Impact of Building Design on Maintenance Costs of Residential Housing Estates owned by Mombasa Municipal council", Unpublihed PhD Thesis, Department of Land Development, University of Nairobi, p.188.

Talukhaba, A. A.,(1988),"Time and Cost Performance of Construction Projects", Unpublished MA Thesis, University of Nairobi

Tatum, C. B., (1987) "Improving Constructibility During Conceptual planning", **Journal of Construction Engineering and Management,** Vol.113, No.2, PP. 57-75

Thierauf, R. J. and Klekamp, R.c., (1975), **Decision Making Through Operations Research, 2nd Edition**, New York, John Wiley and Sons Inc., p.125

Thomas, R. H, Sanvido, V. E., and Sanders, S.R.(1989), "Impact of Materials Management on Productivity: A Ccase study", **Journal of Construction Engineering and Management, ASCE**, Vol 115, No. 3, Sept., pp. 370-385

Toakley, A. R., (1995a), "Risk Analysis Techniques", **Australian Institute of Building Papers**, Vol.6, pp. 69-75

Toakley, A. R.,(1995b), "Risk Management Application, A Review", **Australian Institute of Building Papers**, Vol.6, pp.78-87

Toakley, R. A., (1990),"The Nature of Risk and Uncertainty in Building Procurement process", **Australian Institute of Building Papers**, vol.4, pp 171-181

Trickey, G., (1990), **The Presentation and Settlement of Contractors Claims**, E.&F.N. Spon, Chapman and Hall, London.

Tullock, S., (1993), **Readers Digest Wordfinder,** Oxford, Clarendon Press

Uher, T. E. (1988), "Australian Subcontracting Practice", **Australian Institute of Building Papers**, Vol.3. pp.61-69

Uher, T. E., (1996a), "A Probabilistic Cost Estimating Model", **Cost Engineering**, Vol.38 No.4, April, pp. 33-38

Uher, T. E.,(1996b), "Cost Estimating Practises in Australian Construction", **Blackwell Science Ltd, Engineering Construction and Architectural Management,** Vol.1, No.2, pp. 83-95

Uher, T. E., (1994), "A General Risk Classification Model", **Australian Institute of Building Papers**, Vol.5, pp.25-33

Uher, T. E.,(1991),"Risks in Subcontracting , Subcontract Conditions", **Construction Management and Economics**, Vol.9, pp.495-508

Uher, T. E. and Levido G.,(1992), **Project Planning and Control**, School of Building, University of New South Wales.

Van Houtte, V., (1988), "Professional Liability Risk in Construction, Damages which are not caused by Negligence", **Building Research and Practice, The Journal of CIB**, November, pp.352-355

Vorster, M. C., and Sears, G. A.,(1987), "Model of Retiring, Replacing and Reassigning Construction Equipment", **Journal of Construction Engineering and Management,** ASCE, Vol.113, No.1, March, pp. 1125-137

Wachira, I. N., (1994), "A Missing Link in the Kenyan Construction Industry: Planning and Scheduling", **Construction Review**, October, pp.28-33

Waithaka, A., (1988), "The Relevance of Timber Prefabrication to Housing Production in Kenya", Unpublished M.A. Thesis, University of Nairobi

Walker, A., (1989), **Project Management in Construction**, London, BSP Professional Books.

Walker, D. H. T.,(1995),"An Investigation into Construction Time Performance", **Construction Management and Economics**, Vol.13, pp.263-274

Walker, D. H. T.,(1990), "Diversity in Management Structures on Construction Sites in Australia", **Australian Institute of Building Papers**. Vol.4, pp. 3-17

Walkerdine, J., (1982), "An Architects View of Site Managers", **Building Technology and Management**, April, pp.13-17

Wells, J., (1993), "Appropriate Building Technologies: An Appraisal Based on Case Studies on Building Projects in Senegal and Kenya", **Construction Management and Economics**, Vol.11, pp.203-216

Wilson, R. A., Songer, A. D., and Diekmann, J.,(1995), "Partnering; More Than a Workshop, a Catalyst for Change", **Journal of Management in Engineering**, Vol.11, No. 5, Sept. pp. 40-44

Yeo, K. T., (1990), "Risks, Classification of Estimates and Contingency Management", **Journal of Management in Engineering**, Vol.6, No.4, pp.450-470

Young, G., (1971), "Building Organisations and Contractual Procedure Past and Present", **Building Forum**, Sept.,pp.67-74

Zhi, He, (1995), "Risk Management for Overseas Construction Projects", **International Journal of Project Management**, Vol.13, No. 4, pp.231-237

APPENDIX "A": QUESTIONNAIRE

DECLARATION

ANSWERS TO QUESTIONS CONTAINED IN THIS QUESTIONNAIRE

WILL BE KEPT CONFIDENTIAL

Topic

AN INVESTIGATION INTO FACTORS CAUSING CONSTRUCTION

PROJECT DELAYS IN KENYA

A Case Study of High Rise Buildings in Nairobi

<u>ADDRESSED TO</u>

1. Project Managers
2. Architects
3. Engineers
4. Quantity Surveyors
5. Contractors
6. Site Agents
7. Clerks of Works
8. Foremen

QUESTIONNAIRE NUMBER ______________________________

ENUMERATOR NUMBER ________________________________

DATE: D/M/Y __________/____________/______________

PART A: BACKGROUND INFORMATION

1. Project ______________________________

2. Client ______________________________

3. Contractor ___________________________

4. Contract Period ____________________ Months/Weeks

5. Period Spent _______________________ Months/Weeks

6. Period of delay ____________________ Months/Weeks

7. PART B: FACTORS CAUSING PROJECT DELAYS

During the period of construction, for how long did the factors given cause delay in the project?

(A)

Design Change	No. of days	Why	Solution
1. Client's instructions			
2. Architect's instructions			
3. Contractor's Problems			
4. Subcontractor's Problems			
5. Others (Specify)			

(B)

Subsoil Conditions	No. of days	Why	Solution
1. Black Cotton Soil			
2. Rock			
3. Normal Soil			
4. Underground Water			
5. Running Sand			
6. Others (Specify)			

(C)

Subcontractor's Problems	No. of days	Why	Solution
1. Late Nomination			
2. Poor Workmanship			
3. Labour Problems			
4. Material Problems			
5. Late Payment			
6. Others (Specify)			

(D)

Contractual Disputes	No. of days	Why	Solution
1. Poor workmanship			
2. Variations			
3. Claims			
4. Others (Specify)			

(E)

Industrial Disputes	No. of days	Why	Solution
1. Wages			
2. Safety			
3. Welfare			
4. Others (Specify)			

(F)

Sample of Materials or Work Approvals What Samples	No. of days	Why	Solution
1. By Architect			
2. By Client			
3. By Engineer			
4. Others (Specify)			

(G)

Weather Conditions	No. of Days	Why	Solution
1. Rain			
2. Hot Temperatures			
3. Cold Temperatures			
4. Others (Specify)			

(H)

Material Shortages	No. of Days	Why	Solution
1. Cement			
2. Steel			
3. Timber			
4. Sand			
5. Ballast			
6. Others (Specify)			

(I)

Equipment Breakdown	No. of Days	Why	Solution
1. Crane			
2. Mixer			
3. Excavator			
4. Vibrator			
5. Transport Equipment e.g. Lorries, Pick-ups			

(J)

Financial Problems	No. of Days	Why	Solution
1. Payment by Clients			
2. Architect's Certificates			
3. Contractor's Cash flow			
4. Others (Specify)			

(K)

Local Authority Approvals	No. of Days	Why	Solution
1. Foundations			
2. Steel			
3. Others (Specify)			

(L)

Labour Availability	No. of Days	Why	Solution
1. Skilled			
2. Unskilled			
3. Others (Specify)			

(M)

Accidents	No. of Days	Why	Solution
1. Fatal			
2. Serious Injuries			
3. Minor Injuries			
4. Others (Specify)			

(N)

Politics	No. of Days	Why	Solution
1. Politician's Interference			
2. Political Wrangling between workers			
3. Political Decrees			
4. Others (Specify)			

(O)

Availability of Manufactured Items	No. of Days	Why	Solution
Specify the items			

(P)

Permits/Licences (Specify the permit)	No. of Days	Why	Solution
1. Central Government			
2. Local Authority			
3. KP & L Co.			
4. KP & TC			
5. Others (Specify)			

(Q)

Shop Drawings	No. of Days	Why	Solution
1. Preparation			
2. Approval			
3. Others (Specify)			

(R)

Materials Testing	No. of Days	Why	Solution
1. Sand			
2. Ballast			
3. Soils			
4. Steel			
5. Concrete			
6. Timber			
7. Others (Specify)			

(S)

Any Other Problems not mentioned above	No. of Days	Why	Solution
1.			
2.			
3.			
4.			
5.			

APPENDIX 'B':HYPOTHESIS TESTING WITH MEAN SCORES RESULTS

Table B.1: Design Changes Critical Values compared with Mean Scores.

Design changes	Confidence Interval 99%	Critical Value	Mean Score	Decision .
Client's Instructions				
Overall	n=38	2.026	2.350	Reject Ho
Public	n=11	1.440	1.727	,,
Private	n=27	1.918	2.552	,,
>KSh. 50M	n=14	1.653	2.313	,,
Ksh 50-100M	n=13	1.475	2.385	,,
<Ksh. 100M	n=11	1.365	2.364	,,
Architect's Instructions				
Overall	Ditto	2.059	2.875	Reject Ho
Public		1.730	3.364	,,
Private		1.924	2.690	,,
>KSh 50M		1.643	2.500	,,
Ksh 50-100M		1.582	2.769	,,
<Ksh 100M		1.927	3.545	,,
Contractor's Instructions				
Overall	Ditto	2.093	1.500	Accept Ho
Public		1.637	1.455	,,
Private		1.972	1.517	,,
>KSh 50M		1.714	1.563	,,
Ksh 50-100M		1.756	1.385	,,
<Ksh 100M		1.488	1.545	,,
Subcontr's Instructions	Ditto			
Overall		2.207	1.225	Accept Ho
Public		2.500	1.000	,,
>Private		2.074	1.310	,,
Ksh 50M		1.833	1.375	,,
Ksh 50-100M		2.500	1.000	,,
<Ksh 100M		1.746	1.273	,,
Others				
Overall	Ditto	2.500	1.000	Accept Ho
Public		2.500	1.000	,,
Private		2.500	1.000	,,
>Ksh 50M		2.500	1.000	,,
Ksh 50-100M		2.500	1.000	,,
<Ksh 100M		2.500	1.000	,,

Source: Field Survey

Table B.2: Subsoil Conditions; Critical Values Compared with Mean Scores.

Subsoil Conditions	Confidence Interval 99%	Critical Value	Mean Score	Decision
Black Cotton Soil				
Overall	n = 38	2.169	1.400	Accept Ho
Public	n = 11	1.711	1.455	,,
Private	n = 27	2.086	1.379	,,
>KSh.50M	n = 14	1.920	1.438	,,
Ksh 50-100M	n = 13	2.232	1.462	,,
<Ksh. 100M	n = 11	1.746	1.273	,,
Rock				
Overall	Ditto	2.009	2.525	Reject Ho
Public		1.360	2.545	,,
Private		1.880	2.517	,,
>KSh 50M		1.662	2.063	Accept Ho
Ksh 50-100M		1.566	1.923	Reject Ho
<Ksh 100M		1.637	3.545	,,
Normal Soils				
Overall		2.500	1.000	Accept Ho
Public	Ditto	2.500	1.000	,,
Private		2.500	1.000	,,
>KSh 50M		2.175	1.125	,,
Ksh 50-100M		2.087	1.154	,,
<Ksh 100 M		2.500	1.000	,,
Underground Water				
Overall	Ditto	2.046	2.175	Reject Ho
Public		1.527	2.182	,,
Private		1.917	2.241	,,
>KSh 50M		1.648	2.125	,,
Ksh 50-100M		1.526	1.462	Accept Ho
<Ksh 100M		1.446	3.000	Reject Ho

Table B:2: Continued

Subsoil conditions	Confidence Interval 99%	Critical Value	Mean Score	Decision
Loose Soils				
Overall	Ditto	2.500	1.000	Accept Ho
Public		2.500	1.000	,,
Private		2.500	1.000	,,
>Ksh.50M		2.337	1.063	,,
Ksh 50-100M		2.500	1.000	,,
<Ksh. 100M		2.500	1.000	,,
Breaking Up concrete				
Overall	ditto	2.442	1.025	Accept Ho
Public		2.500	1.000	,,
Private		2.500	1.000	,,
>KSh 50M		2.500	1.000	,,
Ksh 50-100M		1.881	1.231	,,
<Ksh 100M		2.500	1.000	,,
Electr. Cables	ditto	2.252	1.175	Accept Ho
Overall		2.500	1.000	,,
Public		2.140	1.241	,,
Private		2.337	1.063	,,
>KSh 50M		2.294	1.077	,,
Ksh 50-100M		1.746	1.273	,,
<Ksh 100M				
Others				
Overall	ditto	2.500	1.000	Accept Ho
Public		2.500	1.000	,,
Private		2.500	1.000	,,
>KSh 50M		2.500	1.000	,,
Ksh 50-100M		2.500	1.000	,,
<Ksh 100M		2.500	1.000	,,

Source: Field Survey 1994

Table B.3: Subcontractors: Critical Values Compared with Mean Scores.

Subcont-ractors	Confidence Interval 99%	Critical Value	Mean Score	Decision
Late Nominate				
Overall	n = 38	2.032	2.250	Reject Ho
Public	n = 11	1.537	3.182	,,
Private	n = 27	1.925	1.793	Accept Ho
>KSh. 50M	n = 14	1.648	2.125	Reject Ho
Ksh 50-100M	n = 13	1.518	2.077	,,
<Ksh. 100M	n = 11	2.198	2.636	,,
Poor Work				
Overall	ditto	2.187	1.300	Accept Ho
Public		1.488	1.545	Reject Ho
Private		2.202	1.172	Accept Ho
>KSh 50M		1.788	1.500	,,
Ksh 50-100M		1.881	1.331	,,
<Ksh 100M		2.500	1.000	,,
Labour Problems				
Overall	ditto	2.500	1.000	Accept Ho
Public		2.500	1.000	,,
Private		2.500	1.000	,,
>KSh 50M		2.500	1.000	,,
Ksh 50-100M		2.500	1.000	,,
<Ksh 100M		2.500	1.000	,,
Materials Prob.	ditto			
Overall		2.026	2.975	Reject Ho
Public		1.482	3.091	,,
Private		1.875	2.828	,,
>KSh 50M		1.712	3.000	,,
Ksh 50-100M		1.466	2.538	,,
<Ksh 100M		1.488	3.455	,,

Table B:3: Continued

Late Payment				
Overall	ditto			
Public		2.056	2.850	Reject Ho
Private		1.722	3.545	,,
>KSh. 50M		1.944	2.483	,,
Ksh 50-100M		1.696	3.063	,,
<Ksh. 100M		1.515	2.385	,,
		1.713	3.091	,,
Absconded				
Overall		2.326	1.075	Accept Ho
Public	ditto	1.746	1.273	,,
Private		2.500	1.000	,,
>KSh 50M		2.500	1.000	,,
Ksh 50-100M		2.500	1.000	,,
<Ksh 100M		2.500	1.000	,,
Others				
Overall	ditto	2.500	1.000	Accept Ho
Public		2.500	1.000	,,
Private		2.500	1.000	,,
>KSh 50M		2.500	1.000	,,
Ksh 50-100M		2.500	1.000	,,
<Ksh 100M		2.500	1.000	,,

Source: Field Survey 1994

Table B.4: Contractual disputes: Critical Values Compared with Mean Scores.

Contractual Disputes	Confidence Interval 99%	Critical Value	Mean Score	Decision
Poor Work				
Overall	n = 38	2.203	1.250	Accept Ho
Public	n = 11	2.500	1.000	,,
Private	n = 27	2.071	1.345	,,
>KSh.50M	n = 14	1.996	1.250	,,
Ksh 50-100M	n = 13	2.500	1.000	,,
<Ksh. 100M	n = 11	1.488	1.545	,,
Variations				
Overall	ditto	2.093	1.500	Accept Ho
Public		1.488	1.545	Reject Ho
Private		2.000	1.483	Accept Ho
>KSh 50M		1.714	1.563	,,
Ksh 50-100M		1.751	1.385	,,
<Ksh 100M		1.488	1.545	Reject Ho
Claims				
Overall	ditto	2.078	1.600	Accept Ho
Public		1.488	1.545	Reject Ho
Private		1.975	1.621	Accept Ho
>KSh 50M		1.670	1.813	Reject Ho
Ksh 50-100M		1.662	1.462	Accept Ho
<Ksh 100M		1.637	1.455	,,
Others				
Overall		2.500	1.000	Accept Ho
Public	ditto	2.500	1.000	,,
Private		2.500	1.000	,,
>KSh 50M		2.500	1.000	,,
Ksh 50-100M		2.500	1.000	,,
<Ksh 100 M		2.500	1.000	,,

Source: Field Survey 1994

Table B.5: Industrial Disputes: Critical Values Compared with Mean Scores

Industrial Disputes	Confidence Interval 99%	Critical Value	Mean Scores	Decision
Wages				
Overall	n = 38	2.019	2.325	Reject Ho
Public	n = 11	1.417	1.904	,,
Private	n = 27	2.042	2.103	,,
>KSh.50M	n = 14	1.683	2.875	,,
Ksh 50-100M	n = 13	1.598	2.000	,,
<Ksh. 100M	n = 11	1.417	1.909	,,
Safety				
Overall	ditto	2.318	1.100	Accept Ho
Public		2.500	1.000	,,
Private		2.234	1.138	,,
>KSh 50M		2.500	1.000	,,
Ksh 50-100M		2.294	1.077	,,
<Ksh 100M		1.746	1.273	,,
Welfare	ditto			
Overall		2.327	1.075	Accept Ho
Public		2.500	1.000	,,
Private		2.500	1.000	,,
>KSh 50M		2.500	1.000	,,
Ksh 50-100M		2.500	1.000	,,
<Ksh 100M		2.500	1.000	,,
Refusal to Work on Saturday				
Overall	ditto	2.326	1.075	Accept Ho
Public		1.746	1.273	,,
Private		2.500	1.000	,,
>KSh 50M		2.500	1.000	,,
Ksh 50-100M		1.881	1.231	,,
<Ksh 100M		1.746	1.273	,,
Laying off				
workers	ditto	2.500	1.000	Accept Ho
Overall		2.500	1.000	,,
Public		2.245	1.103	,,
Private		2.500	1.000	,,
>KSh 50M		2.500	1.000	,,
Ksh 50-100M		2.500	1.000	,,
<Ksh 100M				

Others	ditto			
Overall		2.500	1.000	Accept Ho
Public		2.500	1.000	,,
Private		2.500	1.000	,,
>KSh 50M		2.500	1.000	,,
Ksh 50-100M		2.500	1.000	,,
<Ksh 100M		2.500	1.000	,,

Source: Field Survey 1994

Table B.6: Weather Conditions: Critical Values Compared with Mean Scores.

Weather	Confidence Interval 99%	Critical Value	Mean scores	Decision
Rain				
Overall	n = 38	2.041	3.025	Reject Ho
Public	n = 11	1.274	2.182	,,
Private	n = 27	1.688	3.241	,,
>KSh.50M	n = 14	1.730	3.250	,,
Ksh 50-100M	n = 13	1.706	3.154	,,
<Ksh. 100M	n = 11	1.243	2.545	,,
Hot Temp.				
Overall	ditto	2.500	1.000	Accept Ho
Public		2.500	1.000	,,
Private		2.500	1.000	,,
>KSh 50M		2.500	1.000	,,
Ksh 50-100M		2.500	1.000	,,
<Ksh 100M		2.500	1.000	,,
Cold Temp.				
Overall	ditto	2.442	1.025	Accept Ho
Public		2.248	1.091	,,
Private		2.500	1.000	,,
>KSh 50M		2.337	1.063	,,
Ksh 50-100M		2.500	1.000	,,
<Ksh 100M		2.500	1.000	,,
Wind				
Overall	ditto	2.500	1.000	Accept Ho
Public		2.500	1.000	,,
Private		2.500	1.000	,,
>KSh 50M		2.500	1.000	,,
Ksh 50-100M		2.500	1.000	,,
<Ksh 100M		2.500	1.000	,,

Others	ditto			
Overall		2.500	1.000	Accept Ho
Public		2:500	1.000	,,
Private		2.500	1.000	,,
>KSh 50M		2.500	1.000	,,
Ksh 50-100M		2.500	1.000	,,
<Ksh 100M		2.500	1.000	,,

Source: Field Survey 1994

Table B.7: Sample of Materials and Work Approvals: Critical Values Compared with Mean Scores.

Materials/Work Approvals	Confidence Interval 99%	Critical Value	Mean Scores	Decision
By Architect				
Overall	n = 38	2.148	1.450	Accept Ho
Public	n = 11	1.332	1.818	Reject Ho
Private	n = 27	2.174	1.310	Accept Ho
>KSh.50M	n = 14	1.932	1.313	,,
Ksh 50-100M	n = 13	1.864	1.308	,,
<Ksh. 100M	n = 11	1.527	1.818	Reject Ho
By Client				
Overall		2.312	1.100	Accept Ho
Government	Ditto	1.746	1.273	,,
Private		2.415	1.034	,,
>KSh 50M		2.012	1.188	,,
Ksh 50-100M		2.294	1.077	,,
<Ksh 100M		2.500	1.000	,,
By Engineer				
Overall	Ditto	2.102	1.550	Accept Ho
Public		1.637	1.545	,,
Private		1.986	1.552	,,
>KSh 50M		1.615	1.875	Reject Ho
Ksh 50-100M		1.864	1.308	,,
<Ksh 100M		1.826	1.364	,,
Others				
Overall	Ditto	2.500	1.000	Accept Ho
Public		2.500	1.000	,,
Private		2.500	1.000	,,
>KSh 50M		2.500	1.000	,,
Ksh 50-100M		2.500	1.000	,,
<Ksh 100M		2.500	1.000	,,

Source: Field Survey 1994

Table B.8: Equipment: Critical Values Compared with Mean Scores

Equipment	Confidence Interval 99%	Critical Value	Mean Scores	Decision
Crane				
Overall	n = 38	2.083	1.700	Accept Ho
Public	n = 11	1.637	1.545	,,
Private	n = 27	1.957	1.759	,,
>KSh.50M	n = 14	2.337	1.063	,,
Ksh 50-100M	n = 13	1.521	1.692	Reject Ho
<Ksh 100M	n = 11	1.507	2.721	,,
Mixer				
Overall	Ditto	2.094	1.950	Accept Ho
Public		1.428	2.364	Reject Ho
Private		2.044	1.724	Accept Ho
>KSh 50M		2.012	1.500	,,
Ksh 50-100M		1.609	2.538	Reject Ho
<Ksh 100M		1.482	1.909	,,
Excavator				
Overall	Ditto	2.258	1.225	Accept Ho
Public		1.627	1.545	,,
Private		2.025	1.103	,,
>KSh 50M		2.125	1.250	,,
Ksh 50-100M		1.885	1.231	,,
<Ksh 100M		1.997	1.182	,,
Vibrator				
Overall	Ditto	2.419	1.050	Accept Ho
Public		2.316	1.091	,,
Private		2.415	1.034	,,
>KSh 50M		2.278	1.125	,,
Ksh 50-100M		2.500	1.000	,,
<Ksh 100M		2.500	1.000	,,
Transport Equip.	ditto	2.299	1.175	Accept Ho
Overall		2.248	1.091	,,
Public		2.216	1.207	,,
Private		1.976	1.375	,,
>KSh 50M		2.500	1.000	,,
Ksh 50-100M		2.248	1.091	,,
<Ksh 100M				
Hoist				
Overall	Ditto	2.384	1.050	Accept Ho
Public		2.500	1.000	,,
Private		2.330	1.069	,,
>KSh 50M		2.500	1.000	,,
Ksh 50-100M		2.087	1.154	,,
<Ksh 100M		2.500	1.000	,,

Others				
Overall	Ditto	2.500	1.000	Accept Ho
Public		2.500	1.000	,,
Private		2.500	1.000	,,
>KSh 50M		2.500	1.000	,,
Ksh 50-100M		2.500	1.000	,,
<Ksh 100M		2.500	1.000	,,

Source: Field Survey 1994

Table B.9: Materials: Critical Values Compared with Mean Scores

Materials	Confidence Interval 99%	Critical Value	Mean Scores	Decision
Cement				
Overall	n = 38	2.003	2.600	Reject Ho
Public	n = 11	1.365	2.364	,,
Private	n = 27	1.875	2.690	,,
>KSh.50M	n = 14	1.611	2.500	,,
Ksh 50-100M	n = 13	1.469	2.385	,,
<Ksh. 100M	n = 11	1.382	3.000	,,
Steel				
Overall	ditto	2.009	2.275	Reject Ho
Public		1.888	2.182	,,
Private		1.887	2.310	,,
>KSh 50M		1.627	2.250	,,
Ksh 50-100M		1.633	1.769	,,
<Ksh 100M		1.354	2.909	,,
Timber	ditto			
Overall		2.010	2.100	Reject Ho
Public		1.639	1.545	Accept Ho
Private		1.852	2.276	Reject Ho
>KSh 50M		1.662	2.938	,,
Ksh 50-100M		1.547	1.846	,,
<Ksh 100M		1.637	1.455	Accept Ho
Sand	ditto			
Overall		2.384	1.050	Accept Ho
Public		2.500	1.000	,,
Private		2.330	1.069	,,
>KSh 50M		2.175	1.125	,,
Ksh 50-100M		2.500	1.000	,,
<Ksh 100M		2.500	1.000	,,

Aggregate	ditto			
Overall		2.262 -	1.200	Accept Ho
Public		2:500	1.000	,,
Private		2.156	1.276	,,
>KSh 50M		2.337	1.063	,,
Ksh 50-100M		2.087	1.154	,,
<Ksh 100M		1.637	1.455	,,
Quarry Tiles	ditto			
Overall		2.207	1.225	Accept Ho
Public		2.500	1.000	,,
Private		2.415	1.834	,,
>KSh 50M		2.337	1.063	,,
Ksh 50-100M		1.882	1.231	,,
<Ksh 100M		1.746	1.273	,,
Electrical Fittings	ditto			
Overall		2.326	1.075	Accept Ho
Public		1.746	1.273	,,
Private		2.145	1.207	,,
>KSh 50M		2.012	1.188	,,
Ksh 50-100M		1.881	1.231	,,
<Ksh 100M		2.500	1.000	,,
Ceramic Tiles	ditto			
Overall				
Public		2.384	1.050	Accept Ho
Private		2.500	1.000	,,
>KSh 50M		2.245	1.103	,,
Ksh 50-100M		2.500	1.000	,,
<Ksh 100M		2.500	1.000	,,
		1.997	1.182	,,
Marble Tiles	ditto			
Overall		2.232	1.225	Accept Ho
Public		2.500	1.000	,,
Private		2.330	1.069	,,
>KSh 50M		2.500	1.000	,,
Ksh 50-100M		1.785	1.385	,,
<Ksh 100M		2.500	1.000	,,
Roofing Tiles	ditto			
Overall				
Public		2.235	1.200	Accept Ho
Private		1.746	1.273	,,
>KSh 50M		2.330	1.069	,,
Ksh 50-100M		2.500	1.000	,,
<Ksh 100M		1.881	1.231	,,
		2.500	1.000	,,

P.V.C. Tiles	ditto			
Overall		2.384	1.050	Accept Ho
Public		1.746	1.273	,,
Private		2.500	1.000	,,
>KSh 50M		2.500	1.000	,,
Ksh 50-100M		2.087	1.154	,,
<Ksh 100M		2.500	1.000	,,
Facing Tiles	ditto			
Overall		2.326	1.074	Accept Ho
Public		2.500	1.000	,,
Private		2.330	1.069	,,
>KSh 50M		2.500	1.000	,,
Ksh 50-100M		2.500	1.000	,,
<Ksh 100M		2.500	1.000	,,
Imported Materials	ditto			
Overall		2.442	1.025	Accept Ho
Public		2.500	1.000	,,
Private		2.245	1.103	,,
>KSh 50M		2.012	1.188	,,
Ksh 50-100M		2.500	1.000	,,
<Ksh 100M		2.500	1.000	,,
Others	ditto			
Overall		2.500	1.000	Accept Ho
Public		2.500	1.000	,,
Private		2.500	1.000	,,
>KSh 50M		2.500	1.000	,,
Ksh 50-100M		2.500	1.000	,,
<Ksh 100M		2.500	1.000	,,

Source: Field Survey 1994

Table B.10 : Construction Finance: Critical Values Compared with Mean Scores

Finance	Confidence Interval 99%	Critical Value	Mean Scores	Decision
Client Payment				
Overall	n = 38	1.985	2.775	Reject Ho
Public	n = 11	1.961	3.727	,,
Private	n = 27	1.834	2.414	,,
>KSh.50M	n = 14	1.540	2.750	,,
Ksh 50-100M	n = 13	1.425	2.615	,,
<Ksh. 100M	n = 11	1.667	3.091	,,
Architect's Certificate	Ditto			
Overall		2.189	1.275	Accept Ho
Public		2.500	1.000	,,
Private		2.052	1.378	,,
>KSh 50M		1.932	1.313	,,
Ksh 50-100M		2.500	1.000	,,
<Ksh 100M		1.488	1.545	Reject Ho
Contractor's cashflow	Ditto			
Overall		2.129	1.425	Accept Ho
Public		1.746	1.273	,,
Private		2.016	1.483	,,
>KSh 50M		1.717	1.625	,,
Ksh 50-100M		1.662	1.462	,,
<Ksh 100M		2.248	1.091	,,
Others				
Overall	Ditto	2.500	1.000	Accept Ho
Public		2.500	1.000	,,
Private		2.500	1.000	,,
>KSh 50M		2.500	1.000	,,
Ksh 50-100M		2.500	1.000	,,
<Ksh 100M		2.500	1.000	,,

Source: Field Survey 1994.

Table B.11: Local Authority: Critical Values Compared with Mean Scores

Local Authority Approval	Confidence Interval 99%	Critical Value	Mean Scores	Decision
Foundations				
Overall	n = 38	2.206	1.375	Accept Ho
Public	n = 11	2.162	1.182	,,
Private	n = 27	2.083	1.448	,,
>KSh.50M	n = 14	2.278	1.125	,,
Ksh 50-100M	n = 13	2.032	1.308	,,
<Ksh. 100M	n = 11	1.458	1.818	Reject Ho
Steel				
Overall	ditto	2.442	1.025	Accept Ho
Public		2.500	1.000	,,
Private		2.415	1.034	,,
>KSh 50M		2.337	1.063	,,
Ksh 50-100M		2.500	1.000	,,
<Ksh 100M		2.500	1.000	,,
Dumping Exc. Mate.	ditto			
Overall		2.372	1.075	Accept Ho
Public		2.500	1.000	,,
Private		2.415	1.034	,,
>KSh 50M		2.500	1.000	,,
Ksh 50-100M		2.500	1.000	,,
<Ksh 100M		2.500	1.000	,,
Access Roads	ditto			
Overall				
Public		2.326	1.075	Accept Ho
Private		2.500	1.000	,,
>KSh 50M		2.199	1.172	,,
Ksh 50-100M		2.175	1.125	,,
<Ksh 100M		2.294	1.075	,,
		1.746	1.273	,,
Others	ditto			
Overall		2.500	1.000	Accept Ho
Public		2.500	1.000	,,
Private		2.500	1.000	,,
>KSh 50M		2.500	1.000	,,
Ksh 50-100M		2.500	1.000	,,
<Ksh 100M		2.500	1.000	,,

Source: Field Survey 1994

Table B.12: Labour Availability: Critical Values Compared with Mean Scores

Labour Availability	Confidence Interval 99%	Critical Value	Mean Scores	Decision
Skilled				
Overall	n = 38	2.318	1.100	Accept Ho
Public	n = 11	2.500	1.000	,,
Private	n = 27	2.234	1.138	,,
>KSh.50M	n = 14	1.996	1.250	,,
Ksh 50-100M	n = 13	2.500	1.000	,,
<Ksh. 100M	n = 11	2.500	1.000	,,
Unskilled				
Overall	ditto	2.326	1.075	Accept Ho
Public		2.500	1.000	,,
Private		2.245	1.103	,,
>KSh 50M		2.012	1.188	,,
Ksh 50-100M		2.500	1.000	,,
<Ksh 100M		2.500	1.000	,,
Others	ditto			
Overall		2.500	1.000	Accept Ho
Public		2.500	1.000	,,
Private		2.500	1.000	,,
>KSh 50M		2.500	1.000	,,
Ksh 50-100M		2.500	1.000	,,
<Ksh 100M		2.500	1.000	,,

Source: Field Survey 1994

Table B.13: Shop Drawings: Critical Values Compared with Mean Scores.

Shop Drawings	Confidence Interval 99%	Critical Value	Mean Score	Decision
Preparation				
Overall	n = 38	2.172	1.350	Accept Ho
Public	n = 11	1.997	1.182	,,
Private	n = 27	2.049	1.414	,,
>KSh. 50M	n = 14	1.932	1.313	,,
Ksh 50-100M	n = 13	2.055	1.231	,,
<Ksh. 100M	n = 11	1.488	1.545	Reject Ho
Approval				
Overall	ditto	2.442	1.025	Accept Ho
Public		2.500	1.000	,,
Private		2.415	1.034	,,
>KSh 50M		2.337	1.063	,,
Ksh 50-100M		2.500	1.000	,,
<Ksh 100M		2.500	1.000	,,
Others				
Overall	ditto	2.500	1.000	Accept Ho
Public		2.500	1.000	,,
Private		2.500	1.000	,,
>KSh 50M		2.500	1.000	,,
Ksh 50-100M		2.500	1.000	,,
<Ksh 100M		2.500	1.000	,,

Source: Field Survey, 1994

APPENDIX "C": STEPWISE- REGRESSION ANALYSIS.

07 Jun 97 SPSS for MS WINDOWS Release 6.1

List of variables on the working file

	Name		Position
PD	Percentage of Delay		1
		Print Format: F8.2	
		Write Format: F8.2	
A1	Clients Instructions		2
		Print Format: F8.2	
		Write Format: F8.2	
A2	Architects Instructions		3
		Print Format: F8.2	
		Write Format: F8.2	
B2	Rock		4
		Print Format: F8.2	
		Write Format: F8.2	
B4	Underground Water		5
		Print Format: F8.2	
		Write Format: F8.2	
C1	Late Nomination		6
		Print Format: F8.2	
		Write Format: F8.2	
C2	Poor Workmanship		7
		Print Format: F8.2	
		Write Format: F8.2	
C4	Materials Problems		8
		Print Format: F8.2	

Write Format: F8.2

C5 Late Payment 9

Print Format: F8.2
Write Format: F8.2

D2 Variations 10

Print Format: F8.2
Write Format: F8.2

D3 Claims 11

Print Format: F8.2
Write Format: F8.2

E1 Wages 12

Print Format: F8.2
Write Format: F8.2

F1 Architects Approval 13

Print Format: F8.2
Write Format: F8.2

F3 Engineers Approval 14

Print Format: F8.2
Write Format: F8.2

G1 Rain 15

Print Format: F8.2
Write Format: F8.2

I1 Tower Crane 16

Print Format: F8.2
Write Format: F8.2

I2 Concrete Mixer 17

Print Format: F8.2
Write Format: F8.2

H1 Cement 18

Print Format: F8.2
Write Format: F8.2

H2 Reinforcement Steel 19

Print Format: F8.2
Write Format: F8.2

H3 Structural Timber 20

Print Format: F8.2
Write Format: F8.2

J1 Clients Payment 21

Print Format: F8.2
Write Format: F8.2

J2 Architects Certificates 22

Print Format: F8.2
Write Format: F8.2

J3 Contractors Cash flow 23

Print Format: F8.2
Write Format: F8.2

K1	NCC Foundation Approval	24
	Print Format: F8.2	
	Write Format: F8.2	
Q1	Shop Drawing Preparation	25
	Print Format: F8.2	
	Write Format: F8.2	

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* * * * M U L T I P L E R E G R E S S I O N * * * *

Listwise Deletion of Missing Data

Equation Number 1 Dependent Variable.. PD Percentage of Delay

Block Number 1. Method: Stepwise Criteria PIN .0100 POUT .1000

A1	A2	B2	B4	C1	C2	C4	C5
D2	D3	E1	F1	F3	G1	H1	H2
H3	I1	I2	J1	J2	J3	K1	Q1

Variable(s) Entered on Step Number

1.. J1 Clients Payment

Multiple R	.79200
R Square	.62727
Adjusted R Square	.61746
Standard Error	36.27802

Analysis of Variance

	DF	Sum of Squares	Mean Square
Regression	1	84165.49789	84165.49789
Residual	36	50011.60211	1316.09479

F = 63.95094 Signif F = .0000

------------------ Variables in the Equation ------------------

Variable	B	SE B	Beta	T	Sig T
J1	.718410	.089836	.792005	7.997	.0000
(Constant)	20.247356	6.479698		3.125	.0034

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* * * * M U L T I P L E R E G R E S S I O N * * * *

Equation Number 1 Dependent Variable.. PD Percentage of Delay

------------- Variables not in the Equation -------------

Variable	Beta In	Partial	Min Toler	T	Sig T
A1	.093259	.139400	.832795	.856	.3973
A2	.282092	.460690	.994101	3.157	.0032
B2	.208292	.341084	.999474	2.207	.0336
B4	.168022	.269491	.958843	1.702	.0971
C1	.198742	.207200	.405128	1.288	.2056
C2	-.065348	-.107024	.999755	-.655	.5167
C4	.110864	.180099	.983640	1.114	.2726

C5	-.077088	-.125595	.989374	-.770	.4462
D2	.038138	.062465	.999878	.381	.7056
D3	.057462	.093932	.996020	.574	.5695
E1	.267997	.428773	.954087	2.887	.0065
F1	-.079575	-.130339	.999980	-.800	.4290
F3	-.013308	-.021742	.994909	-.132	.8955
G1	.095833	.156971	.999989	.967	.3399
H1	.119778	.194853	.986393	1.208	.2346
H2	.074521	.121735	.994636	.746	.4604
H3	.108751	.178039	.998978	1.101	.2782
I1	-.036763	-.060124	.996913	-.366	.7162
I2	.007691	.012285	.951060	.075	.9408
J2	-.013308	-.021742	.994909	-.132	.8955
J3	.004880	.007965	.992921	.048	.9616
K1	.087708	.143120	.992459	.880	.3847
Q1	.028764	.047092	.999094	.287	.7759

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**** MULTIPLE REGRESSION ****

Equation Number 1 Dependent Variable.. PD Percentage of Delay

Variable(s) Entered on Step Number

2.. A2 Architects Instructions

Multiple R .84046

R Square .70638

Adjusted R Square .69051

Standard Error 32.63117

Analysis of Variance

	DF	Sum of Squares	Mean Square
Regression	2	94779.74320	47389.87160
Residual	35	39397.35680	1064.79343

F = 44.50616 Signif F = .0000

------------------ Variables in the Equation ------------------

Variable	B	SE B	Beta	T	Sig T
A2	.389056	.123225	.282092	3.157	.0032
J1	.738063	.081044	.813672	9.107	.0000
(Constant)	10.357634	6.616728		1.565	.1260

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* * * * M U L T I P L E R E G R E S S I O N * * * *

Equation Number 1 Dependent Variable.. PD Percentage of Delay

------------- Variables not in the Equation -------------

Variable	Beta In	Partial	Min Toler	T	Sig T
A1	.080125	.134815	.826395	.816	.4197
B2	.107135	.178459	.810324	1.088	.2837
B4	.093330	.161572	.879995	.982	.3325
C1	.231145	.270831	.403102	1.688	.1000
C2	-.063233	-.116677	.993840	-.705	.4854
C4	.092612	.169141	.976584	1.030	.3100
C5	-.049513	-.090439	.979629	-.545	.5892
D2	-.012067	-.021915	.962906	-.132	.8961
D3	.014082	.025621	.970177	.154	.8786

E1	.148870	.214772	.611118	1.319	.1954
F1	-.054803	-.100728	.986112	-.607	.5474
F3	-.007594	-.013975	.989284	-.084	.9336
G1	.088689	.163618	.993449	.995	.3263
H1	.011909	.020125	.838502	.121	.9045
H2	.071598	.131770	.988683	.798	.4303
H3	.021663	.037894	.894063	.228	.8213
I1	-.045608	-.083998	.990777	-.506	.6161
I2	.005500	.009898	.945482	.059	.9530
J2	-.007594	-.013975	.989284	-.084	.9336
J3	.032729	.059900	.983470	.360	.7209
K1	.030906	.055604	.950412	.334	.7402
Q1	.039575	.072948	.992649	.439	.6634

End Block Number 1 PIN = .010 Limits reached.

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