TIME AND COST PERFORMANCE OF CONSTRUCTION PROJECTS

BY

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DECLARATION

I, ALFRED ATSANGO TALUKHABA, hereby declare that this thesis is my original work and has not been presented for a degree in any other University.

SIGNED

DECLARATION OF THE SUPERVISORS

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

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ABSTRACT

There is much optimism in preparing estimates for costs and construction periods for construction projects where it is hoped that such estimates are adequate for completion of the projects. An unacceptable trend has been noticed whereby the majority of projects do not get completed within initially set targets of time and cost. This problem is not only rampant in Kenya but is worldwide ironically including even the developed countries.

Given the important role the construction industry plays in National economic development, this is a problem whose importance is a national headache and cannot be taken for granted because it bears in a part on the very basic facets of National economic development and the social welfare of the state. Particularly for developing countries which have a long way to go in the process of development and given that some projects are funded with foreign debt, this is an issue that needs to be taken seriously with a view of curbing it.

At micro level, the participants in the construction process are facing more challenges than ever before. The economic changes that affect issues in the industry are creating more awareness especially among the clients and this has led to the expansion of the liabilities thereby increasing litigation and hence the problem.

However, a lot has been said about the cause of the problem. Some studies have cited size of projects, others type and others

location. Yet other studies have come up with new methods of construction by improved materials, machinery, prefabrication, mechanization, etc, which seem not to offer any advantage. In the recent years interest has developed in the management and organization of the construction process where there is an attempt to emulate the manufacturing sector. It has been said that very much better performance may be achieved by improvement in organization and management than say technical improvements in construction methods.

The management and organization of the construction process has remained mainly traditional with no noticeable change in the way it was adopted from Britain. In Britain, where the processes originated some changes have been initiated to suit the changing circumstances in the industry.

The primary objective of this study was to investigate the cause of time and cost overruns of construction projects.The study has demonstrated that,time performance is the poorest whereby about 70 percent of projects initiated have a chance of overrunning in time with a magnitude of up to about 53.3 percent as compared to the chance that about 53.7 percent can overrun in cost with the magnitude of about 20.7 percent.

Methods of tendering, variations and delayed payments have been found to be significant factors in project performance.The study further shows that competitive tendering does not necessarily achieve value for money as originally thought,and the bill of quantities does not offer any advantage in project

time and cost performance,despite the resources that go in its production. However that is not to say that the Bill of quantities is useless in the construction industry. Poor time performance is mainly attributed to the method used in fixing contract period which is found to be obsolete,though the study has also revealed that the factors that cause time overruns are many and varied.

The study further has demonstrated that time and cost performance is influenced by conditions associated with different types of clients. The factors which are significant in time and cost overruns are found to be associated with different types of clients in varying magnitudes such that in a situation where the time and cost performance is poorest, the factors are dominant. The government has been found to be the poorest in project management, followed by the private sector while parastatals are performing comparatively better.

The study recommends institutional and structural changes in the organizational set up for construction process. However, the changes should be coupled with evaluation of some methods, rules and procedures inherent in the construction industry that need to be reviewed to incorporate changing circumstances. The study also recommends further research on the improvement of the performance of construction projects.

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INTRODUCTION

The Problem Statement

Production is defined as any process or procedure designed to transform a set of input elements into a specified set of output elements[1]. It involves the utilization and organization of human and material resources (land and capital) known as agents or factors of production[2]. The end result of the production function are goods and services all of which are termed products[3]. Building and Civil Engineering projects are products of the construction industry.

The construction industry has many facets which are far removed in their nature from those of the generally acknowledged manufacturing industries but when broken down and their basic elements analyzed it will be found that there are fewer divergencies than may at first seem apparent[4]. Hillebrandt (1974)[5] cites the physical nature of the products of the construction industry, the structure of the industry together with the organization of the construction process, the determinants of demand for the industry's products and the method of price determination, combined, to be unique and important to the construction process.

The characteristics of the product which is being manufactured naturally exert an overriding influence upon the production process and hence upon the control procedures which are most appropriate and the problems which face management[6].

Factory production lines are carefully worked to give the most advantageous flow patterns for a product to move through the factory from the earliest stages to the dispatch bay. Thus the principle on which the manufacturing system is based is one of routing the product through sequence of operational stages at each of which its form is transformed in some manner [7,8]. The factory can therefore be located conveniently for its supply routes for raw materials or component deliveries, or for onward dispatch of its output, and once the plant layout has been designed it can be established for as long as the product is likely to be marketable. This also means that the place at each stage can be laid out to facilitate the manufacturing process with full control of the lighting, temperature, humidity, and other environmental conditions as well as check points for quality control[9].

The uniqueness of the construction product and the process of production presents great challenges in management. The construction product essentially is different in that its final constructed form is by nature static and the factory rather than the product moves on. It is thus not possible to have permanent

production layout which can be used consecutively for a series of outputs. Whilst it may be possible to fabricate components under normal factory conditions, the actual assembly process must take place in the location in which the finished product will be used, however inconvenient this may be in regard to the transportation of resources, both men and materials and however unsuited the microclimate may be for construction work. Many problems are likely to be associated with construction projects[10].

One very notable problem associated with construction projects is the widespread and unnecessary escalation of construction time and cost over and above initially set targets achieved at project completion. In a recent press report, a contractor was summoned by councillors to show cause why he should not be prosecuted for delaying the construction of a Kshs. 3 million buspark[11]. In another press report the delay of a hospital project and its subsequent escalation in cost was blamed on a contractor[12]. These disclosures are common in our local press. However, while the foregoing is what can be read in the press, it may not be clearly obvious to know who or what is responsible for the delay and therefore the blame. What we read in the press is only a "tip of the iceberg". A lot of these escalations are seldom talked about publicly. In one technical journal which often reviews recently completed projects there was a commentary that:-

> We agree that any review of a local project ought to be accompanied by the Quantity Surveyor's economic analysis, but members will be surprised how often architects refuse to have this information published[13].

Birundu (1986) reckons that the problem of time and cost escalations is as old as history of mankind[14]. Since time immemorial shelter has been the primary necessity for man. Architecture (and related disciplines) was born from this necessity[15]. To build pyramids, the largest construction works on earth hitherto, it took Egyptians a great number of people and a long time[16]. It took King Solomon seven years to build the temple of God and thirteen years to complete the construction of his palace[17]. However, at that early time, it is not reported whether the projects suffered time and cost overruns and whether it was of any concern for those involved to control time and cost. It may not have been a problem really given the abundance of resources then; most of which were obtained freely, and the motive of building may have been different from what it is today.

According to Kharbanda and others (1983) the problem of time and cost overruns is worldwide and overruns are actually a norm[18]. The developing countries suffer more from the problem[19]. It is expected that industrialized nations, which have attained high levels of efficiency in resource management should be free from the problem. It is unfortunate that this is not the case.

The scarcity of resources has necessitated set targets be achieved not only for construction projects but also for products of other industries. The need for quantity surveyors in the construction industry became evident as building work increased in volume and building owners became dissatisfied with the method adopted for setting the cost of the work [20].

The mere fact that construction projects exceed in initial time and cost anticipated is bad enough. It reflects the level mankind has attained in understanding his environment. However, the problem of time and cost overruns goes much deeper than what we see on the face of it. It affects not only the client but also all the parties involved in the construction process including the public.

The client requires a low price, good quality product and an early completion date. The speed with which the work is completed is often of considerable importance both to the client and the community. The longer the period of construction the greater tends to be the cost of capital tied up in the construction [21].

Rising prices, restriction on the use of capital and high interest rates have caused some building clients to demand that their professional advisers should accept cost as an element of design, and that they should provide a balanced cost in all parts

of the building as well as accurately forecast all costs [22]. Another aspect that prompt clients to be time and cost conscious is that, the sources of funds for the project may not be flexible to allow for extra costs which were not initially envisaged in the original plan. Clients require a financial appraisal or feasibility study to determine the likely capital expenditure and probable revenue in order to arrive at the anticipated return on the money invested. The viability of a project is based on its profitability or in case of public projects, its social benefits outweighing costs. Clients usually wish to know whether the investment of capital in the project will be justified by the return expected to be received. The calculations are based on initially set time and cost with the assumption that there will be no overruns. If the project overruns, the initial rationale for project inception may no longer be logical.

Contractors would be the least to welcome overruns except in cases where it is to the firms direct benefit for example variations to increase scope of work. Extra time on site leads to more expenses incurred on items like preliminaries, idle labour and plant. Payments to contractors usually lag behind outgoings, a situation which can lead to cash flow problems if unchecked. This can lead to more serious problems like late payments for materials, labour and plant and hence causing problems like strikes thereby aggravating the problem of overruns. Contractors wish to create or protect a good reputa-

tion in their business environment. Delayed projects can be detrimental to the firm's goodwill particularly in terms of securing future contracts.

Consultants, whose main role is to advise the client and occasionally the contractor should be on the forefront in protecting the clients interest particularly as regards overruns given that they are the experts in matters pertaining to construction. Cases of consultants failing to take proper regard for the interest both of those who appoint them (clients) and those who may be expected to use or enjoy the products of their professional work are known to exist [23]. Clients prepare their briefs in accordance with their requirements of cost and time, their needs and aspirations for the particular project and having in mind political, community and environmental attitudes. It is interesting to note that these constraints - time and money - seem to carry much less weight with consultants than do questions about design and finishes[24].

This is affecting the trust the client and the public in general have in the professional as regards his competence. A trend has been noticed whereby client consultation with draughtsmen and the like is on the increase. In a recent seminar held to discuss the problems prevailing in the construction

industry in the country one participant lamented that:-

> "It is saddening that after 24 years of independence we still seem to shun away our own professionals when alot of the taxpayers money has been spent on training. It is even more so when non-professionals are commissioned projects when the country is full of trained professionals "[25].

According to sladek [26] the profession of architecture has been infiltrated by people with high sounding names. Scores of draughtsmen enjoy higher status than architects in the country as many developers do not realize the need to seek their services since an inexperienced draughtsman can do. However, there was a commentary in a local technical journal to the contrary that:-

> ..... much work that is currently produced by Architects in Kenya does not justify the term "Architecture", most architects operating in this country are simply "Building erection Administrators" at best ..... it is difficult to see why society should bother to pay fees to a person who provides little more than an efficient contractor would provide as part of the contract sum[27].

Delaying public projects leads to more serious repercussions given that there is a large number of interested parties. Increased costs will mean taxpayers going "deeper" in their pockets. Social benefits and costs derived from delaying a project cannot be financially allocated with any accuracy and

must be attributed by estimated community costs and community convenience[28]. Attaching monetary value to these aspects can present difficulties.

In developing countries the construction industry plays a very important role in the process of development [29]. The roads, dams, irrigation works, schools, houses, hospitals, factories and other construction works are the physical foundations on which development efforts and improved living standards are established[30]. The main objective of all governments, regardless of the level of social and economic development and political ideology is to improve the living standards of the people[31]. When public projects delay and cost more the effects bear directly on the process of development in all its facets meaning that:-

(i) The cost of development, that is the actual amount of money paid for development facilities increases and it means that the process of development is unnecessarily expensive particularly if the extra cost does not add anything extra to the intended facility.

(ii) The extra money and time incurred could be devoted to providing more development facilities.

(iii) The process of development is retarded. A higher level of development could have been attained if all projects were completed in time.

(iv) The effect of denying the public goods and services the project is intended to provide by simply delaying a project is enormous and difficult to measure.

Amongst all the participants in the construction process it is the client who suffers the greatest loss when projects overrun, being the financier of the project and for whose interest the project started in the first place. For Government projects the loss is to the public. At the same time the client is the least protected by rules, regulations and conditions inherent in the construction process set up.

The contractual procedures are a muddle resulting from a process of evolution over many years in which the interest of the contractor and architect have been fought over and compromised, with the unrepresented clients' interest coming a very poor third[32]. According to Ferry[33] the objectives of an architect, because of his training and outlook in design, may be more to impress other architects and the public than give the client what he wants. The Quantity Surveyor more often than not makes subjective forecasts of the outcome of events which he has no

control over. The professional bodies to which clients' advisers belong have very strict codes of practice but usually concern such trivial matters as the size of lettering that may be used on a firm's signboard and do not extend to areas of greater client interest such as professional competence or negligence.

Contracting firms have a way of protecting themselves by submitting claims relating to extra costs and time incurred on site. Sometimes profit margins on competitive work are so low that the company's management facilities have to be unduly concentrated on devices to obtain additional payment rather than to organizing the operatives efficiently.

The basic reason for lack of concern for client interest, Ferry says, is that members of the professional team and the contractor have other and more important goals, profitability, safeguarding of professional areas from each other and outsiders, maintenance of professional procedures, and satisfying of their own professional needs. It has been suggested that project management should be introduced in the construction process set up as a way of "policing" the professional team and the contractor[34].

Money is undoubtedly the most important "resource" in the construction process for without it the other resources viz materials, labour and plant cannot be easily obtained[35]. The

scarcity of money which is brought about by either lack of security for borrowing or high interest rates for loans due to government controls and regulations of money supply in the economy is greatly causing widespread awareness in the construction industry particularly due to the fact that the activities of the construction industry rely very heavily on borrowed money. Clients are becoming more time and cost conscious. The litigious times in which we live plus the growing impact of consumerism has fostered in the minds of many the thought that if something goes wrong somebody else has to pay. The disinclination to sue one's professional advisers which existed many years ago no longer holds good[36].

It is common knowledge amongst those involved in the building professions that over recent years there has been a substantial increase in claims and litigation arising out of building construction. All persons involved in the building professions are now subject to a very much greater liability than they ever were in the past. This can only lead to substantial increase in the number of negligence claims in the future[37]. In the case of the large and difficult building and engineering contracts, clients often wish to know the extent to which their professional consultants and advisers are insured[38].

The liabilities of professional people have widened considerably primarily because of the growth of liability in tort

both to third parties and subsequently to the client. Before the expansion of tort liability the professional man's duty of care was to his client. It was a liability which arose in contract. But tort liability now runs concurrently with contractual liability. Claims for breach of professional duty can now arise in contract to the client and in negligence to third parties who are not clients[39].

Industrial relations which has often been the focus in the manufacturing industry, is now an issue of debate in the construction industry. Recent years have seen sharp struggles between management and labour. Serious industrial relation problems have often been experienced on large sites[40].

More and more of the operatives have joined trade unions and this growth has been reflected within the major building trades. This has enabled them to be more informed of their rights and increased their bargaining power with their employers (contractors). On the other hand employers have long recognized that by combining,they are more able to withstand demands for better wages and conditions from trade unions. It has been a long established trade union negotiation tactic to "leap frog" in terms of wages and conditions, isolating one employer at a time. Employers have formed associations to represent their interests in a collective manner by negotiating with trade unions on a national basis over the questions of wages and conditions of

employment. But this general role is supplemented by giving advice and assistance to individual member firms when dealing with their particular labour problems[41]. These developments substantially aggravate the problem of time and cost overruns with the result that it leads to more claims, more disputes, and more time and cost overruns of construction projects.

The Study Objectives

The primary purposes of this study are, first to investigate and establish the influence of various factors in the construction industry and process to the performance of projects in terms of both time and cost. It is widely held that the following factors when viewed in their respective variations portray characteristics which could influence the performance of projects.

(i) Clients; whether government, parastatal or private.

(ii) Design teams; whether client employees or private consultants.

(iii) Type of projects; whether building or civil engineering.

(iv) Contractors and their experience; contractors are classified as African, citizen and non-citizen and experience is linked to the contractor's Ministry of Public Works categorization of H to A.

(v) Methods of tendering; whether open tendering, selective tendering or negotiation.

(vi) Form of contract; whether a Bill of Quantities forms part of the contract documents or not.

One of the aims of the study is to investigate and establish the influence of these factors on time and cost performance of construction projects.

Secondly, the study will investigate the adequacy of contract periods as a factor affecting mainly the time performance of construction projects.

Thirdly, the study will attempt to establish the effect of the number of variations issued per individual project to both time and cost performance of construction projects.

Fourthly, an attempt will be made to establish the effect of the period payments to a contractor are delayed to both time and cost performance of construction projects.

The Study Hypotheses

The first hypothesis is that the factors; clients; design teams, type of the project, contractors and their experience, methods of tendering and forms of contract influence the performance of construction projects.

The second hypothesis is that initially fixed contract periods are inadequate and is a factor affecting time overruns.

The third hypothesis is that the number of variations issued on an individual project affects its performance in both time and cost.

The fourth hypothesis is that delay in payments to a contractor affects both time and cost performance of construction projects.

The Scope of Study

The study will specifically be confined to the performance of construction projects in terms of time and cost during the actual construction process of the project. The projects under study are those initiated in Nairobi, which were constructed between 1978 and 1987 and whose final account was accomplished by December, 1987.

The measure of success for most construction projects is mainly related to timely construction, completion within predetermined cost and the fulfillment of the accepted quality standards[42]. This trio of objectives is supported by secondary aims such as utility to the client, the absence of disputes or litigation and the generation of satisfaction amongst contract participants[43]. Infact, a project completed within initial time and cost and with acceptable quality standards is to a large extent unlikely to have severe problems of disputes or litigation. It is with that in mind that in this study time and cost performance at project completion are regarded as measures of project success. The choice is in recognition of the facts that time and cost in the construction process are aspects which are: easy to measure; easily understood by most parties interested in issues pertaining to the construction industry and particularly the performance of projects; aspects with easily available data and aspects of particular interest to the client.

Quality as a measure of success, is not taken into consideration because it is directly related to cost and it tends to be subjective. By dealing with cost, quality is indirectly taken care of. However, that is not strictly to say that the higher the cost the higher the quality. What people readily see and feel about construction products are the finishes used and the workmanship achieved. The rest of the construction fabric tends to be similar from project to project and is hidden by

finishes and workmanship. Therefore it would be logical to link quality to finishes and workmanship. An expensive finish might be seen to portray high quality work. Certain high quality architectural works can be achieved by low cost finishes. To use quality as a measure of success it must be in relation to something else, for instance, money, client requirement or certain circumstances very unique to the project in question.

Another measure of success is the satisfaction of the parties involved in the construction process. However, satisfaction like quality has a problem of measurement and also is subjective. The economics rule of people preferring more for less[44] applies to most people. When a construction project overruns some people will suffer loss while others will gain benefits. Those who suffer losses will be dissatisfied while those who gain benefits will be satisfied. This conflict of interests renders satisfaction a difficult aspect to deal with in this regard. However, some factors already mentioned are directly or indirectly linked to satisfaction, for instance, time and cost achieved at project completion, quality and functionality, can be said to create a level of satisfaction amongst participants in the construction process.

The time and cost referred to in this study are the time and cost "physically" above initial contract period and cost. The social cost of delaying a project is not part of this study.

The other aspect is that the overruns this study is dealing with are those that occur during the actual construction process of the project. Overruns that are likely to occur during the pre-contract period i.e. during the feasibility study and design stage are not part of this study.

The overruns that occur in the two stages of project implementation need different approaches. Problems experienced during the precontract stage of a project may call for a study of its own.

This study will not analyse the effectiveness of the methodology used in setting time and cost targets. Set cost of construction is usually competitive and sometimes negotiated but is greatly influenced by economic forces and usually is never standard. Time on the other hand is sometimes competitive and depends entirely on the contractor's experience and familiarity with the job. In certain instances, time is predetermined in which case it is at the discretion of the project Quantity Surveyor. But time more or less depends on the urgency of the work, the availability of funds and the requirements of the client among others. Reduced contract time is usually at the expense of cost. However, certain trades in construction cannot be accomplished before certain set time, for example concreting, and this has an influence on the overall time of construction.

The Study Assumptions

It is basically assumed in this study that all the other factors in the construction industry and process which are not part of this study have a constant and negligible influence on the performance of projects in both time and cost.

It is also assumed that the probability that a given package of factors in the construction industry and process will affect a given project is the same for every project initiated such that each project has an equal chance of being completed within initial time and cost targets or an equal chance of overrunning in both time and cost.

It is assumed that designers take into consideration within the framework of existing methodology all the factors that might have an influence on project performance during project implementation given that it is to their utmost interest to protect the client's interest in the project.

It is also assumed that there is homogeneity in the process of project inception, design, construction and supervision and that precontract issues have no influence over project performance in terms of time and cost during the actual construction process of the project.

Significance of the Study

It need not be emphasized that all research work, of course, is of great significance to the society and particularly to the industry in which it is relevant either directly or indirectly. However, this study needs particular and special mention of its subtle importance to specific parties within the construction industry. Time and cost escalations, as mentioned earlier, affect all parties involved in the construction process. However, each individual party is affected in one way or another and in different forms and magnitudes according to the role played in the construction industry and to a particular project.

Clients will find this study a good start to a pointer to the causes of time and cost overruns. The study will be educative by making clients be properly aware of their roles and obligations as regards the construction process. This is an aspect which to some extent is lacking within the construction industry which is exemplified by some client actions such as by-passing the professionals in issuing instructions to the contractor without knowing the implications of such actions thereby evolving unforeseen and unplanned for variations. It might provoke actions such as institutional changes within client organizations particularly relating to better project management and performance.

To the design team or professionals, this study will assist in evaluation of their roles and successes or failures as advisers to clients as a means of showing whether or not they are living to their expectations. The findings of this study should be able to show where and which changes should occur in the professional's attitude and their organization so as to realize the required necessary result to the industry.

This research work will also be useful to contractors by helping them to understand better the industry in which their businesses operate. The various factors which are under consideration in this study and their effect in the construction industry should be able to prepare contractors for better understanding of their business environment. This should be able to lead to a drastic improvement in the services contractors offer to the industry.

Other parties who might benefit from the result of this study are loaning institutions which provide funds, materials and building societies, international donor agencies, material manufacturers and merchants. They should be able to understand their roles in the construction process better.

The work will be useful as a reading material for students in institutions of higher learning particularly those pursuing disciplines such as Building Economics, Project Management, Architecture, and Civil Engineering. It will also be useful as a

reading material for any party interested in the activities of the construction industry.

Generally, the study will cause awareness to the various parties interested in the construction industry, reduce ignorance in this subject and at the same time add to the wealth of knowledge for the better understanding of the environment.

The Research Methodology

This study begun with the identification of a population of projects which were expected to give the desired information. The population encompasses construction projects; both building and civil engineering works and a combination of both. However, there was a problem of demarcation in cases whereby some projects had both building and civil engineering works. In such cases the criteria of classification was what was predominant; buildings with minor civil works were classified as buildings, while civil engineering works with minor associated buildings were classified as civil engineering.

The period of study is restricted to between 1978 and 1987, a period of 10 years. The projects under this study are those initiated and completed within the study period. Projects which were started within the study period but either were still under construction or their final accounts were not yet ready by

December 1987 were not considered. It is after the final account that it can be said with certainty about the performance of projects. Also aspects like variations and claims (which are the focus of this study) are summarized for easy usage in the final account.

Projects of all sizes were considered regardless of cost or floor area. Kharbanda and others assert that "time and cost overruns can occur on any project large or small, size has nothing what-so-ever to do with it"[45].

The projects considered were those initiated and supervised in Nairobi. The reason for this being that since Nairobi is the Central "point" for initiation and planning of most development activities throughout Kenya, and all professional firms are based here, it was felt wise to take the sample from amongst projects initiated and supervised in Nairobi. However, the new development strategy - the district focus for rural development has not fully taken off. Nairobi still retains most development planning activities, for instance, funds still have to be allocated in Nairobi and certain sizes of projects have to be supervised in Nairobi. Projects initiated and supervised at District level were left out of this study because most districts have not developed proper project documentation procedure, some districts do not even have offices for project administration and neither have qualified personnel. Again most projects at

district level may not have been completed given that the district focus for rural development is a recent concept.

Another problem experienced in the districts is the homogeneity of project administration. There is still a problem of clash and conflict of interests as regards duties and roles amongst the administration and the technical team. In some districts administrators have got more say; in certain districts the technical team has more say. In such a situation it would be difficult to compare the performance of projects in the districts.

A questionnaire, Appendix "A", was designed for the purpose of aiding in the extraction of the required information from the project files and by perusing through the project files the interviewees filled the information in the questionnaire. The information filled in the questionnaires was further extracted and tabulated as shown in Appendix "B".

It is only construction projects whose final accounts were ready at the time of going to the field and which were properly documented to reflect most of the factors under consideration that were relevant to this study. Initially it was intended to have a sample of 150 projects with an equal distribution of 50 projects from each of the case studies considered, i.e,the Government, parastatals and the private sector. Out of the 150

questionnaires distributed,86 were received back. The sample for government projects was obtained from the Ministry of Public Works. Government projects whose most of the information required was available were 45 in number out of which 26 were inhouse and 19 were commissioned. The rest of the lot of projects had either missing files or no final accounts. The two parastatals considered are National Housing Corporation and Kenya Posts and Telecommunications Corporation. The choice of the two was owing to the fact that they are constantly constructing which has necessitated the existence of an inhouse design team and as such their projects are likely to be properly documented. From the two parastatals 27 projects were found to have relevant information, out of which 15 were from the Kenya Posts and Telecommunications Corporation, out of the 27, 19 were inhouse and 8 were commissioned.

For private sector projects, clients, consultants and contractors were approached. It was found that most private projects were neither documented nor went through the known channels of the construction process. Some firms had moved from their original offices and could not be traced. Sometimes the people concerned were not willing to give information about their projects. Fourteen projects were found from consultants' offices with the information required. The total number of projects considered is thus 86. The ratio of all the projects as per client is approximately 3:2:1 for government, parastatal and

private respectively.

Data Analysis:

The data collected was varied in nature in that some of its aspects were quantitative, that is it could be expressed in quantity form. There were other aspects which were qualitative, being descriptive in nature. In that respect various statistics were employed to suit particular characteristics in revealing the desired information. Notably the following statistics were used extensively.

(i) Chi-square (x^2)

This was applied to sample data to test whether or not two or more variables within the sample data are independent. It was useful particularly in the analysis of qualitative data, especially type of client, contract used, method of tendering etc; to ascertain whether or not those characteristics influence time and cost overrun or saving. The formula for calculating chi-square statistic is:-

$$x^2 = \Sigma \frac{(fa - fe)^2}{fe}$$

Where, x^2 = Chi-square

fa = Actual Frequencies

fe = Expected Frequencies

The expected frequencies are hypothetical data based on the hypothesis that the variations are truly independent. The formula for expected frequency (fe) is:-

$$fe = \frac{\text{Row total x column total}}{n}$$

Where, n = The number of observations.

To be able to test the hypotheses and make conclusion, chi-square distribution (denoted by X^2_a) was compared with chi-square statistic calculated from the sample data (denoted by X^2). Chi-square distribution is a theoretical probability distribution and under the proper conditions may be used as a sampling distribution of chi-square statistic.Thus given the required degrees of freedom and the significance level X^2_a is an estimate of X^2 in the sample such that if X^2 exceeds X^2_a it signifies dependence of variables and if X^2 is less than X^2_a, it shows independence.The level of confidence adopted throughout the analyses is 95 percent.

(ii) Regression Analysis:-

This was used in the analysis of quantitative data. The primary goal of regression analysis is

to obtain predictions of one variable using the known values of the other[47]. By employing the equation: $y = a + bx$, which provides the estimate of a variable y when the value of another variable x is known, y can readily be predicted from the regression equation given x. The "a" and "b" in the expression are found from sample data and are referred to as estimated regression Coefficients. "a" is the intercept of the regression line on the vertical axis and is the value of y when "b" is zero, while "b", the slope of the regression line, is the influence of x on y.

The formulae for finding "a" and "b" are given as follows:-

$$b = \frac{\Sigma xy - n\bar{x}\bar{y}}{\Sigma x^2 - n\bar{x}^2}$$

$$a = \bar{y} - b\bar{x}$$

The regression line was calculated to show the relationship between the level of time and cost performance and the number of variations per project and also the relationship between the period of delayed payments to the contractor and the level of time and cost performance.

The regression equations obtained were tested to ascertain whether their slopes are Zero.If the slope is equal to zero the regression equation is of no importance in making predications of Y using X and the conclusion is that X does not affect Y.

The student t test was used to test the significance of both variations and delayed payments in time and cost performance. The student t statistic for the slope is calculated using the following formula:-

$$t = \frac{b}{SY.X \Big/ \sqrt{\Sigma x^2 - nX^2}}$$

Sy.x refers to the standard error of estimate for the regression line, which is the square root of the mean Squared deviations from the regression line, and is calculated by the formula:

$$Sy.x = \sqrt{\frac{\Sigma y^2 - a\Sigma y - b\Sigma xy}{n-2}}$$

The value of the student t statistic is compared to the critical value denoted by (t_a) that corresponds to the prescribed significance level ($_a$), and in this case, 95 percent significant level was adopted. If t is amaller that t_a then the null hypothesis that the slope of the regression line is equal to zero is accepted. If t is greater than t_a the null hypothesis is rejected

(iii) The co-efficient of determination:-

This expresses how strong X is associated with Y. It was used to show the magnitude of the relationship between the number of variations and the period of delayed payment to the contractor, and the level of time and cost performance.

The formula for finding the coefficient of determination (r^2) is :-

$$r^2 = \frac{a\Sigma y + b\Sigma xy - n\bar{y}^2}{\Sigma y^2 - n\bar{y}^2}$$

(iv) The correlation Co-efficient:-

This is used to measure the degree of relationship between x and y. In this regard it was particularly used to show whether there is

any relationship between the period of delayed payments to the contractor and the level of time and cost performance.

The formula for finding co-efficient of correlation (r) is:-

$$r = \sqrt{\frac{a\Sigma y + b\Sigma xy - n\bar{y}^2}{\Sigma y^2 - n\bar{y}^2}} \quad \text{or} \quad \sqrt{r^2}$$

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CHAPTER II

REVIEW OF RELATED LITERATURE

Contract Performance

Time and cost achieved at project completion are the most widely used measures of project success. Mbatha (1986)[1] carried out research on the performance of government projects in Kenya.He found that government projects overrun in terms of time and cost; 73 percent of projects examined had time overruns as compared to 39 percent which had cost overruns, showing that time performance was the poorest in government projects.

As regards time and cost performance as it relates to size, it was found that size alone influences cost performance by 12 percent; other factors influence 88 percent. That meant that the problems of cost performance have very little bearing on contract size, other factors have stronger influence[2,3]. It was further found that there was no relationship between time performance and size [4,5,6,7].

Remoteness is expected to have far reaching effect on project performance. It is expected that projects located in areas which have highly developed infrastructure network like the big towns should have better performance. But contrary to that, projects in remote areas such as the North Eastern Province were

showing comparatively good performance. The conclusion was that location had no major influence on time and cost performance[8], [9]. However, it is pointed out that over-pessimism in estimation of time and cost for projects in remote areas allowed generous time and cost estimates which consequently produced seemingly good results.

Type of project was found to have no influence on performance. Although some types of projects showed higher percentages of overruns than others, that was not enough reason to say that project type had any influence on time and cost performance. The differences could have been due to either sampling error in which case some type of projects were dominant in the sample or other external factors.

Mbatha derived a formula for cost performance as follows:-

$$P_1 = 108.02 - 36.61C_2$$

Where, P_1 = Cost performance X 1/100

C_2 = Contract sum (Kshs. million)

The formula in the practical sense can produce misleading results for it shows that projects of higher contract value have got the best performance and those of less contract value have

the worst performance. Its usage can be only with limitations.

For time performance three formulae were derived as follows:-

(a) Projects less than 1 million shillings

$$T_1 = 25 + 82C_2$$

(b) Projects exceeding 1 million but not more than 2 million shillings

$$T_1 = 112 - 22C_2$$

(c) Projects over 2 million shillings

$$T_1 = 67C_2 + 56$$

Where, T_1 = Time performance X 1/100

C_2 = Contract sum (Kshs. million)

This suggested that projects within the 1 million and 2 million shillings range were comparatively properly estimated for time and properly managed. Bromilow[10,11] studied Australian projects as regards time and cost performance and derived a

formula expressing cost performance as a function of project size in the form:-

$$P = K + B \log_{10} c$$

Where, P = Cost performance ratio X 100.

C = Project final cost in million Australian Dollars at 1965 prices for labour/material.

K = A constant indicative of the general level of cost performance in Australia. Its value was then 96.5.

B = A constant indicative of the sensitivity of cost performance to project size. Its value was then 1.9 in a one million dollars project.

C = 1.0 so that k/100 is the value of the cost performance ratio a project of this size. K was equal to 96.5 so

$$P = \frac{96.5}{100} = 0.965.$$

The formula suggests that size is related to the cost of the project and it can be used to establish the cost performance level of a project if the size is known.

In another study[12,13] the same Bromilow derived another formula expressing time performance of a project as a function of size in terms of cost in the form:-

$$T = K.C.^{B}$$

Where, T = Construction time in working days

C = Estimated construction cost (or tender price) in millions of dollars

K = A constant

B = A constant

The formula suggests that time is related to contract cost and it can be used to estimate the contract period if the cost can be estimated.

Bromilows conclusion was that size has an influence on contract performance. Mbathas conclusion was that size, location and type have got very little influence, other factors have got a

greater influence. Kharbanda and others say that size has no influence on time and cost performance[14].

Other studies have been carried out in other countries like Northern Ireland and New Zealand and different results and conclusions have been found[15]. The formulae derived are different even for different sizes of similar projects. The differences could be owing to the fact that various factors that might exert an influence on project performance are varied from region to region. Factors such as climate, cultures, Politics and level of socio-economic development are different from one country to another and one region to another and can influence not only project performance but also other development issues to a large degree. Size, type and location of a project are aspects that are taken care of by the parties concerned right from the onset and it is not surprising that in some studies these factors have no influence on project performance. The problem could be the extent to which these aspects are considered given a particular project.

The studies just reviewed are concerned with the state of the situation as it is as regards project performance which reveals that the problem of time and cost overruns is a worldwide problem. The studies do not say what the causes of time and cost overruns are.

Sidwell[16] critically examines client organizations and concludes that they tend to have different priorities. In particular private clients are usually profit motivated and may behave differently from a public client in terms of project management.

The degree of personal and close client involvement in the construction process has been observed to produce good results in terms of project performance. This is attributed to the effect it has on the organization and working relationships of the construction team. Sidwell cites bureaucratic internal procedures as one of the disadvantages ot some clients. Clients who get the quickest results are those who provide the construction team with well defined specialized needs and are able to become closely involved with the construction process. Close client involvement is evident in the private sector.

This view is also expressed by Harris[17] who says that client involvement in the project has far reaching effects on a satisfactory completion of a project. Another problem Harris cites is that many clients do not clearly establish their construction requirements before approaching the construction industry. He recommends that the industry should liaise with the client bodies in order to provide them with a fundamental understanding of the procedures involved.

Very little if any, is known about the performance of private sector projects and its problems in Kenya. The developed world, being a head in technology, research and development has attempted new methods for use in the construction process, such as package deal, management contracting and so forth. There is no evidence to show that the new methods have produced good results but their application has tended to be suited to particular circumstances of projects, usually upon the size and nature of the project[18]. Package deal has been critized for its many flaws. The client has no independent consultant to advise him on the adequacy of the designs offered or of the reasonableness of the price; the price, of course, is negotiated. Usually the contract does not closely specify what is to be provided for the price, so that even if a consultant is hired, at extra cost, it is difficult to evaluate the building in relation to the cost, or to determine whether the implied terms of the contract have been fully carried out. The success of the package deal type of contract, therefore, depends on goodwill[19].

In Kenya the process of construction, the traditional methods of contracting which were adapted from Britain, have remained unchanged. If new methods of contracting have either produced good results or failed in the developed world, it may not be right to conclude that the same methods can produce the same results in Kenya or any other third world country. Differences in environmental attributes, socio-economic

development and cultures are bound to exert their own influence on project performance within the methodology of new ideas and consequently showing different results.

It has also been observed in Kenya that the formal construction sector is organized very much along lines similar to those of the British Construction Industry[20]. The methods of contracting are the same in both public and private sectors. What happens in the private sector follows closely what happens in the public sector. New ideas will normally start in the public sector and then end up being adopted in the private sector. If there is any practice that is observable and unique in the private sector, it is either by accident or rooted in the Kenya's Socio-cultural set up. The reason is that the private client in Kenya has remained small and fragmented with very little influence in the construction industry. The government has remained the main client controlling about 60 percent of all construction work[21]. The government is likely to have the means to venture into areas of research for new and improved methods in the construction process for it is to the government that the problem of time and cost overruns could have far reaching effects. However, similarities in the practice of the construction process in public and private sectors does not necessarily mean that the results of project performance will be the same.

Management and Organization of the Construction Process

Sidwell[22] says that many studies have been propounded to improve time and cost performance by more efficient construction methods, components and improved designs etc. These have failed to produce good results. Stone is more specific in his approach to new improved and efficient methods which have come in existence by way of innovation.

Innovation in building has come in many different ways. Clients have set new problems, they have demanded better standards of comfort and convenience, better services and more economic solutions. Designers have looked to the potential of new materials to solve new problems and old problems in new and better ways.Contractors have used the new materials in an effort to reduce the costs of construction[23].

While innovations have added to the range of materials for building, increased the number of possible techniques, and made it possible to provide a better standard of comfort and service they have done little to reduce the cost of construction[24].

Many observers have felt that traditional building, involving as it does the joining together of a large number of small units must be basically inefficient. Construction has been critically compared with the factory industries and with the

success they have achieved in mechanization, in replacing craft processes with machines and with semi-skilled labour and with their success with large scale methods. There have been various attempts to try to emulate these methods in building.Broadly these attempts have taken four forms: prefabrication, system building, mechanization,and the rationalization of the building process[25].

Prefabrication has developed on two lines: in the form of standard as compared with purpose made components and in the form of systems of construction based on large scale purpose made components. More and more items of joinery and metal goods are purchased ready made. The development of systems of construction has naturally been most noticeable in those fields in which a standardized product is acceptable for example, housing and schools[26].

Mechanization has mainly developed in four directions: earth movement, materials handling, concrete mixing and powered hand tools to assist manual tasks. The greatest success has perhaps been obtained in earth moving, where the power and endurance of the machine in relation to its cost is so much greater than that of the man it replaces[27].

In Japan, system building has been developed for school construction. The reasons given for such development are that

the increase in the population of urban areas in Japan and the resulting sudden increase in school children are causing local governments to build quite a number of schools each year. Conventional construction processes have not been able to cope adequately with the demands[28]. The following reasons are given for the inadequacy:-

i. The shortage of skilled workers, the quality of work is falling and there is lack of uniformity in the work.

ii. Normal processes require large numbers of workers whose wages are rising rapidly, causing the cost of construction to go up very quickly.

iii. Since the normal processes require relatively long construction time, unexpected situations such as general price hikes, shortages of materials and bad weather, frequently give rise to unforeseen problems.

iv. The long construction time has an impact not only on the construction cost but also on the function of the school itself. For example the children may be deprived of the use of the playground while it is used for the storage of construction materials.

v. Communities wish to have better school buildings as living standards improve, yet the financing to achieve such high standards is not necessarily provided.

vi. Even though it is not easy to secure the land for schools, school sites are not necessarily efficiently utilized.

vii. Changing needs and trends especially in the field of education has necessitated new developments.

The report however, does not say anything about the success of system building in Japan.

Stone cautions about new developments in construction when he says the following about system building.

> Perhaps both the virtues and the disadvantages of various types of system building have been exaggerated. At present there appears to be no evidence that system building offers any advantage in price, and while system building does reduce the site time there seems to be some doubt about whether overall design, or ordering to completion time is any less with traditional building[29].

The development of pre-fabricated methods of building and mechanization has necessarily to be accompanied by the rationazation of the construction process. This starts with the study of the flow of work on site upto a point a building job can be pre-planned so that all the operations can be timed to fit

in one continuous sequence of operations. To be successful such planning must be accompanied by very good organization so that all the various types of labour and materials are brought into the site at the right time. The full potential of such methods cannot be realized unless the design and building are examined together. Successful rationalization in the building industry requires an examination of the design and construction together and their development as an organic whole.In the long run the design and production together with the contractual procedures which link together the various parts of the industry must be considered as a single organism, each part of which goes towards determining the forms of the product which best meets the requirements[30].

More recently researchers have become more interested in the organization and management of the construction process citing management as a crucial element in project success. The philosophy is that very much better performance may be achieved by improvement in organization and management than say technical improvements in construction methods[31].Clients have been more and more frustrated by the high costs,long design and construction times and functional shortcomings particulary as projects have become longer and more complicated during periods of inflation, labour problems and growing bureaucracy. Current fashionable architecture has often been seen to come about through exclusively visual considerations and to be therefore, often irrelevant to its proposed role[32].

The critisisms of traditional methods of contracting have come from many quarters. Sidwell says it does not lend itself to new organizational forms[33].Collier says that it is no longer effective[34].

Harris[35] advocates for package deal form of contract instead of competitive tendering which he says has produced better results. But as said earlier package deal does not offer the best alternative for the client, in terms of price. Brooks[36], Sidwell, Seeley[37], and Harris also blame the traditional construction process to be the cause of poor project performance. The process with its acceptable practices and contract forms has been unable to cope with the changes and pressures forced on the construction industry. Those pressures need changes in the organization and management which has remained unchanged for centuries. Collier supports those views when he says that:-

> The increasing complexity of technology and the building construction process has brought us to the point where the design team and the contractor cannot be responsible to the client for all the specialized work of many of the specialized sub-contractors[38].

Brooks recommends management contracting which he says has been a very considerable improvement in the service the industry is providing to its clients.

Mbaya[39] in his study acknowledges the problem of poor performance, to put it in his words "experience has shown that most of the projects carried out in developing countries have been either unreasonably delayed, suffered uncontrolled cost escalations or precipitated poor functional qualities".

Mbaya attributes this poor performance to lack of a fundamental framework of management organization theory relating to building projects. Thus rather supports Wai[40], Sidwell, Harris and Brooks. He recommends a systems approach in project administration that could be capable of bringing all the participants in the construction process in coordination. He further recommends that the building contract procedures and the Architects and Quantity Surveyors act, Chapter 525, which have not changed to cater for the changing environment within the industry should be reviewed and restructured.

The incorporation of management theory framework within the existing set-up of the construction process is good enough. Management is essential in all organized co-operation, as well as at all levels of organization in an enterprise[41]. The need for management theory application in enterprise was recognized many years ago by such early practical scholars of management as Henri Fayol, Chester Barnard, and Alvin Brown[42]. It is not so clear why it has taken so long to adopt management principles in the process of construction.

The incorporation of the management theory into the construction process can only be done within the framework of the existing rules and regulations which have developed over the years and which are unique in the construction industry. The design, contractual and construction procedures are issues management will have to contend with as to their role in the construction process and the performance of projects. This is an aspect the management theory approach proponents do not talk about.

Past researches particularly in Kenya dealt with only government projects assuming that the performance of government projects is the same as private projects. To some extent the private sector portrays some practices which are unique and rooted in the Kenya's socio-cultural system and therefore it would be of paramount importance to learn something about the performance of private sector projects.

Project Planning and Control

Planning for any enterprise is essentially deciding what objectives should be accomplished, what actions should be taken to achieve them, what organizational position is assigned to them, and who would be responsible for the actions needed[43]. The purpose of every plan and all derivative plans is to facilitate the accomplishment of enterprise purpose and objectives[44].

since managerial operations in organizing, staffing, leading and controlling are designed to support the accomplishment of enterprise objectives, planning logically precedes the execution of all other managerial functions.

Planning and control are especially inseparable, the Siamese twins of management. Unplanned action cannot be controlled, for control involves keeping activities on course by correcting deviations from plans. Any attempt to control without plans would be meaningless, since there is no way for people to tell whether they are going where they want to go (the task of control) unless they know first where they want to go (the task of planning). Plans thus furnish the standard of control[45].

The object of planning applied to construction is to ensure that work is carried out with maximum economy and efficiency. Economy and efficiency can only be achieved by the adequacy of plans the absence of which produces no benefits and may attract penalties in the form of additional future costs[46]. Lee points out some of the causes of uneconomic work as follows:-

(i) Non-productive time caused by excessive travelling from job, waiting for instructions and materials, failure to gain access to sites, inclement weather and so forth.

(ii) Improper work methods resulting in more time being spent on the job than necessary and waste of materials. The

cause may be attributed to imprecise instructions or incompetence on the part of the operatives.

(iii) Lack of motivation on the part of operatives.

(iv) Inappropriate tendering procedures and contract arrangements in relation to type of work and prevailing market conditions.

(v) Changes to the nature and scope of the work after commencement.

(vi) Lack of efficient system of recording and controlling.

Building and civil works and consequently their construction, have become increasingly complex and proper management of a contract and the control of cost on the part of the architect at design stage and the contract during construction are more than ever essential if construction is to be carried out efficiently both in terms of time and money.

Only by proper planning can aids to productivity such as mechanical plant, incentives and the efficient use of labour become fully effective. With the greater mechanization of the construction operatives and the increased use of expensive plant, the contractor must obtain maximum use of the plant and speed the construction of the job in order to keep his costs to a minimum. The design/construction continuum must be seen as a production process from inception to completion and there must be a programme on which the job may be organized against which performance may be assessed and within which control may be exercised[47].

Building and civil engineering industry is peculiar in that the contractor who will be responsible for carrying out the work usually plays no part in the design of a project, and has no opportunity at this point to contribute from his experience on matters of construction, planning and the nomination of subcontractors and thus to assist in the work being carried out efficiently, quickly and economically. In these circumstances it is therefore essential that architects, quantity surveyors and engineers should have sufficient knowledge of contract planning and of its implications to ensure a well organised job[18].

Burgess also blames lack of early contractor involvement in design as a problem causing poor contract performance. The most critical period in the life of any contract is unquestionably the pretender period. In almost all instances in this procedures, the contractor is compelled to produce his tender in most unreasonable haste. Often unrealistic rates are given in the Bill because of human error, laxiness in checking and quesswork where careful calculations ought to have been made[19].

Management science experts have come up with techniques which have been applied to modern management problems with tremendous success. In the words of Burgess[30] "the starting point of project control is to prepare a production programme. The programme shows what work will be done, and when, and the resources of men, machines, and materials required to achieve

it". A technique which has found particular application in construction especially for work programming is the critical path method (CPM). Many writers Antill[51], Harris[52], Sears[53], Austin[54], Lock[55], on project planning and control acknowledge that the CPM is a powerful tool for the planning and management of all types of projects. Essentially CPM is the presentation of a project plan by a schematic diagram or network that depicts the sequence and interrelation of all the component parts of the project and the logical analysis and manipulation of this network in determining the best overall programme of operation. Thus a fully developed network is a logical mathematical model of the project[56].

Once the CPM network for the project has been accomplished each activity can be estimated of its time and cost of accomplishment. Therefore control of time and cost is enhanced by observing the trend of actual progress, comparing the progress with the desired standard (the CPM plan) and taking corrective action to keep costs and time within acceptable bounds.

However, the success of the CPM plan depends to a large extent upon the accuracy with which future performance can be estimated[57]. The accuracy of estimates will depend on the information available on:-

(i) The nature and extent of the work.

(ii) The conditions under which the work will be executed.

(iii) The availability of labour and the cost of its employment.

(iv) The inflationary trend.

(v) The availability of materials and their prices

If the estimates are wrong then the CPM cannot serve its useful purpose. The CPM technique therefore does not ensure 100 percent project success because of these limitations and changing circumstances during construction process cannot be overlooked as to their impact on the process.

Another problem with CPM is that it can be used to control one of the items time or cost at a particular moment. But it cannot be used to control both. If time is controlled, it will be at the expense of cost and vice versa. However, it is useful in indicating the best alternative decision to take. For example if there is an attempt to control time in the network by compression or decompression the alternative with the least cost implication is taken. That does not mean that cost will be less but what it means is that cost cannot be as high as another possible alternative in the network.

Inherent in the initial approach to CPM network analysis is the assumption that the resource requirements for the various activities can be met when required. For the CPM network to work, the resources required to execute the plan must be

available when needed - the labour, plant, materials etc. must be available at the right time, and more important the money to acquire those resources. The CPM's greatest shortcoming is therefore that, it does not allow for shortages of materials, cash flow problems, etc, which are part and parcel of the construction process.

Cash Flow

Cash flow is defined as the actual movement of money in and out of a business[58]. Money flowing into a business is termed positive cash flow while money paid out is termed the negative cash flow. The difference between the positive and negative cash flow is termed the net cash flow.

Within a construction organization positive cash flow is mainly derived from money received in the form of monthly payment certificates. Negative cash flow is related to money expended on a contract in order to pay wages, materials, plant, sub-contractor's accounts rendered and overheads expended during the process of construction.

During recent years the construction industry has been forced into a state of quite severe recession, brought about by several causes both domestic and international notably government regulations of the domestic economy and reduction of capital

expenditure in the public sector. High interest rates have accentuated the industry's problems. Client organization await a lowering of interest rates to facilitate cheaper borrowing whilst contractors must pay high rates of interest on borrowed funds at a time of enhanced competition, reducing profit margins[59].

Perhaps the most obvious response by contractors to the prevailing situation is the reduction of profit margins, in extreme cases, their complete abolition. Where a firm obtains a contract by the submission of a tender below the full long-term cost (including normal profit) it is strictly "buying work". The dangers of buying work are great suffice it to say that liquidity is essential to contracting[60].

Much attention has recently been given to the role of cash flow, even by the courts of law, where cash flow was cited as being "the life-blood" of the construction industry[61].

Large contracts with a cost of millions of shillings to be expended over several years, essentially require a reasonably reliable forecast of the likely flow of expenditure. Even where costs are more modest, and the contract time correspondingly shorter, its to the clients advantage to be able to anticipate his cash flow requirements and to be able to arrange for finance to be available accordingly and also to control cost[62].

From the CPM network or the bar chart which are the representative of the project plan and on which there is money and time implication of each activity, can be calculated the cumulative costs and value of the work. These figures plotted on a graph, cost and/or value verses time produce what is called an S-Curve. The graph can be used to derive cash in and cash out. Value can be derived from cost by adding to cost the profit margin[63].

The same S-Curve can be derived from records of the past projects. This produces similar results because within a company, projects of the same type and similar shapes, cumulative value verses time when expressed in percentage terms, and when the profit margin is uniformly spread throughout the project, usually have s-curves.

A group of researchers in Britain investigated the formula underlying the s-curve and found that the following formula was a close approximation to it:-

$$Y = s[x+cx^2-cx-1/k(6x^3-9x^2+3x)]^{64}$$

Where, Y = Cumulative monthly value of work executed before deduction of retention money or addition of fluctuations.

X = Proportion of contract period

S = Contract sum

C & K = Parameters.

Figure 2 - 1 shows a typical s-curve. The s-curve can be used for project control by comparing the actual cost/expenditure with the forecasted cost/expenditure and if divergencies are noticed, the necessary corrective action can be taken. The s-curve can provide an early warning about problems in the progress of the project.

An examination of the normal s-curve for a project under the standard form of contract shows that the break - even point, i.e. a point where positive cash flow begins to set in is much later in the contract period. Most of the time the contractor is in a state of negative cash flow. This situation is affected further by attitudes of the parties to the contract which tend not to adhere to the policies of the standard form of contract[65].

Contractors naturally would wish a situation where they break-even early enough - i.e. situation where the project would be self-financing and therefore reducing their capital lock up in the project. Policies, acts or omissions that will affect the contractor's finance whether directly or indirectly must have an influence on project performance[66].

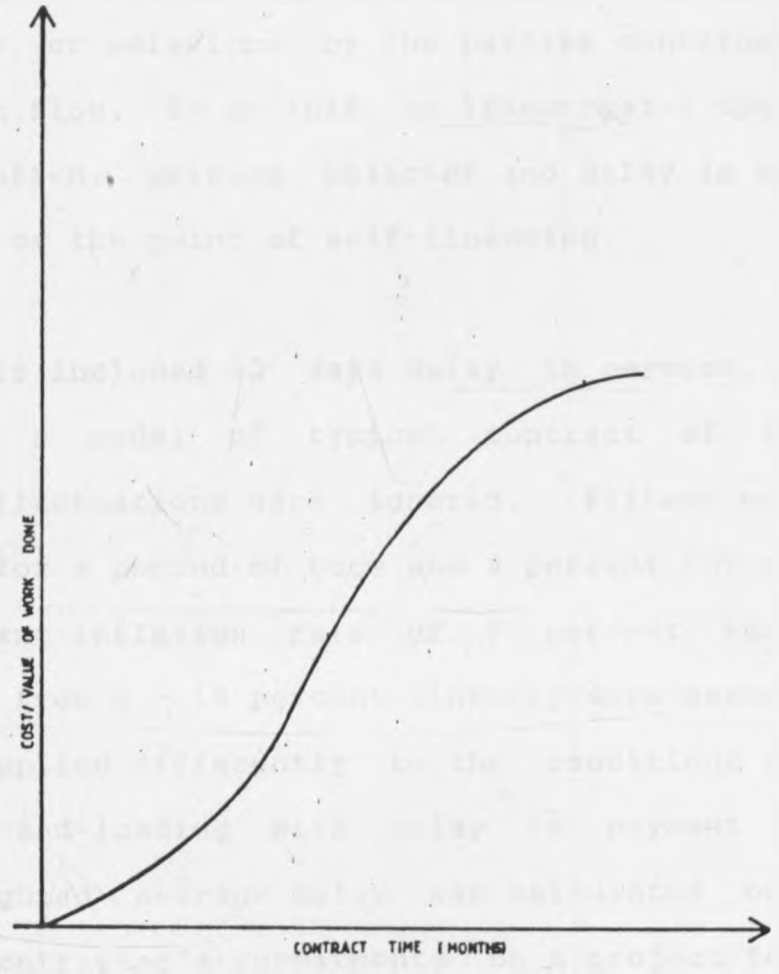

FIG. 2-1: THE STANDARD S-CURVE

Fellows[67] carried out an analysis based on a typical project s-curve and the 1963 edition of the JCT SFBC, private with quantities, conditions of contract, then operational in Britain.

The analysis was to investigate the effect of policies in the conditions, acts or omissions by the parties concerned with the contractors cash flow. To do this, he investigated the effect of mark up, inflation, pricing policies and delay in payments on capital lock up or the point of self-financing.

The analysis included 22 days delay in payment, 5 percent retention and a model of typical contract of 12 months. Variations and fluctuations were ignored. Fifteen percent mark up was assumed for a period of boom and 4 percent for a period of slump. A constant inflation rate of 6 percent and a rising inflation rate from 6 - 18 percent linearly were assumed. These aspects were applied differently to the conditions like normal pricing, front-end-loading with delay in payment and normal payment. A weighted average delay was calculated on the basis that various contractor's commitments on a project for example, payment to direct labour, plant hire, sub-contractors etc, have different average delays for which payment can be made and have different proportions in terms of cost to the total project cost. By dividing individual commitment's average delay with its cost proportion in the total project cost, a weighted individual average delay was found. All individual weighted average delays

were added to arrive at the weighted average delay for the project.

Fellows found that:-

(i) The most significant cash flow advantages appear to be obtained by the application of weighted average payment delay, illustrating the advantages of good credit control.

(ii) The application of weighted average payments delay in the analysis reduced particularly the long term finance requirements, reinforcing the advantage of good credit control.

(iii) The use of pricing manipulations,such as front-end-loading and valuation enhancements are of only secondary importance to contractors cash flow and finance requirements.

(iv) Finance costs are usually as part of overheads. Activities which benefit a project's cash flow situation should lead to profit increase.This accrues to the firm by reducing the cost of finance and may become manifest only by a reducing level of overheads.

(v) The requirements of accurate profitability reporting must be publicized so that control can be correctly implemented.

(vi) Inadequate allowance for inflation in project estimates has the following major effects:-

(a) The cost of the project increases and profit is consequently reduced.

(b) The amounts of finance required by the contractor to execute the project are increased.

(c) The cost of finance is increased.

These results are useful especially to contractors for credit control. But the problem of the s-curve is that it ignores issues which are very crucial in the construction process such as variations and fluctuations. Also the effect of inflation can never be uniform; it tends to fluctuate from time to time. However,conditions in Britain under which the s-curve was developed are quite different from Kenya and as such these results may not readily be applicable in this country.

Delays

Delays in construction can occur in many ways. There are delays on the part of the client for example in honouring payment certificates to the contractor and this can affect the contractors cash flow as seen earlier. Delays can emanate from the

design team especially from the architect or the engineer for not giving the necessary instructions to the contractor and thus inhibiting the contractors progress. Delays can also be attributed to contractors especially when it is neither the clients cause nor the design team's and the works are not progressing as programmed. Clients can delay to pay consultants fees.The effect of this on project performance is not part of this study.

The schedule of conditions of building contract in use both for government and private contracts lists circumstance under which a contractor can be compensated for lost time by way of extending contract time as follows:-

(i) By force majeure.

(ii) By reason of any exceptionally inclement weather.

(iii) By reason of such loss or damage by fire, earthquake and so forth.

(iv) By reason of civil commotion,local combination of workmen, strike or lock out affecting any of the trades upon the works.

(v) By reason of instructions for variation or postponement given.

(vi) Because the contractor has not received in due time necessary instruction which he shall have specifically applied for in writing.

(vii) By delay on the part of other contractors or tradesmen engaged in executing work not forming part of the contract.

(viii) By reason of the opening up for inspection of any work covered up or of the testing of any of the materials or goods, unless the inspection or test showed that the work,materials or goods were not in accordance with the contract.

(ix) By the contractors inability for reasons beyond his control and which he could not reasonably have foreseen at the date of the contract to obtain delivery upon the works of such imported goods or materials imported from outside the country in which the contract is being executed as are essential to the proper carrying out of the works.

The client is protected by the agreements from contractors delay by determination,where it is said that determination shall follow if the contractor shall fail to proceed regularly and diligently with the works. However,determination usually may not be the best alternative to follow in such circumstances for it involves more expenses for the client and the project is delayed even further. Liquidated and ascertained damages can be deducted as a penalty to the contractor.

The contractor is also protected by determination in a situation where the client does not pay the contractor within the period allowed for honouring certificates. But that is only for private contracts.Under the government agreement there is no mention of what a constractor should do if the payments are delayed.

Both the conditions of contract are silent on the delays caused by the design team. There is neither mention of such delay nor the redress open to the client or the contractor. Redress may be found in the laws of contract and tort.

The building industry advisory council of South Australia[68] examined the problems relating to the failure to achieve timely completion of contracts and found that the problem is caused by the laxity of the parties involved. Clients, consultants and contractors delay to play their respective parts in the building process. It was also observed that though the conditions of contract allow for the deduction of liquidated and ascertained damages, the clause was not being enforced.

In Kenya the same could be said that there is laxity among the parties concerned. Incidences of clients delaying payment either to the contractor or to the consultants are quite common. Also incidences of delays on the part of the consultants in terms of giving instructions or giving details in time to the

contractor are also evident. Whether there can be an improvement in the project performance due to concerned parties taking their work seriously is something that is not known. However, the mere fact that the construction process allows laxity for any party involved is an aspect that cannot be blamed on the parties involved, but the process that allows such laxity.

Variations

The private agreement and schedule of conditions for building contract defines variation as the alteration or modification of the design,quality or quantity of the works as shown upon the contract drawings and described by or referred to in the contract bills,and includes the addition omission or substitution of any work.The alteration of the kind of standard of any of the materials or goods to be used in the works and the removal from the site of any work, materials or goods executed or brought thereon by the contractor for the purpose of the works other than work, material or goods which are not in accordance with the contract[69].

Variations may arise in any one or more of the following situations:-

i When the architect needs or wishes to vary the design or the specification.

ii When a discrepancy is discovered between any two or more of the contract documents.

iii When a discrepancy is discovered between statutory requirements and any of the contract documents.

iv When an error or omission from the contract bills is discovered.

Variations may not necessarily add to cost,for instance in a situation of an omission, but whether the client gets the product as originally intended is not easy to tell.

Bromillow[70] investigated the effect of variations on performance of projects and found that variations are the cause of many problems in building contracts and a source of increases in time and cost.The same was expressed by the committee of public accounts upon the public works department(Australia)[71]. In addition,it was said that variations cause delay in payments to contractors, claims and disputes between the client and the contractor. It was further asserted that variations are part and parcel of the construction process and even the most skillfully designed project finds itself with changes during the construction process and that the majority of variations are caused by clients. It was recommended that there should be thoroughness in design and planning to avoid later changes.

Bromilow derived formulae for predicting variations as follows:-

$$N = K_1 C^{B1}$$

where, N = Number of variations in the project.

C = Final cost of the building in millions of dollars (1965 money values).

K_1 = Constant characteristic of building variations performance in Australia, value = 200.

B_1 = Constant indicative of the sensitivity of variation performance to cost level, value = 0.81.

The other formula relates the gross value of variations to final cost.

$$V = K_2 C^{B2}$$

where, V = Gross value of variations in thousands of dollars.

C = Final cost of building in millions of dollars (1965 money value).

K_2 = Constant characteristic of building variation value performance in Australia, value = 110.

B_2 = Constant indicative of sensitivity of variation value performance to cost level, value = 1.25.

Using the first formula, the number of variations on a project given its cost can be predicted. The second formula can be used to find the value of variations expected on a project given its cost. The two formulae can be useful at pre-contract stage for project planning and control.

However, these formulae were developed in the early sixties and between then and now many things might have changed in the construction industry that can render them obsolete. On the other hand the formulae were developed in Australia whose circumstances under which they developed may not be necessarily those applicable in Kenya.

Conclusions

There are many factors that affect the construction process,those within the construction industry and those outside the industry. Factors within the industry range from the behavior of clients and their institutions; the behavior of consultants or designers and the framework of their operation; the behavior of contractors and sub-contractors and the framework of their operation and the policy matters that affect the activities of the industry such as conditions of contracts and the legislation.

Factors outside the construction industry are varied and many encompassing factors such as, the building materials industry,, the plant and equipment industry,the labour force market, the financial sector and so fourth. Other factors include government policies, and economic performance both domestic and international.

There are also natural factors such as inclement weather conditions, earth movements and so forth.

All these factors create conditions in the construction process that affect its performance in one way or another. It is not therefore possible to come up with solutions to the problems of the construction industry by merely considering one, two or three factors only.

It is until all factors that have an effect have been examined and the effect ascertained that a step would have been made towards understanding time and cost performance of construction projects. However, it is not possible to have one study considering all the factors in one nutshell. But it is possible to consider a few factors in a series of small studies. When all the related studies are put together it would be easier to find a solution to the problem.

The researchers who have dealt with this problem before have done their part of the series by considering a few factors in the construction industry or even outside the industry. That, as expected has not offered a solution to the problem. The search for the solution must continue by looking at the other factors which were not considered in past studies.

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CHAPTER III

THE CONSTRUCTION INDUSTRY - AN OVERVIEW

Introduction

The construction industry has been defined as "that total industry which involves the utilization of human, economic and natural resources in the conception, design, construction, maintenance or demolition of building and civil engineering works"[1]. Official sources refer to the building and civil engineering industry as the two constituent parts of the construction industry. It could be argued that there is a third equally important part namely, the construction materials producing and extracting industry which not only supplies materials but is also responsible for supplying considerable credit to construction firms to supplement working capital[2].

In both the developed and developing worlds the construction industry plays a leading role in the process of national development. There is no aspect of development that does not bear a part in construction. This important role the construction industry plays in national economies is stressed in the Kenya's fifth development plan[3] which covers the period 1984 to 1988, where it is stated that, "the construction industry is

expected to contribute to the growth of the economy and will further be used as a means of achieving the governments objectives of employment creation and provision of vital services such as housing, hospitals, schools, offices and protective sea walls". To realize these very important objectives a well organized and efficient construction industry will be needed.

The importance of the industry could be appreciated by examining some of the major economic indicators with particular reference to the Kenya economy. These are:-

- The Gross Domestic product (GDP)
- The Gross Fixed Capital Formation (GFCF)
- and Employment.

Contribution of Gross Domestic Product (GDP)

The Gross Domestic Product is defined as the total value of all goods and services produced in the economy during one year inclusive of the value of goods produced by foreigners residing in that economy and without regard to the value of goods produced abroad by the economy's citizens. When the last two have been subtracted and added respectively to the GDP the result is the Gross National Product (GNP)[4].

The direct contribution of the construction industry to the country's national economy can be measured in terms of value added by the industry as a percentage share of the total GDP. Value added is defined as "the gross value of the output of the construction industry minus the value of purchases from other economic sectors for products and services (such as building materials and transportation services) which are incorporated in the final constructed facility, otherwise known as intermediate goods[5].

The contribution of the construction industry as a percentage of the total GDP is given in Table 3 - 1. The table shows that the construction industry is one of the seven major sectors of the Kenya economy. While the share is typically in the range of 3 - 5 percent, it is evident that between 1982 and 1984, the industry's contribution to GDP was declining. This decline may have resulted from the need to curtail both private and public capital investment in order to restore the country's unhealthy balance of payments situation which was created by importation of huge quantities of food as a result of poor harvests because of drought.

Table 3 - 1:Percentage of total Gross Domestic Product Monetary Economy 1979 - 1984

	1979	1980	1981	1982	1983	1984
Agriculture	31	30	30	31	31	30
Manufacturing	13	13	13	13	13	13
Wholesale, Retail trade restaurants and hotels	12	12	11	10	10	11
Finance,insurance,Real Estate and business service	7	6	8	7	8	9
Transport,storage and communication	5	6	5	6	6	5
Ownership of Dwellings	5	5	5	5	4	4
Building and construction	5	5	5	4	4	3

Source : Statistical Abstract (1985)

Contribution to Gross Fixed Capital Formation (GFCF)

Gross Fixed Capital Formation is defined as "outlays (i.e. purchases and own account production) of industries, government and private non-profit institutions on additions of new durable goods to their stock of fixed assets. These fixed assets include residential, and non-residential buildings, other construction (such as industrial plants, civil engineering infrastructure facilities), land improvement and plantation development, transport equipment, machinery and other equipment; and breeding stock draught animals, dairy cattle and the like"[6].

The construction industry's contribution to Gross Fixed Capital Formation of four countries is compared in Table 3 - 2. It is evident that the construction industry generally contributes between 50 - 60 percent of the GFCF, while that of Kenya ranged between 40-50 percent between 1960 and 1977. In 1977 this contribution was the lowest of 42 percent. This could be the effect of increased oil prices in the year 1973 and 1974. Oil forming the bulk of Kenya's imports, there was need to curtail domestic investment to raise enough foreign exchange for oil importation.

Table 3 - 2 :Gross capital Formation by Construction as a percentage of total Gross Fixed capital Formation

	1969	1970	1971	1972	1973	1974	1975	1976	1977
Greece	63	61	61	62	62	57	59	59	61
Kenya	51	47	49	54	54	56	54	49	42
Mexico	55	54	54	56	57	59	58	57	59
Tunisia	64	62	59	57	55	58	58	58	57

Source : Reference 7

Contribution to Employment

In developing countries there is a widespread unemployment problem which is caused simply by the fact that the rate of economic growth which is closely linked to employment creation does not march that of population growth. The population growth tends to be higher and thus the number of individuals who enter the labour force market keeps on increasing year after year. There is a general awareness in most developing countries to reduce the rate of population growth not only for checking unemployment escalation but also to reduce the pressure on governments in providing services such as health care, education etc.

Higher unemployment levels are experienced among the unskilled and semi-skilled labour force otherwise the skilled labour market portrays signs of job opportunities. This is exemplified by the fact that in many sectors of economies, the developing countries rely on expatriates for skilled labour.

Another aspect is that in developing countries while the figures of employment level may look expressive in some instances, there is another aspect of underemployment. This is a situation where the labour force may portray signs of full employment, that is working full time but the output does not tally with the hours worked. Such people would well be termed as partly employed.

Employment or unemployment are aspects within the economy that are subject to fluctuation. The economic performance of any economy depends on many factors some of which are beyond the control of governments, for instance the international economic activities. In Kenya for example the economic performance over the years has been susceptible to the prices of coffee and oil. Notable examples with remarkable effect on the performance of Kenya economy are the economic recession of the early seventies which was caused by increased price of oil; and the coffee boom of the late seventies and early eighties which was caused by the high price of coffee on the international coffee market that was as a result of coffee disease in Brazil thus curtailing world supply of coffee.

These aspects have got remarkable effect on employment opportunities. A recession is characterized by a heavy unemployment level. The most to be affected are those in the construction industry because during recession it is the construction industry that suffers the greatest stagnation because of the reduction in the level of investment. A boom is characterized by a higher employment level. This is because existing resources tend to be utilized to capacity. It is also those involved in the construction industry that experience the boom with higher employment levels.

For most governments the provision of adequate employment opportunities is a primary concern. Kenya's fifth development plan 1984 - 1988 has stressed the creation of income earning opportunities as one of its facets of its efforts to alleviate poverty. The plan indicates that the objective of maximizing employment opportunities in the country's construction industry will be achieved by pursuing a deliberate policy of fragmenting large construction contracts, giving preference to the construction of low cost buildings and using appropriate combinations of labour intensive building methods.

Table 3 - 3 shows the profile of employment statistics of workers in the construction industry, numbers and a percentage of total workforce. It can be seen that the industry's contribution to employment between the years 1970 and 1977 was a steady one, between 5 and 6 percent. The figures also show that employment in the construction industry has been growing at 10 percent year after year except in 1975 when it fell by the same percentage probably due to economic depression already mentioned owing to rising price of oil.

Table 3 - 3: Profile of employment statistics of workers in the construction industry Numbers and percentage of total workforce.

Year	1970	1971	1972	1973	1974	1975	1976	1978
Number	30800	34800	37600	41200	44500	40500	47100	48900
% of work force	5	6	5	5	5	5	5	5

Source : Reference 8

The government and the construction industry

The Government from time to time controls economic activities depending on the economic circumstances in the country and the desired economic trend. At its disposal are two measures; the fiscal and monetary policies. Fiscal Policy is defined as, "the use by the central authorities of government revenues and expenditures in an effort to influence the circular flow of income"[9]. The monetary policy is a device used to control the supply of money in the economy[10].

Fiscal policy would include government actions such as increased public expenditure aimed at increasing employment level and income within the economy. The increased income is expected to increase savings and therefore investments within the economy. But this depends largely on the marginal propensity to save,

which specifies the fraction that will be saved out of each additional shilling of disposal income received[11]. The opposite effect can be achieved by reduced government expenditure.

The monetary policy involves government actions, through the Central Bank, such as increased interest rates for borrowing and decree to Commercial Banks to limit lending money. Such actions are expected to reduce the money supply in the economy and probably inflation. The opposite effect can be achieved by reduced interest rates.

The magnitude by which changes can occur in the economy is affected by the multiplier. The multiplier is defined as "the ratio of the change in income to the permanent change in expenditure that brought it about"[12]. Thus the multiplier is the factor used to multiply a given change in spending to obtain a corresponding change in income. The strength of the multiplier is depended on the marginal propensity to consume among the citizens of the country. The marginal propensity to consume specifies the fraction of each additional shilling of disposable income received that will be spent on consumption[13].

The success of the two policies mentioned in real life is not a subject of discussion in this study. But what can be said is that those government policies, when applied, have drastic effects on the construction industry. This is because

construction finance, whether for the client or the contractor is obtained to a large extent by borrowing from financial institutions. Therefore, any action to curtail or increase borrowing or lending affects the construction industry both directly and indirectly.

The Informal Construction Sector

There is no clear definition of the Informal Construction Sector. In Kenya's statistical books it is referred to as the traditional or non-monetary sector. Brian[14] attempted to define the informal sector by stating that "the informal sector comprises of economic activities that fall outside the rules, regulations and fiscal provisions of the state". He further stated that "the informal sector is a consequence of and a response to the breakdown of the economy's rules and regulations". The informal sector therefore would include such activities as do-it-yourself, and small enterprises that would easily escape national income accounting.

The importance of the traditional economy, as referred to by the Kenya's Central Bureau of statistics, cannot be ignored. Between 1979 and 1984, the sector contributed an estimated 6 percent of the Gross Domestic Product, 2 percent of which was by building and construction alone [15].

In recent years the government of Kenya has developed a lot of interest in the activities that occur in the informal sector. It has been realized that the informal sector, also referred to as "Jua Kali", if encouraged, can be a source of employment creation, income generation, indigenisation of the economy and a starting point in taking off in establishing an industrial base. In line with the Kenya government objective of developing the informal sector, sessional paper number 1 of 1986[16] on economic management for renewed growth, sets out policy measures aimed at providing a suitable environment to the development of informal sector activities.

However, most people considered to belong to the informal sector interact to varying degrees with the monetary or formal sector. One observes in Kenya in the rural areas some shops and houses with cement floors or galvanized iron roofs. Similarly, on various construction projects there is a practice of sub-contracting jobs sometimes more that once, so that sometimes it is difficult to identify the demarcation between formal and informal sectors.

Industry's Participants

The Client Sector:

The client is the most important party in the construction industry because it is in his interest that a construction project is initiated. The client, who may be an individual, a public or private enterprise, or an agency of the government is responsible for initiating and obtaining finance for the project. Clients may have an inhouse design team of Architects, Engineers and Quantity Surveyors or commission their work to practicing consultants. Clients with inhouse design team usually are those with constant need to construct, for instance, the government, and large public and private firms. Occasionally their work is also commissioned to private consultants as the situation may demand. Small private firms and individuals usually resort to the services of practising consultants.

In Kenya the government is a major client contributing a large volume of capital formation by construction. Other government agencies are the local authorities and public corporations. Their construction work encompasses the provision of infrastructure services, offices and housing for their staff and the community.

In the recent past, there has emerged the speculative property developers especially in the urban centres. These are firms or individuals who construct buildings for renting or sale to individuals or firms at a profit. The would be buyers or renters get ready buildings on the market like one would find an item in the supermarket. They have no say over design and workmanship.

Speculative property development has emerged due to the rising urban population brought about by the rural-urban population migration and the increasing shortage of essential facilities in urban centres such as office space and housing.

The Design Sector:

This sector includes professionals such as Architects, Engineers, Quantity Surveyors, Planners etc. There are two main bodies that govern the registration of Architects, Quantity Surveyors and Engineers; the board of registration of Architects and Quantity Surveyors, and the board of registration of Engineers. Registration is approved following the applicants having passed the relevant examinations and attained the necessary experience.

In addition there are professional associations aimed at standardizing the professional education, setting the relevant

examinations and disseminating information to the professionals among other aims. There is the Architectural Association of Kenya(AAK) to which belong the Architects, Quantity Surveyors, structural Engineers and planners while the other engineers register under the Institute of Engineers of Kenya (IEK).

The Architects and Quantity Surveyors operate under the rules and regulations specified in chapter 525 of the Laws of Kenya. The professional bodies to which they belong also have codes of conduct. However, the role of the design sector in the industry is as follows:-

(i) Ascertaining the needs and desires of clients.

(ii) Developing a satisfactory design.

(iii) Drawing up plans and specifications.

(iv) Aiding in the selection of a contractor and

(v) Overseeing the project by certifying that the work conforms to the contract documents and by serving as a liaison between client and contractor.

The Construction Sector:

The Contractor is primarily a resource manager in charge of an assembly operation, where the resources include, men, materials, equipment, money and time. The general contractor must be skilled in both the techniques of construction and the management of construction operations, because he plans, co-

ordinates and supervises the entire production process and ensures that the facility conforms to the plans and specifications.

The Ministry of Public Works registers contractors who are legible to carry out government work. Several other institutions insist on Ministry of Public Works registration as a pre-requisite in giving out contracts. The conditions a contractor has to meet before qualifying for registration with the Ministry of Public Works are that:-

(i) The firm must have done some construction work before.

(ii) There must be good bank statement.

(iii) It must be well equipped with the necessary tools and equipment for carrying out construction work.

(iv) The firm must have in employment qualified staff in various trades who can carry out construction work.

Depending on how the firm rates on the above scale, a category is given ranging from H to A, lowest to highest respectively. The firms are also classified as African, Citizen and Non-citizen. Another classification is by type of work e.g. Building, Civil Engineering, Painting etc. Tables 3 - 4 and 3-5 show the situation as it is regarding contractors registered with the Ministry of Public Works.

Some changes may have occurred between the time of

collecting the data and the time of writing this study; however, the information gives an insight about building and civil engineering contractors in Kenya.

Table 3 - 4 General Building Contractors

Category	Value	Non-Citizen	Other Citizen	African	Total
A	£ 750,000 +	54	25	9	88
B	£ 250,000-750,000	36	21	3	60
C	£ 100,000-250,000	37	17	26	80
D	£ 50,000-100,000	38	33	83	154
E	£ 25,000-50,000	34	19	226	279
F	£ 10,000-25,000	10	15	343	373
G	£ 5,000-10,000	11	14	375	400
H	£ 0-5,000	8	15	853	876
	Total	228	59	1,923	2,310

Source: Ministry of Public Works

contractors Register, 1985

Table 3 - 5 Civil Engineering Contractors

Category	Value	Non-citizen	Other Citizen	African	Total
A	£ 750,000 +	23	13	2	38
B	£ 250,000-750,000	7	7	3	17
C	£ 100,000-250,000	6	5	6	17
D	£ 50,000-100,000	4	2	4	10
E	£ 25,000-50,000	2	-	4	6
F	£ 10,000-25,000	-	-	11	11
G	£ 5,000-10,000	-	-	5	5
H	£ 0-5,000	-	-	8	8
	Total	42	27	43	112

Source: Ministry of Public Works

Contractors Register, 1985

The tables portray that the majority of contractors who can handle large contracts in value of either building or Civil engineering are non-citizen.

Most of them are multinational firms which have access to heavy equipment and large capital outlay that is necessary for projects of such magnitude. Foreign firms usually repatriate their profits to their mother countries and this is not good for the local economy in which they operate. However, the only consolation is that those foreign firms employ local labourers who earn income that is spent locally.

Majority of the African contractors are in the lower categories and legible to handle the smallest contracts in value. They are inhibited to qualify to higher categories by lack of equipment, capital, skilled labour and management abilities.

Contractors have their associations which promote education and disseminate information to the members. There is the Kenya Association of Building and Civil Engineering Contractors (KABCEC) and the Kenya Association of African Contractors (KAAC). To the former belong to the large scale contractors while the latter is mainly for the upcoming African contractors. The two associations have voiced on issues pertinent to problems of their members.

The Financial Sector:

The financial sector provides the capital needed by both contractors and clients for construction. There are two types of capital involved in construction. First is the client's funds which are used to finance the project between its inception and the time it begins to yield its social and economic benefits. For public clients's, this type of capital comes by way of government expenditure whose source is taxation or borrowing from local banking institutions. In developing countries the capital also comes by way of borrowing and grants. Foreign capital has been associated with large civil engineering projects like dams and roads and in essential services such as schools and health facilities.

Private clients such as individuals, commercial and industrial organizations, obtain their capital by way of savings and borrowing from local institutions. There exist building societies whose purpose is to lend capital for construction purposes. Building societies provide loans and mortgage facilities to individuals and firms.

The second type of capital in construction is the contractor's capital which bridges the gap between payments by the client and the purchases of materials and equipment, and payment to operatives. The gap in payments comes about due to

retention and delayed payments. The major source of the contractors capital is the commercial banks where overdraft facilities can be given. Contractors also get materials and equipment on credit from suppliers usually for a month. Also contractors who may have several projects going on concurrently may finance one project with payment from another project.

The Regulatory Sector:

The regulatory sector encompasses those aspects that affect the construction industry both directly and indirectly. Government fiscal and monetary policies already mentioned affect the industry indirectly. The regulatory framework that affects the industry directly include building codes, zoning ordinances, planning laws etc. In this country most of these codes and the like have effect in the urban centres. The laws do not affect the rural construction activities. Even in the urban centres, slums have emerged in the face of the existing laws.

The building code has remained unchanged since the colonial days. It has not been able to cater for changing circumstances like the rising cost of construction materials. It is concentrated on prescribing the materials and methods to be used in construction rather than the desired performance characteristics. Therefore recent concepts like the provision of low cost housing (by using local materials) especially for the

urban population, majority of whom are in the low income bracket, have been inhibited by the existing rules and regulations governing construction. The need to revise the building code to allow for use of alternative building materials has been raised in many fora[17]. The motive of the colonial masters in construction may not be what it is today.

The Manufacturing and Supplier Sector:

The manufacturing and supplier sector provides materials and components for the construction process. Most of the materials incorporated in the construction process are a result of the construction industry's backward linkage. The main industries that provide the construction industry with raw materials are the cement, mining and quarrying, steel, plastic and timber industries.

The forward linkage of the construction industry is limited because the product of construction remains stationary where it was constructed and cannot be used as a raw material for the manufacture of another product. However, construction goods provide services for other industries, for instance, manufacturing, warehousing and transport industries rely on the services of the construction industry products.

Contractual Procedures:

A contract is an agreement between two or more persons which is intended to create legally binding obligations[18]. The nature of a contract is such that it binds the contracting parties together in an inclusive relationship referred to as "privity of contract"[19].

After the design team has obtained approval of the design from the client and the local authorities and has obtained the clients instructions to proceed, Bills of Quantities or specifications are prepared to serve as contract documents. Tendering is then done to the construction firms. Tendering is merely an invitation to treat. This could be done by advertising in the local press for pre-qualification of contractors, known as open tendering. The method is common in government and public enterprises. The other method is selective tendering where pre-qualification is done from a register for contractors maintained by the client. The selected contractors are then invited to tender. The method is practised to some extent in the government and public enterprises and commonly in the private sector. Alternatively, depending on the type and nature of the contract required, negotiation with one or more construction firms is often used as a means of selecting the contractor.

The contractor quotes his price and if accepted a contract is signed between him and the client. A contract must have certain ingredients to be valid, notably there must be:-

(i) Matual agreement, an offer and acceptance.

(ii) Consideration, that is "some right, interest profit or benefit accruing to one party or some forbearance, detriment, loss or responsibility given, suffered or undertaken by the other[20].

(iii) Lawful object, the contract must not be for illegal acts.

(iv) Capacity; none of the parties must be a minor, a bankrupt or lunatic.

(v) Genuine intention; no fraud.

There are two main types of contracts in common use; one where the Bill of Quantities forms part of the contract documents together with drawings. An alternative is where Bills do not form part of contract documents and usually is based on specifications, schedule of rates and drawings. There are standard forms of contract which are signed, namely:-

- Ministry of Works with quantities.
- Ministry of Works without quantities.
- Architectural Association of Kenya with quantities.
- Architectural Association of Kenya without quantities.
- Conditions of contract (international) for works of civil engineering constructions (FIDIC).

The sub-contractors usually enter into contract with the main contractor and sign standard sub-contract form of contract.

Standards:

The Kenya Bureau of Standards (KBS)[21], is the institution charged with the responsibility of standardizing materials and products in this country. It is a statutory organization of the government set by an act of parliament known as the standards act chapter 496 of the laws of Kenya. The main functions of the Kenya Bureau of Standards are:-

- To draft, modify or amend specifications and codes of practice.
- To assist the government or any local authority or other organizations or persons in setting any specifications or codes of practice.
- To encourage standardization in Commerce and Industry.

For a long time the country and particularly the construction industry had relied on British standards, some of which are not suitable for Kenya conditions, and that is why the government realized the need for the country to have standards of its own.

The date the Kenya Bureau of Standards has established 64 standards of materials and products in the construction industry,

among them are timber, steel and cement, while 23 materials are still undergoing the process of standardization.

One noticeable problem is the persistent reference to British standards despite the establishment of Kenya Standards.

Research and Information:

The Kenya Building Research centre[22] is a department of the Ministry of Public Works. The centre is devoted to the collection and dissemination of available knowledge pertaining to housing, Building, Physical planning and associated activities. The centre endeavours to keep upto date with information in connection with the availability and sources of supply of building. and allied materials, their specification and application. Close touch is also maintained with various bodies and organizations engaged in research in the fields of housing, building and physical planning.

Relevant details are recorded and made available for reference by interested parties to building and allied industries.

The Housing Research and Development Unit (HRDU)[23] is a multi-disciplinary research unit within the Faculty of Architecture, Design and Development of the University of

Nairobi. It was established in 1967 through the agreement between the Ministry of Public Works and the University of Nairobi to focus on research covering various aspects of housing, community facilities, planning and human settlements for low income groups in Kenya.

The materials which so far have been tested as suitable through demonstration projects throughout the country by HRDU include, stablised soil blocks, natural fibre cement, roofing sheets and natural fibre cement tiles. Research also continues into the use of alternative materials to replace cement, and design appropriate construction techniques.

The Case Studies

The study covers the Ministry of Public Works, the National Housing Corporation, the Kenya Posts & Telecommunications and the private sector.

The Ministry of Public Works is a government body that deals with design, construction and maintenance of all government building and civil engineering projects. It acts as a consultant Ministry for all other government departments.

The Kenya posts and Telecommunications corporation is a statutory body which was established by an act of parliament

chapter 411 of the laws of Kenya. Its main function is to provide postal and telecommunication services within Kenya and foreign countries. To be able to do this, the corporation has to establish, acquire, construct and maintain post offices, telephone offices, telegraph offices, radio communication offices, buildings and any other necessary facility for the purpose of the corporation and its functions.

The national housing corporation is a statutory body established by an act of parliament, chapter 117. The corporation is the main government housing agency whose responsibility is to ensure effective implementation of government housing policies and programmes. The main programmes are the site and service schemes, mortgage housing scheme and the tenant purchase scheme.

The private sector encompasses the activities of individuals, commercial and industrial firms such as banks, manufacturing companies, and the speculative property developers.

For government projects, the client Ministry identifies the need for a construction project. The treasury approves the construction project and agrees to a sum necessary for the financing of its estimated cost. The Ministry of Public Works surveys the site and prepares sketch designs for the approval of the client ministry after which working drawings, and

specifications or bills of quantities are prepared. The Ministry of Works selects the method of carrying out the work and obtains the client ministry's approval to commence construction, and the work is carried out on site under the Ministry of Public Works supervision.

For the corporations and the private projects, inception is drawn from their works programme, and having gone through the design processes either by an inhouse team or by consultants, the plans are taken to the relevant local authority for approval before construction commences.

In the ministry of Public Works the most preferred method of tendering is competitive either open or selective. Negotiation is done to a limited extent mainly for main contracts upto £40,000 in value and with African contractors and K£10,000 for African sub-contractors[24]. Negotiation is also preferred for the very large multi-million contracts.

The corporations, also prefer competitive tendering but to some extent negotiation is practised. In the private sector negotiation is widely used.

Table 3 - 6 shows the contract value verses contract period and is the one used for fixing contract period for government projects. However, the methodology for calculating the period

based on the value of the contract is not known. It is evident that there are short comings in the table. For projects whose value ranges between K£10,000 and £ 40,000,every K£10,000 change in value has a corresponding change of 2 months in contract period. Projects in the range of K£40,000 and K£100,000 a change of K£20,000 necessitates still 2 months change in contract period, while for projects in the range of K£100,000 and K£250,000 a change of K£50,000 still necessitate a 2 months change in contract period. It is difficult to see how the values of K£10,000, K£20,000 and K£50,000 can have the same contract period, in one or two instances the 2 months will be either generous or inadequate.

Table 3 - 6: Contract Value Vs. contract Period

Contract Value £	Contract Period (months)
Less than 10,000	6
10,001 to 20,000	8
20,001 to 30,000	10
30,001 to 40,000	12
40,001 to 60,000	14
60,001 to 80,000	16
80,001 to 100,000	18
100,001 to 150,000	20
120,001 to 200,000	22
200,001 to 250,000	24
Over 250,000	26+

Source :Reference 25.

The methods used in the corporations and the private sector is not known, but chances are that it is by intuition.

In the Ministry of Public Works extra works which do not require additional funds are approved by the Departmental representative (D.R.). All extra works inside or outside the scope of the contract which may or might require additional funds must be referred to the client Ministry for approval. The form of contract agreement (1970 edition)[26] states that "the D.R. shall have the right, by varying the bills of quantities and drawings, to increase or decrease the quantities of any item of items without the consent of the contractor, provided that the total contract sum is not thereby increased or decreased in value more than 25 percent". However, if any extra work may cause the original contract sum to be exceeded by more than 25 percent, the D.R. has to obtain approval of the permanent Secretary or the Chief Engineer before the matter is referred to the client Ministry.

Table 3 - 7 summarizes who grants approval of variations in the Ministry of Public Works. These revelations show that the Ministry of Public Works recognizes variations as a normal occurrence in the construction process. It can be seen that there is no effort instituted by the Ministry to limit or discourage variations.

Table 3 - 7:Summary of who grants approval for variations

Variation	Additional Funds not required	Additional funds may be required	Additional funds will be required
Within scope of original contract	Departmental representative (D.R.)	D.R after G. leader advises C.M	Client Ministry
Outside scope of original contract	Client Ministry (CM)	Client Ministry	Client Ministry

Source : Reference 27

In the National Housing corporation there is strict control of variations, funds for any variation must be catered for within the contract sum and a situation where additional funds may be required is never entertained. The same is true with the Kenya Posts and Telecommunications Corporation.The two corporations both use private agreement and schedule of conditions which though allows variations, but does not give the architect the discretion of varying the contract by 25 percent in value as does the government one.

Payments are made to contractors for work which they have carried out on a job. A payment certificate is a document which lists the details of who is to be paid and how much he is be paid. In The ministry of Public Works a certificate is raised at

the direction of the D.R. but at intervals not greater than the period for interim certificate named in the contract conditions. The Quantity Surveyor responsible for the job prepares a payment certificate. The document is sent to the group leader who checks and signs, and then passes it to the Chief Architect for signature, from where it goes to the Chief Quantity Surveyor, examination and cash office. In the situation where other client Ministries are involved, from the Chief Quantity Surveyor, the document is despatched to the client Ministry for issue of cheque and payment.

The process definitely is long and cases where contractors receive their payment long after the 14 days allowed in the conditions of the contract are known to exist. The situation is worsened when a payment cerficate goes to another Ministry.

The processing of payment cerficates to contractors in the National Housing Corporation and the Kenya Posts and Telecommunications Corporation is known to be shorter than in the Ministry of Public Works because of the cut on the number of certification and the process of examination, and contractors get their payments before the 14 days expire.

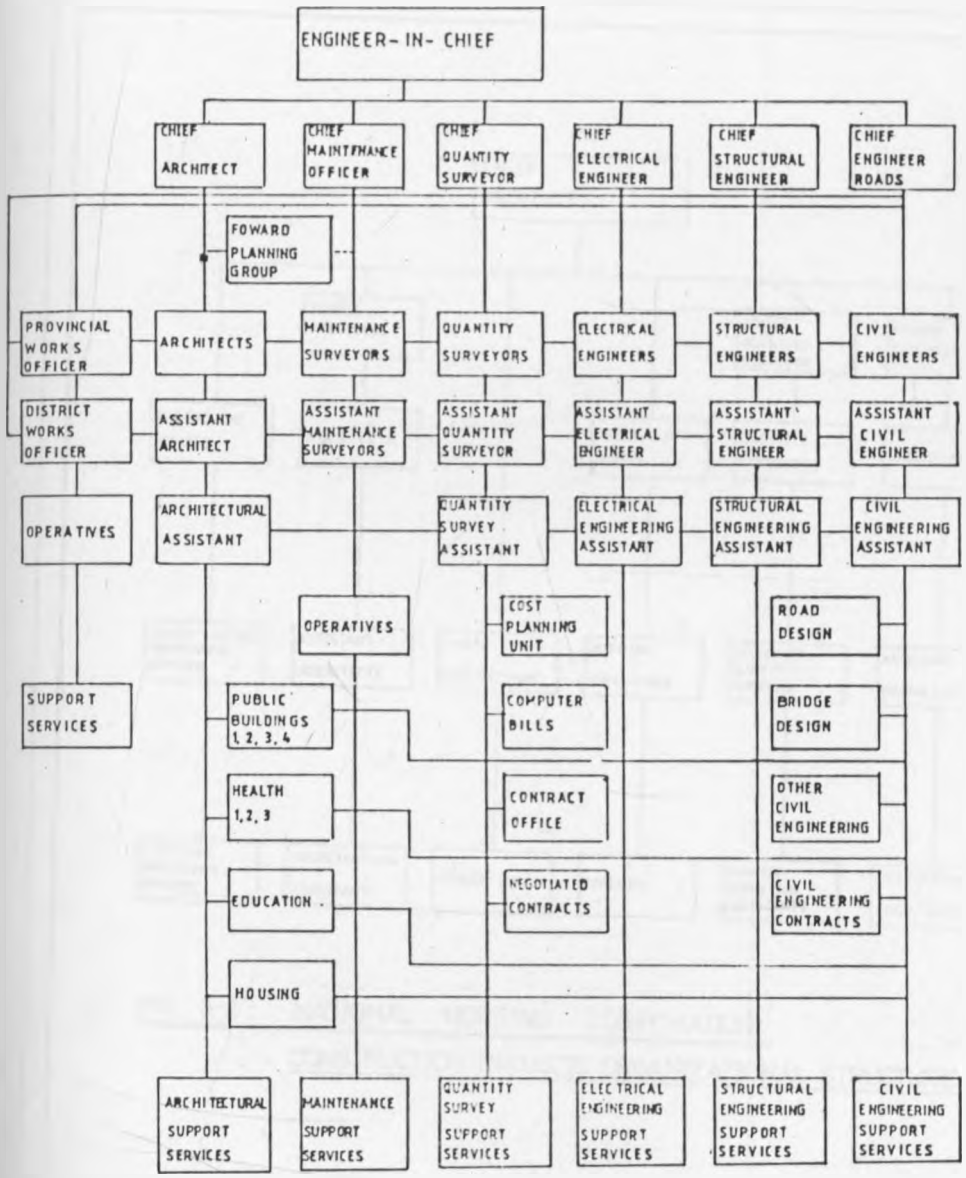

FIGURE 3-1 MINISTRY OF PUBLIC WORKS CONSTRUCTION PROJECTS ORGANISATION STRUCTURE

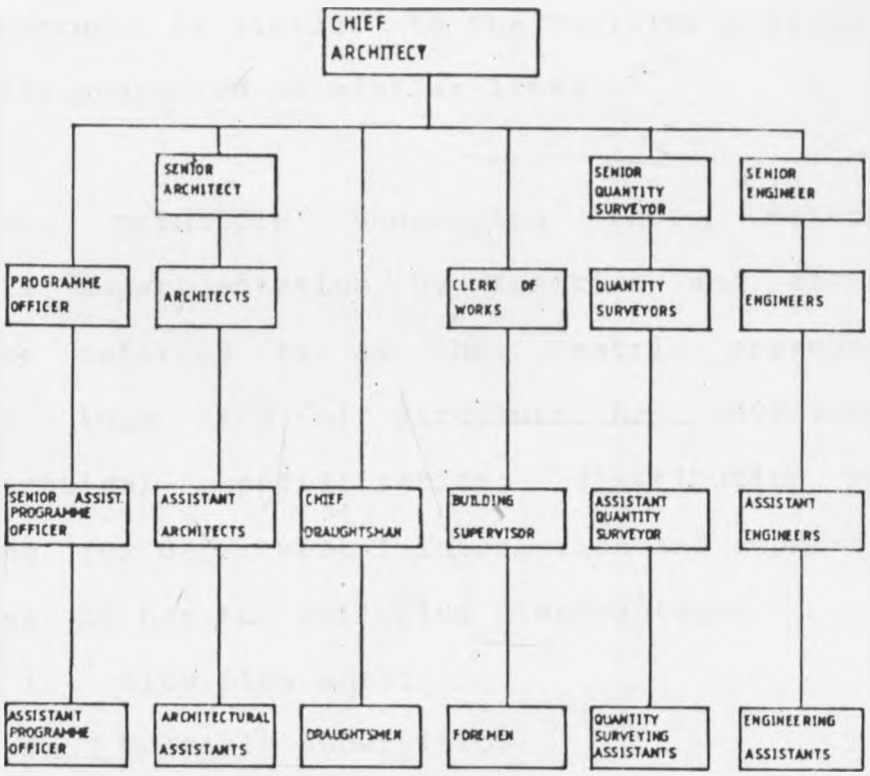

FIG 3-2 : NATIONAL HOUSING CORPORATION
CONSTRUCTION PROJECTS ORGANIZATIONAL STRUCTURE

The organization structures for construction project implementation in the Ministry of Public Works is as shown in Figure 3 -1 and that of the National Housing Corporation is shown in figure 3 - 2. The Kenya Post and Telecommunications Corporation structure is similar to the two. The private sector structure is also organized on similar lines.

The basic principle underlying these methods of organization is departmentation by function and direct line authority, also referred to as the "matrix organization". However, while this kind of structure has advantages of; Permitting technical specialization; distributing workload evenly, allowing for departmental interaction and rendering more uniform services, it has the following disadvantages:-

i Slow flow work.

ii Multiple supervision.

iii Difficulty in shifting personnel.

iv Liaison complex.

These disadvantages have got remarkable effect on project performance.

FOOTNOTES

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24. Republic of Kenya, "Building organization and operations manual", (Nairobi: Ministry of Public Works, 1974), p. ALS/75.

25. Ibid Annex 49.

26. Republic of Kenya, "Contract Agreement 1970 Edition with Quantities, " (Nairobi, Government Printer, 1970), p. 4.

27. Republic of Kenya, "Building organization and operations manual", (Nairobi: Ministry of Public Works, 1974), p.Art 8.53.

CHAPTER IV

DATA ANALYSIS

Introduction

The information contained in each individual questionnaire (Appendix A) was extracted and tabulated in Appendix B which shows the characteristics and performance of each individual project in the sample. In Appendix B, column 13 marked X_1 was adopted directly from the questionnaire and shows the number of variations issued on an individual project. Column 16 marked X_2 shows the period payment to a contractor were delayed and also was adopted directly from the questionnaire.

The figures in column 20, marked Y and column 24 marked Y_1 were derived and show the percentage cost overrun/saving and time overrun/saving respectively, hereinafter referred to as cost and time performance level respectively. The formulae used to derive the figures are as follows:-

Column 20,

$$\frac{\text{Final contract sum (col. 18)} - \text{Initial contract sum (col. 17)}}{\text{Initial contract sum (col. 17)}} \times 100$$

Column 24,

$$\frac{\text{Final contract period (col.22)} - \text{Initial contract period (col.21)}}{\text{Initial contract period (col. 21).}} \times 100$$

The percentages calculated show a positive in case of an overrun and a negative in case of a saving. The result was adopted as calculated by convection to differentiate between an overrun and a saving. Appendix B further shows the frequencies of time and cost overruns and time and cost savings given varying characteristics of the projects in the sample. The frequencies have been shown in the form of tables, from which the figures used in the chi-square calculations were extracted.

Clients

The variation in different clients is the government, parastatals and the private sector. The null hypothesis tested is that time and cost performance of construction projects is independent of different types of clients. The calculations for chi-square statistics are shown in Appendix C in a table headed clients. Table 4 - 1 shows the results of the calculations from Appendices B and C.

Table 4-1: Clients and time and cost performance of construction projects

	Government	Parastatal	Private	Overall
% of total projects cost overrun	82	22	57	53.7
% of total projects time overrun	93	74	43	70
Mean % cost overrun	51	-0.3	12	20.7
% cost overrun standard Deviation	78	17	18	___
Mean % time overrun	112	19	30	53
% time overrun standard deviation	106	28	45	___
Chi-square test:	$X^2_{0.05}$	X^2		
Cost performance	5.991 <	26.743	Reject H_o	
Time performance	5.991 <	15.680	Reject H_o	
2 degrees of freedom				
95% confidence level				

Source: Field Survey 1987

The figures in rows 1 and 2 of table 4-1 were calculated from tables in Appendix B headed clients. The table shows that, out of the projects sampled 82 percent of government projects had cost overruns while 93 percent had time overruns. For parastatal projects, 22 percent had cost overruns and 74 percent had time overruns while for the private sector, 57 percent of the projects

had cost overruns and 43 percent time overruns.

The overall percentages are 53.7 for cost overruns and 70 for time overruns. This shows that government projects have the worst performance in both time and cost, while the parastatal projects have got a comparatively better cost performance but an equally poor time performance. The private sector projects have got a comparatively better time performance than the rest in terms of frequency of occurrence but poor in magnitude of time overrun. The mean percentage cost and time overruns were calculated from the figures in columns 20, and 23 marked Y and Y_1 respectively in Appendix B, and are shown as by different clients in rows 3 and 5 respectively. The parastatals have got an overall percentage cost saving of 0.3. Parastatals also have a better time performance in terms of the magnitude of the time overrun, 19 percent which is less than 112 and 30 percent for government and private sector respectively.

The percentage cost overrun standard deviation and the percentage time overrun standard deviation for different clients are shown in rows 4 and 6. For Government projects the standard deviations for both cost and time are high, showing that the reasons for both time and cost overruns in government projects are many and varied. The parastatals show the lowest standard deviations which shows that both the percentage time and cost overruns in parastatal projects do not differ very much from

their mean. This shows that the causes of time and cost overruns in parastatal projects are not so much varied.

For cost performance, the value of chi-square statistic computed is 26.742 which is greater than the value of chi-square distribution at 2 degrees of freedom, and 95 percent confidence level, and therefore falls within the rejection region. For time performance at the same confidence level and degrees of freedom, chi-square statistic computed is 15.680 which is also greater than chi-square distribution of 5.991, and therefore also falls within the rejection region.

Therefore the null hypothesis (H_0) that time and cost performance is independent of different types of clients is rejected and the alternative hypothesis (H_A) that time and cost performance is dependent on different types of clients is accepted. The analysis done earlier of mean percentage time and cost overruns revealed that there is a remarkable variation in project performance as by client. The government as a client has the worst time and cost performance followed by the private sector while the parastatal projects are performing comparatively better.

Design Teams

The design teams in the construction industry are varied mainly on two lines; those employed by the client as an inhouse

team and those working as private consultants. The chi-square statistic test was carried on the two types of design teams. Table 4-2 shows the results of the calculations as regards time and cost performance in relation to the two types of the design teams.

Table 4-2: Design teams and time and cost performance of construction projects

	In house	Private consultants
% of total projects: cost overrun	53	66
% of total projects: time overrun	87	70
Chi-square test:	$X^2_{0.05}$ X^2	
Cost performance	3.841 > 1.408:	Accept H_o
Time performance	3.841 > 3.074:	Accept H_o
1 degree of freedom		
95% confidence level		

Source: Field Survey 1987.

The figures in rows 1 and 2 were computed from the table headed clients in Appendix B. The percentages show that time and cost performance is equally bad in both projects which are done inhouse and those commissioned, though it is evident that time performance is the worst with regard to both design teams.

The calculations for chi-square statistic are shown in Appendix C in the table headed design teams. For cost performance the chi-square statistic value of 1.408 is less than that of the chi-square distribution of 3.841 at 95 percent confidence level and one degree of freedom. Similarly, for time performance, the value of chi-square statistic of 3.074 is less than that of chi-square distribution of 3.841 at one degree of freedom and 95 percent confidence level. The null hypothesis that time and cost performance is independent of the two types of design teams is accepted. Therefore the conclusion is that construction time and cost performance is not influenced by whether a project is commissioned or not. However, this result is confirmed by the high percentages for both time and cost overruns shown in rows 1 and 2 of table 4-2. This nullifies the generally held belief that private consultants manage projects better than those employed by the clients as an inhouse team because of the self motivation of private consultants. However, given that all the professionals in the construction industry whether client employees or private consultants undergo similar training, and the lack of competition among them, no difference should be expected in the performance of the two types of design teams.

Types of Projects

The variation in type of project is building and civil engineering. Table 4-3 shows the result of the calculation for type of the projects.

Table 4-3: Type of project and time and cost performance of construction projects.

	Building	Civil Engineering
% of total project: Cost overrun	62	50
% of total project: Time overrun	81	50
Chi-square test	$X^2_{0.05}$ X^2	
Cost performance	3.842 >0.377	Accept Ho
Time performance	3.842 >3.831	Accept Ho
1 degree of freedom 95% confidence level		

Source: Field survey 1987.

It was found that 62 percent of the buildings had cost overruns as compared to 50 percent for civil engineering projects. The percentage for time overruns, is 81 for buildings and 50 for civil engineering.. This suggests that civil engineering projects perform comparatively better in both time and cost.

But when the chi-square test is applied, a different result is obtained. The calculations for chi-square statistic are as tabulated in Appendix C, in tables headed types of projects,and the result are shown in table 4-3. The null hypothesis tested is that time and cost performance is independent of different types of projects; whether building or civil engineering. For cost performance X^2 was found to be 0.377 against $X^2_{0.05}$ value of 3.841 at 95 percent confidence level and one degree of freedom, thus the null hypothesis is accepted. For time performance X^2 was found to be 3.831 against $X^2_{0.05}$ of 3.841 at 95 percent confidence level and one degree of freedom also rendering the null hypothesis to be accepted. It is therefore concluded that time and cost performance are independent of whether projects are buildings or civil engineering.

Contractors

Construction firms were analyzed based on Ministry of Public Works categorization of African, Citizen and non-citizen. The analysis was carried further to the experience of contractors, where experience is associated with the Ministry of Public Works classification by category.

The figures in rows 1 and 2 of table 4-4 were computed from the table headed contractors in Appendix B while those in rows 3 and 4 were computed from the frequency table in Appendix C, also

headed contractors. For cost performance all types of contractors experience the problem of cost overruns with their projects but the African contractors have a comparatively better cost performance than the rest, so is the same with time performance. Like the case with other factors already considered, time performance is the poorest.

Table 4-4: Contractors and time and cost performance of construction projects

	African		Citizen	Non-citizen
% of total projects: cost overrun	53		61	71
% of total projects: time overrun	64		80	100
Chi-square test	$X^2_{0.05}$		X^2	
Cost performance	5.991	>	0.812	Accept H_o
Time performance	5.991	>	4.920	Accept H_o
2 degrees of freedom 95 % confidence level				

Source: Field Survey 1987

Comparatively better performance of African contractors negates the widely held view that projects handled by african contractors are the worst managed.

The null hypothesis tested is that the time and cost performance is independent of the type of contractor. For cost performance, chi-square statistic computed value is 0.812 which is less than the chi-square distribution value of 5.991 at 2 degrees of freedom and 95 percent confidence level, thus lying in the acceptance region. For time performance the chi-square statistic computed value is 4.920 and chi-square distribution value is 5.991 at 95 percent confidence level and 2 degrees of freedom also lying in the acceptance region. The null hypothesis is accepted that cost and time performance is independent of type of contractor.

Table 4-5 : Contractor's experience and time and cost performance of construction projects.

	Contractors Ministry of works category				
	A	B	C	D	E
% of total projects: cost overrun	67	50	63	56	36
% of total projects: time overrun	85	85	56	78	63
Chi-square test	$X^2_{0.05}$ X^2				
Cost performance	9.488 > 3.138 Accept H_o				
Time performance	9.488 > 6.708 Accept H_o				
4 degrees of freedom 95% confidence level					

Source: Fieled survey 1987.

The experience of contractors is indicated by the category of the contractor as per the Ministry of Public Works register of contractors already referred to in chapter III. It is expected that contractors in the higher categories, that is C, and above are the most experienced and also have acquired the relevant equipment and plant coupled with high project managerial abilities and in that case projects handled by them should be performing better in terms of cost and time. Only Contractors registered in categories A, B, C, D and E were identified in the sample. There was no data available on contractors in the lower categories of F,G and H. The chi-square test was applied, whereby the null hypothesis was that, the category of the contractor and therefore the experience is independent of time and cost performance. The results of the caculations for the category of the contractor as it affects time and cost performance are shown in table 4-5. It shows that contractors in category E have a comparatively better cost performance than the rest, while time performance is equally bad for all the categories. For cost performance, the value of chi-square statistic computed as indicated in Appendix C is 3.138 which is less than the value of chi-square distribution of 9.488 at 95 percent confidence level and 4 degrees of freedom and therefore lying in the acceptance region. Chi-square statistic computed for time performance is 6.708 compared to chi-square distribution value of 9.488 at 95 percent confidence level and 4 degrees of freedom also lying in the acceptance region. Therefore, the null

hypothesis that time and cost performance is independent of the experience of contractors is accepted.

Method of Tendering

From the sample data it was identified that there are three main methods of contractor selection in this country and these are open, selective and negotiation. The figures in rows 1 and 2 of table 4-6 were computed from the table headed method of tendering in Appendix B while those in rows 3 and 4 were computed from the frequency table in Appendix C.

Table 4-6: Method of tendering and time and cost performance

	Open		Selective	Negotiation
% of total projects cost overrun	53		72	29
% of total projects time overrun	75		79	71
Chi-square test	$X^2_{0.05}$		X^2	
Cost performance	5.991	<	6.185	Reject H_o
Time performance	5.991	>	0.372	Accept H_o
2 degrees of freedom				
95% confidence level				

Source: Field Survey 1987

Table 4-6 shows that amongst the different methods used for

tendering time performance is the worst and equally bad for each method. However, cost performance is comparatively better with negotiated projects than the other methods.

The chi-square test for cost performance shows that cost performance is dependent on method of tendering. The null hypothesis being tested is that time and cost performance is independent of the method of tendering. For cost performance, the value of chi-square statistic computed, row 4, is greater than that of chi-square contribution at 95 percent confidence level and 2 degrees of freedom and therefore lies in the rejection region. It is therefore concluded that the method of tendering has an influence on cost performance. It has already been shown that negotiation leads to better cost performance. For time performance the value of chi-square statistic is less than that of the chi-square distribution, row 5, at 95 percent confidence level and 2 degrees of freedom, and therefore lying in the acceptance region. It is therefore concluded that the method of tendering has an influence on cost performance but not on time performance.

Table 4-7: Type of Contract and time and cost performance of construction projects

	With Bills of quantities	Without Bills of quantities
% of total project: cost overrun	59	54
% of total projects: time overrun	79	62
Chi-square Test	$X^2_{0.05}$ X^2	
Cost performance	3.841 > 0.008	Accept H_o
Time Performance	3.841 >1.004	Accept H_o
Degree of freedom 95% Confidence		

Source: Field survey 1987

Type of Contract

The variation in different types of contracts is basically, where the bill of quantities forms part of the contract documents, in which case the work is measured and quantified. The other variation is where the bill of quantities does not form part of contract documents and in that case the contract is based on schedule of rates, specifications and drawings. The comparison in the performance of projects under the two different types of constracts is as shown in table 4-7. It cannot be said that the bill of quantities offers any advantage in the project proformance. The figures of the chi-square statistic computed are shown in Appendix C. The null hypothesis tested is that time

and cost performance of construction projects is independent of the form of contract used. For cost performance the value of chi-square statistic computed is 0.008 as compared to the value of chi-square distribution of 3.841 at 95 percent confidence level and one degree of freedom, and therefore lies in the acceptance region. For time performance the value of chi-square statistic computed is 1.009 which is also, as is the case with cost performance is less than that of chi-square distribution of 3.841 at 95 percent confidence level and one degree of freedom, also lying in the acceptance region. The null hypothesis is therefore accepted, that time and cost performance is independent of the type of contract used. However, this does not mean that the Bill of quantities is useless.

Contract Period

The foregoing analysis has generally shown that time performance of the construction projects is the poorest. A comparison was done between initially fixed contract periods and actual construction periods for projects in the sample and the result is as shown in table 4-8.

Table 4-8: Initial Vs Final Contract Period

Project Value Kshs. (million)	Mid point (S)	Mean of initial period in weeks (P_1)	Mean of Final period in weeks (P_2)	Change in contract period
< 0.1	0.05	5	6	20%
0.1 - 0.5	0.3	13	15	15%
0.5 - 2.0	1.0	30	36	20%
2.0 - 15.0	9.0	58	84	45%
15.0 -100.0	58.0	85	148	75%

Source: Field Survey 1987.

The figures in table 4-8 were computed from Appendix B. It was found that a range of contract sums shared contract periods with little variance and these were grouped, and the mean of the varying contract periods per group calculated as shown both for initial and final contract periods. The mid contract value was computed to represent each group. The table shows that among all the value groups of projects, the initially set time is never adequate. The poorest time estimated projects are those in the range of Kshs. 2 million and above because the percentage change in contract period is the highest.

A relationship using regression analysis in the form $p=a + bs$ was established, to relate both the initially set and final project completion time with the contract value taking the midpoint of each contract value group for easy computation. The

calculations are as follows in tables 4-9.

Table 4-9: Initial Contract Period Vs Contract Value Regression Analysis

Initial period (P_i)	Contract sum (s)	$P_i S$	P_i^2	S^2
5	0.05	0.25	25	0.0025
13	0.3	3.9	169	0.09
30	1.0	30	900	1.00
58	9.0	522	3364	81
85	58.0	4930	7225	3364
Σ = 191	68.35	5486.15	11683	3446.1

Source: Field Survey 1987

$b = 1.14$

$a = 22.6$

Where, P_i = initial contract period in weeks

S = contract value in Kshs. millions

Therefore, $P_i = 22.6 + S$

The formula $P_i = 22.6 + S$ is an estimate of the existing method used in fixing contract period given the contract sum. The fact that estimated contract period is inadequate, has already been mentioned. The interpretation is that about 23 weeks are built into all projects sizes to cover aspects in the project which do not boost construction progress, like inclement weather, labour and material shortages, delayed payments etc. The slope of the curve shows that changes in contract value are not adequately catered for in time adjustment.

As for a relationship between the actual contract completion period and the contract sum as shown in Appendix B, and using the same method as above the calculations are as follows in table 4-10.

Table 4-10: Final Contract Period Vs Contract Value, Regression Analysis

Final contract(P_2) period	Contract sum (s	$P_2 S$	$P^2{}_2$	S^2
6	0.05	0.3	36	0.0025
15	0.3	4.5	225	0.09
36	1.0	36	1296	1.00
84	9.0	756	70.56	81
148	58.0	8584	21904	3364
Σ = 289	68.35	9380.8	30517	3 46.1

Source: Field Survey 1987

b = 2.16

a = 28.27

Therefore, $P_2 = 28.3 + 2s$

Where, P_2 = Final contract period in weeks

S = contract value in Kshs. millions

The formula $P_2 = 28.3 + 2s$ is an estimate for the final contract period given the contract sum.

This revised formula for estimating contract period shows that the 23 weeks built in contract period for unforeseen circumstances during the process of construction is inadequate and instead should be 28 weeks. The slope of the revised formula is also twice that of the first formula, which shows that each additional million on contract sum has a double impact on the contract period than earlier thought. Therefore, the null hypothesis that initially set contract periods are inadequate is accepted and the revised formula $P_2 = 28.3 + 2s$ is a reflection of existing events as regards contract sum in relation to contract period given the current construction conditions in Kenya, and can be used to estimate contract period given the contract value. The graph for contract sum verses contract period is shown in figure 4-1. The graph shows that the divergency between initial contract period and the final contract period increases as the contract value increases, also a reflection that the poorest estimate for contract period is experienced in the larger projects in terms of contract value.

Variations

The number of variations issued on each individual project were as shown in column 13 marked X_1 in Appendix B. They varied from no variation to the highest number of 63, with a sample mean of 18. This shows that up to about 18 variations generally can be issued on an individual project other factors remaining the

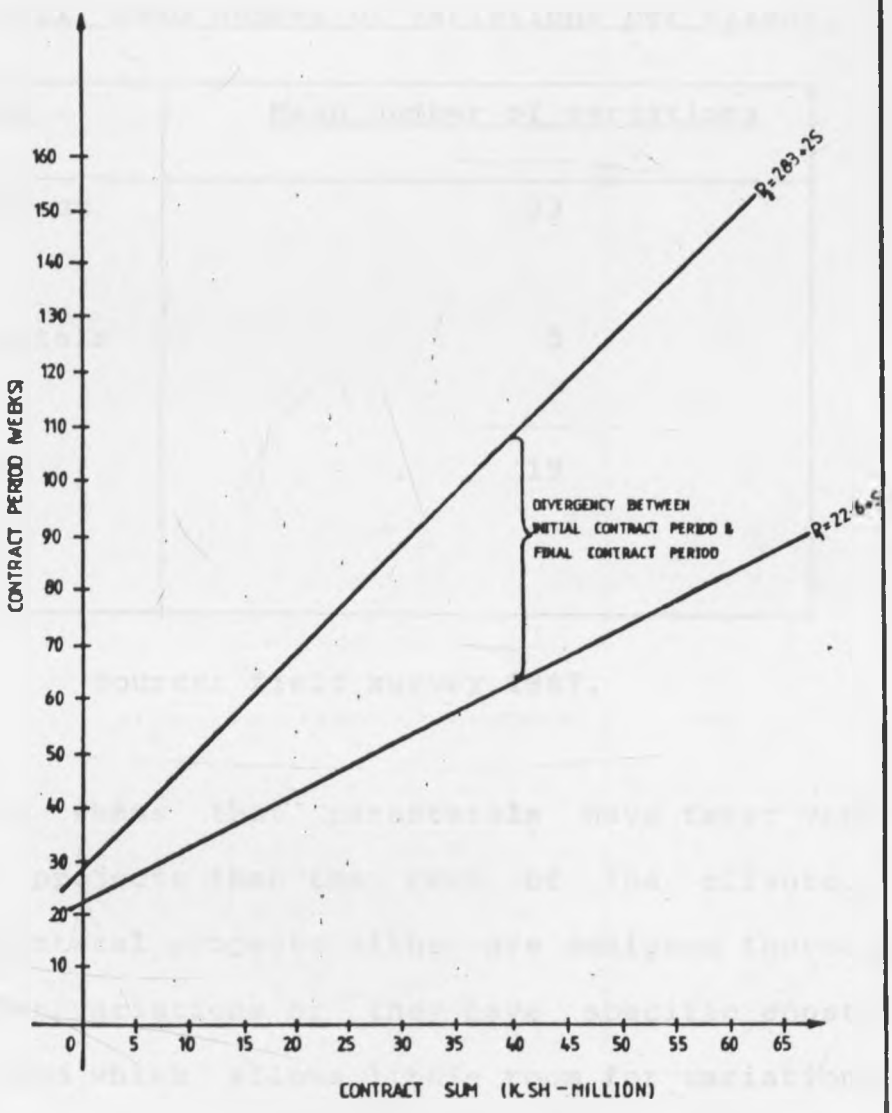

FIG 4-1 RELATIONSHIP BETWEEN CONTRACT PERIOD AND CONTRACT SUM

same. However, when the mean number of variations was calculated as per client the means were different as shown in table 4-11.

Table 4-11: Mean number of variations per client.

Client	Mean number of variations
Government	23
Parastatals	5
Private	19

Source: field survey 1987.

Table 4-11 shows that parastatals have fewer variations issued on their projects than the rest of the clients. This shows that parastatal projects either are designed thoroughly to leave no room for variations or they have specific construction needs before hand which allows little room for variations. The Government and the private sector portray the worst situation in terms of the number of variations issued per individual project.

Earlier it was found that clients have an influence on cost performance of construction projects and that parastatal projects

are performing better in terms of cost. In terms of the number of variations issued per individual project it has been demonstrated that parastatals have got the least. Crudely, it can be said that the number of variations issued has an effect on project cost performance.

The cost performance level was computed and is shown in column 20 Appendix B marked Y. A relationship using regression analysis in the form $Y = a_1 + b_1 X_1$ was established. Using the formulae set out in chapter one and Appendix D, calculations for a_1 and b_1 are found as follows:-

$$b_1 = 2.06$$

$$a_1 = -10.4$$

Therefore, $y = -10.4 + 2.06x_1$

Where, y = cost performance level

x_1 = the number of variations per individual project

The value -10.4 is the level of cost performance when there is no variation issued at all. This is to say that if a project, is started and no variation of addition is issued, a cost saving of up to 10.4 percent can be expected. It further shows that the design team protects itself of the effect of variation on total cost of the project by building in up to 10.4 percent of the contract value. The value of 2.06 reflects the effect of

variations alone on the total cost performance. For each additional variation the cost performance level varies by about 2.06 percent.

The formula $Y = -10.4 + 2.06X_i$ can be used to predict the level of cost performance if the expected number of variations on a project is known and this can help designers to take early necessary precautions. As a demonstration of its use, the values in table 4-11 which show the expected number of variations per project as by client, are substituted in the formula. The result is shown in table 4-12 which shows the expected performance level of any project as per client.

Table 4-12: cost performance level given mean number of variations

Client	No. of variations (X_i)	Cost performance level Y
Government	23	35.6
Parastatal	5	-0.1
Private	19	27.6

Source: Field Survey 1987.

Table 4-12 shows that the cost performance of parastatal projects is the best and is in an overall state of cost saving. For the Government and private projects, the cost performance levels are in an overall state of cost overrun.

The time performance level is shown in column 24 marked Y_1 in Appendix B. A relationship in the form $Y_1 = a_2 + b_2 x_1$ was established between the time performance level and the number of variations issued on an individual project. The values of a_2 and b_2 were computed as follows:-

$$b_2 = 2.05$$

$$a_2 = 35.959$$

$$Y_1 = 36 + 2.05X_1$$

Where, Y_1 = Time performance level

X_1 = The number of variations per individual project.

The relationship shows that whether variations are issued on a project or not, there is a guarantee that the project will overrun in time by at least 36 percent. It further suggests that, when estimating time, the designers under-estimate by not taking into consideration the factors that might escalate project construction period e.g., variations, weather, material shortages etc. The formula shows that with every additional variation the time performance level is worsened by 2 percent.

The formula $Y_1 = 36 + 2.05X_1$ can be used to predict the time performance level of a project given the expected number of variations, and the necessary precautions taken early enough.

The similarity between the cost performance level and the time performance level as influenced by the number of variations lies in the slopes of the two curves which are similar and parallel. The poor estimate for contract period is also evident as shown by the point at which the time performance curve meets the vertical axis which shows that all projects are in a state of time overrun even before they take off.

This finding suggests that with every variation issued the contract cost and time should be revised by at least 2 percent.

Figure 4 - 2 shows that the gap between cost performance and time performance is wide, 46 percent, and that time performance is the worst. This is to suggest that cost estimate and control is given more emphasis than time.

Table 4-13: shows the various statistics calculated in relation to the regression equations derived from the cost and time performance level and the number of variations. For cost performance. It is shown that about 27.7 percent of cost overruns can be explained by the nember of variations. The coefficient of correlation of about 0.527 shows that the relationship is fairly strong. However, the predictive capabilities of the regression formula is hampered by the large standard error of estimate factor which indicates an error of 52.56 percent. Although a 47.44 percent accuracy would not be considered as bad in the absence of a better predicator.

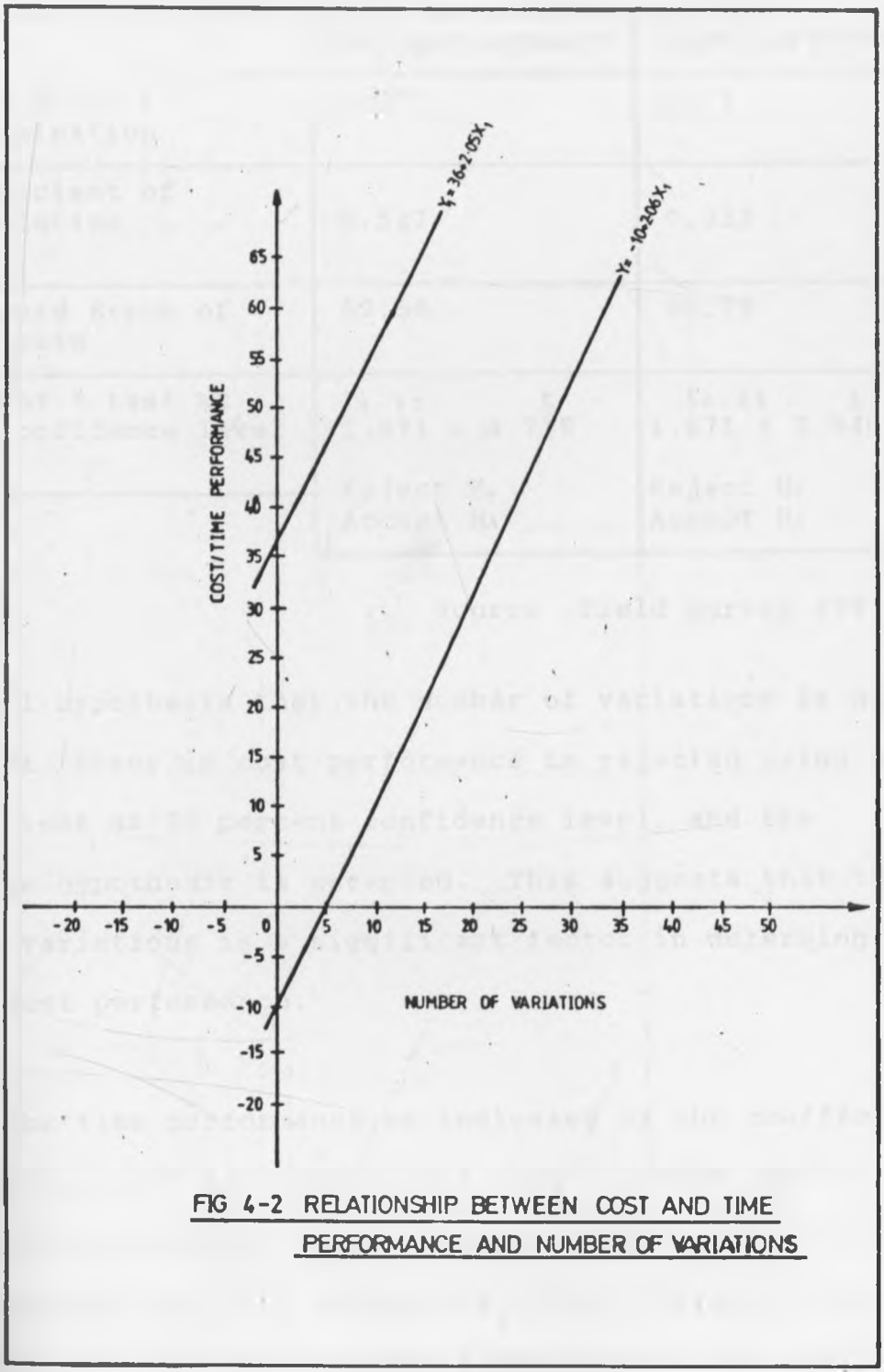

FIG 4-2 RELATIONSHIP BETWEEN COST AND TIME PERFORMANCE AND NUMBER OF VARIATIONS

Table 4-13: Cost and Time performance and number of variations

	cost performance	Time performance
Coefficient of Determination	0.277	0.11
Coefficient of correlation	0.527	0.332
Standard Error of estimate	52.56	90.79
Student t test at 95% confidence level	$t_{0.05}$ < t 1.671 < 4.715 Reject H_0 Accept H_A	$t_{0.05}$ < t 1.671 < 2.940 Reject H_0 Accept H_A

Source :Field survey 1987

The null hypothesis that the number of variations is not a significant factor in cost performance is rejected using the student t test at 95 percent confidence level, and the alternative hypothesis is accepted. This suggests that the number of variations is a significant factor in determing the level of cost performance.

For the time performance,as indicated by the coefficeint of determination,about 11.1 percent of time overruns can be explained by variations, which is quite a small percentage. It can be concluded that the problem of thime overruns is not in variations. However, the student t test shows that variations are a siginficant factor in determining the the level of time

performance. But to predict time performance level using variations as shown by the regression formula, one would be wrong by about 91 percent. This shows that although variations are a siginficant factor in time performance,there are other factors which are also significant.

Delayed payments

Column 14 of Appendix B shows the number of payments that were delayed on an individual project while column 15 shows the number of payments which were not delayed. the mean percentage number of delayed payments was computed for the whole sample and found to be 31 percent. This shows that generally other things remaining the same and regardless of the client chances are that about 31 percent of payments to a contractor can delay.

The mean percentage number of delayed payments was computed for different types of clients and the result is as shown in table 4 - 14.

Table 4 - 14: mean percentage number of delayed payment.

Client	Mean percentage
Government	50
Parastatal	15
Private	2

Source: Field Survey 1987.

Table 4 - 14 shows that government projects are prone to delayed payments, generally half of which have chances of being delayed. The effect of delaying payments to the contractors cash flow has already been addressed to in previous chapters.

An analysis was carried further into the actual period payments are delayed. The period of delaying payments to the contractor in the sample varied considerably from no delay to a maximum of six months on an individual project. The mean period for all the clients is 3 weeks above the normal contractual time allowed for honouring certificates. This is to say that other things remaining the same and regardless of the type of client the contractor should expect his payments to delay by at least about 3 weeks.

The mean period of delaying payments (as shown in appendix B,column 16 marked X_2) was calculated as per different client and the result is as shown in table 4 - 15.

Table 4 - 15: mean period of delaying payments as per client.

Client	Mean period of delay
Government	1 month 2 weeks
Parastatals	1 week
Private	No delay.

Source: Field Survey 1987

Table 4 - 15 shows that the government has a serious problem

of delaying payments to the contractor while the private sector has no problem of delaying payments. In the parastatals the problem cannot be termed as serious.

If the best cost performance in the parastatals could be attributed to the limited period of delaying payments, the same cannot be said for the private sector which has no problem of delayed payments and yet the problem of cost overruns is remarkable. However, the private sector showed the best time performance so far in terms of frequency (Table 4 - 1) than the rest of the clients. Therefore the problem of delaying payments could be affecting time more than cost.

An attempt was made to establish a relationship between cost performance level (column 20 marked Y in Appendix B) and the period of delaying payments (column 16 marked X_2 Appendix B). The computations are shown in Appendix D. A relationship in the form $Y = a_3 + b_3 x_2$ was established.

The constants a_3 and b_3 are found to be as follows:-

$$b_3 = 6.2$$

$$a_3 = 21.9$$

Therefore, $$Y = 21.9 + 6.2x_2$$

Where Y = cost performance level

x_2 = period in months of delaying payments.

The formula $Y = 21.9 + 6.2\ x_2$ shows that whether payments are delayed or not, a construction project can overrun in cost by 21.9 percent due to factors not related to delayed payments. Since the mean period of delaying payments as shown in table 4 - 15 varied from 0 in the private sector to a maximum of 1.5 months in the government, the influence of period of delayed payments on cost performance level cannot be said to be much if the figures 0 - 1.5 are substituted in the formula above.

Another relationship was established between the time performance level (column 24 marked Y_1 Appendix B) and the period of delayed payments (column 16 marked X_2 Appendix B in the form $Y_1 = a_4 + b_4 x_2$. The constants a_4 and b_4 are found as follows:

b_4 = 28.94

a_4 = 48.96

Therefore, $Y_1 = 48.96 + 28.94x_2$

Where, Y_1 = Time performance level

X_2 = Period in months of delaying payments.

The relationship between time performance level and period of delaying payments is found to be $Y_1 = 48.96 + 28.94\ x_2$. The

relationship shows that there is a remarkable effect that delay in payments has on time performance level of a project, to the extent that every one month delay in payment should cause the contract period revised by at least 29 percent in addition.

However, the relationship further shows that a project can overrun in time by at least 49 percent of its contract period due to factors not attributable to delay in payments. The inadequacy of initially set contract period has already been addressed to, and could be the cause of the built in 49 percent time overrun.

Table 4-16: Cost and Time Performance and period of Delayed Payments

	Cost Performance	Time Performance
Coefficient of Determination	0.016	0.163
Coefficient of Correlation	0.129	0.433
Standard Error of estimate	11.31	84.69
Student t test at 95% confidence	$t_{0.05}$ t 1.671 > 1.087 Accept H_0 Reject H_A	$t_{0.05}$ t 1.671 < 3.853 Reject H_0 Accept H_A

Source: Field Survey 1987.

Table 4 - 16 Shows the various statistics calculated in relation to the regression formulae derived from the cost and time performance levels and the period of delayed payments. The table shows that delayed payments explain cost performance by a negligible 1.6 percent, and the student t test at 95 percent siginificant level shows that delayed payments is not a significant factor in determining cost performance level. The conclusion is that the problem of cost overruns has a negligible bearing on delayed payments.

For time performance, although delayed payments explain time performance by only 16.3 percent, the student t test at 95 percent significant level shows that delayed payments is a significant factor in determining time performance.

However, the large standard error of estimate factor of about 85 percent shows that, as the case is with variations, although delayed payments is significant, there are other significant factors, variations being one of them. This suggests that the causes of time overruns are many and varied.

CHAPTER V

SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

Introduction

This study on the time and cost performance of construction projects addresses itself to a wide range of issues within the construction industry and the construction process including the discussion of the problem of time and cost overruns in construction projects in chapter I, the review of related literature regarding construction project performance in chapter II, the role, contribution and characteristics of the construction industry in the national economy in chapter III, and the analysis of various factors in the construction industry as to their influence on time and cost performance of construction projects in chapter IV.

Summary and conclusions

i) Time and cost performance:

The study has shown that time performance is the worst in construction projects both in frequency and magnitude, chances are that about 70 percent of projects initiated can overrun in time with a magnitute of about 53 percent over and above the original contract time; as compared to the chance that about 53.7

percent can overrun in cost with up to about 20.7 percent above the initial contract sum regardless of the client. However, while time and cost overruns are experienced by both the clients, the problem is worse in government projects.

ii) Clients:

The chi-square test at 95 percent significant level has shown that time and cost performance of projects is influenced by conditions associated with different types of clients. However, it has been shown that government projects perform the poorest in terms of both time and cost. Parastatal projects perform comparatively better in terms of cost but equally poor in terms of time; the private sector projects perform poor in cost but comparatively better in time. It is therefore concluded that conditions associated with different types of clients influence time and cost performance of construction projects.

iii) Method of Tendering:

The other variables examined viz the design teams, type of projects, contractors and their experience and types of contract, using chi-square test and at 95 percent significant level were found to have no influence on project performance. The bill of quantities provides a clear picture of the extent of each party's respective commitments and the unit rates provide a sound basis

for the valuation of any variations to the design, and this should be quite useful in controlling both project time and cost. The Bill of Quantities has been shown not to have any influence on project performance, and this shows that the length of time taken in the design of the project and the preparation of the bill does not pay any benefits. This does not mean that the bill of quantities is useless in the construction industry.

The method of tendering has been found to have an influence on cost performance but not on time performance. It has further been found that competitive tendering i.e. the open and selective, does not achieve value for money as intended. Negotiation, though as mentioned in chapter II is believed not to be the best alternative for the client, has the least problem of cost overruns though still does not offer any advantage in time performance.

iv) Contract periods:

It has been demonstrated that the initially set contract periods are inadequate and a factor affecting particularly time overruns of projects. As such, most projects initiated are in a state of time overrun even before they take off. It has been found that designers give about only 23 weeks as a protection against the effect of unforeseen circumstances on contract period which is inadequate. It has been demonstrated that about 28

weeks are needed to be built in the project contract period for unforeseen circumstances like bad weather, shortages of materials etc.

A relationship has been established between project value and initially set contract period as $P_1 = 22.6 + s$ and between the actual construction period and value as $P_2 = 28.3 + 2s$. This shows that every change in contract value has a greater impact on contract time than earlier thought.

It has also been demonstrated that the larger contracts of say Kshs. 2 million and above are the worst in poorly estimated time such that the gap between initially set time and the actual time of construction keeps on widening as the project value increases. The formula $P_2 = 28.3 + 2s$ can be used to estimate contract period given the contract value.

iv) Variations:

Variations have been found to be a significant factor in determining both time and cost performance levels.About 27.7 percent of cost overruns and 11.1 percent of time overruns can be explained by variations. The government and the private sector which are found to be the poorest in cost performance are also found to have the highest number of variations issued on an individual project. The parastatals with the least variations

are found to have the best cost performance.

A relationship has been established between the number of variations and cost performance as $Y = -10.4 + 2.06 X_1$ and that of the number of variations and time performance to be $Y_1 = 36 + 2.05X_1$ which shows that each additional variation has the same impact on cost performance as it has on time performance. The formulae can be used to estimate both time and cost performance given number of variations, though with a large error margin.

v) Delayed Payments:

The government is found to be prone to the problem of delaying payments to contractors. On average a payment can delay by up to about $1^1/_2$ months in government projects while there is no delay in the private sector. However, it has been demonstrated that the problem of delayed payments affects time more than cost. In other words, delayed payments is not a significant factor in determining the cost performance level. The private sector with no delay in payment portrayed the best time performance. Delayed payments explain time performance level by 16.3 percent while for cost is only about a negligible 1.6 percent. However, while delayed payments is a significant factor in determining time performance level,there are other factors which are also significant.

An achievement has been accomplished in that the main objectives of the study set out in chapter I have been carried out successfully through the analysis of the data whereby an investigation has been carried out on the various factors as regards their influence on both time and cost performance of construction projects. A relationship has been established between project value and period of construction. Also relationships have been established between the number of variations and period of delayed payments with time and cost performance. Out of all the factors examined, it is the different types of clients, method of tendering, variations and delayed payments that seem to have to a certain extent, an influence on time and cost performance while the inadequacy of initially set contract periods and the ignoring to consider unforeseen circumstances in fixing contract periods is found to be a factor affecting time overruns. These aspects are interrelated in that in a situation where time and cost performance is worse, it is associated with a remarkable presence of the factors.

Though the problem of time and cost overruns is influenced by conditions associated with different types of clients, the problem is rife with all the three categories of clients. The difference lies in the magnitudes of the problem. The parastatals could boast of the best cost performance.

When the government is mentioned as a client it is meant the Ministry of Public Works which is the institution responsible for the implementation of all government projects. The implication of the government for poor time and cost performance of projects therefore could be traced to the problems inherent within the Ministry of Public Works. The problems include among others: bureaucracy which leads to delays in communication flow leading to issues like, late decision making and taking, variations, delayed payments etc. lack of incentive for the staff leads to laxity. There is also poor co-ordination of the various parties involved in the project. This is traced to lack of co-ordinating machinery coupled with the level of expansion the Ministry has reached which has made it difficult to co-ordinate all the parties involved.

The private sector problems also could be traced to lack of co-ordinating machinery between the client and the design team. Also given that in some private institutions ownership is divorced from management, there could be lack of motivation on the part of those charged with the responsibility of project implementation.

Recommendations

In view of the findings and conclusions which have just been summarized, this study recommends that:-

(a) All participants in the construction process should be committed to controlling project time and cost and more so the design team which already is charged with that responsibility.

(b) More emphasis should be given to project time control than has been the case.

(c) In estimating for contract period the effects of the many varied factors that affect time performance should not be overlooked.

(d) The problem of time overruns of construction projects is an area needing further research.

(e) The Ministry of Public Works should be decentralized so that each individual Ministry should have its own design team for easy co-ordination and reduction in red tape.

(f) There should be an introduction of a project manager in the construction process set up to co-ordinate the activities of all other participants.

(g) The Bill of Quantities should be re-examined as to its role in the construction process given the time and cost it takes to prepare it. However, the effectiveness of the Bill of Quantities in the

construction industry is an area needing further research.

(h) The performance of different types of projects whether building or civil engineering and contractors is an area needing further research.

(i) Competitive tendering should be re-examined as to its usefulness in the construction process given that it is time consuming and costly. The lowest tender may not necessarily be offering the best price for the project and could be as it were "a wolf in goats skin". However, this is an area needing further research.

(j) The method used to determine the contract period should be reviewed to incorporate changing circumstances and greater emphasis should be given to the unforeseen circumstances as to their influence on contract period and cost.

(k) Every effort should be made to avoid variations by:-

i) Extensive site exploration initiations to avoid variations emanating from unforeseen site conditions.

ii) Extensive documentation of the project in terms of complete drawings and bills of quantities to avoid variations associated

with inaccurate tender documents.

iii) Extensive estimates for specialist work and price fluctuations such that estimates are reflected in the tender documents as true and coupled with early appointment of sub-contractors.

iv) There is need to establish a project information centre which can be used to store information related to cost data and time performance to be used by the participants in the construction industry.

v) Clients should have a clear picture of their requirements before approaching the design team so as to limit variations emanating from new ideas from the client.

(l) The process of payment certification should be reduced by avoiding unnecessary certification. In the government a process where the authority to incur expenditure (AIE) is held by the client Ministry complicates the certification process. It should be encouraged that AIE's for all projects be held by the One institution.

(m) Adequate funding for the projects should be encouraged. The problem of part funding experienced in the Treasury should be discouraged.

As noted in chapter II the construction industry and process has many factors which influence the performance of projects. The findings of this study are under assumption that the other many and varied factors which were not considered in this study remain the same and have a constant influence on project performance.

The problem of time and cost overruns in the construction industry is far from complete until all the other factors are considered, to find their influence on the time and cost performance of projects. Factors such as, to name just a few, weather, geographical differences of sites, material markets, labour force market, disputes, organizational structures, communication, motivation, National economic performance, government policies etc. need to be researched on. This study therefore is only a beginning for further studies into the problem of construction project performance.

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APPENDIX A

Questionnaire

Construction project time and cost performance survey

Name of interviewee ----------

Designation ----------

Firm ----------

Date ----------

Please refer to any completed project in kenya upto final Account by you/your firm and tick/fill in proved spaces as appropriate.

1. The period of construction:19 ____ to 19 ____
2. Project Location: _____ _____ _____
3. Project Type:
   (1) Building
   (2) Civil Engineering
   (3) Combination of building and Civil Engineering
4. If Building:
   (a) Type of building
      (1) Houses
      (2) Offices
      (3) School
      (4) Hospital
      (5) Factory

(6) Any other (specify)

(7) Combination (specify)

(b) Type of structure:

(1) Concrete/Masonry block walling

(2) Structural Steel Frame

(3) Reinforced Concrete Frame

(4) Any other (specify)

(5) Combination (specify) ----------

(c) The Building was:

(1) Single storey

(2) Multi-storey

(3) Combination

(d) Total Floor area ----------

(e) If multi-storey the number of floors

---

5. If Civil Engineering; type of project:-

(1) Road

(2) Dam

(3) Water Works

(4) Sewerage

(5) Any other (specify) ----------

6. Type of client:

(1) Government

(2) Parastatals

(3) Private

7. Type of Financier:

(a) Local

(1) Government

(2) Parastatals

(3) Private

(b) Foreign

(1) World Bank

(2) E.E.C.

(3) USAID

(4) DANIDA

(5) Any other (specify) ----------

(6) Combination (specify) ----------

8. Composition of Design Team:-

(a) Client's Employees:

(1) Architect

(2) Quantity Surveyor

(3) Civil Engineer

(4) Others (specify)

(b) Consultants:-

(1) Architect

(2) Quantity Surveyor

(3) Civil Engineer

(4) Others (specify) ----------

9. Type of Main Contractor:-

(1) African

(2) Citizen

(3) Non-citizen

10. Contractor's MOPW Category:

A B C

D E F

G H

11. Method of Tendering:-

(1) Open Tendering

(2) Selective Tendering

(3) Negotiation

(4) Combination (specify) ----------

12. Type of contract:-

(1) A.A.K. with Quantities

(2) A.A.K. without Quantities

(3) MOPW with Quantities

(4) MOPW without Quantities

(5) FIDIC

(6) Any other (specify)

13. Could you please fill in the project details:-

(1) Contract sum Kshs. ----------

(2) Preliminaries Kshs. ----------

(3) P. C. sums Kshs. ----------

(4) Provisional sums Kshs. ----------

(5) Final contract sum Kshs. ----------

(6) Initial contract time ---------- weeks/months

(7) Final contract time ---------- weeks/months

14. The Final Contract sum is:-

(1) (1) Within initial cost

(2) More than initial cost

15. Causes of your Answer to Question 14:

_____

_____

_____

_____

_____

_____

_____

16. The Final Contract time is:

(1) Within initial time

(2) More than initial time

17. Causes of your Answer to Question 16.

_____

_____

_____

_____

_____

18. The number of variations issued .....

19. The number of months when payments to the contractors were not delayed.

_____

20. The number of months when payments to the contractor were delayed

_____

21. The number of days/weeks/months on average for which each delayed monthly payment was delayed.

22. The causes of delay in payment

_____

_____

_____

_____

_____

APPENDIX B

FORMAT OF RAW DATA

(1)	(2)	(3)	(4)	(5)	(6)
Project No.	Floor Area M_2	Year of construction	Building Type	Civil Type	Structure
1	—	84-87	S		C
2	2076	84-87	H		B/W
3	2403	82-84	S		C
4	—	82-87	S		B/W
5	2065	82-87	S		B/W
6	—	83-87	—	W	—
7	247	81-82	O		B/W
8	—	83-84	H		—
9	450	85-87	O		C
10	—	83-83	H		—
11	258	84-85	O		B/W
12	2200	79-83	H		B/W
13	3460	83-85	O		C
14	1536	82-85	O		B/W
15	—	78-79	HO		B/W
16	1420	78-82	O		R.C.
17	2839	83-85	H		B/W
18	9100	81-84	S		C
19	—	84-84	H		—
20	496	84-85	O		B/W
21	—	85-85	H		—
22	614	79-82	HO		B/W
23	819	78-79	HO		R.C.
24	612	84-85	S		C
25	610	80-81	S		C

APPENDIX B

FORMAT OF RAW DATA

	(7)	(8)	(9)	(10)	(11)
Project No.	No of Storeys	Financier	Contractor Type	Contractor category	Tender method
1	1	G	A	C	O
2	2	G/USAID	A	C	O
3	—	G	A	A	O
4	1	G/IDA	C	A	S
5	1	G/IDA	C	A	S
6	—	G	A	E	O
7	1	G	A	B	O
8	—	G	NC	A	O
9	2	G/WB	A	D	S
10	—	G	A	D	O
11	1	G	A	B	N
12	1	G	C	E	O
13	1	EEC	C	A	S
14	1	G	A	C	O
15	1	C/CIDA	A	D	S
16	2	G	C	B	N
17	3	G	C	A	N
18	1	CIDA	C	B	S
19	—	G	A	B	O
20	1	G	A	B	O
21	—	G	C	E	S
22	1	G	C	D	S
23	1	G/CIDA	C	D	S
24	1	G/WB	C	C	O
25	2	G/WB	C	B	O

APPENDIX B

FORMAT OF RAW DATA

	(12)	(13)	(14)	(15)	(16)
Project No.	Contract Type	(X_1) No. of variations	No. of delayed payments	No. of payments not delayed	(X_2) period of Delayed payment (months)
1	MQ	22	21	18	1
2	MQ	18	0	25	0
3	MQ	25	12	20	2
4	MQ	27	—	—	—
5	MQ	26	—	—	—
6	M	10	0	10	0
7	MQ	21	0	10	0
8	MQ	—	0	10	0
9	MQ	13	—	—	—
10	MQ	21	0	4	0
11	MQ	—	0	5	0
12	MQ	34	32	11	6
13	MQ	44	0	30	0
14	MQ	13	2	23	1
15	MQ	—	10	0	4
16	MQ	35	—	—	—
17	MQ	17	20	44	5
18	MQ	—	46	0	0
19	MQ	12	0	3	—
20	MQ	21	20	3	3/4
21	MQ	0	0	3	0
22	MQ				
23	MQ	25	8	0	1
24	MQ	54	7	33	3/4
25	MQ	47	4	29	1/2

APPENDIX B

FORMAT OF RAW DATA

	(17)	(18)	(19)	(20)	(21)
Project No.	Initial contract sum (shs)	Final contract sum (shs)	Cost saving/ overrun (shs)	(Y) % of cost saving/ overrun	Initial contract period (weeks)
1	4,722,513	8,716,538	3,994,025	85	90
2	6,246,000	10,884,000	4,638,000	74	60
3	12,705,187	15,039,029	2,333,842	18	80
4	16,093,563	27,462,222	11,368,659	71	90
5	10,725,508	17,015,111	6,289,603	59	75
6	1,047,500	1,060,887	13,387	1	20
7	3,049,748	3,361,033	311,315	10	8
8	8,076,780	7,668,616	-408,162	-5	28
9	868,000	1,300,000	432,000	50	30
10	470,000	589,411	119,411	25	12
11	776,315	729,715	-46,600	-6	12
12	5,645,131	9,955,845	4,310,714	76	52
13	18,812,729	21,787,307	2,974,578	16	100
14	5,913,453	10,674,736	4,761,283	81	52
15	2,969,816	4,158,881	1,189,065	40	65
16	984,350	2,134,948	1,150,598	117	48
17	35,833,816	35,344,459	-489,357	-1	100
18	19,999,000	38,593,463	18,594,463	93	120
19	2,500,000	2,392,463	-107,537	-4	8
20	3,450,160	3,525,120	74,960	2	70
21	179,000	159,000	-20,000	-11	12
22	1,994,142	2,507,373	513,231	26	40
23	2,028,612	3,505,323	1,476,711	60	
24	2,438,667	12,868,914	10,430,247	428	36
25	5,760,460	9,236,781	3,476,321	60	50

APPENDIX B

FORMAT OF RAW DATA

Project No.	(22) Final contract period (week)	(23) Time overrun/ saving (weeks)	(24) (Y_1) % of contract period		
1	156	66	73		
2	100	40	67		
3	104	24	30		
4	208	118	131		
5	200	125	167		
6	40	20	100		
7	40	32	400		
8	40	12	43		
9	82	52	173		
10	16	4	33		
11	20	8	67		
12	237	185	356		
13	120	20	20		
14	100	48	92		
15	75	10	15		
16	152	104	217		
17	128	28	28		
18	178	58	48		
19	12	4	50		
20	92	22	31		
21	12	0	0		
22	72	32	80		
23	95	35	58		
24	164	128	356		
25	132	82	164		

APPENDIX B

FORMAT OF RAW DATA

(1) Project No.	(2) Floor Area M_2	(3) Year of construction	(4) Building Type	(5) Civil Type	(6) Structure
26	—	83-85	H		—
27	—	82-85	—	W	—
28	—	80-84	HO		C
29	3803	85-87	H		C
30	—	85-85	H		R.C.
31	9354	81-85	S		B/W
32	11449	83-86	S		C
33	958	82-86	O	—	B/W
34	—	80-84	—	R	—
35	—	82-83	—	W	—
36	5300	79-80	O	—	C
37	—	79-86	—	R	—
38	—	85-86	S	—	B/W
39	—	82-84	O	—	R.C.
40	1512	83-87	H	—	C
41	6993	82-83	O	—	C
42	150	82-84	H	—	B/W
43	5000	79-82	HO	—	R.C.
44	1579	82-87	F	—	C
45	3950	78-85	HO	—	B/W
46	—	87-87	—	S	—
47	780	84-87	H	—	B/W
48	900	85-86	H	—	B/W
49	1375	85-87	H	—	B/W
50	5575	85-87	H	—	B/W

APPENDIX B

FORMAT OF RAW DATA

	(7)	(8)	(9)	(10)	(11)
Project No.	No of Storeys	Financier	Contractor Type	Contractor category	Tender method
26	—	G	C	A	O
27	—	G	C	A	O
28	1	G	C	A	S
29	1	G	C	B	O
30	1	G	C	C	O
31	1	CIDA	C	E	O
32	3	G/WB	C	A	O
33	1	G/NORAD	C	D	S
34	—	G	NC	A	O
35	—	G	C	A	O
36	5	G	C	A	S
37	—	G	NC	A	S
38	1	G/DANIDA	C	A	O
39	1	G	NC	B	S
40	1	G	A	C	S
41	2	G	C	A	O
42	1	G	C	A	S
43	1	G	C	A	O
44	1	G	A	B	S
45	1	G	C	A	S
46	—	P	A	E	O
47	1	P	C	A	O
48	1	P	C	B	O
49	1	USAID	C	A	
50	1	USAID	C	A	O

APPENDIX B

FORMAT OF RAW DATA

	(12)	(13)	(14)	(15)	(16)
Project No.	Contract Type	(X_1) No. of variations	No. of delayed payments	No. of payments not delayed	(X_2) period of Delayed payment (months)
26	M	63	0	21	0
27	FIDIC	1	8	15	3/4
28	MQ	20	26	0	1
29	AQ	20	5	12	1/2
30	MQ	2	9	0	3/4
31	MQ	56	0	45	0
32	AQ	—	0	32	0
33	MQ	14	32	0	3
34	FIDIC	4	28	2	1 1/2
35	FIDIC	5	24	0	1
36	MQ	52	—	—	1
37	FIDIC	14	78	18	2
38	MQ	0	0	—	0
39	AQ	30	20	2	6
40	MQ	5	199	0	1
41	MQ	26	15	5	3/4
42	MQ	10	24	0	2
43	MQ	35	11	19	2
44	MQ	10	59	0	3
45	MQ	42	78	0	3
46	AQ	0	0	1	0
47	AQ	1	1	29	1
48	AQ	3	2	10	1/2
49	AQ	4	2	22	1
50	AQ	3	0	11	0

APPENDIX B

FORMAT OF RAW DATA

	(17)	(18)	(19)	(20)	(21)
Project No.	Initial contract sum (shs)	Final contract sum (shs)	Cost saving/ overrun (shs)	(Y) % of cost saving/ overrun	Initial contract period (weeks)
26	51,801,044	89,645,108	37,844,064	73	52
27	23,000,000	—	—	—	—
28	3,436,759	6,078,344	2,641,585	77	52
29	19,129,177	21,345,002	2,215,825	12	50
30	84,177	84,177	0	0	5
31	19,999,000	38,593,963	18,594,963	93	120
32	45,794,118	46,344,118	550,000	1	110
33	1,551,600	2,212,000	660,000	43	40
34	42,000,000	49,000,000	7,000,000	17	80
35	17,000,000	31,000,000	14,000,000	82	72
36	12,400,000	47,000,000	35,000,000	292	—
37	58,000,000	68,000,000	10,000,000	17	108
38	23,000,000	23,000,000	0	0	—
39	2,840,000	3,702,295	862,295	30	37
40	8,171,346	9,062,733	891,387	11	100
41	27,989,000	31,724,279	3,735,279	13	50
42	83,000,000	90,000,000	7,000,000	8	72
43	17,500,000	19,220,000	1,720,000	10	75
44	7,000,000	8,800,000	1,800,000	26	56
45	20,000,000	32,000,000	12,000,000	60	104
46	14,800	14,800	0	0	4
47	3,886,694	4,205,480	318,789	8	80
48	2,000,000	1,684,598	-315,947	-16	36
49	2,382,998	2,268,598	-114,400	-5	54
50	8,229,700	6,455,920	-1,773,780	-22	80

APPENDIX B

FORMAT OF RAW DATA

	(22)	(23)	(24)		
Project No.	Final contract period (week)	Time overrun/ saving (weeks)	(Y_1) % of contract period		
26	84	32	62		
27	—	—	—		
28	104	52	100		
29	68	18	36		
30	9	4	80		
31	178	58	48		
32	126	16	15		
33	168	128	320		
34	120	40	50		
35	96	24	33		
36	—	—	—		
37	384	276	256		
38	—	—	—		
39	87	50	135		
40	199	99	99		
41	87	37	74		
42	96	24	33		
43	120	45	60		
44	237	181	323		
45	312	208	200		
46	3	-1	-25		
47	120	40	50		
48	48	12	33		
49	108	54	100		
50	85	5	6		

APPENDIX B

FORMAT OF RAW DATA

(1)	(2)	(3)	(4)	(5)	(6)
Project No.	Floor Area M_2	Year of construction	Building Type	Civil Type	Structure
51	720	85-86	H	—	B/W
52	1625	84-85	H	—	B/W
53	—	87-87	H	—	—
54	—	87-87	H	—	—
55	—	85-87	H	—	B/W
56	—	—	S	—	B/W
57	975	82-83	S	—	C
58	1146	—	S	—	C
59	1150	85-86	H	—	B/W
60	1906	83-85	H	—	B/W
61	1158	85-86	O	—	R.C.
62	—	85-86	O	—	C
63	—	85-85	—	S	—
64	1400	87-87	H	—	B/W
65	—	80-81	O	--	R.C
66	15558	84-86	O	--	R.C
67	207	86-86	O	--	C
68	550	85-87	O	--	C
69	—	84-85	—	W	-
70	12234	84-86	O	—	C
71	1250	83-84	O	—	R.C
72	1959	86-87	H	—	B/W
73	—	85-87	H	—	B/W
74	1900	78-78	O	—	C
75	3000	85-86	O	—	C

APPENDIX B

FORMAT OF RAW DATA

	(7)	(8)	(9)	(10)	(11)
Project No.	No of Storeys	Financier	Contractor Type	Contractor category	Tender method
51	1	USAID	A	C	O
52	1	P	A	A	O
53	—	P	A	D	O
54	—	P	A	C	O
55	1	P	C	B	O
56	1	P	NC	E	S
57	4	P	NC	E	S
58	2	P	A	A	S
59	1	P	A	A	O
60	1	P	C	B	N
61	3	P	C	C	S
62	—	P	C	B	S
63	—	P	C	C	O
64	1	USAID	A	A	O
65	—	P	C	D	O
66	15	P	C	A	O
67	1	P	A	C	O
68	4	P	C	B	S
69	—	P	A	B	O
70	21	P	C	A	S
71	3	P	NC	B	S
72	1	P	C	D	S
73	1	Pr	C	A	S
74	9	Pr	C	B	N
75	6	Pr	C	B	S

APPENDIX B

FORMAT OF RAW DATA

	(12)	(13)	(14)	(15)	(16)
Project No.	Contract Type	(X_1) No. of variations	No. of delayed payments	No. of payments not delayed	(X_2) period of Delayed payment (months)
51	AQ	3	0	7	0
52	AQ	3	2	12	1/2
53	AQ	0	0	4	0
54	AQ	0	0	4	0
55	AQ	4	0	16	0
56	A	14	1	5	1/2
57	AQ	2	0	8	0
58	A	—	0	12	0
59	AQ	3	1	14	1/2
60	A	8	17	0	—
61	AQ	6	6	3	3/4
62	AQ	6	8	4	1/2
63	AQ	0	0	5	0
64	AQ	2	0	4	0
65	AQ	—	—	—	—
66	AQ	—	—	—	—
67	AQ	20	0	5	0
68	FIDIC	—	—	—	—
69	FIDIC	0	0	—	0
70	AQ	—	0	24	0
71	AQ	26	6	3	1 1/2
72	AQ	4	0	17	0
73	AQ	25	0	8	0
74	FIDIC	3	0	12	0
75	AQ	12	2	12	0

APPENDIX B

FORMAT OF RAW DATA

Project No.	(17) Initial contract sum (shs)	(18) Final contract sum (shs)	(19) Cost saving/ overrun (shs)	(20) (Y) % of cost saving/ overrun	(21) Initial contract period (weeks)
51	1,490,000	1,247,381	-242,619	-16	7
52	5,140,266	4,730,841	-409,425	-8	60
53	204,708	204,708	0	0	16
54	186,000	186,000	0	0	16
55	3,106,825	3,084,000	-22,825	-1	40
56	529,249	596,363	67,114	13	20
57	1,902,836	1,821,736	-81,100	-4	24
58	1,800,000	2,049,627	249,627	14	48
59	1,900,000	1,444,000	-456,000	-24	52
60	11,859,041	11,438,449	-420,592	-4	48
61	6,613,836	6,128,938	-484,898	-7	48
62	5,357,024	4,125,370	1,231,654	-23	44
63	621,416	592,340	-29,076	-5	20
64	1,749,418	1,731,858	-17,560	-1	16
65	—	—	—	—	—
66	82,674,025	82,674,025	0	0	72
67	1,338,159	2,175,000	836,841	63	32
68	6,965,409	6,965,409	0	0	39
69	4,000,000	4,000,000	0	0	—
70	82,074,625	96,397,171	13,723,146	17	72
71	3,757,845	4,268,716	51,087	14	45
72	8,080,000	7,998,859	-81,141	-1	50
73	1,526,955	2,305,079	778,122	51	15
74	7,500,000	9,000,000	1,500,000	20	36
75	15,120,000	14,998,700	-621,300	-4	52

APPENDIX B

FORMAT OF RAW DATA

Project No.	(22) Final contract period (week)	(23) Time overrun/ saving (weeks)	(24) (Y_1) % of contract period		
51	7	0	0		
52	72	12	20		
53	16	0	0		
54	16	0	0		
55	64	24	60		
56	24	4	20		
57	31	7	29		
58	48	0	0		
59	60	8	15		
60	70	22	46		
61	55	7	2		
62	59	15	3		
63	20	0	0		
64	18	2	13		
65	—	—	—		
66	96	24	33		
67	20	-12	-38		
68	47	8	21		
69	—	—	—		
70	92	20	3		
71	62	17	38		
72	68	18	36		
73	32	17	113		
74	48	12	33		
75	50	-2	-4		

APPENDIX B

FORMAT OF RAW DATA

(1) Project No.	(2) Floor Area M_2	(3) Year of construction	(4) Building Type	(5) Civil Type	(6) Structure
76	1152	85-86	F	—	C
77	—	86-87	S	—	B/W
78	8512	82-84	O	—	C
79	865	86-87	H	—	C
80	2087	85-86	F	—	C
81	1021	87-87	F	—	C
82	700	87-87	O	—	C
83	2000	85-87	O	—	R.C.
84	1535	86-87	H	—	C
85	—	85-85	F	—	C
86	300	84-85	H	—	B/W

APPENDIX B

FORMAT OF RAW DATA

	(7)	(8)	(9)	(10)	(11)
Project No.	No of Storeys	Financier	Contractor Type	Contractor category	Tender method
76	2	Pr	C	D	N
77	2	Pr	A	C	S
78	5	Pr	C	A	S
79	2	Pr	C	C	S
80	4	Pr	C	A	S
81	1	Pr	C	B	S
82	1	Pr	C	C	S
83	3	Pr	C	A	S
84	4	Pr	C	A	S
85	1	Pr	C	A	S
86	1	Pr	A	E	N

APPENDIX B

FORMAT OF RAW DATA

	(12)	(13)	(14)	(15)	(16)
Project No.	Contract Type	(X_1) No. of variations	No. of delayed payments	No. of payments not delayed	(X_2) period of Delayed payment (months)
76	A	3	0	13	—
77	AQ	5	0	6	0
78	AQ	46	0	62	0
79	AQ	19	0	21	0
80	AQ	24	0	23	0
81	AQ	6	0	4	0
82	AQ	8	0	11	0
83	AQ	40	0	15	0
84	AQ	20	0	12	0
85	AQ	34	0	30	0
86	AQ	—	—	10	0

APPENDIX B

FORMAT OF RAW DATA

Project No.	(17) Initial contract sum (shs)	(18) Final contract sum (shs)	(19) Cost saving/ overrun (shs)	(20) (Y) % of cost saving/ overrun	(21) Initial contract period (weeks)
76	3,000,000	3,000,000	0	0	48
77	2,174,202	1,862,902	-311,300	-14	25
78	51,000,000	48,409,942	-2,590,058	-5	120
79	4,872,369	4,900,000	27,631	1	40
80	8,400,000	10,492,064	2,092,064	25	60
81	2,768,815	2,767,878	-922	0	16
82	4,500,000	5,100,000	600,000	13	53
83	3,808,000	5,312,700	1,504,700	40	30
84	7,180,000	7,695,800	515,800	7	48
85	12,187,020	13,332,699	1,145,679	9	120
86	562,944	677,944	115,000	20	40

APPENDIX B

FORMAT OF RAW DATA

Project No.	(22) Final contract period (week)	(23) Time overrun/ saving (weeks)	(24) (Y_1) % of contract period		
76	60	12	25		
77	26	1	4		
78	128	8	7		
79	84	44	110		
80	92	32	53		
81	16	0	0		
82	45	-8	-15		
83	60	30	100		
84	48	0	0		
85	120	0	0		
86	40	0	0		

APPENDIX B

Abbreviations used

Types of building column

S = School

H = House(s)

O = Office(s)

HO = Hospital

F = Factory

Types of Civil Engineering Project Columns

W = Water works

R = Road

S = Sewerage

Types of Structure Columns

B/W = Concrete/masonry block walling

R.C. = Reinforced concrete

Financier Column

G = Government

P = Parastatal

Pr = Private

Type of Contractor Column

A = African

C = Citizen

NC = Non-citizen

APPENDIX B

Tender Method Column

O = Open tendering

S = Selective tendering

N = Negotiation

Type of Contract Column

MQ = MOW with quantities

M = MOW without Quantities

AQ = AAK with Quantities

A = AAK without Quantities

APPENDIX B

SUMMARY OF PROJECT PERFORMANCE AS PER VARIOUS FACTORS

1. Clients and Design Team

	G.K. INHOUSE	G.K. COMM.	PARAST. INHOUSE	PARAST. COMM.	PRIVATE	Total
Cost save	5	3	16	5	6	35
Cost over	21	16	3	3	8	51
Time save	1	2	5	2	8	18
Time over	25	17	14	6	6	68
Totals	26	19	19	8	14	86

2. Location

	Nbi.	Central	Eastern	R.V.	West	Ny.	Coast	North/E	Totals
Cost save	12	8	4	7	2	2	0	0	35
Cost over	14	7	7	6	4	5	4	4	51
Time save	8	4	2	1	1	1	0	0	17
Time over	18	11	9	12	5	6	4	4	69
Totals	26	15	11	13	6	7	4	4	86

3. Type of Project

	Building	Civil Engineering	Totals
Cost save	30	4	34
Cost over	48	4	52
Time save	15	4	19
Time over	63	4	67
Totals	78	8	86

4. Type of Building

	Houses	Offices	Schools	Hospital	Factory	Totals
Cost save	16	7	5	0	3	31
Cost over	11	17	9	8	2	47
Time save	4	3	5	0	3	15
Time over	23	21	9	8	2	63
Totals	27	24	14	8	5	78

5. Type of Structure of Building

	B/W	R.C.	Combination	Totals
Cost save	15	5	6	26
Cost over	16	6	23	45
Time save	4	0	8	12
Time over	27	11	21	59
Totals	31	11	29	71

6. Building Storeys

	Single storey	Multi-storey	Totals
Cost save	16	12	28
Cost over	30	16	46
Time save	7	5	12
Time over	39	23	62
Totals	46	28	74

7. Type of Civil Engineering

	Roads	Sewerage	Water works	Totals
Cost save	1	2	1	4
Cost over	1	0	3	4
Time save	1	2	1	4
Time over	1	0	3	4
Totals	2	2	4	8

8. Category Contractor

	A	B	C	D	E	Totals
Cost save	11	10	6	4	5	36
Cost over	22	10	10	5	3	50
Time Save	5	3	7	2	3	20
Time over	28	17	9	7	5	66
Totals	33	20	16	9	8	86

Type of contractor

	African	Citizen	Non-citizen	Totals
Cost save	13	20	2	35
Cost over	15	31	5	51
Time save	10	10	0	20
Time over	18	41	7	66
Totals	28	51	7	86

10. Source of Finance

	G.K.	Parast.	Private	E.E.C.	USAI	DANIDA	GK/NORAD
Cost save	7	16	6	0	6	1	0
Cost over	24	6	8	1	0	0	1
Time save	2	6	8	0	3	1	0
Time over	29	16	6	1	3	0	1
Totals	41	22	14	0	6	1	1

	GK/WB	CIDA	GK/CIDA	GK/IDA	GK/USAID
Cost save	0	0	0	0	0
Cost over	4	1	2	2	1
Time save	0	0	0	0	0
Time over	4	1	2	2	1
Totals	4	1	2	2	1

11. Method of Tendering

	Open	Selective	Negotiation	Total
Cost save	19	11	5	35
Cost over	21	28	2	51
Time save	10	8	2	20
Time over	30	31	5	66
Totals	40	39	7	86

12. Type of Contract

	AAK(Q)	AAK	MOW(Q)	MOW	FIDIC	Totals
Cost save	23	2	7	0	4	36
Cost over	14	2	29	1	4	50
Time save	13	2	2	0	3	20
Time over	24	2	34	1	5	66
Totals	37	4	36	1	8	86

APPENDIX C

Chi-square calculations

(1) Different types of clients and cost performance

Observed Frequencies (fa)

Clients	Cost overrun	Cost saving	Total
Government	37	7	44
Parastatals	6	21	27
Private	8	6	14
Total	51	34	85

d.f. = 2

Degrees of freedom (d.f.) = (number of rows - 1) x (number of columns - 1).

Expected frequency (fe) = $\frac{\text{Row total} \times \text{column total}}{n}$

n = number of observations

Row, Column (R,C)	Actual Frequency (fa)	Expected Frequency (fe)	fa-fe	$(fa-fe)^2$	X^2 $\frac{(fa-fe)}{fe}$
1,1	37	26.4	10.6	112.36	4.256
1,2	7	17.2	-10.6	112.36	6.384
2,1	6	16.2	-10.2	104.04	6.422
2,2	21	10.8	10.2	104.04	9.633
3,1	8	8.4	-0.4	0.16	0.019
3,2	6	5.6	0.4	0.16	0.029

X^2 = 26.743

$X^2_{0.05}$ = 5.991 < 26.743

Reject H_0

Accept H_A

APPENDIX C

(2) Different types of clients and time performance

Observed frequencies

Client	Time overrun	Time saving	Total
Government	39	3	42
Parastatals	19	7	26
Private	6	8	14
Totals	64	18	82

d.f. = 2

R,C	fa	fe	fa-fe	$(fa-fe)^2$	$\frac{(fa-fe)^2}{fe}$
1,1	39	32.8	6.2	38.44	1.17
1,2	3	9.2	-6.2	38.44	4.18
2,1	19	20.3	-1.3	1.69	0.08
2,2	7	5.7	1.3	1.69	0.30
3,1	6	10.9	-4.9	24.01	2.20
3,2	8	3.1	4.9	24.01	7.75

$X^2 = 15.68$

$X^2_{0.05} = 5.991 < 15.68$

Reject H_0

Accept H_A

APPENDIX C

(3) Design team and cost performance

Observed frequencies

Design team	Cost overrun	Cost saving	Total
Inhouse	24	21	45
Commissioned	27	14	41
Total	51	35	86

d.f. = 1

(R,C)	fa	fe	fa-fe	$(fa-fe)^2$	$\frac{(fa-fe)^2}{fe}$
1,1	24	26.7	-2.7	7.29	0.273
1,2	21	18.3	2.7	7.29	0.398
2,1	27	24.3	2.7	7.29	0.300
2,2	13	16.7	-2.7	7.29	0.437

$X^2 = 1.408$

$X^2_{0.05} = 3.841 > 1.408$

Reject H_A

Accept H_o

APPENDIX C

(4) Design team and time performance

Observed frequencies

Design team	Time overrun	Time saving	Total
Inhouse	38	6	44
Commissioned	29	12	41
Total	67	18	85

d.f. = 1

R,C	fa	fe	fa-fe	$(fa-fe)^2$	$\frac{(fa-fe)^2}{fe}$
1,1	38	34.7	3.3	10.89	0.314
1,2	6	9.3	-3.3	10.89	1.171
2,1	29	32.3	-3.3	10.89	0.337
2,2	12	8.7	3.3	10.89	1.252

$X^2 = 3.074$

$X^2_{0.05} = 3.841 > 3.074$

Accept H_o

Reject H_A

APPENDIX C

(11) Type of project and cost performance

Observed frequencies

Project type	Cost overrun	Cost saving	Total
Building	48	30	78
Civil Eng.	4	4	8
Total	52	34	86

d.f. = 1

(R,C)	fa	fe	fa-fe	$(fa-fe)^2$	$\frac{(fa-fe)^2}{fe}$
1,1	48	47.2	0.8	0.64	0.014
1,2	30	30.8	-0.8	0.64	0.021
2,1	4	4.8	-0.8	0.64	0.142
2,2	4	3.2	0.8	0.64	0.200

$X^2 = 0.377$

$X^2_{0.05} = 3.841 > 0.377$

Accept H_0

Reject H_A

APPENDIX C

(12) Type of project and time performance

Observed frequencies

Project type	Time overrun	Time saving	Total
Building	63	15	78
Civil Eng.	4	4	8
Total	67	19	86

d.f. = 1

(R,C)	fa	fe	$(fa-fe)^2$	$\frac{(fa-fe)^2}{fe}$
1,1	63	60.8	4.84	0.080
1,2	15	17.2	4.84	0.281
2,1	4	6.2	4.84	0.781
2,2	4	1.8	4.84	2.689

$X^2 \cdot = 3.831$

$X^2_{0.05} = 3.841 > 3.831$

Accept H_0

Reject H_A

APPENDIX C

Category of contractor and cost performance

Observed frequencies

Category	Cost overrun	Cost saving	Total
A	22	11	33
B	10	10	20
C	10	6	16
D	5	4	9
E	3	5	8
TOTAL	50	36	86

d.f. = 4

(R,C)	fa	fe	fa-fe	$(fa-fe)^2$	$\frac{(fa-fe)^2}{fe}$
1,1	22	19.2	2.8	7.84	0.408
1,2	11	13.8	-2.8	7.84	0.568
2,1	10	11.6	-1.6	2.56	0.221
2,2	10	8.4	1.6	2.56	0.305
3,1	10	9.3	0.7	0.49	0.053
3,2	6	6.7	-0.7	0.49	0.073
4,1	5	5.2	0.2	0.04	0.008
4,2	4	3.8	-0.2	0.04	0.011
5,1	3	4.7	-1.7	2.89	0.615
5,2	5	3.3	1.7	2.89	0.876

$X^2 = 3.138$

$X^2_{0.05} = 9.488 > 3.138$

Accept H_o

Reject H_A

APPENDIX C

(16) Type of contractor and cost performance

Observed frequencies

Category	Cost overrun	Cost saving	Total
African	15	13	28
Citizen	31	20	51
Non-citizen	5	2	7
Total	51	35	86

d.f = 2

(R,C)	fa	fe	fa-fe	$(fa-fe)^2$	$\frac{(fa-fe)^2}{fe}$
1,1	15	16.6	-1.6	2.56	0.154
1,2	13	11.4	1.6	2.56	0.225
2,1	31	30.2	0.8	0.64	0.021
2,2	20	20.8	-0.8	0.64	0.031
3,1	5	4.2	0.8	0.64	0.152
3,2	2	2.8	-0.8	0.64	0.229

$X^2 = 0.812$

$X^2_{0.05} = 5.991 > 0.812$

Accept H_0

Reject H_A

APPENDIX C

(17) Type of contractor and time performance

Observed frequencies

Category	Time overrun	Time saving	Total
African	18	10	28
Citizen	41	10	51
Non-Citizen	7	0	7
Total	66	20	86

d.f. = 2

(R,C)	fa	fe	fa-fe	$(fa-fe)^2$	$\frac{(fa-fe)^2}{fe}$
1,1	18	21.5	-3.5	12.25	0.570
1,2	10	6.5	3.5	12.25	1.885
2,1	41	39.1	1.9	3.61	0.092
2,2	10	11.9	-1.9	3.61	0.303
3,1	7	5.4	1.6	2.56	0.474
3,2	0	1.6	-1.6	2.56	1.600

$X^2 = 4.924$

$X^2_{0.05} = 9.210 > 4.924$

Accept H_o

Reject H_A

APPENDIX C

(18) Category of contractors and time performance

Observed frequencies

Category	Time overrun	Time saving	Total
A	28	5	33
B	17	3	20
C	9	7	16
D	7	2	9
E	5	3	8
Total	66	20	86

d.f. = 4

(R,C)	fa	fe	fa-fe	$(fa-fe)^2$	$\frac{(fa-fe)^2}{fe}$
1,1	28	25.3	2.7	7.29	0.288
1,2	5	7.7	-2.7	7.29	0.947
2,1	17	15.3	1.7	2.89	0.189
2,2	3	4.7	-1.7	2.89	0.615
3,1	9	12.3	-3.3	10.89	0.885
3,2	7	3.7	3.3	10.89	2.943
4,1	7	6.9	0.1	0.01	0.001
4,2	2	2.1	-0.1	0.01	0.005
5,1	5	6.1	-1.1	1.21	0.198
5,2	3	1.9	1.1	1.21	0.637

$X^2 = 6.708$

$X^2_{0.05} = 9.488 > 6.708$

Accept H_0

Reject H_A

APPENDIX C

Method of tendering and cost performance

Observed frequencies

Tendering method	Cost overrun	Cost saving	Total
Open	21	19	40
Selective	28	11	39
Negotiation	2	5	7
Total	51	35	86

d. f. = 2

(R,C)	fa	fe	fa-fe	$(fa-fe)^2$	$\frac{(fa-fe)^2}{fe}$
1,1	21	23.7	-2.7	7.29	0.308
1,2	19	16.3	2.7	7.29	0.447
2,1	28	23.1	4.9	24.01	1.039
2,2	11	15.9	-4.9	24.01	1.510
3,1	2	4.2	-2.2	4.84	1.152
3,2	5	2.8	2.2	4.84	1.729

$X^2 = 6.185$

$X^2_{0.05} = 5.991 < 6.185$

Reject H_o

Accept H_A

APPENDIX C

Method of tendering and time performance

Observed frequencies

Tender method	Time overrun	Time saving	Total
Open	30	10	40
Selective	31	8	39
Negotiation	5	2	7
Total	66	20	86

d.f. = 2

(R,C)	fa	fe	fa-fe	$(fa-fe)^2$	$\frac{(fa-fe)^2}{fe}$
1,1	30	30.7	-0.7	0.49	0.016
1,2	10	9.3	0.7	0.49	0.053
2,1	31	29.9	1.1	1.21	0.040
2,2	8	9.1	-1.1	1.21	0.133
3,1	5	5.4	-0.4	0.16	0.030
3,2	2	1.6	0.4	0.16	0.100

$X^2 = 0.372$

$X^2_{0.05} = 5.991 > 0.372$

Accept H_0

Reject H_A

APPENDIX C

Form of contract and cost performance

Observed frequencies

Contract	Cost overrun	Cost saving	Total
Bills used	43	30	73
No bills	3	2	5
Total	46	32	78

d.f. = 1

(R,C)	fa	fe	fa-fe	$(fa-fe)^2$	$\frac{(fa-fe)^2}{fe}$
1,1	43	43.1	-0.1	0.01	0.000
1,2	30	29.9	0.1	0.01	0.000
2,1	3	2.9	0.1	0.01	0.003
2,2	2	2.1	-0.1	0.01	0.005

$X^2 = 0.008$

$X^2_{0.05} = 3.841 > 0.008$

Accept H_0

Reject H_A

APPENDIX C

Form of contract and time performance

Observed frequencies

Contract	Time overrun	Time saving	Total
Bills used	58	15	73
No bills	3	2	5
Total	61	17	78

d.f. = 1

(R,C)	fa	fe	fa-fe	$(fa-fe)^2$	$\frac{(fa-fe)^2}{fe}$
1,1	58	57.1	0.9	0.81	0.014
1,2	15	15.9	-0.9	0.81	0.051
2,1	3	3.9	-0.9	0.81	0.208
2,2	2	1.1	0.9	0.81	0.736

$X^2 = 1.009$

$X^2_{0.05} = 3.841 > 1.009$

Accept H_0

Reject H_A

APPENDIX D

Cost performance and variations

Regression Analysis Calculations

Cost performance level	No of variations			
Y	X_1	YX_1	X^2_1	Y^2
85	22	1870	484	7225
74	18	1332	324	5476
18	25	450	625	324
1	10	10	100	1
10	21	210	441	100
25	21	525	441	625
76	34	2584	1156	5776
16	44	704	1936	256
81	13	1053	169	6561
-1	17	-17	289	1
2	21	42	441	4
26	14	364	196	676
73	25	1825	625	5329
428	54	23112	2916	183184
60	47	2820	2209	3600
73	63	4599	3969	5329
77	20	1540	400	5929
12	20	240	400	144
0	2	0	4	0
93	56	5208	3136	8649
43	14	602	196	1849
17	4	68	16	289

APPENDIX D

Cost performance and variations

Regression Analysis Calculations

Cost performance level Y	No of variations X_1	YX_1	X^2_1	Y^2
82	5	410	25	6724
30	30	900	900	900
11	5	55	25	121
13	26	338	676	169
8	26	208	676	64
10	10	100	100	100
26	35	910	1225	676
60	42	2520	1764	3600
8	1	8	1	64
-16	3	-48	9	256
-5	4	-20	16	25
-22	3	-66	9	484
-16	3	-48	9	256
-8	3	-24	9	64
-1	4	-4	16	1
13	14	182	196	169
-4	2	-8	4	16
-24	3	-72	9	576
-4	8	-32	64	16
-7	6	-42	36	49
-23	6	-138	36	529
-5	0	0	0	25

APPENDIX D

Cost performance and variations

Regression Analysis Calculations

Cost performance level	No of variations			
Y	X_1	YX_1	$X^2{}_1$	Y^2
-1	2	-2	4	1
63	20	1260	400	3969
14	26	264	676	196
-1	4	-4	16	1
51	25	1275	625	2601
20	3	60	9	400
-4	12	-48	144	16
0	3	0	9	0
-14	5	-70	25	196
-5	46	230	2116	25
1	19	19	361	1
25	24	600	576	625
13	8	104	64	169
40	40	1600	1600	1600
7	20	140	400	49
9	34	306	1156	81
Σ = 1633	1095	59644	34459	266141

$\bar{Y}$ = 27.2, $\bar{x}_1$ = 18.25, N = 60

APPENDIX D

Time performance and variations

Time performance level	No of variations			
Y_1	X_1	Y_1X_1	X^2_1	Y^2
73	22	1606	484	5329
67	18	1206	324	4489
30	25	750	625	900
100	10	1000	100	10000
400	21	8400	441	160000
33	21	693	441	1089
356	34	12104	1156	126736
20	44	880	1936	400
92	13	1196	169	8464
28	17	476	289	784
50	12	600	144	2500
31	21	651	441	961
80	14	1120	196	6400
58	25	1450	625	3364
356	54	19224	2916	126736
164	47	7708	2209	26896
62	63	3906	3969	3844
100	20	2000	400	10000
36	20	720	400	1296
80	2	160	4	6400
48	56	2688	3136	2304
320	14	4480	196	102400

APPENDIX D

Time performance and variations

Time performance level Y_1	No of variations X_1	$Y_1 X_1$	X^2_1	Y^2
50	4	200	16	2500
33	5	165	25	1089
256	14	3584	196	65536
135	30	4050	900	18225
99	5	495	25	9801
74	26	1924	676	5476
33	10	330	100	1089
60	35	2100	1225	3600
323	10	3230	100	104329
200	42	8400	1764	40000
-25	0	0	0	625
50	1	50	1	2500
33	3	99	9	1089
100	4	400	16	10000
6	3	18	9	36
0	3	0	9	0
20	3	60	9	400
0	0	0	0	0
0	0	0	0	0
60	4	240	16	3600
20	14	280	196	400
29	2	58	4	841
15	3	45	9	225

APPENDIX D

Time performance and variations

Time performance level	Period of delayed Payments			
Y_1	X_1	Y_1X_1	X^2_1	Y^2
46	8	368	64	2116
2	6	12	36	4
3	6	12	36	9
13	2	26	4	169
-38	20	-760	400	1444
38	26	988	676	1444
36	4	144	16	1296
113	25	2825	625	12769
33	3	99	9	1089
-4	12	-48	144	16
25	3	75	9	625
4	5	20	25	16
7	46	322	2116	49
110	19	2090	361	12100
53	24	1272	576	2809
0	6	0	36	0
-15	8	-120	64	225
100	40	4000	1600	10000
0	20	0	400	0
0	34	0	1156	0
Σ = 4684	1111	110077	34259	929826

$n = 67$

$\bar{Y}_1 = 69.9$

$\bar{X}_1 = 16.58$

APPENDIX D

Cost performance and period of delayed payments.

Cost performance level	Period of delayed payments			
Y	X_2	YX_2	Y^2	$Y^2{}_2$
85	1	85	7225	1
18	2	36	324	4
1	0	0	1	0
10	0	0	100	0
-5	0	0	25	0
25	0	0	625	0
-6	0	0	36	0
76	6	456	5776	36
16	0	0	256	0
81	1	81	6561	1
40	4	160	1600	16
-1	5	-5	1	25
93	0	0	8649	0
2	0.75	1.5	4	0.56
-11	0	0	121	0
26	1	26	676	1
73	1	71	5329	1
438	0.75	321	183184	0.56
60	0.5	30	3600	0.25
73	0	0	5329	0
77	1	77	5929	1
12	0.5	6	144	0.25
0	0.75	0	0	0.56

APPENDIX D

Cost performance and period of delayed payments.

Cost performance level	Period of delayed payments			
Y	X_2	YX_2	Y^2	$Y^2{}_2$
43	3	129	1849	9
17	1.5	25.5	289	2.25
82	1	82	6724	1
292	1	292	85264	1
17	2	34	289	4
0	0	0	0	0
30	6	180	900	36
11	1	11	121	1
13	0.75	9.75	169	0.56
8	2	16	64	4
10	2	20	100	4
26	3	52	676	9
60	3	180	3600	9
0	0	0	0	0
8	1	8	64	1
-16	0.5	-8	256	0.25
-5	1	-5	25	1
-22	0	0	484	0
-16	0	0	256	0
-8	0.5	-4	64	0.25
0	0	0	0	0
0	0	0	0	0

APPENDIX D

Cost performance and period of delayed payments.

Cost performance level	Period of delayed payments			
Y	X_2	YX_2	Y^2	$Y^2{}_2$
-1	0	0	1	0
13	0.5	7.5	169	0.25
-4	0	0	16	0
14	0	0	196	0
-24	0.5	-12	576	0.25
-7	0.75	-5.25	49	0.56
-23	0.5	-11.5	529	0.25
-5	0	0	25	0
-1	0	0	1	0
63	0	0	3969	0
0	0	0	0	0
17	0	0	289	0
14	1.5	21	196	2.25
-1	0	0	1	0
51	0	0	2601	0
20	0	0	400	0
-4	0	0	16	0
-14	0	0	196	0
-5	0	0	25	0
1	0	0	1	0
25	0	0	625	0

APPENDIX D

Cost performance and period of delayed payments.

Cost performance level	Period of delayed payments			
Y	Y_2	YX^2	Y^2	$X^2{}_2$
0	0	0	0	0
13	0	0	169	0
40	0	0	1600	0
7	0	0	49	0
9	0	0	81	0
20	0	0	400	0
Σ = 1941	58.25	2367.5	348669	175.06

$\bar{y}$ = 26.958

$\bar{X}_2$ = 0.809

n = 72

APPENDIX D

Time performance and period of delayed payments.

Time performance level	Period of delayed payments			
Y_1	X_2	Y_1X^2	X^2	$Y^2{}_1$
73	1	73	1	5329
67	0	0	0	4489
30	2	60	4	900
100	0	0	0	10000
400	0	0	0	160000
43	0	0	0	1849
33	0	0	0	1089
67	0	0	0	4489
356	6	2136	36	126736
20	0	0	0	400
92	1	92	1	8464
15	4	60	16	225
28	5	140	25	784
48	0	0	0	2304
31	0.75	23.25	0.56	961
0	0	0	0	0
80	1	80	1	6400
58	1	58	1	3364
356	0.75	267	0.56	126736
164	0.5	82	0.25	26896
62	0	0	0	3844
100	1	100	1	10000
36	0.5	18	0.25	1296

APPENDIX D

Time performance and period of delayed payments.

Time performance level	Period of delayed payments			
Y_1	X_2	Y_1X^2	X^2	Y^2_1
80	0.75	60	0.56	6400
48	0	0	0	2304
15	0	0	0	225
320	3	960	9	102400
50	1.5	75	2.25	2500
33	1	33	1	1089
256	2	512	4	65536
135	6	810	36	18225
99	1	99	1	9801
74	0.75	55.5	0.56	5476
33	2	66	4	1089
60	2	120	4	3600
323	3	969	9	104329
200	3	600	9	40000
-25	0	0	0	625
50	1	50	1	2500
33	0.5	16.5	0.25	1089
100	1	100	1	10000
6	0	0	0	36
0	0	0	0	0
20	0.5	10	0.25	400
29	0	0	0	841
0	0	0	0	0
15	0.5	7.5	0.25	225

APPENDIX D

Time performance and period of delayed payments.

Time performance level	Period of delayed payments			
Y_1	X_2	Y_1X^2	X^2	$Y^2{}_1$
2	0.75	1.5	0.56	4
3	0.5	1.5	0.25	9
0	0	0	0	0
13	0	0	0	169
-38	0	0	0	1444
3	0	0	0	9
38	1.5	57	2.25	1444
36	0	0	0	1296
113	0	0	0	12769
-4	0	0	0	16
4	0	0	0	16
7	0	0	0	49
110	0	0	0	12100
53	0	0	0	2809
0	0	0	0	0
-15	0	0	0	225
100	0	0	0	10000
0	0	0	0	0
0	0	0	0	0
0	0	0	0	0
Σ = 4671	56.75	7792.75	173.8	927604

$\bar{Y}_1$ = 72.98

$\bar{X}_2$ = 0.83

n = 68