BUILDING CONTRACT PERFORMANCE:

A CASE STUDY OF GOVERNMENT PROJECTS, KENYA.

BY

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DECLARATION

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

Chrismbatha.

Signed.

DECLARATION OF SUPERVISOR

This thesis has been submitted for examination with my approval as University Supervisor.

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ABSTRACT

The success of any project is determined mainly by the effectiveness of the procedure used and by the efficiency of the organizational tools employed.

Building and construction projects in general are particularly very sensitive to the nature of the organizational structure of the implementation team. This is so because many different, autonomous and fragmented institutions are brought together to combine their various expertise with a common objective of producing a structure to the satisfaction of the client. It is the efficiency of combining their various activities that generally determines the success of the project.

In Kenya, many reports have continued to appear in the local newspapers, professional journals and even meetings have been held by the respective institutions on accusations and counter accusations on the performance of government building contracts. The concern has been raised by a few cases of delayed projects which are likely

to be the tip of the iceberg, because nobody has come up with an emperical data to prove their side of the argument.

Among other methods of measuring contract performance are cost and time, the success of which contributes to yet another measure - client satisfaction.

The aim of this study is to establish whether or not the performance of government building contracts in terms of cost and time was poor in the period 1967 - 1981. This is done by use of a statistical technique - regression and correlation analysis as programmed in Statistical Package for Social Sciences (SPSS).

It is shown that majority of government building contracts suffer cost and time overruns. Time overruns are more frequent than cost overruns and the two are not related. Big projects have been shown to be more prone to both time and cost overruns than the smaller ones although delays have been found to bear no relationship to contract sizes.

One cause of poor time performance is the inadequacy of initial contract periods. These have been found to be inconsistently and erronously calculated. Remote sites have been shown not to be as badly off as would be expected in terms of contract performance. Time and cost performance have also been found to be related to types of projects and for that reason, some client ministries suffer more than others in these respects.

It is recommended that the implementation teams should be more objective in approach and if possible adopt a scientific technique of analysing the sensitivity of projects. The study has mainly explored the state of contract performance, thus laying a basis for future researchers.

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CHAPTER I

INTRODUCTION

Definition of Construction Industry.

The standard industrial classification definition of construction includes the erection, repair and demolition of all types of buildings and civil engineering structures.[1] The definition includes also such works as done by public civil engineering and building authorities. It also includes on-site industrialized building but excludes the off-site manufacture of components, prefabricated buildings and builder woodwork.

Many establishments that are classified outside construction may do work which includes erection, repair or demolition of structures thus falling under construction. Such works, are not considered as output from the construction industry. On the other hand, any kind of work carried out by establishments while they are doing construction work is all accounted as part of construction.[2]

Importance of the Construction Industry

(i) Gross Domestic Product (G.D.P.)

The essence of an industry is borne out of the necessity to satisfy a demand which in most industries

is for direct consumption. The demand in the construction industry is for investment goods for which ultimate use is; as a means for further production, as an addition to or improvement of the infrastructure of the economy, as a social investment and as an investment good for direct enjoyment.[3]

The industry's importance in an economy stems from three of its characteristics namely; its size, provision of predominantly investment goods, and that, government is the client for a large part of its work.[4]

Construction industry in terms of percentage contribution to G.D.P. ranks seventh in Kenya in the following order:

1. Agriculture.
2. Manufacturing.
3. Trade, restaurant and hotels.
4. Finance, insurance, real estate and business services.
5. Transport, storage and communications.
6. Ownership of dwellings.
7. Building and construction.[5]

The table below shows the trend of the two major industries compared to building and construction from 1978 to 1983.

Table 1.1.

Percentages of Total Gross Product at Constant (1976) Prices.

	1978	1979	1980	1981	1982	1983
Agriculture	36.1	34.4	32.8	33.1	0.5	0.5
Manufacturing	12.7	13.1	13.4	13.2	1.4	1.4
Building and Construction	3.7	3.9	4.0	4.1	9.7	9.6

Source: Statistical Abstract 1984, page 37.

In Kenya, the mean percentage contribution of the construction industry to the G.D.P. in the monetary economy and at 1976 constant prices for the year 1978 to 1983 was 5.83 per cent.[5] During the same period, the mean contributions of agriculture and manufacturing to the G.D.P. were 22.9 and 9.2 per cent respectively.

Below is a table which shows the G.D.P. percentage rates of growth from 1979-1983 at 1976 constant prices for the building and construction industry.

Table 1.2.

Gross Domestic Product Growth Rates

1979-1980	1980-1981	1981-1982	1982-1983
6.4	8.2	-11.7	-4.2

1976-1983 (Cumulative)
3.6

Source: Statistical Abstract 1984, pp.40.

It can be observed from the table above that the rate of growth in most immediate years has been negative. The negative growth rate was caused by the 1980 drought which depleted the savings that would have been invested in construction. It is however, felt that the industry should not have been affected so much so fast. What possibly caused the drastic drop from +8.2% to -11.7 was lack of efficiency and economic maturity of the industry.

(ii) Wage Employment

Between 1979 and 1982, the building and construction industry employed an annual average of 13.14 per cent of total annual number employed in all the industries.[6] The rest, 86.86 per cent was employed by the other industries. Within that number employed by the construction industry 47.62[7] per

cent was employed by the public sector and the rest 52.38 per cent by the private sector. The public sector therefore, contributed in terms of numbers employed approximately 50 per cent or a half of the total number employed by the building and construction industry.

Employment contribution can also be assessed in terms of amount of money spend in payment of wages to the employees. Between 1979 and 1982 inclusive, the public construction sector contributed 43.82 per cent to the total amount spend in the whole construction industry. Below is a table showing the mean percentages of the two major industries in terms of money spent in wages with respect to the total amount spent in the economy. The two are compared with the building and construction industry.

Table 1.3

Mean percentage expenditures on wages per industry.

	1979	1980	1981	1982
Agriculture	11.15	9.08	8.66	7.91
Manufacturing	15.38	15.98	15.34	4.42
Building and Construction	6.38	5.64	5.64	5.12

Source: Economic Survey 1983, page 53.[8]

(iii) Capital Formation

The construction industry is one of the main contributors to the nation's gross fixed capital formation. Capital formation can be grouped into seven types of assets which are its constituents.[9] These seven are:

1. Residential Buildings.
2. Non-residential Buildings.
3. Construction and Works.
4. Land Improvement and Plantation Development.
5. Transport Equipment.
6. Machinery and other equipments.
7. Breeding Stock and Dairy cattle.

All these assets can be subdivided further into public and private sectors and residential into traditional and modern within the private sector.

During the years 1977 to 1982 inclusive, the first three of the sectors above, namely, residential buildings, non-residential buildings and construction and works contributed a mean total of K£184 million to capital formation at 1976 constant prices. The mean per year for the whole total of all the seven sectors was K£382 millions. The buildings i.e. residential and non-residential together with the construction accounted for 48.19 per cent of the total capital formation for the whole economy. Within the building

and construction industry, there are two sectors, public and private. Public sector had an annual mean for the period considered of K£112 millions which was about 61 per cent of the total value of capital formation from the building and construction industry.

The performance of the construction industry in 1983 continued to decline according to all economic measures.[10] The value of all building plans approved during the year declined indicating a possible poor performance in 1984 for the sector. The decline in activities which started in 1981 has been occasioned by the current credit squeeze by the financial institutions, the increasing building cost as measured by the building cost index, and the general cut in the government's expenditure. The cut in the government's expenditure is the result of austerity measures being pursued. The aim of the pursuance of those measures is short term curative and remedial action for adjustment purposes.

As noted earlier, the demand for construction is derived demand. Construction projects are not an end but means to the end; for example the demand for an industrial building will be derived from the demand for the product manufactured in the building. Whether or not a new industrial building is required will depend on the nature of the change in demand of the product and on whether the demand is short term or long term.

The economic infrastructures are necessary for the growth of the general economy; such infrastructures are roads, bridges, water reservoirs, hydroelectric power stations and irrigation schemes to mention but just a few relevant ones.

The demand for such infrastructures will depend on the interrelationships of all the sectors of the economy. The objective of establishing an infrastructure is to acquire a further means of production and so the success of the construction process of the infrastructures has a direct influence on the ultimate goal of economic growth and development.

The welfare of the people is greatly influenced by the availability of social facilities such as hospitals, schools, churches, public libraries, sports fields etc. The demand for these also is for further production. In hospitals one may assume that good health is enhanced hence production, and in schools manpower is manufactured. In housing however, the demand is for a product to be consumed directly and is not derived from another demand but influenced by the need to house the people. The point being stressed here is that construction is predominantly an investment activity. Income earned in the past and not consumed is put into the

production of construction structures. The construction good is an expensive one and so a great deal of a country's resources is utilized in construction activities, thus making the performance of the industry a general concern. Both the public and the government are alert on the use and misuse of building resources because, after all, the progress and success of other sectors which enhance man's welfare depend on the performance of the appropriate construction and building activities.

It was shown earlier on that the public sector creates 47.62 per cent job opportunities of all vacancies created by the construction industry. To service those vacancies, the sector spends approximately 44 per cent of all monies spent by the industry on wage employment. Although it is generally believed that the public contributes 50 per cent[11] to the construction industry, in Kenya the proportion is slightly lower. Nevertheless, the percentages are significantly high and the fact remains that the government is responsible for approximately half the demand on the industry. Due to her involvement, the government can affect the demand on the industry directly by reducing the government's projects. The remainder of the demand can be affected indirectly through the fiscal and the monetary policies like credit squeeze and

interest rates. This preponderance of government influence, together with the investment nature of demand means that demand tends to fluctuate particularly according to the state of the economy and the social and economic policies of the government with consequent effects on the industry.[12]

We found that residential buildings, non-residential buildings and construction and works together contributed 48.19 per cent of the total capital formation for the whole economy. The industry is therefore a provider of about half the country's fixed investment. When the output of the industry is down, total investment is also down yet the investment level is very sensitive to the health of the economy.

The participants in the industry have blamed the government for the fluctuating nature of the industry and have suggested that the 'stop-go' operation should stop. On the other hand, the governemnt would not afford to stop the operation because she has to achieve her major economic objectives namely: solvency, full employment and growth. Apart from these major objectives, the government has to adjust for inflation which is always notoriously around us, moreover given the government's share of the industry, and the industry's relationship with the health of the economy, stopping the 'stop-go'

operation would not be in the interest of the industry.

Problem Formulation, and Objectives of the Study.

In the last section, the importance of the construction industry in the whole economy was made clear and cannot be overemphasized. Also, the relationship of the government and the industry was established with respect to regulations. It has a great influence in the industry partly through economic policies and especially because it is a main client of the industry (50%).[13]

The government as a client had by the year 1983/84 acquired buildings whose value was £498,791,147.[14] This property is developed as projects; where a project means; "a unit of purposeful activity with a beginning and ending point in time that is chosen to be separately planned, analysed and administratively implemented."[15] The unit of activity can be the construction of a new steel plant or the expansion of an existing facility. It can be the establishment of a family planning activity which is designed to yield services or it can be an agricultural project that is expected to yield food or fibre.

Projects are often part of a programme or have a close relationship to a programme. A programme is generally a combination of related projects and/or on going activities.

Most of the government building projects which produce the government building stock have been designed, supervised and monitored by the Ministry of Works, Housing and Physical Planning, whose name has been changing over time but the role with respect to development and maintenance projects has remained the same.

There has been a public outcry about the performance of the implementation teams with respect to public building projects. The local newspapers have carried accusations and counter accusations of who is to blame for the alleged poor performance of the building contracts. As recent as 6th February 1985[16] the Minister in the Office of the President suggested that government officers who delay implementation of development projects are not justified to receive their salaries and should be sacked. The following day, an editorial in The Kenya Times[16] discussed the same topic supporting the minister.

The public pays for the government projects through tax while the projects

are for their benefit. It is therefore not surprising that the same public gets concerned when things do not seem to go well with the implimentation of the projects. A lot has been commended from many quarters towards this end.

The capacity of the industry has been questioned and doubts casted about its efficiency.[17] It has been felt that contracts are awarded to unqualified contractors and enough attention has not been focused on the contractor's past performance and workload at the time of awarding the contract.

Civil servants have also been accused of procrastination. The arguement advanced is that these government officers are not impartial in their duties because they have intentions of making their own illegal deals.[18]

Another aspect that has been highlighted to be influencing the performance of government projects is political interference and influence.[19] There have been cases where projects have been speeded because of political influence. The issue of civil servants being lax may be supported by the incidence of Nakuru hospital which had been delayed for seven years and was completed in two months, when the President intervened. The very fact that the completion was in two months shows that the civil servants have the necessary potentiality. However, it is not known how many

projects were adversely affected due to the concentration on that one project.

Changing-government-policies have not been matched with corresponding changes in contract procedures. For example, when foreign exchange was restricted which caused the shortage of imported materials, contract plans and procedures could not be changed overnight to cope with the restriction. This is a responsibility of the government[20]. Labour immobility and the "dirty and hard" nature of construction operation have been blamed to cause delay. A case at hand was in Nyeri where the contractor complained Nyeri men shunned manual work.

The bureaucracy in the government offices has a share in the poor performance of construction projects. This however may not last any longer if the district-focus policy is going to bring the fruits expected of it. It is, however, doubtful if this policy will actually help building projects because of the serious constraints such as; insufficient office accommodation, insufficient housing, insufficient office equipment, insufficient transport, insufficient staff, insufficient high calibre staff, lack of training resources, under-utilization of staff and lack of funds.[21] If the rural focus will not be helpful, then it means the present

limitation of the size of projects to be handled at provincial level will remain and leave most projects to be handled from the headquarters for quite a long time.

The activities involved in implementing a project operate within a legal framework. This framework has to be appropriate and effective if it has to positively help the construction activities. Our law and particularly the building bye-laws and regulations have not been revised for a long time and are not able to cope with the changing needs and technology of today.[22]

The government at national level has also realized that the building and construction industry has been faced by a number of constraints. The 1983-88 development plan[23] talks of the constraints as shortage of technical manpower, limited availability of locally manufactured materials, and various impediments to timely completion of projects. The plan intends to have these constraints ameliorated by improved organization of implementing ministry, standardization of building materials and practices, and increased support for training and job creation programmes.

Time and cost overruns are not an unusual phenomenon or only unique to Kenya. Stallworthy

and Kharbanda (1983)[24] say they are the rule rather than the exception in developing countries. These problems are not among those that are known in the developing world only like hunger, these are world-wide the variation is only that of degree.

Concern has been expressed in the developed countries for many years about the organization and effectiveness of the building team and it is clear that the alternative contractual arrangements which developed over the last decade or so have been aimed at answering this criticism.[25]

As recent as November 1984, one Professor Ted Happold wrote:

> "..... I put the fact that the industry has at last recognized that through the complex network of relationships that are wrapped round us or we wrap around ourselves - lying out there, somewhere, is a customer. A customer who has always been entitled to but rarely got, a good building, on time, within budget."[26]

We in Kenya are looking forward to the time when our industry will recognize such a fact, when nothing will be done which does not directly contribute to the finished building, when we shall allow innovation and change our attitudes.[27] How long it will take before that day dawns - if at

all it will dawn - will depend among other things on the effectiveness of research like this one and how many more will follow.

Many different suggestions have been given on how to tackle the problem of poor project implementation, and these suggestions vary from group to group depending on their respective positions in the government or otherwise. Mbugua S.J.[28] (1979) talked about staff incentives, co-ordination of ministries, client ministries not having sites by the time of tendering, client ministries not consulting Ministry of Works, Housing and Physical Planning for estimates. The move to decentralize government machinery to the districts is meant to serve among other purposes the reduction of project delays.

The importance of avoiding delays and saving on contract period cannot be overemphasized. Construction time savings are important because they mean real money savings to the building owner (W.H. George 1973)[29] provided always that the implementation of the time-saving system is not itself inherently more costly than the value of the time saving to the owner. A shorter contract period produces savings to the building owner both in the price he pays the builder for the construction of the building and in the reduced value of carrying costs.

The lower construction cost is achieved by reduced builder's overheads or preliminaries. The builder's item of major plant such as cranes and hoists and his supervisory staff such as project manager and general foremen are all on the job for a shorter period with a consequential lesser cost.

Performance as shown elsewhere can be measured in many ways. It can also be measured at different stages in part or for the whole project period, i.e. from inception to completion. The implementation of a building project is divided mainly into two stages with respect to tendering; the pre-contract and post-contract and this research is limited to the post-contract period only.

The fact that there have been complaints about delays of government projects, and the fact that some of the complaining parties are part of the government, shows that something must be particularly very wrong with the performance of these projects. The sentiments about the performance have been aroused by the evidence of a handful of projects which by chance may happen to be "sensitive" in terms of their location or in other aspects. It is, however, not known how many more of such projects are lying in records in the government offices. It is also not known to what extend these projects and any

others unknown are delayed or have their costs exceeded.

Suggestions have been made about the apparent endemic disease:- giving such suggestions is alright, in any case the causes are not supernatural. They are not so hard to come by so that when one suggests a cause one has to go in record as a great discoverer. According to World Bank Reports the causes of delay and cost overrun are:

- inefficient technical/economic appraisal.
- poor estimates by client/consultant.
- Lack of contract strategy.
- Badly written conditions of contract.
- poor assessment and inappropriate allocation of risk.
- wrong type of contract.
- inadequate tender evaluation.
- excessive variation, disruption.
- poor contract management/control.
- bad industrial relations.
- lack of competence by contractors and suppliers.
- poor inter-ministerial communication and rigorous government procedures.[30]

The problem is not so much what the causes of delays and cost overrun are, but how much of each there is and how they are interrelated. Moreover, if the government is already addressing itself to the constraints in the Development Plan it means that the causes are known and ways are being sought to rectify them. The underlying question now is, how will it be known whether a new method is improving the performance or not, without having a reference point? The other worry is; how will a doctor for example prescribe medicine before diagonising the nature of the disease? In other words, it would not be foolproof to recommend on how to reduce delays before one knows which projects are mostly delayed, whether location and size have any effect, whether the contract periods are infact sufficient and the trend-mean of the delays over a period of time. The same can be said about the cost overrun with respect to size, location and the relationship of the delay and the cost overrun.

On the other hand, when a few projects have been delayed, it is not a good enough reason to say that government projects are delayed, those few may be the only ones with peculiar reasons and their

failure should not warrant indiscriminate condemnation of all projects and degradation of the noble task of the civil servants. There is a need to go further and establish the extent of the phenomenon.

On that note, it may be stated that this research is concerned with establishing the performance level of the government building projects. It is an exploratory research where the results will only be suggestive.[31] This is because it is the first such research in Kenya and there is no basis of testing the hypothesis that the performance level is poor. However, a significance level of testing will be decided upon after examining the data. Any one doing a follow-up study would then be in a position to make legitimate statistical tests.

The objectives of the research are:-

1. To establish cost performance with respect to size.
2. To establish time performance with respect to size.
3. To investigate the relationships of contract period with final contract sum.

4. To investigate the effect of location and size of the project on the time and cost performance.

5. To investigate the adequacy and reliability of initial contract periods.

Delimitations and Scope of The Study

Building project performance can be measured using a number of indicators some of which are:-

1. Cost.
2. Time.
3. Productivity.
4. Rate of return.
5. Value for money.
6. Contractor's profit margin.
7. Participant's satisfaction.

Cost and time are the easiest to measure because impirical data can be obtained on the initial estimate and the final cost and time of the project. These are the two indicators that the researcher has adopted as opposed to the others like productivity. This is measured using the input/output relationship in terms of labour, materials, plant, management level or a combination of part or all of these factors together. Such a combination is not easy to evaluate on the same basis because it has not been possible for architects to specify the quality of management required to the contractor's as they specify materials and workmanship.[32]

The rate of return on the invested capital

is not easy to calculate for public utilities. This would involve welfare economics where the social benefits are assessed and given a scale of measurement for purposes of comparison. Such a measure would require more time and skills than was available. For the same reason, a measure using value for money is equally unfeasible.

Holding the workmanship constant, the profit margin on a contract to the contractor can be used as a measure of performance because this means, the contractor has improved on his management and technology thus making a saving without affecting the quality of work and hence the client's satisfaction. The latter, i.e. client's satisfaction is very subjective. The measure of satisfaction becomes even more complex when one has to consider all the participants. These participants include the contractor, the contractors operatives, the client's tradesmen, the professionals, the general public and the ecology. Success in balancing the interests of all these parties would be a success to the project itself.

We are then left with time and cost as our measures of performance and this is what the researcher will use. Project time can be considered in one of two ways, the total time of implementing a project or only the contract period.

Since the research is concerned with only the contract period, then project implementation period will not be an issue. The period under consideration will be that during which the contractor has been chosen, site identified and contract documents ready. Delay in the pre-contract stage is, however, no less important; it also has cost effects in that prices may change or government revenue position may deteriorate thus necessitating a revision of the budget and designs. Data on delay in this stage is, however, difficult to get.

The costs to be considered in this research will be direct economic costs and only those that are contractual and can be measured. Other costs like social costs of delaying a hospital, the extra costs that are due purely to delay and professional costs will not be considered in the research. The research will be concerned with initial contract sum and the final contract sum inclusive of course, of prime cost and provisional sums.

The choice for research on government projects as opposed to private projects was due to obvious reasons; data is more readily available with the government than with private clients who are anyway scattered and fragmented. The government continuously erects building from its programme, also it is the government's projects that are more prone to mismanagement and that can benefit more

greatly from a research of this nature.

The government contributes in terms of demand, about 50% to the building industry, which is a very significant contribution from a single client. An improvement in performance in such a sector, however, small would be great when applied to the whole sector; due to its value it would mean a sizable saving nationally than would be the case for a single private client.

It would have been more appropriate and exact to establish the nature and extent of variations which inherently are causes of cost overrun and delay; but unfortunately the researcher could not get access to the correspondence in the project files due to their confidential nature.

The sources and nature of the variations are, however, an area requiring further research. This is because it is only by knowing the contribution to variations by the various parties concerned i.e. professionals, contractors, and the client ministries that further investigation can be conducted so as to avoid the delays and the cost overrruns. All this is in the endeavour to establish the real causes of delay and cost overruns.

The research covers projects started and completed between 1967 and 1981, a period of 15 years. Some of the projects that were started in the years 1982, 1983 and 1984, are still under construction, while others may not have been concluded for one reason or the other. The projects appearing for those years have, therefore, been discarded.

The types of projects under consideration are only building projects that have been designed, documented and administered centrally from the Ministry of Works, Housing and Physical Planning headquarters. The sizes of the projects range from the smallest to the largest, in other words, the sampling was not stratified.

Significance of the Research

Since there has not been contract performance measurement before in Kenya in terms of cost and time overruns, either in the public or in the private sector, the level of performance established in this research will serve as a basis for future comparisons. When input combinations change, when organizational structure changes, when technology changes, then we may have to assess the effect of such changes. The only way would be to compare with the previous results which this research intends to establish. As this research is only exploratory, i.e. discovering which areas need further research and of what nature, it will be easier for the follow-up study that may take place in the future to choose specific areas of further investigation. Such areas would be location, size and type. This research intends to go only as far as establishing the effect of factors such as location, size and type of projects to the performance. A follow-up study may for example, investigate on how to give weighting for locations. etc.

An essential need of a client for project control is to estimate, as accurately as possible, the final cost of the project i.e. the tender price plus rise and fall.[33] The functional relationship

to be established between the contract period and contract size can be used to estimate the final contract period and hence the accurate period. The same can be done with the relationship between contract size and final contract sum. Since the data is based on past performance which has not changed for a long time and is not likely to change in the short run, the relationship will be accurate assuming a certain level of technology and management, and can be used to estimate within a given percentage error, the most probable total cost. In the absence of a better estimating method, this would suffice.

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CHAPTER TWO

REVIEW OF RELATED LITERATURE AND THEORETICAL FRAME WORK

Review of Related Literature

Introduction

The research topic under discussion in this work is concerned with measurement of performance of building contracts and this essentially is the evaluation of the success of the contracts using given parameters namely cost and time. The implementation of a building contract involves the participation of different groups organised to work together towards a common objective. The success or the performance of that group depends on how efficiently the participants work together so that the performance of the contract in terms of achieving its objective is also the measure of performance for the implementing group.

It is the actions and omissions of those parties that will determine the level of success. Those actions and omissions will have both negative and positive attributes towards the success of the contract. One would then argue that, for more improved performance only actions and omissions with

positive attributes to the contract should be encouraged. In practical life, however, we experience some negative and some positive attributes simultaneously - and the ultimate level of performance depends on how much of each is used in the "resource mix." If we supposed the activities with positive attributes to be 'P' and those with negative attributes to be 'N'; the performance can be improved by increasing 'P' holding 'N' constant, or reducing 'N'. However, before anything in this direction can be done. the actions and omissions with 'P' . and those with 'N' need be identified.

In addition to establishing the level of performance, this research investigates what effects such factors as location, size and type of project have on the "performance." The past research works that may be termed relevant literature must then concern themselves with the following:

1. Cost performance.
2. Time performance.
3. Variations - nature and extent.
4. Causes of delay.
5. Causes of cost overruns.

Cost Performance

Bromilow[1] conducted a research on cost performance in Australia and the cost of buildings as measured by the final contract sum was found on average to be 2.5 per cent greater than expected at the time of signing the contract. The difference was found to be smaller for lower-cost buildings, but could be up to 5 per cent for ones in the $10 million class. The research was based on 284 projects completed in the mid-1960s. The mean trend of the cost performance ratio with project cost was shown as a line which followed a simple relationship of the form $P=K + B \log_{10} C$

where

P = cost performance ratio x 100

C = project final cost in $ million 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 $1 million project C = 1.0, so that $\frac{K}{100}$ is the value of the

cost performance ratio for a project of this size. K was equal to 96.5 so P = $\frac{96.5}{100}$ = 0.965

The higher the ratio, the better the performance for that size of the project.

In Kenya, some sites are so remote that the location may have more effect on performance than the size of the project. In Bromilow's formular, location is not considered and therefore, it is not easy to tell the sensitivity of cost performance to project location. The same applies to the type of project, hospital projects, for example may not necessarily have the same problems as public buildings and this sensitivity need be known at design stage. Also, Australia being more developed than Kenya, it is expected that the results may not necessarily be the same and so a study of the Kenyan case is necessary.

Time Performance

Bromilow[2] in 1969 formulated a relationship of construction time and estimated construction cost. The function was of 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 original values of K and B were determined for C in millions of dollars at June 1969 prices. A recent survey (Bromilow, Hinds and Moody 1980) resulted in an updated value of K with B remaining constant. In June 1981 prices, updated values for C in millions of dollars are K = 248 and B = 0.30.

In Kenya, there is no fast and hard rule on how to calculate construction time, the decision is left to the Quantity Surveyor[3] who operates from intuition. He bases the calculation on the performance of a previous contractor on a similar project in type, size and location and uses the rate of expenditure per calendar week. This kind of method is suspected to be faulty and self-defeating in the sense that, since government projects are known to be mostly delayed, then the estimate on construction is likely to be based on a contractor whose performance was already poor.

The irony is, however, that, even

when the contractor is mistakenly given more time than is necessary, he still delays the project.

The consistence of allocating construction time will be examined by bringing all projects to a common base using a cost index. The trend mean for this data will be compared with that of the actual time taken and if it is found that there is no relationship it will be concluded that some of the delays are due to insufficient contract period or too much contract period. (When one thinks he has all the time, one may relax and eventually get delayed).

The Nature and Extent of Variations.

Variations are the cause of many problems in building contracts and are a source of increases in time and cost. Builder's administration fees alone arising from variations add from 0.5 to 2 per cent to the total cost (Bromilow 1970)[4]. Bromilow investigated 248 projects worth $186 million and he showed that variations are an unavoidable feature of building and their complete elimination is a virtual impossibility.[5] The standards of project design and contract supervision determine the number and magnitude of variations, which vary between limits. It was shown nevertheless, that the average extent to which they occur is predictable, as also

are the boundaries within which 50 per cent of all contracts lie.

A simple relationship was established between number of variations and cost as thus:

$$N = K_1 C^{B_1}$$

where N = Number of variations in the project

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

K_1 = indicative of building variation performance in Australia, value = 200.

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

A relationship was also established of the gross value of variations in each project. It was

$$V = K_2 C^{B_2}$$

where V = gross value of variations in thousands of dollars.

$B_2 K_2$ = as B_1 and K_1 above respectively.

K_2 = 110 and B_2 = 1.25

Detailed examination of 25 project revealed the nature and principal sources of the more significant variations. The client originates the major share, closely followed by the designers.

In this research, the reasons given by contractors for extension of time will be tabulated and the most frecuent will be noted for further discussion. The assumption here is that since in almost all cases extension is awarded then the reasons should be genuine even if not contractual and they are infact the causes of delays. Whether or not they are eliminatable, depends on the reasons behind their happening.

Faster Buildings for Industry

A research was conducted recently by Economic Development Committee (EDC) in the United Kingdom (UK) under the title "Faster Buildings for Industry." The objective was "to establish the key factors that affect the time taken to construct industrial buildings, to identify best practice in planning and maintaining control of construction periods and formulate recommendations for action by client, designer, and contractor." The research was on industrial buildings because they are more sensitive to time value of money than other types of buildings.

The factors considered were:

1. the number of projects.
2. the type of project; purpose build or advance.
3. contract value in £000's at 1980 prices
4. floor area (m^2).
5. method of contract organization.
6. customer experience; either continuous building programme, experience of previous projects or first-time building experience.
7. site and total project times and the difference from average times for contracts of similar size.

It was found that the client's management and control accounted for most successful completions. It was also found that: negotiated projects saved on average 1 month over projects using competitive tendering.

- construction times increased with contract value although not in proportion.
- non-traditional organization methods tended to be faster than average.

Other relevant researches conducted and documented are:

(a) An Economic Development Committee (EDC) paper by Perry and Thompson[7] for U.K. National Development Office, in which 2000 public sector contracts were considered.

(b) 1979 World Bank Review of project performance.[8]

In both of these works, the results were in form of cost and time overruns and were expressed in terms of percentages. No functional relationship was established but suggestions were given on the causes for delay and cost overrun. The conclusion was that contract strategy was lacking. Contract strategy is concerned with decisions on organizational method for design and construction, type of contract, bidding procedure and conditions

of contract.

Performance of building projects is an aspect of management and in Kenya, and particularly in the public sector, the management approach and the project organizational structure and its mechanisms have not changed well enough with changing conditions and technology.[9]

Mbaya[9] in his work discussed mainly contingency approach to the design process, organizational structure and their integrating mechanisms; this, however, differs from performance measurement in that the latter is concerned with evaluation of success and failure while the former is concerned with describing the state of art with respect to project organizational structure.

Harris[10] in his thesis compared two tendering procedures namely competitive tendering and package dealing. In the comparison, time element of each procedure was analysed and it was concluded that package dealer designed projects are more reliable than architect designed, as far as the estimated planning time is concerned. The writer[11], however, warned that in measuring the performance of the two procedures, no single factor should be evaluated in isolation, but quantified within the overall framework of the specific project in question. For example, if speed is required,

then this may have repercussions on tender price, quality of construction, and full design requirements satisfaction. The data were based on industrial buildings which are more suitable for package deals than public buildings.

Harris[10] measured time performance of each procedure by merely comparing which took shorter than the other for each phase from inception to completion of the project. In evaluating contract performance in the Ministry of Works Projects, it will not be possible to compare tendering procedures firstly, because the procedures there are predominantly open tendering, and secondly, because the facts may not be easily obtainable. However, as discussed in later sections, time performance will be measured in terms of the difference between the final and the initial contract period. The details of the concept of time overrun are under the section of theoretical model in the next section.

Theoretical Framework

Origin and Responsibility of Ministry of Works, Housing and Physical Planning

During the colonial era, government works were done under the Public Works Department (PWD) which originally was headed by the Commissioner for Works and later by the Director for Works.[12]

Buildings Department came into being in January 1970 when the buildings, structural, electrical, contracts and quantity surveying branches were incorporated in one department under the direction of the head of the former buildings branch, the Chief Architect. During that time, the Engineer-in-chief was acting as a director because all heads of departments including roads were answerable to him.

After the 1979 general elections, roads department was combined with communication to form Ministry of Transport and Communication (MOTC) leaving Ministry of Works to deal with buildings only. During this time, the buildings department was decentralized into the following departments:

Department of Architecture; Department of Contracts and Quantities, Structural Department; Electrical Department; Personnel Department.

The primary objective of the Ministry of Works, Housing and Physical Planning is to provide client ministries with suitable accommodation.[13] The ministry is responsible for the implementation of the government annual programme of building/ construction works, the National Housing Development programme and maintenance works funded through the Development and Recurrent Estimates. The role of the ministry is to create standards, design, tender supervise construction and advise client ministries on the cost of works and the disbursements to be made.[14]

The Ministry of Works, Housing and Physical Planning works closely with other related agencies such as client ministries, Ministry of Finance and Planning (Treasury), the Ministry of Lands and Settlement and the National Construction Corporation (NCC).

Any ministry whose request for specified accommodation is accepted by the Ministry of Works, Housing and Physical Planning, becomes a client ministry. Ministry of Works itself can also become a client. The treasury is responsible for approving

the expenditure incurred by all government ministries while the Ministry of Lands is responsible for obtaining all land required for government building projects. The national Construction Corporation was established in 1968 to provide assistance to African contractors through loans, quarantees, performance bonds, and technical advice.[15]

Definitions of Important Terms.

Scope of Contract.

This is as defined in clause 2 of conditions of contract for the Ministry of Works, Housing and Physical Planning (1970 edition) but the scope generally refers to the extent of works as described on the contract documents namely Bills of Quantities, Drawings and Specifications. This is the same meaning to be adopted in this research.

Variations

Clause 13 of the Ministry of Works conditions of contract (1970 edition) gives the D.R. the right of varying the specification and drawings, to increase or decrease the quantities of any item or items, or to insert any additional item or items without the consent of the contractor, provided that the total contract sum is not thereby increased or decreased in value more than 25%.

Prime Cost Sums:

Such sums mean the net cost after deducting any trade or other discount and should be expanded in favour of such persons as the D.R. should instruct and all specialists P.C. sums are allowed in the contracts because it is initially not possible to tender the works and determine the actual cost.

Provisional Sum:

These are used where the exact nature or extent of parts of the work cannot be ascertained before the construction begins, although such work can be reasonably foreseen as necessary or likely to be necessary. These sums cover the costs that are often not ascertainable precisely beforehand.

Contingency Sum:

A special kind of provisional sum, to meet or offset costs of work or expenses which cannot be foreseen before construction begins which may not arise at all. A contingency sum has no real relation therefore to the contract works at all and in practice merely serves to reduce the total nett cost of any extra or more expensive work than that originally envisaged.

The Departmental Representative (D.R.)

This is the person so designated by the person signing the contract on behalf of the Government.

The Concept of Time-Overrun

A building contract is based on three basic parameters namely the scope, the cost and the contract period. The cost and the time depend on the scope, such that if the scope varies the other two ought to vary holding other factors constant.

The scope is the extent or limit of work to be done which is fixed by the requirements of the client; the professionals are employed by the client to provide services which will enable the client get value for his money. Value for money here means giving the client what he wants for the money available. Apart from giving the scope by drawings or describing in the bills of quantities, it can also be reduced into activities that are interrelated and interdependent. Each activity has a magnitude of the minimum time necessary to have it done. The time required for completing each single activity is determined by the technique used while the technique itself depends on the level of technology in the industry.

At the time of deciding or calculating the construction time, assumptions are made about productivity of the firm and of course the capacity

of the industry which are directly related to the technology level. The techniques alone are however not sufficient to enable an accurate decision on contract period; they need a "vehicle" just like the pigmentation of paint needs a vehicle in form of water or oil, for application. Management ingenuity will give rationale and direction to the otherwise mere activities. The level of management determines the succeess of an activity or the success of a combination of activities. This is because management enables resources to be combined in the right proportion for a known objective.

In government contracts, the quantity surveyor fixes the contract time and the contractors compete on contract sum only. Given that the professionals should give value for client's money, they ought to work towards that objective. One way of doing it is to save the client from financial embarrassement by providing for provisional sums to cater for unascertainable costs. The quantity surveyor does his best to establish the client's commitment beforehand. This is more so in government projects where public accountability is important. The time allocated to the contract initially should then be the most accurate approximation considering all other circumstances; otherwise, if

the quantity surveyor was certain of a future event that can adversely affect the time then he would allow for it. The only way he would by-pass the event is to prepare to overcome it in other methods e.g. if it is rain, by sheltering the site and its activities.

Theoretically therefore, the time estimate should include time spent on everything predictable and affecting the critical path and for which there is no way of overcoming. The predictability of future events depends on measures of perfect knowledge which is very lacking in man; all the estimator depends on is his own past experience.

At the end of the contract, suppose the construction time gets extended we then talk about a delay; meaning the project took longer than was originally expected. The delay is of course undesirable, unfortunate and unwelcome, but why should it be there? It is there because events that had not been foreseen at the start of the project actually took place and affected the critical path. If in the next contract, a delay occurs and also in most of the subsequent contracts so that, in the long run a norm of delays is established, what it means is that the estimator and his colleagues have been unable to achieve the desired standard.

The standard can be achieved by making a positive effort otherwise the delays are inevitable and there isn't much one can do about the events that cause the delay. An illustration of this concept can be that of a farmer who sets a target of weeding one acre everyday, and then for the whole season he manages to weed only 0.68 of an acre everyday. He should accept that he is simply unable to do one acre in a day given the current circumstances.

A delay is a deviation from the original estimate. When it occurs, it disapproves the accuracy of the assumptions that were made when deciding on the time initially and shows how misguided and erroneous the estimator was. Even if the drawings are not complete by the time of tendering, or if you are certain of designers instructions, then you should make an allowance in the time for that. If one talks about delay, when the time allocated was obviously insufficient that would not be real delay but a fundamental error of estimation. It should be taken as a variation to the contract because it originates from the estimator.

Since the estimator's figure for time is his best approximation to reality and truth of the events, then the deviation from the estimate should also be his measurement of error.

The Concept of Cost Overrun

The tender sum is an offer by the contractor at which he would be willing to erect the building and is subject to acceptance by the client. Before inviting tenders, the quantity surveyor makes an estimate to establish the approximate cost of the project. In the case of the government, this estimate is used as the basis for approving and funding the project. To give the value for money, the quantity surveyor tries to be as accurate as possible by including any foreseeable circumstances at that stage, for remote sites he resorts to use of weighting percentages which reflect the extra costs due to transportation and other hardships. The quantity surveyor should reconcile the tender so that the lowest tenderer should not necessarily win the contract.

Cost overrun is caused by additions, fluctuations, adjustment of P.C. sums, provisional quantities, uncertain ground conditions, wrong designs, claims due to delay from designers etc. In this respect the contractor cannot cause cost overrun, he can only exert his rights which may mean extra cost to the client. This then means cost overrun should be blamed on the myopism of the design team and the client for they are the ones who fail to predict the outcome of events. Just like in delay

we can use the deviation of actual cost from the original sum to measure our success or failure.

Contract performance as shown elsewhere in this research, is essentially an evaluation of the success of the project. In giving the client value for his money, the professionals should enable the client to achieve his objectives. It is these objectives that contribute to client satisfaction, and since satisfaction is not easy to measure one can determine the level of the satisfaction by measuring the separate objectives which contribute to the total satisfaction.[16] Some of those objectives are getting a building in the expected time and within the given budget without sacrificing on the quality.

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CHAPTER THREE

METHODOLOGY

Random Sample

In the Ministry of Works, Housing and Physical Planning new jobs are given numbers and entered in job cards as they come. The particulars of the jobs are entered in the cards initially and all subsequent variation orders and interim payments are also entered in the appropriate columns of the cards. After completion of the contract, the date of completion and final contract sum are, too, entered in the card which is henceforth kept in the place of completed jobs. An effort is made to arrange the cards for the on-going and the completed jobs as serially as possible.

The period chosen in which the contract performance would be investigated is from 1966 to 1984 when the data were collected. The method designed to ensure randomness in selection was that of randomly selecting the first job card and thereafter picking every tenth card. Nine pieces of paper were inscribed with 1 to 10, wrapped and mixed together for picking. The number picked '3' was a random one and it became the starting card i.e. the third card from the first was the first to pick,

the second one to pick was the tenth from the third and so on until the last one.

The particulars of each completed job were entered in a data sheet starting with the job card number, p.c. and provisional sums, then the names, location and type of job, the initial contract sum, the commencement date, the original completion date the extended completion date and the final contract sum (see appendix A).

The sample size selected was 287 job cards and since every tenth card was picked, a total of 10 per cent was the proportion of the population which was sampled. The population therefore must have been approximately $287 \times \frac{100}{10} = 2870$ projects.

There are other important factors that would have assisted in establishing the level of contract performance and its basis, such are:

(a) Liquidated Damages

Liquidated and ascertained damages are meant to penalise the contractor for delay of completion of the works, by knowing the number of contractors who paid the damages, it would help to show whether or not the contractors had defaulted and if they had defaulted, how many of them. This exercise was not possible because, except in very few cases this information was not available in the job cards. However, by having those

few cases with the information it meant one of the following: either the information was entered by mistake or it was entered rightly and those projects were the only ones affected or it was entered rightly and others were omitted by mistake. The researcher chose the second alternative that the information was entered rightly and that the projects affected were the only ones. He ruled out the possibility of mistakes because it would not be easy to prove them. It was assumed in this research that cases of damages charged for delays in government contracts have been so few that they have no significance.

(b) Location Factors

In a study to compare construction costs between U.K. and U.S., a location index called Bockh's[1] index was used to reduce the cost figures for U.S. projects to a common location. This was necessitated by the expanse of the spread of possible sites in the U.S. given its geographical size although within the same country. A similar index is not operational in the U.K. nor is it operational here in Kenya. There may be obvious locational constraints due to remoteness of sites and this is subject to investigation in this research.

(c) Effect of Inflation

Since 1966, building costs have changed many times and this can only be determined by cost indices. The researcher for convenience chose to use the published cost indices for building costs (labour and materials combined). These indices are compiled and published by Central Bureau of Statistics, and they had not been recorded until 1972. For that reason, it was only projects of 1972 and the later years that could be adjusted for their costs using 1972 as a base year.

(d) Tendering Procedure and Type of Contract

These would have been helpful in establishing the causes of poor performance but data relating to them were rather obscure and hence hard to come by. Tendering procedure and type of contract are therefore not among the particulars recorded about the sampled projects.

(e) Contract Period

Contract period in the Ministry of Works, Housing and Physical Planning is estimated by the professionals and the contractors tender on contract sum only. It has been such a practice for so long a time that in the standard letters of invitation to tender,[2] a provision is included for contract

period to be inserted by the quantity surveyor. There may, however, be a few cases where the contractor tenders on period as well, but that, the researcher is yet to come across. For purposes of this research, the period is determined before tendering and the contractor has no say except in negotiation contracts.

Calculations

From the data sheets, calculations were made on cost overrun which was calculated as the difference between the final contract sum and the tender sum. The percentage of the cost overrun to the original contract sum or tender sum was also calculated and recorded. Some values were positive and others were negative. The differences between some of those values were too small to be plotted on a graph and for more sensitive data, the researcher used percentages of original contract sum to final contract sum.

The only details available on contract period were: the commencement date, the completion date, and the extended completion date. For 287 data points it was not easy to calculate manually the actual period in weeks between any two of the three dates and so a computer programme was used.

The programme calculated only the initial contract period, the extra or extension period and the percentage of the extension period to the original period but not the total period. By adding the initial and extended periods the total was obtained which representes the actual time used to execute the works.

P.C. sums and provisional sums were given in the cards as a lump sum. The percentages of these sums to the original contract sum were also calculated and tabulated. These percentages are related to the amount of uncertainty about future events the quantity surveyor is able to predict.

Tabulation of the whole Sample

The sample was broken down into small groups per year of starting the projects. The groups were tabulated each showing how many projects had been sampled that were started in each year. The years 1966, 1982, 1983 and 1984 were having too few points and were therefore discarded.

Another tabulation was that of the distribution of means of costs overrun percentages and time overrun percentages per year. The presentation here is meant to show which years had the worst cost or time performances and the results were also presented on a graph. All the tables

described and all the graphs or diagrams mentioned in this chapter can be seen in the next chapter where the results are discussed.

Also tabulated are the values of means of cost overrun and time overrun as regards classification of projects in terms of size. The classification was only in two groups, less than Ksh.½ million and more than Ksh. ½ million at current prices.

To enable comparisons, all the data were reduced to a common base year namely 1972 and those projects started before 1972 were omitted from the sample thus reducing the sample size from 287 to 184 for projects less than Ksh. 1 million. The other categories were more than Ksh. 1 million but less than 2 millions which had 15 data points, and more than Ksh. 2 million but less than 5 million which had 5 data points.

The category with 184 points was analysed using a computer package called Statistical Package of Social Sciences (SPSS) while the other ones the researcher handled manually. According to Ashworth (1981),[3] when establishing a cost model, 2½ times the number of variables should equal the number of sets of data required. In the case of this research there was only one independent

variable at a time and therefore the set of data should have been at least 2.5 and since we cannot have 0.5 of data, then the minimum according to Ashworth is 3. Since the points were 184, 15 and 5, then the rule was obeyed. This rule, he says, is applicable mostly where normality is being assumed. The same author also said that the nature of the sample should be such that the data is homogeneous. The homogenity assumed here is that of all the projects being subjected to similar regulations i.e. all projects are government projects, they are administered through the Ministry of Works and they all have more or less similar contract agreements bassically.

In the SPSS package, the regression correlation analysis was utilized; this analysis Bowen (1982)[4] says, although it is the most popularly used cost modelling technique is also the most dangerous. If used thoughtlessly this method is the blackest of black boxes.[5]

Regression and Correlation Analysis

Business planning and decision making are inseparable from prediction and prediction is required in virtually every aspect of the management enterprises.[6]

Regression and correlation analysis is a broad class of techniques for prediction. The term regression analysis refers to the methods by which estimates are made of the values of a variable from a knowledge of the values of one or more other variables, and to the measurement of the errors involved in this estimation process.[7]

The term correlation analysis refers to methods for measuring the degree of association among these variables.[7] In fields such as geometry and trigonometry, the mathematical equation variables express the deterministic (exact) relationships among the variables of interest. In social sciences and in fields such as business and government administration, exact relationships are not generally observed among variables, but rather statistical relationships prevail. Certain average relationshipsmay be observed among variables, but these average relationships do not provide a basis for perfect prediction.

The relationships assumed for the regressions in the research are linear. The term linear means that an equation of a straight line of the form $Y = A + BX$, where A and B are fixed numbers. It is used to describe the average relationship between the two variables and to carry out the estimation process.[8] The factor whose values we wish to estimate is referred to as the dependent variable and is denoted by symbol Y. The factor from which these estimates are made is called the independent variable and is denoted by X.

In addition to the assumption of a linear relationship the following assumptions are involved in the use of the linear regression model.[9]

1. The Y values are independent of one another.
2. The conditional probability distributions of Y given X are normal.
3. The conditional standard deviations are equal for all values of X.

The first assumption implies that there is independence between observations. This means, for example if time overrun for the first variable is low, the second does not have to be low and its value will not be affected by the first.

The second assumption means that for each value of X, we are assuming that the Y values are normally distributed around $\mu_{Y \cdot X}$ The third assumption is about a characteristic known as homoscedasticity which is about equal variability around the regression line at each value of the independent variable X. According to the second assumption, only Y is considered a random variable in the regression analysis X being considered fixed. Y value predicted from the knowledge of X therefore, is subject to error. X is assumed to be known without error. On the other hand, in correlation analysis, both X and Y are treated as normally distributed.

Plotting data on a graph is useful in studying the relationship between two variables. A graph allows visual examination of the extent to which the variables are related and aids in choosing the appropriate type of model for estimation. The chart used for this purpose is known as a scatter diagram, which is a graph on which each plotted point represents an observed pair of values of the dependent and independent variables.[10] In this research, scatter diagrams will be provided as part of the appendix to give a visual impression of the variability of the data.

The Method of Least Squares

The population or true regression line should be $\mu_{Y|X} = A + BX$. Correspondingly, the sample regression line, which is the best-fitting line to the sample data, is denoted as

$\hat{Y} = a + bx$ where 'a' and 'b' represent estimates of 'A' and 'B' in the population regression line.

One may think of many criteria that may be used to establish the best-fitting line to a set of data on a scatter diagram, but the most generally applied technique is the method of least squares. This method imposes the requirement that the sum of the squares of the deviations of the observed values of the dependent variable from the corresponding computed values on the regression line must be a minimum.[11] This implies that, if a straight line is fitted to a set of data by this method of least squares, it is a "best-fit" in the sense that the sum of the squared deviations, $\Sigma(y - \hat{y})^2$, is less than would have been for any other possible straight line.[12] The least squares line also passes through the point of means $(\bar{X}, \bar{Y})$, and therefore makes the total of the positive and negative deviations equal to zero.

In summary $\Sigma(y - \hat{y})^2$ is a minimum $\Sigma(y - \hat{y}) = 0$ are properties of line of least squares.

Measures of Association

In correlation analysis, interest centres on the strength of the relation between the variables, that is, on how well the variables are correlated. In this model, both X and Y are assumed to be random variables.

The amount of correlation between Y and X can be explained in terms of the relative variation of Y values around the regression line and the corresponding variation around the mean of the Y variable namely $\Sigma(y - \hat{y})^2$ and $(y - \bar{y})^2$ respectively.[13] "Variation" as used in statistics refers to a sum of squared deviations. $\Sigma(y - \hat{y})^2$ is the sum of the squared vertical deviations of the Y values from the regression line while $\Sigma(y - \bar{y})^2$ is the sum of the squared vertical deviations from the horizontal line $Y = \bar{Y}$.

Sample coefficient of determination is the measure of the association between 'X' and 'Y' and is determined using the relationship of the variations above.

The coefficient is defined as

$$r^2 = 1 - \frac{\Sigma(y - \bar{y})^2}{\Sigma(y - \bar{y})^2}$$

r^2 may be interpreted as the proportion of variation in the dependent variable 'Y' that has been accounted for, or "explained," by the relationship between 'Y' and 'X' expressed in the regression line. Hence, it is a measure of the degree of association or correlation between 'Y' and 'X'.

A widely used measure of the degree of association between two variables is the coefficient of correlation, which is simply the square root of the coefficient of determination.[14] The algebraic sign attached to $r = \sqrt{r^2}$ is the same as that of the regression coefficient, b. r ranges in value from -1 to +1. A figure r= -1 indicates a perfect inverse linear relationship, r = +1 indicates a perfect direct linear relationship, and r = o indicates no linear relationship.

Hypothesis Testing

The hypothesis to be tested in the research for each regression is that the coefficient of correlation for the population 'Y' is equal to zero. As explained before, the proportion of the total sum of squares of Y explained by X is given by r^2. Likewise, the proportion left unexplained by X will be $1-r^2$. Since the total sum of squares

can be symbolized by Σy^2, (Blalock) the explained and unexplained sums of squares therefore become $r^2\Sigma y^2$ and $(1-r^2)\Sigma y^2$ respectively.

The degrees of freedom associated with the total sum of squares is of course N-1. In computing the unexplained sum of squares we take the sum of the squared deviations about the least-squares line rather than about the grand mean of the Y's. But in order to obtain the least squares line we have to make use of two coefficients 'a' and 'b'. We have therefore lost 2 degrees of freedom, one more than we lost in taking deviations about the single value Y. We thus can associate N-2 degrees of freedom with the unexplained sum of squares, and by subtraction we see there is 1 degree of freedom to be associated with the explained sum of squares.

The estimate of variance for explained variation = $r^2\Sigma y^2$ while that of the unexplained = $\dfrac{(1-r^2)\Sigma y^2}{N-2}$

The ' F ' statistic formular then becomes

$$F_{1\ N-2} = \frac{r^2\cancel{(\Sigma y^2)}}{\dfrac{(1-r^2)\cancel{\Sigma y^2}}{N-2}} = \frac{r^2(N-2)}{1-r^2}$$

The term Σy^2 has disappeared and ' F ' can be obtained with only r^2 and N.[15]

The values of the analysis of variance, the ' F ' statistic and all the coefficients constants and standard errors were calculated by the computer package. The values are given in appendix C. For the remaining data which was analysed manually the ' F ' statistic was calculated using the formulae given above. The significance level adopted was 0.05 and for the hypothesis to be rejected, the 'F' calculated had to be greater than 'F' tabulated.

In testing for the significance of r we are asking the very important question, "How likely is it that we would obtain an r equal to the calculated value or larger if there were actually no linear association in the population?"

Cause and Effect Relationship

The quantity of the coefficient of determination or any other statistical technique that measures or expresses the relationship among variables cannot prove that one variable is the cause and one or more other variables are the effects.[16] Two variables may show strong correlation when infact they are not related in life - such is called "nonsence" correlation.

Even when the variables are related, neither one nor the other may be the cause or the effect. The cause may be yet a third parameter unidentified. Another cause of wrong correlation is sampling error.

Regression and correlation analysis has been extensively used in the construction industry but mostly in cost modelling. Some of the past users of this technique are authorities like McCaffer (1975).[17] He gave examples of the use of this technique as an estimating tool for the Quantity Surveyor. Buchana (1972)[18] also used the same technique for estimating and similarly Ashworth (1981)[19] and Beeston (1978).[20] Bowen (1980)[21] investigated into the feasibility of producing an econometric cost model for framed structures in his M.Sc project.

The objectives of this research are concerned with relationships of two variables at a time. Time and cost performances will be measured against the project size. Statistically, analysis of relationship of two variables is simple regression. The analysis would have been multiple regression if the objective was to include all possible causes of Time and Cost overrun.

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CHAPTER FOUR

DATA ANALYSIS

Nature of the General Sample

The sample of 287 completed contracts was analysed and the results were tabulated as shown in table 4.1. The characteristics of the individual projects were examined in terms of how many projects had: time overrun, cost overrun, no time overrun, no cost overrun, saving on time, saving on contract sum. These projects were further classified into two main groups in terms of their financial size namely, less than half a million and more than ½ million in Kenya shillings.

From the table, it can be observed that 73 per cent or 73 out of every 100 projects started in the Ministry of Works took a longer contract period than originally anticipated. This is so regardless of the size, location, or type. Generally a project started would have 0.73 chances of getting delayed. There are, however, some projects which got completed in exactly the required period and better still, others were completed in shorter time than originally allocated but these are only 14.98 per cent and 8 per cent respectively. Due to the variability of the time overrun, it was not

Table 4.1

Percentages of the sample: n = 287

	T.O	C.O.	E.T.	E.C.S.	T.S.	C.S.S.
Less than Ksh. ½ million at current prices	-	58,72	-	94.44	-	80.38
More than Ksh. ½ million at current prices	-	41.28	-	5.56	-	18.98
Total percentages	73	37.98	14.98	6.27	8	55.05

T.O. = Time Overrun

C.O. = Cost Overrun

E.T. = Exact Time

E.C.S. = Exact Contract Sum

T.S. = Time Saving

C.S.S. = Contract Sum Saving

Source: Own Field Study 1984.

considered useful to apportion what percentage delayed was for what size; this will be discussed in a later section.

As for the cost overrun, it was measured as the difference between the final contract sum and the tender sum. That difference does not reflect the actual cost overrun and therefore the researcher chose to call it contract sum overrun.

Table 4.1 shows that about 38% of the projects started ended up requiring more money to be paid by the client than the client had initially been led to believe. This percentage appears small when compared to the 55 per cent for projects with contract sum saving but the effect it has on overall financial position may be great considering that 80.38 per cent of those with contract sum saving are less than ½ million in size. Again, although a bigger proportion of the projects with contract sum overrun are the smaller ones of less than ½ million, it does not mean that the smaller project perform worse than the bigger ones. As a matter of fact, about 57 per cent of the big projects have a contract sum overrun as compared to about 31 per cent for those of ½ million and below.

Table 4.2

Distribution of Number of Projects Sampled per year

Year of starting	Number of Projects Sampled
1966	1
1967	14
1969	12
1970	12
1971	15
1972	14
1973	17
1974	18
1975	21
1976	17
1977	17
1978	21
1979	34
1980	19
1981	20
1982	6
1983	5
1984	2

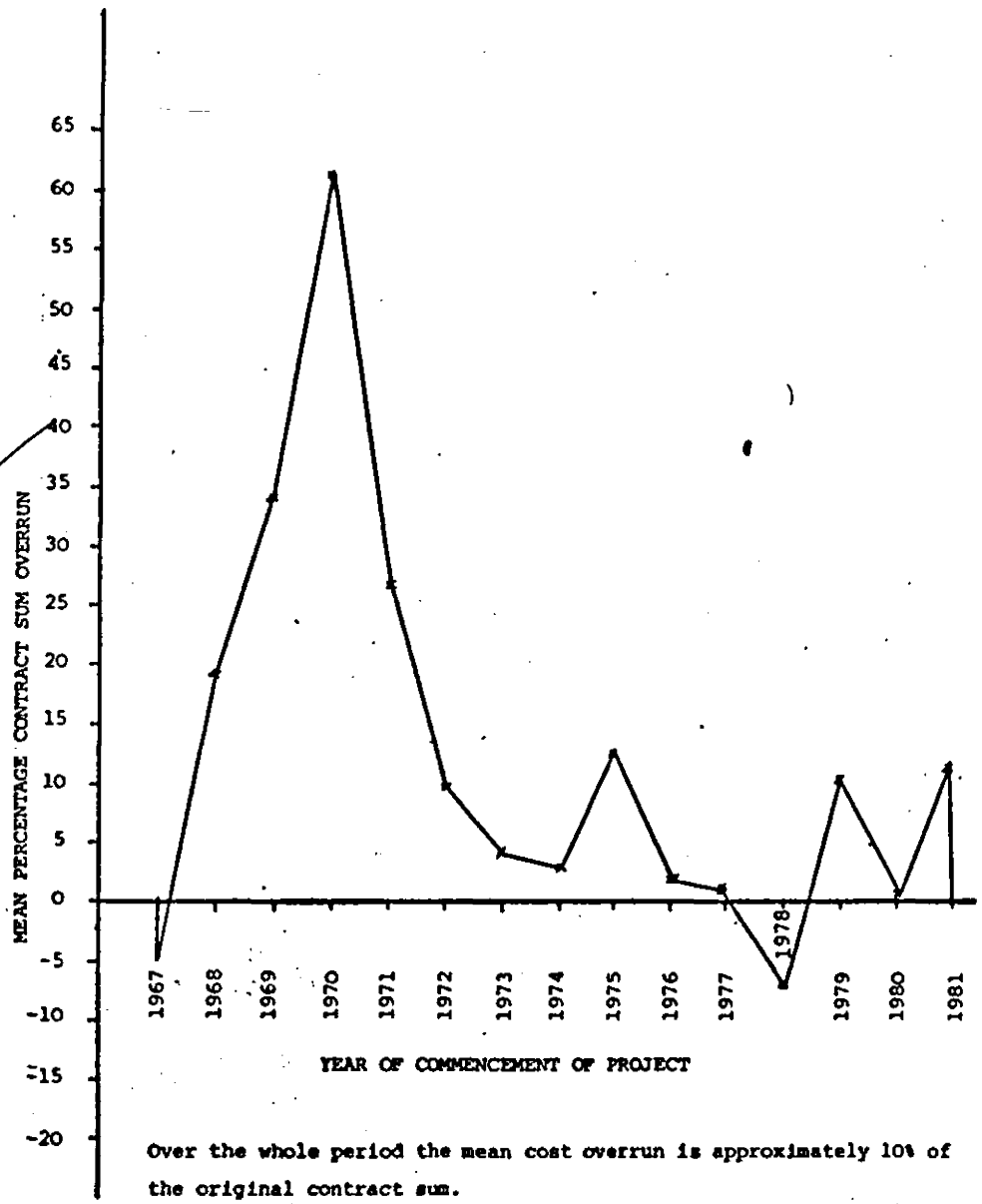
Source: Own Field Study 1984.

Table 4.2 shows the distribution of the number of projects sampled falling under each year from 1966 to 1984 a period of 15 odd years. Except for 1966 which has only one project and 1982, 1983, 1984 with 6, 5, and 2 respectively, the rest have between 12 and 21 projects sampled. It was considered more accurate to leave out the years 1966, 1982, 1983 and 1984 because their data were not representative.

The reason why the data for those years became unrepresentative is because of their placement in time and space. 1966 is the first year in the sample and it was included to make sure that 1967 was completely exhausted. This sample was collected sometimes towards the end of 1984 and many projects started from 1982 onwards are likely to have not been completed.

For the data of the remaining years i.e. 1967 to 1981, the percentages of the contract sum overrun to the original contract sum were calculated and plotted against the respective years of commencement of the project as shown on figure 4.1.

From the figure it can be observed that, according to the sample, contract sum overrun reached its peak in 1970 at 61.24% after increasing



Over the whole period the mean cost overrun is approximately 10% of the original contract sum.

Fig. 4.1

DISTRIBUTION OF MEANS OF PERCENTAGE CONTRACT SUM OVERRUN FOR THE YEARS 1967 TO 1981

Source: Own Field Study 1984.

rapidly from -4.6 in 1967. The years 1967 to 1970 show a very poor performance in terms of contract sum overrun. After 1970, the percentage decreases again very rapidly to about 9.6 in 1972 after which it fluctuates more uniformly between about 1 per cent and 12 per cent reaching its lowest at -7.67 in 1978. The mean over the whole period under consideration is 9.95 according to the sample.

Since the sample is a random one, its characteristics should estimate the characteristics of the population. The reason why the cost performance should have been poor between 1967 and 1970 could be due to the economic and political growth of the country. This was the time after independence, and as construction lags behind other industries, this may have been the time when the industry suffered the side effects of independence. The independent government may have initiated more projects than the industry could handle, also, lack of technical personnel owing, probably, to Kenyanization and/or repartriation of foreigners. However, it did not take too long for the new team to stabilize because in 1972 they were already performing at the industry's norm.

For comparison purposes, the contract sums, both initial and final were reduced to a common year

base and since building cost indices available in Kenya are only from 1972, projects started earlier than 1972 were left out and the number therefore reduced. In addition to the number reducing out of the need to have a common year base, there was a further subdivision in terms of contract sizes thus: (see appendices F and G).

1. Less than 1 million.
2. More than 1 million but less than 2 million.
3. More than 2 million but less than 5 million. (see also appendix E)

After the subdivision, group 1 had 184 projects, group 2 had 12 and group 3 had 5. It is only group 1 data that was utilized in a computer package (SPSS) because the points were too many for the statistics to be calculated manually. The other data points were however, handled manually and the results tabulated in tables 43, 44 and 45. See also appendices B-D.

For each size group, four regressions were done (a) percentage of original contract sum to final contract sum (cost performance = P_1) on final contract sum (C_2); (b) percentage of time overrun to initial contract period (time performance = P_2) on final contract sum (C_2); (c) actual

contract period (T_1) on final contract (C_2); (d) initial time (T_2) on original contract sum (C_1). The following is the discussion of the results obtained for each regression on each group.

GROUP 1

Less than Ksh.1 million (1972 prices)

(a) Percentage of original contract sum to final contract sum (cost performance = P_1) on final contract sum.

From the computer package, the sample gave a coefficient correlation r of -0.35125 which when squared gives a coefficient of determination of 0.12338. Correlation coefficients range from 0 (no relationship) to 1 (perfect relationship); the r being 0.35125 shows there is a relationship but a weak one. This relationship could however, be due to sampling chance and so to be sure, we need to test whether or not the coefficient is significantly different from zero.

Table 4.3

Values of 'F' statistic for

Projects less than Ksh. 1 million (1972 base year

Variables	F-calculated	F-expected or Tabulated	Hypothesis Ho Rejected/ Accepted
P_1/C_2	25.61539	3.897	Reject Ho
P_2/C_2	0.94386	3.897	Accept Ho
T_1/C_2	43.45371	3.897	Reject Ho
T_2/C_1	132.03279	3.897	Reject Ho

Source: Own Field Study 1984.

As shown on table 4.3, the F statistic calculated is 25.61539 while the F tabulated is 3.897 at 95% significance level and at 1 and N-2 degrees of freedom for regression and residual respectively. Since the F calculated is greater than F tabulated, we reject the hypothesis that

the correlation coefficient of the population is equal to zero Ho: $\rho = 0$ and accept the alternative H_1 that $\rho \neq 0$. In other words, at the 95% level of significance we are proving that the cost performance (where cost performance is measured in terms of contract sum overrun), is related to the contract size of the project in money value but negatively. As the contract value increases, the cost performance level decreases.

The basic assumption on the relationship was that it is linear where a linear relationship is of the form $Y = a + bx$ where Y is the dependent and x the independent variables. From the data, the values of 'a' and 'b' were obtained as 108.0921 and -38.60953 respectively. Using the values of 'a' and 'b' we can construct the relationship as

$$P_1 = 108.02 - 38.61C_2$$

where P_1 = cost performance x $\frac{1}{100}$

C_2 = contract sum (Ksh. million).

The relationship suggests that when $C_2 = 0$ or when there is no project, then the performance is at its maximum of 108.02% which is not practical. However, since this value 108.02% was obtained due to the nature and magnitude of the data used, and since the smaller the project the higher the

performance level, then the smallest contract value in the data should give the highest performance practically obtainable given the M.O.W. tendering constraints. The smallest contract value was 0.0016 which gives P_1 = 107.96%. This may still not be correct unless we introduce the measure of contribution to the performance. The coefficient of determination gives the proportion of dependent variable which is explained by the independent variable. In our case the proportion is 0.12338 or 12.338 per cent; this means, contract size alone influences the cost performance by only 12.34 per cent and other factors influence the rest by 87.66 per cent. It also means, about our constant 'a' that, it reflects a small contribution and may therefore not be practical.

What this small percentage means is that the problems of cost performance have very little to do with contract size for projects in this category and so undue consideration should not be based on cost. The other factors combined would ensure over 80% success.

The unidentified factors were not a part of this research and would be best dealt with using a multiple regression. The other problem would be that of units of measurement. The value of the

coefficient 'b' is the measure of the change in cost performance due to a change in contract value. It is infact the measure of the sensitivity of the cost performance to the contract value. Since this relationship is for projects not more than Ksh. 1 million, then the minimum value of P_1 is when C_2 = 1.0 and that will be 69.41%. This means the contract would have overrun by Ksh. 0.3059 million as per 1972 prices which in 1983 would have been Ksh. 1,147,125.

(b) Percentage of time overrun to initial contract period (Time performance = P_2) on final contract sum (C_2).

The coefficient of linear relationship was calculated to be 0.07183 and its square is 0.00516. Table 4.3 gives the value of 'F' statistic calculated and tabulated where 'F' calculated is less than 'F' tabulated thereby accepting the hypothesis that there is no relationship between time overrun and the size of the contract. This result suggests that time overrun does not increase with the size of the project-Kharbanda[1] and others put it this way "size has nothing to do with it" i.e. to do with time and cost overrun "small projects can go wrong just as easily as large projects. It is only that, the larger the project the higher the stakes, and the more likely the

publicity". The value of r^2 being 0.00516 means that the size of the project plays a very insignificant role in time overruns - the contribution is only 0.516% which is almost negligible.

It is therefore not possible to determine the time performance with respect to contract sums because the two are not related; we can, however, use the mean which is 159.67 per cent for 184 projects of size not exceeding Ksh. 1 million (1972 base year). The standard deviation is at 415.18 which is very high as compared to the mean and which means the data is not lying in any pattern or distribution.

The cause of poor time performance is not related to the size-related constraints, it is most likely lack of payments. Since the contractors who do the jobs in this category are the small ones, they are more likely to have financial constraints and if a certificate is not honoured in time, the contractor would abandon the work due to lack of alternative sources of finance.

Before one can talk of time overrun and start accusing the contractor of delaying the project, one should be sure of the adequacy of the original contract period - infact the problem

would be more of an under-estimation of time than anything else. In the Ministry of Works, Housing and Physical Planning, time is decided upon by the client's quantity surveyor so that the contractor tenders on contract sum only and the method used to calculate the periods is that of contract size.

There is no evidence that initial contract period is related to time overrun; we therefore cannot conclude on the accuracy of the initial contract period. We have found out that time overrun is not related to final contract sum and as we shall find out later, final contract sum is positively related to final contract period then, time overrun is not related to final contract period. This means time overrun is not related to size of the project yet the size of the project is related to cost overrun. We can conclude that the causes of cost overrun are not the same as those of time overrun. The causes of delay do not necessarily have direct cost implications.

Assuming the main causes of delay to be additions to the scope, variations due to incomplete drawings and delay in payments; in all these cases the contractor has a right of claim on extra direct costs like preliminaries and lost interests. The fact that delays do not cause cost overrun means that either the contractors do not

make any claims or the contigency sum is always enough to cover for these extras.

(c) Actual contract period (T_1) on final contract sum (C_2)

The purpose of regressing actual period on final contract sum was to try and establish a relationship, if one exists, between the time taken to complete a contract and the actual cost of the contract. This kind of relationship when established would be used to calculate the contract period given the contract sum with the necessary amendments for contract variations.

The F significance test showed that the relationship is significantly different from zero at the 95% level. The value of coefficient of determination was calculated as $r^2 = 0.19274$ meaning that although contract period is directly related to contract final value, the contract value contributes only 19.27% to the contract period while 80.73% is due to other unidentified factors. It is important to remember that this holds only for projects less than Ksh. 1 million (1972 base year) which was Ksh. 3,750,000 in 1983. If this relationship is used, it will be only 19% accurate. This does not mean that if we had considered all other factors our contract periods would be

longer, no, some factors would pull while others push the period.

From the model of $Y = a + bx$, we obtain from the SPSS package that the values of 'a' and 'b' are 24.96 and 81.54 respectively. This suggests a relationship in the order $T_1 = 24.96 + 81.54\ C_2$. As some of the constants in this relationship and others in this research make no sense, one possible reason is the assumption of the relationship: the relationship may not infact be linear. The value of the coefficient here suggests that the contract period is very sensitive to the contract sum and for a project of 1 million we require a period of 24.96+ 81.56 = 106.5 weeks which is an equivalent of 2.05 years. For a contract of Ksh. 3.75 million in 1983 to take over two years appears unreasonable but that is the average time performance practically in government projects.

(d) Initial time (T_2) on original contract Sum (C_1).

As earlier discussed, regressing initial contract period and initial contract sum measures whether or not estimating of contract periods is based on the initial estimates. The test as in table 4.3 proves that there is a strong correlation between the two with a coefficient of determination $r^2 = 0.42044$. Theoretically, this suggests that

42 per cent of the initial period is determined through use of the contract estimated value as the determinant. 58 per cent is attributed to other factors. 42 per cent is the contribution or weighting factor used in estimating the initial contract period due to the estimated contract value. We also found in (c) that, in terms of actual performance, the contract value affects the period by only 19 per cent. The fact that 42 per cent is higher than 19 per cent suggests that the estimator over-weights the size factor by approximately 23 per cent. We can therefore conclude that the initial estimated contract period is usually inaccurate.

GROUP 2

More than Ksh. 1 million but less than Ksh. 2 million (1972 prices).

(a) Percentage original contract sum to final contract sum (cost performance = P_1) on final contract sum.

Table 4.4:

Values of 'F' statistic for projects more than Ksh. 1 million but less than Ksh.2 millions (1972 base year)

P_1/C_2	19.4083	4.96	Reject Ho
P_2/C_2	0.3989	4.96	Accept Ho
T_1/C_2	1.1078	4.96	Accept Ho
T_2/C_1	0.6042	4.96	Accept Ho

Source: Own Field Study 1984.

As shown in table 4.4 the hypothesis that there is significant relationship between cost performance and the contract size in monetary terms is rejected at 95 per cent significance level. Compared to a similar relationship in the lower group of projects (less than Ksh. 1 million) we

notice that in the present group, the coefficient of determination is higher and its value is 0.6599 meaning that in this group, contract size influences the cost performance more than it does in the previous group. This generally means that size oriented factors that mitigate against good cost performance are directly related to the amount of money to be spent and also to the amount of resources to be managed - both materials and labour. Although the basic principles of management remain the same no matter the size of the projects[2] but once the scope of application of these principles changes, then the number of the problems to be solved changes and more skill and competence is required.

A big project will require more finance, it will involve more manhours and manyears, it will require more labour to organize, it will involve more materials to manage and above all, it will require a well-organized and a "financially-disciplined" client who pays promptly to make it succeed. Cost overruns are mainly due to variations in the scope of work, mainly, additions and alterations[3] of designs due to lack of precise prediction of future events. Such variations will most likely be caused by inadequate brief or

incomplete or inaccurate working drawings. Contracts falling in the group under discussion also qualify for the use of the fluctuations clause (more than 2 million at current prices)[4] and given that the mean time overrun percentage in this group is about 86 per cent (1 year becomes 1 year 11 months) almost double the original period, then the costs due to fluctuations of prices are high.

Cost overruns mean among other things that neither does the architect design exhaustively, nor does the quantity surveyor accurately estimates the cost of the details that cannot be settled before going to tender. This is mostly true for both p.c. sums and provisional sums which although not the only areas of under-estimation but they are among those in which the quantity surveyor makes decisions. The other source of under-estimation is the tender figure whereby after the contractor realizes he has under-priced he may resort to unscrupulous methods of raising claims. These claims, as long as they are enforceable will effect the cost. The question then is why should they be allowed to take root? The allowing comes in when the documents, the designs and the contract clauses become faulty and the contractor decides to exploit the loopholes. Is he indeed to blame?

The contractor is a businessman and he won't hesitate to under-price when he is sure of how to recover his costs.

(b) Percentage of time overrun to initial contract period (Time performance = P_2) on final contract sum (C_2).

As shown on table 4.4, we have to accept the hypothesis that there is no significant relationship between time overrun and the size of the contract. This was the same result in the previous group and the reasons for the absence of the relationship are taken as common despite the change in the size of contracts in the later group. The coefficient of determination has however, changed from 0.00516 to 0.038 meaning that as the size increases, percentage of contribution of the size to time overuuns improves. In this case it has improved from 0.52 per cent to 3.8 per cent which suggests that comparatively the large projects are more sensitive to time performance.

(c) Actual contract period (T_1) on final contract sum (C_2).

Unlike what was observed in the lower group, under this group as shown in table 4.4 there is significant relationship between contract period

and the size of the project.

In the previous case, it was observed that the bigger the project the longer it takes but percentage contribution was only 19. Presently the data results suggest that there is no linear relationship and the assumption that there is a linear relationship is wrong but that does not mean there is no relationship at all. The percentage contribution is however as high as 10 per cent which is approximately ½ of the former case. This means projects of the magnitude under consideration are not so much affected by the size factor in terms of time required to complete them as by other factors.

The values of the coefficient of the independent variable is negative suggesting that, in this category projects will take shorter times as their sizes increase. This may be attributed to economies of scale and capacities of the contractors in this category. The complete picture of this phenomenon will be clearer when we discuss this same relationship but in the higher category.

(d) Initial time (T_2) on original contract sum (C_1).

Unlike the same regression in the lower

group, the test here shows that there is no significant relationship between initial contract period and initial contract sum. $r^2 = 0.05697$ which means the contribution or role played by the contract size in estimating its contract period is only 5.7 per cent. Again as explained previously, this could be due to the wrong assumption that the relationship is linear. The whole picture can again be made clear with illustration in the next group for a similar regression.

GROUP 3

More than Ksh.2 millions but less than Ksh.5 millions (1972 prices)

(a) Percentage of original contract sum to final contract sum (cost performance = P_1) on final contract sum.

Table 4.5

Values of 'F' statistic for projects more than Ksh.2 millions but less than Ksh.5 millions (1972 base year)

P_1/C_2	14.6804	10.13	Reject Ho
P_2/C_2	0.1361	10.13	Accept Ho
T_1/C_2	11.9481	10.13	Reject Ho
T_2/C_1	43.6696	10.13	Reject Ho

Source: Own Field Study 1984.

The relationship in this group where contract sizes are fairly large is the same as in the previous two cases; what differs is the coefficient of determination. For small contracts not exceeding Ksh. 1 million size factor contributed 12 per cent to cost performance, in the second group of between Ksh. 1 and 2 millions the factor became

65 per cent: now for projects between Ksh. 2 and 5 million (7,500,000 - 18,750,000 1983 prices) it is 83 per cent.

The size factor is seen to be increasing as the contract values increase and the same reasons given in the previous group are equally applicable in this group. The characteristics of this last group are almost the opposite of the first. In the first group less importance was attached to contract size but in this present one consideration should be given to size-oriented cost performance constraints. The mean of cost performance level in the small projects was 102 per cent which is better than ideal thus suggesting that quite a large number of projects experienced a cost saving. One would then ask whether that is good performance? The answer to such question would depend on how the saving affects the objective of the client, namely: getting value for his money. When the final contract sum is lower than the original contract sum; something is likely to be wrong depending on the cause of the difference between the two sums. There may have been an over-estimation of some items, there may have been omission of some works due to original under-estimation or there may have been deliberate deletion of some works

purely due to change in the client's requirements.

In this particular case of small projects; most of them are maintenance contracts which by their nature are not easy to measure thus leading to over measured items and over-estimated p.c. and contingency sums. Generally, therefore, small projects do not have cost performance as a major problem where cost performance is measured in terms of positive cost overrun. However, on the whole, when evaluated in terms of the client's objective it can be equally had to have a cost saving if not worse than a cost overrun especially where the saving is caused by omissions or by uneconomical use of resources. It is a known fact that where there is plenty or excess of something, the wastage is higher than where there is a strain to use inadequate resources. Necessity being the mother of invention, when there is not enough one would be challenged to improvise methods of utilizing what is available. When there is excess one relaxes and retards all other faculties.

(b) Percentage of time overrun to initial contract period (Time performance = P_2) on final contract sum (C_2).

The results in this group for the relationship

of time overrun and final contract sum are similar to those of previous size groups. There is no significant relationship between time overrun and contract size although as in the previous case, the coefficient of determination has increased from 0.38 to 0.43. The same conclusion as before can be drawn that, as the sizes increase, time overrun is influenced more but since there is no relationship, that phenomenon is not important.

(c) Actual contract period (T_1) on final contract sum (C_2).

As can be observed in table 4.5, we are accepting the alternative hypothesis that there is indeed a significant relationship between time taken to complete a project and its size. These completely agree with the case of contracts less than Ksh. 1 million but differs with the middle group. The values of the coefficient of determination for the three groups are 0.19, 0.10, and 0.80 respectively. The third group shows a very high correlation which implies that contracts in this category are very sensitive to contract size where contract period is concerned.

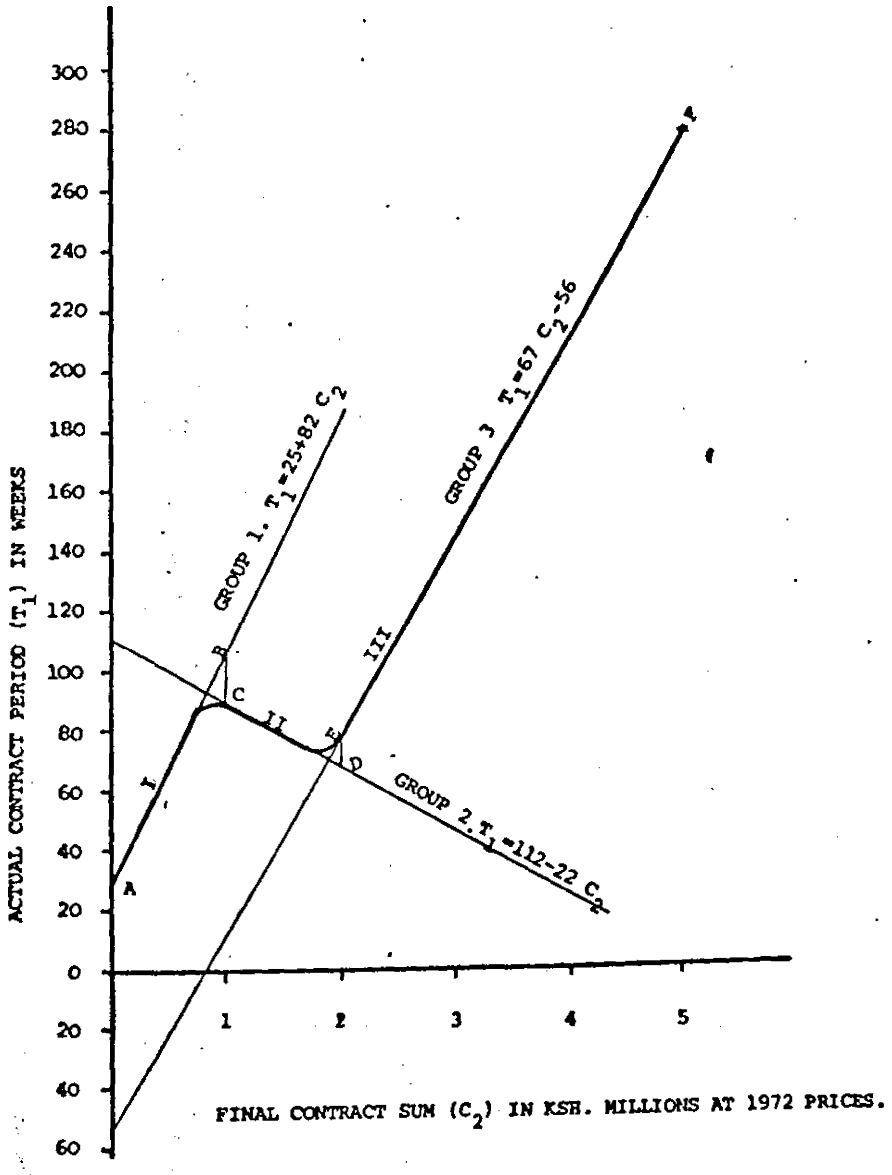


Fig. 4.2

RELATIONSHIP OF ACTUAL CONTRACT PERIOD AND FINAL CONTRACT SUM FOR THE COMPLETE SAMPLE

Source: Own Field Study 1984.

Assuming linear relationship we would have a graph in the form ABCDEF whereby AB is for small contracts or group 1, CD is for middle category or group 2 while EF is for the third category or group.3.

It will be noticed that AB and CD are connected by a perpendicular line BC, and CD connected to EF by DE. In normal life such behaviour would not be possible and such abrupt changes are due to the grouping of the data. However, one thing is true that there is a positive relationship, then a negative one and finally a positive one. The first and the last are in the same direction while the middle one is in the opposite direction, but since all the data are from the same population the curve must be a single continous curve but with turning points. Those turning points suggest that the relationship is non-linear and probably that explains why the middle data show no linear relationship.

Bromlow[5] (1969) found the relationship as $T = KC^B$ where 'T' is the contract period, 'C' is contract sum and 'K' and 'B' are constants. The researcher connected the three straight lines with curves to form an 'N' shaped curve. This curve suggests that contract periods continue increasing with increase of contract sum upto a

certain value around Ksh. 3,750,000 (1983 prices) and then the periods start decreasing with increase in contract sum. The next turning point, just before Ksh. 7,500,000 (1983 prices) gives the most optimal contract size. This curve can also be construed to mean that the contracts which realize economies of scale in terms of time are those on the downward curve. Contracts in regions I and III have diseconomies of scale due to being too small and being too large respectively.

On the other hand, we may also suggest that contractors within categories 'B' and 'C' according to 1983 Ministry of Works register are the most efficient although on the average the period on the graph is higher than expected from the table of periods.[6]

(d) Initial time (T_2) on original contract sum C_1)

The test as can be observed from table 4.5 proves that there is a linear relationship between contract sum and initial contract period. The relationship is almost perfect because the coefficient of determination $r^2 = 0.9357$. This suggests that for contracts in this category the factor mostly considered when calculating the contract period is the contract size.

As observed in (c) above the first curve or relationship for group 1 is positive while the middle one is negative with finally a positive one in group 3. For reasons discussed in (c) above also, the curve will be similar to the one on figure 4.2 except for the values.

The estimators of the contract period may not be aware but their method of calculating contract period gives a non-linear outcome between the period calculated and the initial contract sums. In other words there are other factors which are considered and all of them combined give the observed phenomenon.

It is however, worthy noting that although contract periods are calculated for this group almost entirely on the basis of size, time overruns have no relationship with the sizes and the size affects actual time by only 79.9 per cent. 93 per cent is therefore in excess.

Table 4.6: Location Factor

LOCATION	COST OVERRUN (%)	TIME OVERRUN (%)	P.C.SUM (%)
A	-1.37	180	21.80
B	3.78	165	13.25
C	-0.83	140.78	13.99
D	-11.26	233.50	10.46
E	0.22	165	14.07
F	-0.73	114.25	13.56
G	-4.44	110	21.56
H	-4.54	60.44	26.13

Source: Own Field Study 1985.

Table 4.7:

Type of Project Factor

TYPE	COST OVERRUN (%)	TIME OVERRUN (%)	P.C.SUM (%)
EDUCATION	4.27	166	20.07
HEALTH	19.90	236.57	25.08
MAINTENANCE	-3.006	94.25	10.35
PUBLIC	6.93	291.26	15.78
HOUSING	-0.93	129.49	18.70

Source: Own Field Study 1985.

Locational Factor

Eight categories were identified for all the projects less than Ksh. 1 million and the basis was transportation constraints owing to location of sites. The M.O.W.[7] locational classification which is based on the nearest major towns was used as a guidance.

The following is the list of districts under each location:-

A - Kisii
Homa Bay
Kisumu
Siaya
Kakamega
Busia
Bungoma

B - Nairobi
Central Province
Kajiado

C - Kwale
Kilifi
Mombasa
Taveta

D - Garissa
Lamu
Tana River

E - Isiolo
Wajir
Marsabit
Mandera
Turkana

F - Kericho
Nakuru
Narok

G - Nandi

Uasin Gishu

Elgeyo Marakwet

Baringo

West Pokot

Trans Nzoia

H - Machakos

Embu

Meru

Kitui

The results of the classification are as can be observed on table 4.6 where in cost overrun Nairobi and the Central Province are leading with 3.78 per cent of the original contract sum followed by parts of North Eastern and Eastern Province (E) with 0.22. The rest are showing a cost saving average for this group of contracts i.e. not exceeding Ksh. 1 million.

As explained under cost performance, the performance in terms of cost worsen with size of contract and since most big projects have been centred in Nairobi, it explains why the average cost overrun percentage is higher in Nairobi than other locations. North Eastern and Eastern locations are showing a high percentage because of remoteness although the projects in the sample

were so few that this average may be misleading. Ironically, projects in Garissa, Lamu and Tana River have the highest cost saving on average despite the transportation problems due to occasional flooding of the Tana. However, the sample under this group was also very small and the average may not be representative.

On the whole, location factors based on remoteness of sites are not consistent with the results of this research. There is no established pattern.

If the locational weightings have been used in estimating and qualifying of tenders, where the remotest projects gets the highest weighting, then they have led to an over-estimation. Projects in Nairobi, Central Province, around Nakuru, Kisumu and Mombasa seem to be performing most poorly as compared to more remote projects. Due consideration need therefore be taken for those projects near the main towns otherwise they have been taken for granted.

Time overrun percentages based on location show that category 'D' has the highest but we can safely omit this category because there are only two data points. The next highest is category 'A' even after adjusting for abnormal overruns.

Category 'B' and category 'E' have the same level and since these two represent two extremes i.e. Nairobi and North Eastern, we can conclude that time overrun has no relevance at all to location in terms of remoteness.

Type of Projects

According to table 4.7, Health projects have the highest cost overrun percentages on average, followed by public buildings then education. As explained before for projects less than Ksh. 1 million (1972 prices) cost overrun increases with size. Health projects are likely to be larger than for any other group. Another inference one can make is the payments by the client ministries - if delay of payments affect cost overrun then this problem must be most common with the Ministry of Health. Also, inadequacy of brief and contract documents may lead to increased costs due to new matters arising. Given the importance attached to development of health facilities, it is possible that more often than for any other projects, health projects are started abruptly in desperation to have them started only to realize later that it was too abrupt to progress.

Public buildings are mostly office blocks which are likely to be big, just like the health

projects. Also education projects can also be reasonably big. Maintenance projects most of which are small repairs are infact showing a cost-saving. As explained before, this cost-saving may be attributed to initial over-estimation.

Time overrun percentages seem to fall under a similar pattern to that of cost overrun except public and health groups have swopped positions. This consistency may be explained by attributing some of the extra costs to delay especially for the big projects with fluctuation clauses.

Reasons for extension of time

As observed, the average time overrun as a percentage of the original contract period is very high. Most of the extra time was awarded contractually under clause 26 of the 1970 edition (M.O.W. conditions of contract)[8]. Before the extension of time is awarded, the contractor has to apply and give reasons why the extension should be awarded.

A survey was done on the reasons given by contractors for extension of contract period on 37 projects most of them on-going and not necessarily part of the previous sample. No effort was made

to calculate the effect which each reason would have on contract period in terms of time but the frequency was assessed and tabulated as below. The figures represent the number of times each reason was given i.e. out of all the projects, how many projects gave the reason at least once. Where the reason is given twice in different applications, it is counted only once.

Late payments	-	16
Weather	-	13
Additions	-	15
Sub-contracts	-	20
Import licence	-	0
Materials	-	4

Source: Own Field Study 1985.

From the list above it appears like subcontractors are mostly the causes of delay on projects. In the past, sub-contractors used to be paid through the main contractor but now they are paid directly and this practice may reduce the site problems. Also, the use of p.c. sums has been stopped in the Ministry of Works which reduces the incidence of either underestimating or over-estimating.

The second most frequent reason for extension of time is late payments; this is an issue which goes further than contract

administration because it involves the treasury as well. In the past, the treasury officers have been accused of not appreciating the seriousness of under-funding of projects and how it can cause delayed completion with consequential extra costs. However, now that planning will be done at district level, (district focus policy) - it is expected that this problem may reduce. On the other hand, it may be necessary to have a building contracts adviser stationed in the treasury for the interest of the government as a client.

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CHAPTER V

CONCLUSIONS AND RECOMMENDATIONS.

CONCLUSIONS

(i) Cost Performance

In the whole, cost overrun was found to be 38 per cent majority of which were the small projects not exceeding Ksh.½ million at current prices. This, however, does not in any way mean that small projects perform more poorly than big ones in terms of cost overrun. Among the big projects (more than Ksh.½ million at current prices) 57 per cent experienced cost overrun as compared to only 31 per cent for the small ones. It follows that big projects have higher chances of cost overruns than the small ones.

Small projects on the other hand have higher chances of being completed at costs lower than the original sum. Out of the 55 per cent which is the proportion of all projects with contract sum saving, 80 per cent were small projects.

Over the years, cost performance has fluctuated but within the period of research, it reached its poorest position in 1970. In that year the mean cost overrun was approximately 61 per cent

but the performance improved drastically between then and 1972 when the cost overrun was only 9.5 per cent. Between 1972 and 1981 the fluctuations became more uniform and the mean cost overrun for the period was only 5%. Due to the poor performance in the years 1967 to 1972, however, the mean cost overrun for the total period under research became 10 per cent.

From the research, it has been found that contract size is always a function of cost performance. The relationship observed is a negative one meaning that cost performance improved with the reduction of contract size and worsens when contract size increases. The coefficient of determination (r^2) which measures the proportion of dependent variable explained by the independent variable has been observed to vary with contract size also. In the case of this study, it increased from 12 per cent for the group of small contracts (not more than Ksh. 1 million 1972 prices) to 83 per cent for projects whose value is Ksh. 5 million 1972 prices. The dependent variable was the cost performance while the independent variable was contract size. The implication of the increase of the determinant with contract size is that cost performance of big projects is more sensitive to size than that

of small projects.

The term "sensitive" here refers to the measure of the effects of size-oriented constraints on the cost performance. These size-oriented constraints have been found to be caused by sub-contracts, late-payments, additions and inclement weather in that order. These factors, well managed, would assure over 80 per cent success of the big projects but only 12 per cent of the small ones. On the other hand, if not well managed, they would cause failures of the same magnitudes respectively.

Bromilow (1969) went further than this research has attempted to do and established a constant to indicate the sensitivity of cost performance to project size which was 1.9. This fact of high sensitivity with increase in size coupled with the other of poor cost performance with increase in size gives a very unfavourable situation with respect to the development of the construction industry. What it means is that the more expensive projects which are more prone to cost overrun, than the small ones actually are the majority experiencing the cost overrun. A lot of resources are therefore at stake and this calls for special consideration

of running big projects. In other words, the big projects should not continue to be subjected to the same procedures of implimentation as the small ones.

(ii) Time Performance

The research established that contract size is not a function of time performance. No significance relationship was observed. On the whole it was observed that time performance is worse than cost performance. Out of every 100 projects started, 73 ended up experiencing time overrun as compared to only 38 out of every 100 suffering cost overrun. By the use of these percentages, therefore, we can conclude that time performance is 1.9 times more frequent than cost woverrun. It is widely held that delays cause extra costs; here it is not the case because the proportion of delay cases does not match that of cost overrun. The implication is one of the three alternatives or a combination of them. (i) The scope of work is reduced by deletions. (ii) the provisional sums to cater for delays are always enough if not more, (iii) the contractors either do not make claims or if they do, they never succeed.

This research has only established that there is no linear relationship between the two variables namely size and time performance. There may exist

other types of relationships because the coefficient of determination gives positive values. These values, just like those for cost performance are increasing with increase in contract size. The range is from 0.5 per cent to 4.3 per cent for the smallest to the biggest contract size in the sample respectively. These coefficients may be so small because of an error in the assumption that there is a linear relationship. The other reason and most probable one is that there is actually no relationship between delay and size of the project. Appendix D shows that delay remains almost the same for all contract sizes, the curve is horizontal. The implication of this result is that causes of delay are similar in all cases and that government's big projects have not been receiving any special attention in terms of management.

(iii) Contract period.

The contract-period-determining curve was found to be non-linear, a result which corresponded to a Bromilows findings. The results suggest that for small projects, contract period is positively related to the size and the proportion of the period explained by the size is only 19 per cent. Contract period for small projects therefore is determined mainly by other factors (81 per cent) other than its size. The results were similar for both the very small

and the very big within the sample. The major difference was that of contribution of the size to the contract period. For the large projects, 80 per cent of the contract period is determined by the size of the project.

The middle group was observed to have a negative relationship although the coefficient of determination was very low. This suggests that there may be no relationship or that it may be a weak one. Either way, it is not a positive one.

The implication of the curve is that the middle group is more efficiently done in terms of time. The reason for that may be optimality which may not necessarily be at one point. Given the shortage of research resources, it was not possible to exhaust all possible project sizes and therefore other turning points within the curve cannot be ruled out.

(iv) Adequacy of contract period

The research has observed that the initial contract periods were not adequate and the method of estimating them based on contract size is erroneous. Contract size determines contract period to a lesser extent than the estimators assume.

(v) Location of sites.

Nairobi area and the surrounding districts are most affected by cost and time overruns contrary to the established belief that remote sites suffer more in these aspects. The reason for this phenomenon may be either because of over-weighting for remoteness or the sheer size of projects commonly known to characterise urban and more developed areas. This is mainly in consideration to costs where big projects have higher incidence of cost overrun.

(vi) Types of projects

Health, public and education projects are leading in poor cost and time performancesin that order. These types of projects are also larger and more in number as compared to other types. It was also found out that big projects experience poorer cost performance than small ones which explains why health, public and education lead in poor contract performance. As to the numerous number for each type, it can be argued that the client ministries are faced with more financial and management responsibility than they can possibly cope with.

(vii) Extension of time.

The main causes of extension of time are

sub-contracts, late-payments, additions and inclement weather in that order of seriousness. The rating was, however, based on number of occurences other than their effect on the critical paths. This implies that the originators of contract delay are mainly the client and the sub-contractors. It should also be noted that even in the case of sub-contractors, the client plays a major role in causing extension of time. This occurs when the sub-contractor is not appointed in time and when he is not paid promptly. The second most notorious cause of extension of time is late-payment and that, too, affects the sub-contractors thus making the client even more responsible for delays.

The impression made here is that the contractors do not cause delays which may be a wrong one. The reason why it may be wrong is because these reasons for extension of time were obtained from the list given by contractors applying for extension and naturally, they would not make themselves responsible. These reasons, however are the basis of extending the contract periods a phenomenon which underlies the observation that 73 per cent of government projects are delayed.

Recommendations.

The thesis of this research concludes with the following recommendations based on the preceding conclusions.

1. The parties responsible for implementing big projects in the government need be more objective in approach than they are at present. A scientific analysis is recommended which evaluates the sensitivity of individual projects to contract performance and hence special consideration in implementation. Availability of finance and competence of all the parties should be ascertained before hand.

2. The sheer size of projects should, however, not be the only criterion of giving a project special consideration. A further research is recommended which takes into consideration welfare economics like cost-benefit analysis (CBA). The organizational structure of the Ministry of Works may be the root cause of the poor contract performance, and this, too, requires an evaluation.

3. The calculation of contract period should not be based on the contract size mainly. The relationship of size and contract period is not one of a straight line nature. Identification of the other factors which determine an average 64 per cent of the period

is highly called for. Contractors should always be given a chance in deciding the contract period.

4. The existing weighting system of the Ministry of Works as per annex to departmental, circular 28/80 for upcountry sites is not valid. It is here recommended that a fresh set of weightings should be established based on the performance of the existing ones. This exercise should be done from first principles and not mere alterations based on construction of new road and rail links.

5. Different client ministries have different number of projects each year. Some have more than others and this should be matched not only with equally competent teams but also with more members in the teams. Professionals should be posted to work within the client ministries, the treasury and the auditor general's office.

6. Contract delays will be reduced if the professionals will be more serious in their deliberations thereby acquiring a fullproof basis of exerting their professional demands to the contractors. From this research, it is not clear why delayed projects defy the economics norm that they should cost more. A further research is therefore recommended based on contractors claims and ascertained and liquidated damages.

At the beginning of this research, it was proposed that it would be only of an exploratory nature and that future researches would attempt more legitimate statistical tests. What the researcher feels he has accomplished is only pointers as to the real cause of poor contract performance in government projects. These pointers are but a second reflection or a third reflection of the truth. The realm of truth lies intact with its protective medium unpunctured.

It is hoped that a basis has been formed, however erroneous or faulty but it is a basis all the same for further efforts towards the clearer reflections of the truth, that absolute and philosophical truth which is every researchers dream. To put it in Sir Isaac Newton's words, the researcher has gone into the ocean only once and came out with a beautiful pebble which has amused him while the whole expanse of the ocean lies ahead undiscovered. Imagine how many more and better pebbles there may be.

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APPENDIX A - FORMAT OF RAW DATA

JOB CARD NO.	P.C. AND PROVISIONAL SUMS (Kshillings)	NAME/TYPE/LOCATION	ORIGINAL CONTRACT SUM	COMMENCEMENT DATE	COMPLETION DATE	EXTENDED COMPLETION DATE	FINAL CONSTRACT SUM
2940	40,000	Nurses Hostel - Kisii Hospital	1547365.60	12/12/69	23/10/70	30/5/71	2074765.60
2423	118,200	District Headquarters - Siaya	600344.08	10/6/69	16/3/70	7/5/71	1367340.20
2325	30,250	Houses - Nakuru	278000	2/9/68	31/3/69	30/3/69	446089.80
2291	5,000	Radiotherapy Unit KNH-Nairobi	179327	15/7/68	28/10/68	4/12/68	190275.60
2205	10,000	Pool Housing - Embu	173888.52	16/10/67	31/12/67	5/2/68	170061.00
2132	Nil	Quards Quarters - Gatundu	82820	4/11/66	3/3/67	30/6/67	93973.75
2635	185,400	Border Post - Liboi	899209.60	12/7/71	12/7/71	15/9/73	4274248.70
6204A	45,450	Housing - Kiboko Machakos	249405	15/9/77	1/3/76	17/6/78	234873.45
1661A	1154,625	Staff Housing Makueni Hospital	4514399.65	15/6/75	8/8/76	9/5/77	5227248.75

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STATISTICAL PACKAGE FOR THE SOCIAL SCIENCES SPSSH - VERSION 5.01          30/07/83    PAGE    1
ICL 1900 IMPLEMENTATION - RELEASE 3
THIS VERSION IS DESIGNED TO SAVE PAPER.  A NEW CONTROL CARD, 'PAGING      ' STANDARD', IS AVAILABLE IF REQUIRED.

                RUN NAME        DEFINE MULTIPLE REGRESION RUN
                FILE NAME       PERFORMANCE RATIO
                VARIABLE LIST   C1,C2,T2,T1,P2,P1
                INPUT MEDIUM    CARDS
                VAR LABELS      C1,INITIAL SIZE K.SH. MILLION /
                                C2,ACTUAL COST  K.SH. MILLION /
                                T2,INITIAL TIME  WEEKS /
                                T1,ACTUAL TIME  WEEKS /
                                P2,PERCENT TIME OVERRUN/
                                P1,PERCENT ORIGINAL TO FINAL/
                INPUT FORMAT    FIXED(F5.4,1X,F5.4,1X,F6.2,1X,F6.2,1X,F7.2,1X,F3.0)

ACCORDING TO YOUR INPUT FORMAT, VARIABLES ARE TO BE READ AS FOLLOWS

                VARIABLE  FORMAT  RECORD    COLUMNS

                C1        F 5. 4     1     1-  5
                C2        F 5. 4     1     7- 11
                T2        F 6. 2     1    13- 18
                T1        F 6. 2     1    20- 25
                P2        F 7. 2     1    27- 33
                P1        F 3. 0     1    35- 37

THE INPUT FORMAT PROVIDES FOR    6 VARIABLES.    6 WILL BE READ
IT PROVIDES FOR  1 RECORDS ('CARDS') PER CASE.  A MAXIMUM OF   37 'COLUMNS' ARE USED ON A RECORD.

                N OF CASES      184
                REGRESSION      VARIABLES=C1,C2,T2,T1,P2,P1/
                                REGRESSION=P1 WITH C2(1)/
                                REGRESSION=P2 WITH C2(1)/
                                REGRESSION=T1 WITH C2(1)/
                                REGRESSION=T2 WITH C1(1)/
                STATISTICS      2
                READ INPUT DATA

- - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -

FILE   PERFORMA (CREATION DATE = 30/07/83)   RATIO

VARIABLE          MEAN        STANDARD DEV      CASES

C1              0.1593          0.1037          184
C2              0.1445          0.1013          184
T2             10.2065         11.0670          184
T1             33.7576         27.7072          184
P2            139.6657        415.1001          184
P1            102.4402         17.7554          184
```

APPENDIX B - DEFINITIONS OF REGRESSIONS

Source: Statistical Abstract 1975-1983.

APPENDIX C1 - Cost Performance

```
                                                                                                    1

*DEFINE/MULTIPLE REGRESSION RUN                                                  30/07/85    PAGE    2

FILE   PERFORMA (CREATION DATE = 30/07/85)   RATIO

* * * * * * * * * * * * * * * * * * MULTIPLE REGRESSION * * * * * * * * * * * * * * * * * *   VARIABLE LIST  1
                                                                                               REGRESSION LIST  1

DEPENDENT VARIABLE..    P1        PERCENT ORIGINAL TO FINAL

VARIABLE(S) ENTERED ON STEP NUMBER  1..    C2-       ACTUAL COST  K.SH. MILLION

 MULTIPLE R          0.35125        ANALYSIS OF VARIANCE    DF     SUM OF SQUARES      MEAN SQUARE          F
 R SQUARE            0.12338        REGRESSION               1.      7101.86402       7101.86402       25.61539
 STANDARD ERROR     16.65032        RESIDUAL               182.     50459.47835        277.24988

---------------- VARIABLES IN THE EQUATION ----------------      ---------- VARIABLES NOT IN THE EQUATION ----------

 VARIABLE            B          BETA    STD ERROR B       F      VARIABLE     BETA IN    PARTIAL  TOLERANCE       F

 C2              -38.60953    -0.35125      7.62856      25.615
 (CONSTANT)      108.31921                  1.64961    4236.724

 MAXIMUM STEP REACHED
 - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -

 FILE   PERFORMA (CREATION DATE = 30/07/85)   RATIO

 * * * * * * * * * * * * * * * * * * MULTIPLE REGRESSION * * * * * * * * * * * * * * * * * *   VARIABLE LIST  1
                                                                                               REGRESSION LIST  1
 DEPENDENT VARIABLE..    P1        PERCENT ORIGINAL TO FINAL

                                        SUMMARY TABLE

 VARIABLE                          MULTIPLE R  R SQUARE  RSQ CHANGE  SIMPLE R        B          BETA
 C2          ACTUAL COST  K.SH. MILLION
 (CONSTANT)                          0.35125   0.12338    0.12338    -0.35125    -38.60953    -0.35125
                                                                                 108.31921
 - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -
```

APPENDIX C2 - Time Performance

FILE PERFORMA (CREATION DATE = 30/07/85) RATIO

* MULTIPLE REGRESSION * VARIABLE LIST 1
REGRESSION LIST 2

DEPENDENT VARIABLE.. P2 PERCENT TIME OVERRUN

VARIABLE(S) ENTERED ON STEP NUMBER 1.. C2 ACTUAL COST K.SH. MILLION

MULTIPLE R	0.07183	ANALYSIS OF VARIANCE	DF	SUM OF SQUARES	MEAN SQUARE	F
R SQUARE	0.00516	REGRESSION	1.	162747.95190	162747.95190	0.94386
STANDARD ERROR	415.24380	RESIDUAL	182.	31361789.12939	172427.41260	

VARIABLES IN THE EQUATION

VARIABLE	B	BETA	STD ERROR B	F
C2	-184.82727	-0.07183	190.24421	0.944
(CONSTANT)	100.37279		41.14363	20.519

VARIABLES NOT IN THE EQUATION

VARIABLE	BETA IN	PARTIAL	TOLERANCE	F

DEFINE MULTIPLE REGRESSION RUN 30/07/85 PAGE 3

MAXIMUM STEP REACHED

FILE PERFORMA (CREATION DATE = 30/07/85) RATIO

* MULTIPLE REGRESSION * VARIABLE LIST 1
REGRESSION LIST 2

DEPENDENT VARIABLE.. P2 PERCENT TIME OVERRUN

SUMMARY TABLE

VARIABLE		MULTIPLE R	R SQUARE	RSQ CHANGE	SIMPLE R	B	BETA
C2	ACTUAL COST K.SH. MILLION	0.07183	0.00516	0.00516	-0.07183	-184.82727	-0.07183
(CONSTANT)						100.37279	

APPENDIX C3 - Final Contract Period

FILE PERFORMA (CREATION DATE = 30/07/85) RATIO

* MULTIPLE REGRESSION * * * * * * * * * * * * * * * * * * * VARIABLE LIST 1
REGRESSION LIST 3

DEPENDENT VARIABLE.. T1 ACTUAL TIME WEEKS

VARIABLE(S) ENTERED ON STEP NUMBER 1.. C2 ACTUAL COST K.SH. MILLION

MULTIPLE R	0.43902	ANALYSIS OF VARIANCE	DF	SUM OF SQUARES	MEAN SQUARE	F
R SQUARE	0.19274	REGRESSION	1.	31674.85463	31674.85463	43.45371
STANDARD ERROR	26.99576	RESIDUAL	182.	132565.86193	728.93331	

---------- VARIABLES IN THE EQUATION ----------

VARIABLE	B	BETA	STD ERROR B	F
C2	81.53904	0.43902	12.36950	43.434
(CONSTANT)	24.95518		2.67512	87.023

---------- VARIABLES NOT IN THE EQUATION ----------

VARIABLE	BETA IN	PARTIAL	TOLERANCE	F

MAXIMUM STEP REACHED

DEFINE MULTIPLE REGRESION RUN 30/07/85 PAGE 4

FILE PERFORMA (CREATION DATE = 30/07/85) RATIO

* MULTIPLE REGRESSION * * * * * * * * * * * * * * * * * * * VARIABLE LIST 1
REGRESSION LIST 3

DEPENDENT VARIABLE.. T1 ACTUAL TIME WEEKS

SUMMARY TABLE

VARIABLE	MULTIPLE R	R SQUARE	RSQ CHANGE	SIMPLE R	B	BETA
ACTUAL COST K.SH. MILLION	0.43902	0.19274	0.19274	0.43902	81.53904	0.43902
(CONSTANT)					24.95518	

APPENDIX C4 - ESTIMATED CONTRACT PERIOD

```
FILE    PERFORMA (CREATION DATE = 30/07/85)    RATIO

* * * * * * * * * * * * * * * * * * * * * * * MULTIPLE REGRESSION * * * * * * * * * * * * * * * * * * *   VARIABLE LIST  1
                                                                                                           REGRESSION LIST  4
DEPENDENT VARIABLE..   T2          INITIAL TIME  WEEKS

VARIABLE(S) ENTERED ON STEP NUMBER  1..    C1          INITIAL SIZE K.SH. MILLION

MULTIPLE R          0.64842          ANALYSIS OF VARIANCE     DF     SUM OF SQUARES      MEAN SQUARE          F
R SQUARE            0.42044          REGRESSION                1.      9457.70693        9457.70693        132.03279
STANDARD ERROR      8.46354          RESIDUAL                182.     13036.93353          71.63150

-------------- VARIABLES IN THE EQUATION ---------------          ----------- VARIABLES NOT IN THE EQUATION -----------

VARIABLE              B           BETA      STD ERROR B       F            VARIABLE      BETA IN     PARTIAL   TOLERANCE        F

C1                 39.13753     0.64842       3.40606     132.033
(CONSTANT)          9.95617                   0.82790     144.622

MAXIMUM STEP REACHED

- - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -

FILE    PERFORMA (CREATION DATE = 30/07/85)    RATIO

* * * * * * * * * * * * * * * * * * * * * * * MULTIPLE REGRESSION * * * * * * * * * * * * * * * * * * *   VARIABLE LIST  1
                                                                                                           REGRESSION LIST  4
DEPENDENT VARIABLE..   T2          INITIAL TIME  WEEKS

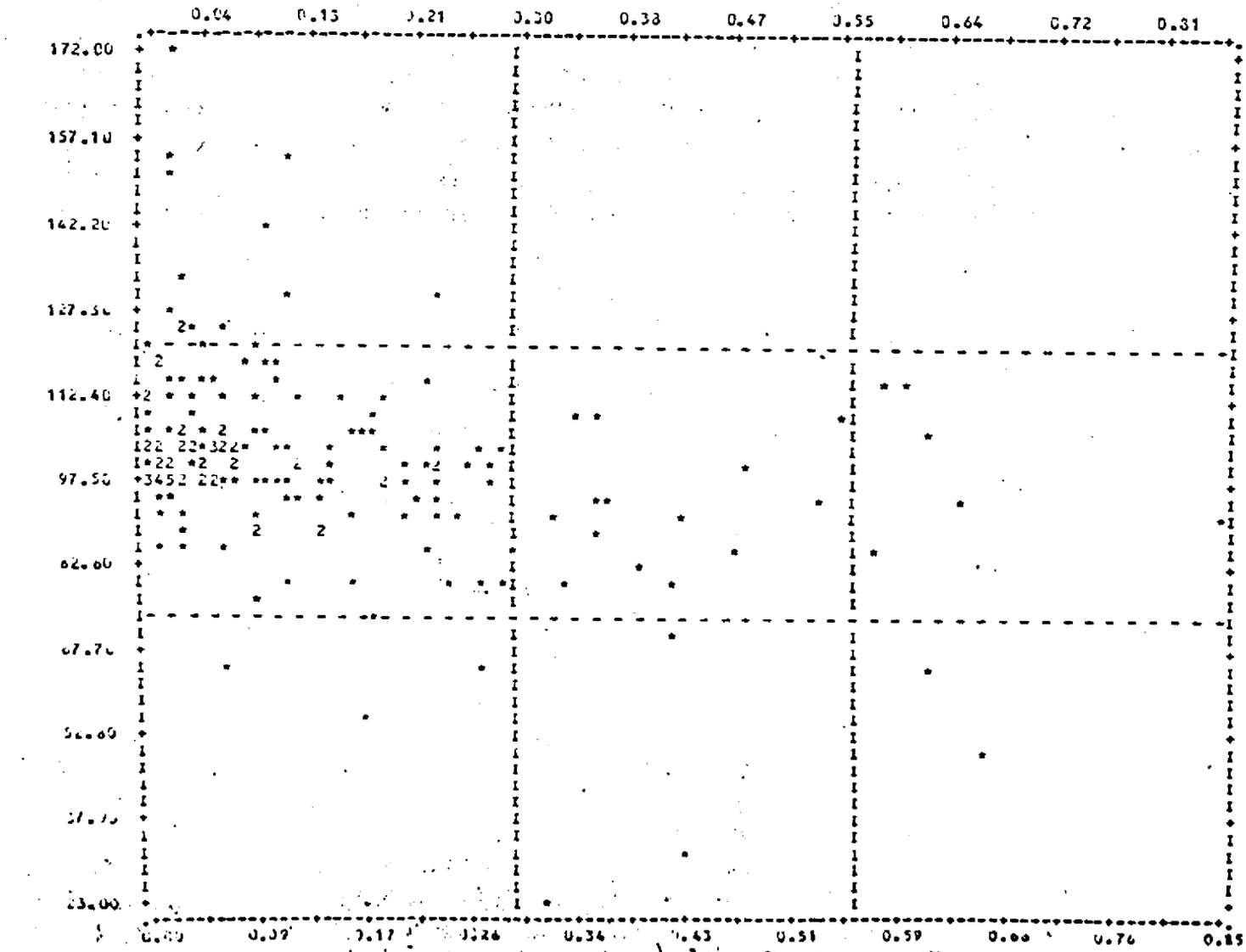
                                                     SUMMARY TABLE

VARIABLE                                             MULTIPLE R   R SQUARE   RSQ CHANGE   SIMPLE R        B          BETA

C1          INITIAL SIZE [illegible]                   0.64842     0.42044    0.42044     0.64342     39.13753    0.64842
(CONSTANT)                                                                                             9.95617
```

DEFINE/MULTIPLE REGRESSION RUN 30/07/85 PAGE 9

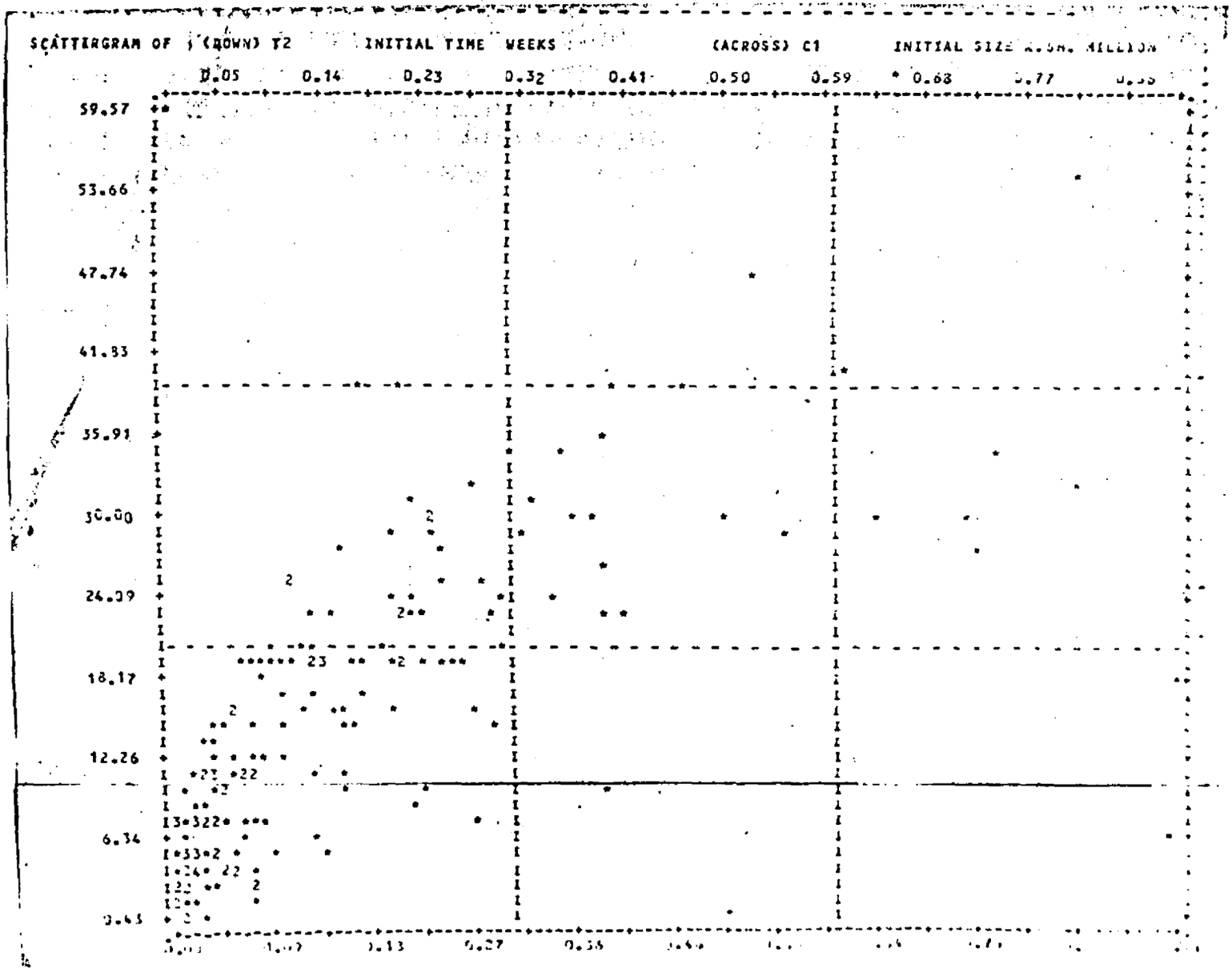
FILE PERFORMA (CREATION DATE = 30/07/85) RATIO
SCATTERGRAM OF (DOWN) P1 PERCENT ORIGINAL TO FINAL (ACROSS) C2 ACTUAL COST K.SH. MILLION



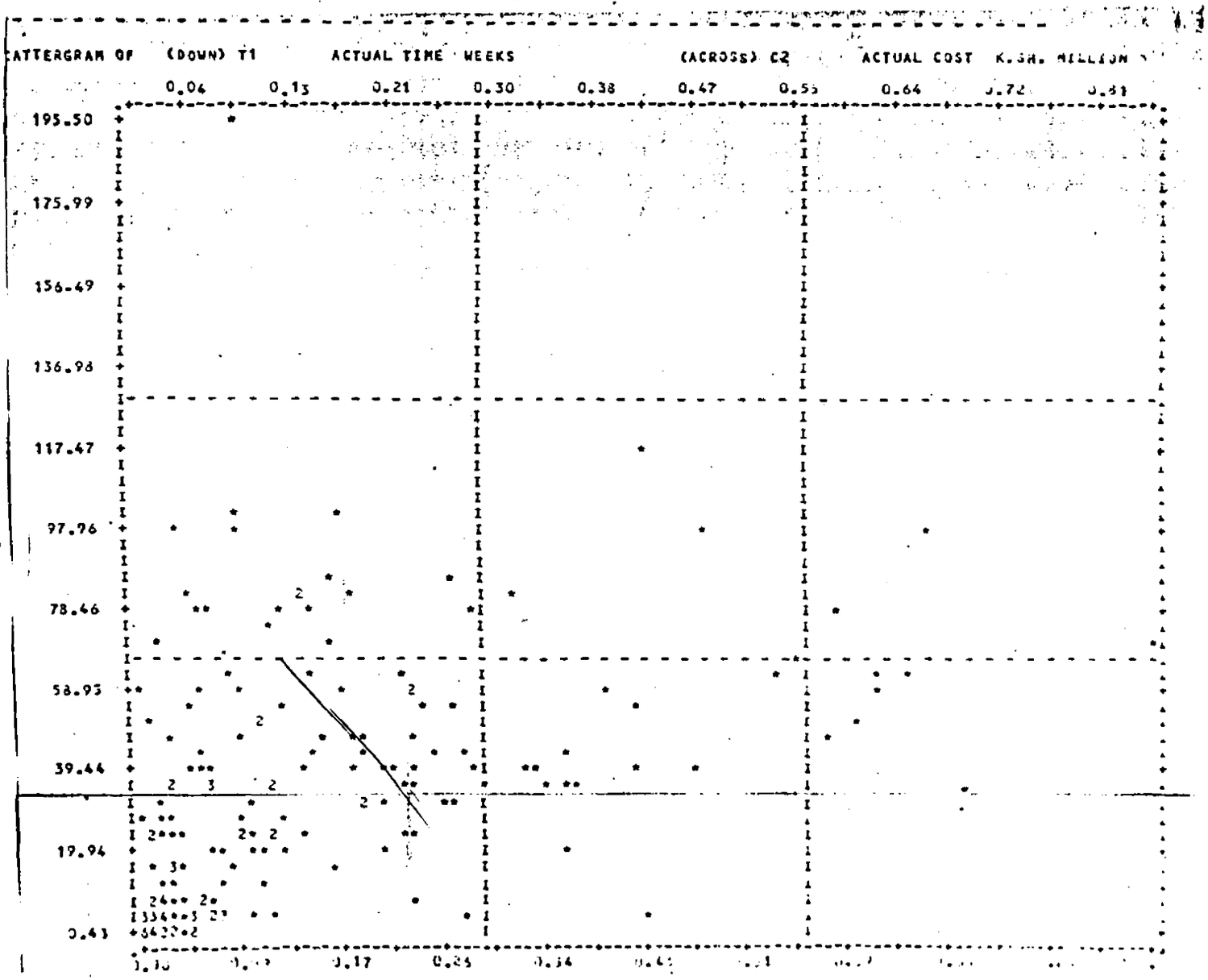
PLOTTED VALUES = 134 EXCLUDED VALUES= MISSING VALUES = 0

APPENDIX D1 -

Cost Performance

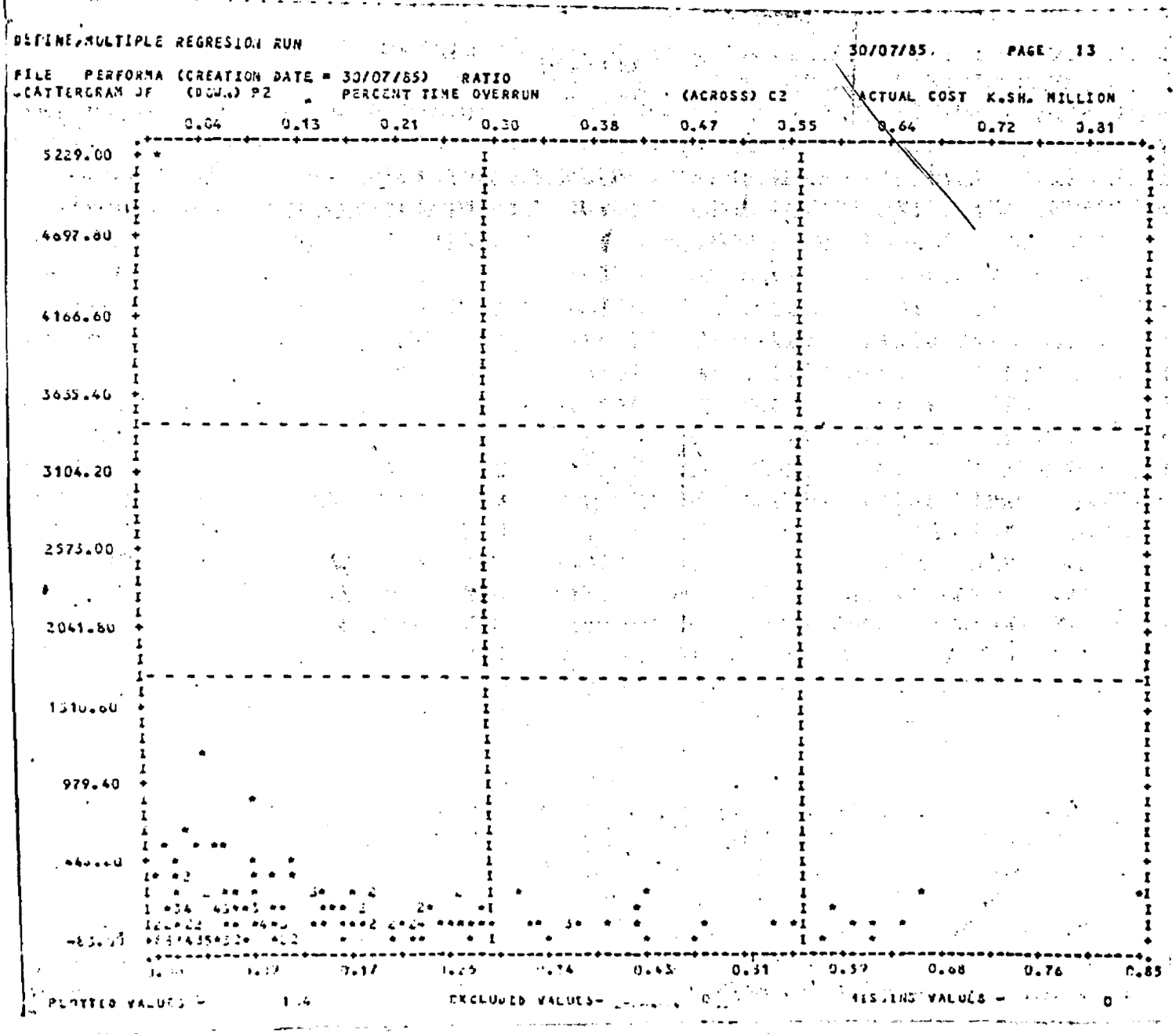


APPENDIX D2 - Initial Contract Period.



APPENDIX D3 -

Contract Period.



APPENDIX D4 -

Time Performance.

Code No.	Size	Initial Contract Sum (Ksh.Million) 1972 prices	Final Contract Sum (Ksh.mln.) 1972 prices	Initial Contract period (Weeks)	Final Contract period (Weeks)	Percentage Cost over-run	Percentage Time Over-run	Location	Type	Percentage of p.c. and Provisional Sums to Initial Contract Sum	Percentage of Final Contract Sum to Original Contract Sum	Year of Commencement of Project
56	Less than	0.061	0.058	6.43	6.43	-0.37	0	B	Repairs	4.53	100	1983
57	½ mln.	0.056	0.055	12.29	12.0	1.43	-0.02	B	"	4.89	99	1983
58	at 1972 prices	0.005	0.005	4.14	4.14	0.32	0	B	"	-	100	1983
59		0.0054	0.0054	8	8	0	0	B	"	-	100	1981
60		0.011	0.011	6	29.29	0.24	388	B	"	-	100	1982
61		0.023	0.022	12	12	0	0	B	"	-	100	1981
62		0.003	0.003	2	2	0	0	B	"	-	100	1981
64		0.217	0.261	8.71	32	24.116	269	B	Supply & Inst.	37.95	81	1983
65		0.073	0.069	2.14	5.57	-4.83	160	B	House	8.13	105	1982
67		0.213	0.166	40.14	90	7.59	129	H	Health Centre	44.64	93	1980
68		0.222	0.267	24.86	89	52.33	260	B	"	38.03	66	1980

APPENDIX E: Final Data Tabulated.

APPENDIX E CONTD.....

Code No.	Size	Initial Contract Sum (Ksh.mln.) 1972 prices	Final Contract Sum (Ksh.mln.) 1972 prices	Initial Contract period (Weeks)	Final Contract period (Weeks)	Percentage Cost Overrun	Percentage Time Overrun	Location	Type	Percentage of p.c. and Provisional Sums to Initial Contract sum	Percentage of Final Contract Sum to Original Contract Sum	Year of Commencement of Project
69		0.083	0.090	20	30	12.55	50	H	Alterations Courts	21.08	89	1982
70		0.175	0.142	40	80.86	-1.13	102	-	Housing	24.44	101	1980
71		0.012	0.01	1.0	53.29	3.33	5229	B	Office	37.73	97	1980
74		0.002	0.002	8.29	2.43	-10.29	-.71	B	House Repair	10.28	112	1978
75		0.0017	0.0016	59.57	59.57	-1.32	0	B	House Repair	-	101	1980
76		0.0052	0.0049	2.14	3.43	-6.08	60	B	House Repair	6.08	106	1979
77		0.0110	0.011	5.71	5.14	13.59	-10	B	Office Repair	1.88	88	1980
78		0.0018	0.0016	3.14	3.14	-11.68	0	B	House Repair	-	113	1980
79		0.016	0.016			-3.18		B	House Repair	12.89	103	1979
80		0.024	0.024	3.14	3.14	0	0	B	House Repair	-	100	1979

Code No.	Size	Initial Contract Sum (Ksh.mln.) 1972 prices	Final Contract Sum (Ksh.mln.) 1972 prices	Initial Contract period (Weeks)	Final Contract period (Weeks)	Percentage Cost Overrun	Percentage Time Overrun	Location	Type	Percentage of p.c. and Provisional Sums to Initial Contract Sum	Percentage of Final Contract Sum to Original Sum	Year of Commencement of Project
81		0.013	0.013	4	4	0	0	B	House Repair	-	100	1979
82		0.003	0.003	3.86	5.86	-8.53	52	B	"	-	109	1980
83		0.036	0.035	10	6.43	-3.0	-36	B	"	-	103	1980
84		0.055	0.042	5	5	-18.37	0	B	Office Repair	19.42	123	1979
85		0.007	0.005	1.86	1.86	-19.15	0	B	House Repair	-	124	1979
86		0.020	0.020	7.86	7.86	0	0	B	"	-	100	1980
87		0.007	0.007	3.86	3.86	-6.06	0	B	"	-	106	1979
88		0.071	0.066	3.14	12.29	-1.16	291	B	"	17.97	101	1979
89		0.022	0.022	4.14	4.14	-1.86	0	B	"	-	102	1979
90		0.035	0.032	6.	9.57	-5.79		B	"	14.28	106	1977
91		0.037	0.028	12.0	19.43	-20.61	62	H	Rewiring House	87.89	126	1976

Appendix E contd...

Code No.	Size	Initial Contract Sum (Ksh.mln.) 1972 prices	Final Contract Sum (Ksh.mln.) 1972 prices	Initial Contract period (Weeks)	Final Contract period (Weeks)	Percentage Cost Overrun	Percentage Time Overrun	Location	Type	Percentage of p.c. and Provisional Sums to Initial Contract Sum	Percentage of Final Contract Sum to Original Sum	Year of Commencement of Project
92		0.054	0.050	4.14	10.43	-3.99	152	B	House Repair	3.02	104	1975
93		0.146	0.108	24	24	-23.97	0	E	Electri- to Work-shop	30.13	132	1978
95		0.079	-	15.86	15.86	-	0	B	House Repair	12.86	-	1980
96		0.017	0.015	4.43	12.43	-14.03	181	B	Re-decora-tion	14.03	113	1977
97		0.131	0.082	18	103.46	2.28	475	A	School	22.49	98	1979
99		0.067	0.055	20.00	60.71	-5.18	200	A	Health Office	27.78	105	1975
100		0.124	0.133	11.86	43.29	10.12	265	A	House	40.31	91	1975
101		0.365	0.328	30.0	41.29	-1.21	38	C	House	48.55	80	1978

Code No.	Size	Initial Contract Sum (Ksh.mln.) 1972 prices	Final Contract Sum (Ksh.mln.) 1972 prices	Initial Contract period (Weeks)	Final Contract period (Weeks)	Percentage Cost Overrun	Percentage Time Overrun	Location	Type	Percentage of p.c. and Provisional Sums to Initial Contract Sum	Percentage Final Contract Sum to Original Sum	Year of Commencement of Project
102		0.113	0.103	19.71	52	1.43	109	G	House	40.26	99	1978
103		0.211	0.229	20	25.86	6.71	29	A	House Repair	19.86	93	1976
104		0.030	0.019	4.14	9.71	-36.31	134	B	Police Station	8.12	167	1977
106		0.031	0.027	5.86	16.67	-6.69	183	B	Repairs		107	1979
107		0.074	0.071	5	4.7	-3.58	-6	B	Repairs	3.58	103	1976
108		0.358	0.281	35	81.71	-5.50	133		A-Lines	23.44	106	1978
109		0.389	0.368	24	37.14	4.03	55	B	Reserve	20.41	96	1975
110		0.060	-			-		G	Electrication House	-	-	1975
111		0.035	0.034		3.86	-3.61	0	B	Repairs	7.38	104	1977
112		0.236	0.231		60.29	4.39	102	H	Office & House	28.8	96	1981

Appendix E contd...

Code No.	Size	Initial Contract Sum (Ksh.mln.) 1972 prices	Final Contract Sum (Ksh.mln.) 1972 prices	Initial Contract period (Weeks)	Final Contract period (Weeks)	Percentage Cost Overrun	Percentage Time Overrun	Location	Type	Percentage of p.c. and Provisional Sums to Initial Contract Sum	Percentage Final Contract Sum to Original Sum	Year of Commencement of Project
113		0.050	0.037	15.0	25.71	-21.19	71	H	House	-	127	1978
114		0.102	0.086	15.29	60.57	-7.59	296	A	Office	20.75	108	1977
116		0.221		32.29	40.29	5.48	25	B	Store	15.79	95	1979
117		0.242	0.177	25.86	84.57	-10.89	227	B	Instal-lation of Generator	56.68	112	1978
118		0.269	0.269	7.71	6.71	0	-13	A	Repairs House	-	100	1975
119		0.273	0.273	16.14	37.57	0.35	133	G	Maternity	32.96	100	1975
120		0.021	0.021	7.86	26.86	0	242	B	Security Work	-	100	1976
121		0.051	0.045	10.71	5.29	-6.62	-51	B	Repairs House	6.62	107	1980
122		0.103	0.069	12.29	26.99	-30.79	120	B	Rewiring Houses	1.03	144	1976

Appendix E contd...

Code No.	Size	Initial Contract Sum (Ksh.mln.) 1972 prices	Final Contract Sum (Ksh.mln.) 1972 prices	Initial Contract period (Weeks)	Final Contract period (Weeks)	Percentage Cost Overrun	Percentage Time Overrun	Location	Type	Percentage of p.c. and Provisional Sums to Initial Contract Sum	Percentage of Final Contract Sum to Original Contract Sum	Year of Commencement of Project
123		-	-	-	-	-8.19	-	B	Installation Electrical	8.19	-	-
124		0.084	0.185		45.71	1.35	256	B		19.26	99	1974
125		0.233	0.205	30.43	42.13	-1.11	38	B	Drainage	25.53	101	1980
126		0.075	0.075	10	10	0	0	B		62.37	100	1975
127		0.027	0.029	11.14	10.0	6.88	-17	B	Redecoration police station	7.83	94	1979
128		0.044	0.044	7.86	7.43	-1.35	-5	B	Repairs House	3.51	101	1979

Appendix E contd...

Code No.	Size	Initial Contract Sum (Ksh.mln.) 1972 prices	Final Contract Sum (Ksh.mln.) 1972 prices	Initial Contract period (Weeks)	Final Contract period (Weeks)	Percentage Cost Overrun	Percentage Time Overrun	Location	Type	Percentage of p.c. and Provisional Sums to Initial Contract Sum	Percentage of Final Contract Sum to Original Contract Sum	Year of Commencement of Project
129		0.007	0.003	5.0	10.43	-0.18	109	B	Hospital	8.44	100	1981
130		0.088		21	21	-0.35	0	B	School	15.28	100	1970
131		0.090	0.110	7.14	7.14	24.89	0	C	Hospital	-	80	1978
132		0.155	0.22	28	28	-3.03	0	G	Instal-lation	-	103	1973
133		0.084	0.037	7.86	25.86	7.42	229	G	Bins	15.06	93	1973
134		0.177	0.39	20	83.75	3.48	319	B	Houses	19.56	96	1973
135		0.133	0.085	20	195.5	10.34	878	G	Hospital	19.63	91	1973
136		0.289	0.287	23.86	38.29	13.13	60	B	Police lines	20.28	88	1973
137		0.406	0.418	23.71	56.29	24.82	137	F	House	12.19	80	1973
138		0.130	0.087	21.57	38.71	-19.25	135	B	School	7.59	123	1973
139		0.205	0.207	19.86	23.29	5.89	17	F	School	15.09	94	1973

Appendix E contd...

Code No.	Size	Initial Contract Sum (Ksh.mln.) 1972 prices	Final Contract Sum (Ksh.mln.) 1972 prices	Initial Contract period (Weeks)	Final Contract period (Weeks)	Percentage Cost Overrun	Percentage Time Overrun	Location	Type	Percentage of p.c. and Provisional Sums to Initial Contract Sum	Percentage of Final Contract Sum to Original Contract Sum	Year of Commencement of Project
142		0.021	0.022	5.14	5.14	3.30	0	C	Transmitter Station		97	1973
143		0.099	0.080	17.29	17.29	-15.80	0	B	House	23.59	119	1973
145		0.219		24	72.14	-7.85	201	B	House	21.25	109	1973
147		0.207		23.85	23.85	15.76	0	C	House	15.28	86	1972
150		0.203				-0.33	10	B	School	2.46	100	1972
163		0.346	0.355	24.14	38.29	2.59	59		School	2.59	97	1972
164		0.049	0.047	10	40.14	-5.06	301	A	School	100	105	1971
165		0.304	0.322	24.29	42.71	5.97	76	G	House	24.02	94	1972
166		0.153	0.148	16.14	64.0	-0.04	296	A	School	3.26	100	1972
168		0.163	0.136	20.0	85.43	-0.39	327	B	School	3.07	100	1972
169		0.208	0.235	20.0	57.63	22.14	187	E	House	-	81	1972

Appendix E contd...

Code No.	Size	Initial Contract Sum (Ksh.mln.) 1972 prices	Final Contract Sum (Ksh.mln.) 1972 prices	Initial Contract period (Weeks)	Final Contract period (Weeks)	Percentage Cost Overrun	Percentage Time Overrun	Location	Type	Percentage of p.c. and Provisional Sums to Initial Contract sum	Percentage of Final Contract Sum to Original Contract Sum	Year of Commencement of Project
172		0.229	0.281	20	41	22.21	105	A	Houses	12.89	82	1972
173		0.045	0.045	4	3	0	-34	B	Houses	-	100	1972
175		0.063	0.051	12	82	-15.09	562	B	Rewiring	37.36	118	1981
176		0.093	0.311	20	82	340.24	310	B	Parking area	30.56	23	1979
177		0.124	0.111	24	39	-5.83	64	H	Housing	18.22	106	1977
179		0.032	0.021	14.14	34.85	-23.19	146	A	House	-	130	1979
180		0.146	0.117	16	82	5.12	413	E	School	-	95	1979
181		0.109	0.171	26	102	73.93	285	B	School	23.51	57	1981
182		0.201	0.168	29.86	62.57	-7.136	110	H	Court House	18.57	108	1978
183		0.079	0.053	18.43	47.14	-5.0	156	C	Office Education	-	105	1981

Appendix E contd...

Code No.	Size	Initial Contract Sum (Ksh.mln.) 1972 prices	Final Contract Sum (Ksh.mln.) 1972 prices	Initial Contract period (Weeks)	Final Contract period (Weeks)	Percentage Cost Overrun	Percentage Time Overrun	Location	Type	Percentage of p.c. and Provisional Sums to Initial Contract Sum	Percentage of Final Contract Sum to Original Contract Sum	Year of Commencement of Project
184		0.277	0.230	32.71	30.71	-1.29	55	B	House	18.17	101	1979
185		0.463	0.471	40.14	40.14	13.0	0	H	House	10.56	88	1975
186		0.155	0.116	10	55.71	-13.18	457	B	Office	-	115	1980
188		0.077	0.138	15.57	24	10	54	B	Fence Walling	-	90.79	1980
189		0.229	0.185	10	33.86	-3.61	239	B	House	20.09	104	1974
190		0.211	0.151	24	75.43	0	214	F	Fencing	3.62	100	1974
191		0.297	0.269	21.14	43.85	-1.95	107	F	Office / House	18.58	101	1974
192		0.266	0.255	20.0	32.43	-1.16	62	B	Farmers T.C. Dormitory	-	101	1976
193		0.118	0.095	15.86	22.42	-15.71	41	F	-	-	119	1975

Appendix E contd...

Code No.	Size	Initial Contract Sum (Ksh.mln.) 1972 prices	Final Contract Sum (Ksh.mln.) 1972 prices	Initial Contract period (Weeks)	Final Contract period (Weeks)	Percentage Cost Overrun	Percentage Time Overrun	Location	Type	Percentage of p.c. and Provisional Sums to Initial Contract sum	Percentage of Final Contract Sum to Original Contract Sum	Year of Commencement of Project
194		0.077	0.058	12	78.86	-19.84	574	C	House	31.49	125	1976
195		0.205	0.186	24.29	32.43	-0.36	34	B	House	23.01	100	1981
197		0.026	0.024	8	8	-5.30	0	B	Instal lation	5.29	106	1982
198		0.326	0.222	32	66.14	-14.97	107	F	House	26.37	118	1979
200		0.229	0.218	24	38.29	-2.43	60	E	House	26.09	102	1975
201		0.057	0.044	6.14	82.59	-0.52	1249	A	Instal-lation	-	101	1978
203		0.234	0.184	30.57	48114	-12.42	57	G	House	23.88	114	1978
204		0.122	0.102	20.71	20.71	-4.04	0	C	Workshop School	10.18	104	1974
205		0.074	0.061	12.57	39.28	-7.05	213	D	House	20.91	108	1980
206		0.134	0.089	20	98.71	-12.31	394	C	Office	21.01	114	1979
208		0.039	0.033	12.29	18.85	-9.49	53	B	Repairs	24.82	110	1979
211		0.248	0.182	28.43	42.84	-6.81	51		Dorm. School	29.41	107	1974

Appendix E contd...

Code No.	Size	Initial Contract Sum (Ksh.mln.) 1972 prices	Final Contract Sum (Ksh.mln.) 1972 prices	Initial Contract period (Weeks)	Final Contract period (Weeks)	Percentage Cost Overrun	Percentage Time Overrun	Location	Type	Percentage of p.c. and Provisional Sums to Initial Contract Sum	Percentage of Final Contract Sum to Original Contract Sum	Year of Commencement of Project
212		0.078	0.062	11.43	39.71	-12.59	248	B	Houses	-	114	1974
213		0.323	0.415	29.86	42.86	40.37	44	B	Re-admission Ed. block	40.21	71	1974
214		0.138	0.421	5.86	5.86	205.50	0	B	Extensions office	11.61	33	1975
216	Less than	0.006	0.005	6.57	7.86	-12.09	20	B	Office	12.09	114	1979
217	½mln. at 1972 prices (Ksh)	0.254	0.229	20.29	43.29	-0.79	113	B	Nyeri House	24.79	101	1974
218		0.104	0.075	19.86	65.29	-5.58	229	B	School	22.14	106	1974
219		0.249	0.243	20	43.86	8.68	119	B	Vet.Clinic House	22.38	92	1975
223		0.155	0.179	15.71	49.57	32.49	215	B	M.O.W. House	15.28	75	1975

Appendix E contd...

Code No.	Size	Initial Contract Sum (Ksh.mln.) 1972 prices	Final Contract Sum (Ksh.mln.) 1972 prices	Initial Contract period (Weeks)	Final Contract period (Weeks)	Percentage Cost Overrun	Percentage Time Overrun	Location	Type	Percentage of p.c. and Provisional Sums to Initial Contract Sum	Percentage of Final Contract Sum to Original Contract Sum	Year of Commencement of Project
224		0.392	0.355	35.14	45.42	9.80	26	B	House	20.29	91	1976
229		0.059	0.045	16.14	57.14	-15.46	254	D	House	-	118	1977
230		0.041	0.028	14.43	38.71	-20.41	168	G	House	17.56	126	1975
231		0.131	0.125	20.14	20.14	-1.38	0	B	House	17.29	101	1978
232		0.282	0.231	26	61.43	-4.81	136	F	F.T.C. House	32.66	105	1978
233		0.389	0.659	27.43	98.14	98.76	255	B	Hospital	31.15	50	1977
234		0.129	0.108	20.28	35.57	5.42	75	B	Office	22.52	95	1974
235		0.041	0.033	14.86	98.89	-12.85	566	B	Rewiring	14.63	115	1981
236		0.065	0.057	12.0	36.14	-0.03	201	B	Rewiring	5.26	104	1981
237		0.017	0.016	6.0	6.0	-7.05	0	B	House Repairs	11.70	108	1979

Appendix E contd...

Code No.	Size	Initial Contract Sum (Ksh.mln.) 1972 prices	Final Contract Sum (Ksh.mln.) 1972 prices	Initial Contract period (Weeks)	Final Contract period (Weeks)	Percentage Cost Overrun	Percentage Time Overrun	Location	Type	Percentage of p.c. and Provisional Sums to Initial Contract Sum	Percentage of Final Contract Sum to Original Contract Sum	Year of Commencement of Project
238		0.011	0.011	10	16.57	8.73	66	B	House Repairs	3.22	92	1980
239		0.012	0.011	5.86	1	-5.57	-88	B	House Repairs	5.57	106	1980
240		0.012	0.011	8.0	24.86	-1.39	211	B	House Repairs	15.97	101	1979
241		0.005	0.005	8.0	5.0	-4.99	0	B	"	13.09	105	1980
242		0.008	0.007	5.86	5.86	-17.66	0	B	"	17.66	121	1981
243		0.028	0.015	12.0	12.0	-41.85	0	B	"	3.03	172	1980
244		0.022	0.020	7.86	2.7	-3.28	-65	B	"	4.92	103	1977
245		0.137	0.166	20	19.86	22.32	-1	B	Car Park Shed	2.91	82	1979
247		0.153	0.106	12.0	54.14	-15.44	351	B	Alterations	44.88	118	1979

Appendix E contd...

Code No.	Size	Initial Contract Sum (Ksh.mln.) 1972 prices	Final Contract Sum (Ksh.mln.) 1972 prices	Initial Contract period (Weeks)	Final Contract period (Weeks)	Percentage Cost Overrun	Percentage Time Overrun	Location	Type	Percentage of p.c. and Provisional Sums to Initial Contract Sum	Percentage of Final Contract Sum to Original Contract Sum	Year of Commencement of Project
248		0.296	0.226	15.29	8.57	-23.65	-44	H	Hospital Nursery School	5.38	131	1976
249		0.055	0.064	11.86	11.86	14.47	0	B	Repairs	73.01	87	1977
250		0.074	0.059	7.86	22.43	-7.23	185	B	Jamhuri park stand show	15.92	108	1974
251		0.037	0.019	12.0	72.86	-34.17	507	B	Rewiring	-	152	1978
252		0.126	0.103	6.43	12.86	-16.57	69	B	Boiler	-	119	1979
253		0.061	0.083	8.14	24.0	29.07	195	B	Parliament Repair	10.36	77	1979
254		0.033	0.030	7.86	13.0	-6.86	65	B	Offices Re-roofing	-	107	1978
255		0.009	0.009	0.43	0.43	0	0	B	Hospital Repair	-	100	1984

Appendix E contd....

Code No.	Size	Initial Contract Sum Ksh.mln.) 1972 prices	Final Contract Sum (Ksh.mln.) 1972 prices	Initial Contract period (Weeks)	Final Contract period (Weeks)	Percentage Cost Overrun	Percentage Time Overrun	Location	Type	Percentage of p.c. and Provisional Sums to Initial Contract Sum	Percentage of Final Contract Sum to Original Contract Sum	Year of Commencement of Project
256		0.027	0.027	0.43	0.43	0	0	B	Redecoration Kiambu Hospital	-	100	1984
257		0.314	0.266	34.86	58	-5.86	66	B	House Nyeri Hospital	28.31	106	1977
258		0.113	0.098	26.0	32.14	-8.64	24	B	House Police station	18.77	109	1977
259		0.073	0.065	3.0	5.0	-5.36	67	B	Repair House	11.57	106	1979
260		0.057	0.050	16.14	41.14	0	155	F	Reflectors Lanet	-	100	1979
261		0.019	0.017	6.14	30.71	-14.56	400	B	Prison	14.56	117	1981
262		0.192	0.152	20.86	50.71	-12.91	143	A	House Bukura	13.78	115	1981

Appendix E contd...

Code No.	Size	Initial Contract Sum (Ksh.mln.) 1972 prices	Final Contract Sum (Ksh.mln.) 1972 prices	Initial Contract period (Weeks)	Final Contract period (Weeks)	Percentage Cost Overrun	Percentage Time Overrun	Location	Type	Percentage of p.c. and Provisional Sums to Initial Contract Sum	Percentage of Final Contract Sum to Original Contract Sum	Year of Commencement of Project
264		0.382	0.392	30	60	18.01	100	B	Workshop forest	20.49	85	1975
265		0.008	0.009	3.86	27.43	-0.72	611	B	Offices	8.63	101	1975
266		0.174	0.114	17.86	26.14	-35.44	46	B	House Ahiti	-	155	1976
267		0.041	0.030	12.0	30	-14.45	150	B	Repairs	14.45	117	1979
269		0.168	0.146	15.71	47.14	-5.02	200	B	Rewiring	2.91	105	1978
270		0.023	0.024	5.14	27.14	12.19	428	B	Repairs	14.23	89	1976
271		0.026	0.023	9.28	49.57	-5.57	434	B	Rewiring	5.57	106	1981
273		0.045	0.030	4.86	35.86	-26.41	700	B	Repairs Alterations	77.17	136	1975
274		0.393	0.357	10.57	21.71	-9.07	105	C	Repairs	-	110	1982
276		0.025	0.024	8.57	19.71	12.93	130	B	Partitions	12.31	87	1974
278		0.017	0.013	8.71	9.71	-16.69	11	B	Fencing	17.24	120	1982

Appendix E contd....

Code No.	Size	Initial Contract Sum (Ksh.mln.) 1972 prices	Final Contract Sum (Ksh.mln.) 1972 prices	Initial Contract period (Weeks)	Final Contract period (Weeks)	Percentage Cost Overrun	Percentage Time Overrun	Location	Type	Percentage of p.c. and Provisional Sums to Initial Contract Sum	Percentage of Final Contract Sum to Original Contract Sum	Year of Commencement of Project
279		0.398	0.344	39.71	37.14	-11.01	-6	B	Class-rooms	20.69	112	1976
281		0.017	0.017	5.86	4.43	-0.005	-24	B	Repairs KNH	5.27	100	1977
282		0.022	0.021	80	10.0	-0.05	25	B	Repairs Rewiring KNH	11.39	100	1977
283		0.092	0.092	5.86	7.86	0	34	B	Repairs	2.15	100	1979
284		0.037	0.057	5.43	5.43	-	0	B	Supply of banquet	-	66	1981
286		0.073	0.064	19.86	33.57	-4.66	94	A	School	23.27	105	1975
287		0.040	0.040	8.0	3.57	-0.16	-55	B	Repairs KNH	11.07	100	1978

Appendix E contd...

Code No.	Size	Initial Contract Sum (Ksh.mln.) 1972 prices	Final Contract Sum (ksh.mln.) 1972 prices	Initial Contract period (Weeks)	Final Contract period (Weeks	Percentage Cost Overrun	Percentage Time Overrun	Location	Type	Percentage of p.c. and Provisional Sums to Initial Contract Sum	Percentage of Final Contract Sum to Original Contract Sum	Year of Commencement of Project
94		0.498	0.618	30.29	62.43	53.02	106	C	Medical stores	45.68	65	1979
98		0.875	1.167	40.43	60.72	34.88	50	H	Rural Health Centre	19.39	74	1976
105		0.724	0.586	28.0	79.14	-15.41	183	B		15.55	118	1981
140		0.635	0.429	30	121.14	6.93	304	G		13.82	93	1973
149		0.909	0.849	18.71	71.71	6.04	283	B	Ventilation installation	2.199	94	1972
151		0.958	1.071	55.86	78.29	27.0	40	H	Teachers College	-	78	1972
167		0.765	1.162	16.14	60.0	87.16	296	A	Nurses Hostel	47.93	53	1972

Appendix E contd...

Code No.	Size	Initial Contract Sum (Ksh.mln.) 1972 prices	Final Contract Sum (Ksh.mln.) 1972 prices	Initial Contract period (Weeks)	Final Contract period (Weeks)	Percentage Cost Overrun	Percentage Time Overrun	Location	Type	Percentage of p.c. and Provisional Sums to Initial Contract Sum	Percentage of Final Contract Sum to Original Contract Sum	Year of Commencement of Project
196		0..608	0.578	40.86	49.86	15.96	22	D	Houses	14.52	86	1979
202		0.743	0.648	35.43	65.43	3.53	85	C	Staff Hsg & Hospital	21.29	97	1978
210		0.529	0.472	48.0	99.57	-1.52	107	H	Offices House	25.83	102	1981
215		0.553	0.537	29.86	65.0	2.77	118	H	Secondary School	73.30	97	1975
221		0.722	0.548	30.57	69.0	-10.18	126	A	Farmers T.C.	2.69	111	1980
272		0.814	0.617	55.0	64.71	-8.11	18	H	Law Courts	10.46	109	1974
280		0.821	0.607	33.0	54.0	-15.29	64	H	Secondary School	19.46	118	1978
285		0.735	1.465	10.0	10.0	99.26	0	B	Supply & Fixing	-	50	1981

Appendix L contd...

Code No.	Size more than 1 million but less than 2 million	Initial Contract Sum (Ksh.mln.) 1972 prices	Final Contract Sum (Ksh.mln.) 1972 prices	Initial Contract period (Weeks)	Final Contract Period (Weeks)	Percentage Cost Overrun	Percentage Time Overrun	Location	Type	Percentage of p.c. and Provisional Sums to Initial Contract Sum	Percentage of Final Contract Sum to Original Contract Sum	Year of Commencement of Project
15	at 1972 prices	1.428	2.008	50.43	34.57	46.86	68		Police lines	25.31	63	1981
41		1.504	0.903	52.14	131.14	-0.74	152	B	District Hqs.	22.36	101	1973
44		1.482	1.164	50.0	65.14	-6.44	30	F	M.T.C. (Health)	22.28	107	1978
48		1.429	1.203	48.0	48.0	0	0	H	Training Centre	37.46	100	1972
53		1.181	1.004	48.0	73.86	11.76	54	H	Farmers T.C.	32.05	89	1973
71		1.225	0.527	52.29	141.15	-32.85	168	B	Instal-lation	-	149	1972
25		1.214	0.770	45.43	81.86	-6.55	80	E	Housing (Police)	17.85	106	1974

Appendix E contd...

Code No.	Size	Initial Contract Sum (Ksh.mln.)	Final Contract Sum (Ksh.mln.)	Initial Contract period (Weeks)	Final Contract period (Weeks)	Percentage Cost Overrun	Percentage Time Overrun	Location	Type	Percentage of p.c. and Provisional Sums to Initial Contract Sum	Percentage of Final Contract Sum to Original Contract Sum	Year of Commencement of Project
226		1.023	0.962	52.14	69.28	5.33	33	E	Housing (Police)	23.34	95	1977
227		1.190	1.284	42.86	113.86	33.16	106		Health Centre	18.18	75	1975
228		1.350	1.600	46.14	68.14	49.38	43	A	Health Centre	14.78	67	1976
268		1.747	16.57	40.0	95.29	22.59	138	B	Hostel	29.00	82	1974
178		3.352	3.581	67.86	143.04	46.84	111	B	Station	58.62	68	1979
187	More than 2 mln. but less than 5 mln. at 1972 prices	2.081	1.560	52.14	58.56	-9.14	12	B	District HQs.	38.7	110	1975
199		4.986	3.904	99.57	253.14	23.25	155	B	Provincial HQs.	1.87	81	1976
207		2.728	2.717	60.0	99.14	15.79	65	H	Staff HQs. Hospital	25.58	86	1975
222		2.397	1.772	65.00	73.71	-0.86	215	B	Health Centre	12.77	101	1974

Appendix E contd...

APPENDIX 'F'

Reducing cost data to a base Year 1972.

Year	Index
1972	100
1983	363.9

Contract sum at 1983 prices - K.Shs. 59,000,000.00

Contract sum reduced to base year

$$= \frac{100}{363.9} \times 59,000,000.00$$

= K.Shs. 16,213,245.00

= K.Shs. 16.21 millions.

APPENDIX 'G'

COST INDICES

YEAR	1 9 7 3			
MONTH	MARCH	JUNE	SEPTEMBER	DECEMBER
Materials	104.7	111.3	122.3	115.1
Labour	100.0	100.0	104.7	109.7
Building Cost Index	103.4	108.1	118.8	113.6

YEAR	1 9 7 4			
MONTH	MARCH	JUNE	SEPTEMBER	DECEMBER
Materials	128.4	139.6	106.0	168.8
Labour	109.7	107.7	120.9	123.3
Building Cost Index	103.4	108.1	118.8	113.6

YEAR	1 9 7 5			
MONTH	MARCH	JUNE	SEPTEMBER	DECEMBER
Materials	168.5	176.2	183.4	199.9
Labour	123.8	138.1	138.1	138.1
Building Cost Index	156.2	165.5	170.9	182.6

YEAR	1 9 7 6			
MONTH	MARCH	JUNE	SEPTEMBER	DECEMBER
Materials	203.6	205.0	200.6	202.4
Labour	152.2	152.2	152.2	152.2
Building Cost Index	159.3	190.3	187.1	188.4

YEAR	1 9 7 7			
MONTH	MARCH	JUNE	SEPTEMBER	DECEMBER
Materials	209.1	205.3	216.9	221.8
Labour	152.2	159.0	159.0	159.0
Building Cost Index	193.2	192.4	200.7	204.2

YEAR	1978			
MONTH	MARCH	JUNE	SEPTEMBER	DECEMBER
Materials	226.7	231.2	201.8	248.9
Labour	159.0	159.0	159.0	159.0
Building Cost Index	207.8	211.0	218.7	223.8

YEAR	1979			
MONTH	MARCH	JUNE	SEPTEMBER	DECEMBER
Materials	261.1	265.5	279.5	284.1
Labour	159.0	159.0	175.8	175.8
Building Cost Index	232.5	235.7	250.5	253.8

YEAR	1980			
MONTH	MARCH	JUNE	SEPTEMBER	DECEMBER
Materials	315.0	320.4	331.5	353.6
Labour	175.8	201.4	201.4	201.4
Building Cost Index	276.1	287.4	295.1	311.1

YEAR	1 9 8 1			
MONTH	MARCH	JUNE	SEPTEMBER	DECEMBER
Materials	369.5	384.5	394.2	406.6
Labour	201.4	201.4	201.4	201.4
Building Cost Index	322.5	333.4	340.3	349.2

YEAR	1 9 8 2			
MONTH	MARCH	JUNE	SEPTEMBER	DECEMBER
Materials	432.2	455.5	456.8	465.6
Labour	201.4	201.4	201.4	246.4
Building Cost Index	323.9	336.1	336.8	362.6

YEAR	1 9 8 3	
MONTH	MARCH	JUNE
Materials	467.9	490.5
Labour	246.4	246.4
Building Cost Index	363.4	375.9

Source: Statistical Abstract 1975-1983.