AN INVESTIGATION INTO THE CAUSES AND IMPACT OF RESOURCE MIX PRACTICES IN THE PERFORMANCE OF CONSTRUCTION FIRMS IN KENYA

A Case Study of the Building Construction Firms in Nairobi.

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DECLARATION

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

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DECLARATION OF THE SUPERVISORS

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

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ABSTRACT

There is evidence that construction projects performance in Kenya is poor. Time and Cost performance of projects in Kenya are poor to the extent that, over 70% of the projects initiated are likely to escalate in time with a magnitude of over 50%. In addition over 50% of the projects are likely to escalate in cost with a magnitude of over 20%. Studies have shown that, although cost performance was not better, time performance was comparatively the worst. Australian studies on construction time performance showed that performance was affected by construction management team, project scope and projects complexity.

Ideally in construction projects, the industry would like to see less quantities of materials used, less machine hours used, shorter construction activity durations, less finances used, less manhours used, zero cost overruns and zero time overruns in these construction projects. While all the above cited studies addressed construction projects performance in terms of factors other than optimum resource mix by construction firms, it is necessary to look at the way these resources are mixed because they play a central role in construction projects performance in terms of cost and time overruns.

It is for this reason that the researcher undertook an investigation into the impact and factors that cause poor construction performance through resource mix practices by construction firms in Kenya. This area of research needs to be adequately addressed in order to understand the causes of both time and cost overruns, in construction projects with a view to looking to solutions to reduce these overruns.

It was therefore proposed that inappropriate resource mix is a major contributor to poor project performance in the Kenyan Construction projects in terms of time and cost overruns.

The study administered survey questionnaires on the respondents to obtain the necessary data in order to achieve its objectives. It also utilized both survey and statistical designs to arrive at its sample size. Two way analysis of variance was used to find out whether there was a significance difference among the means of the construction firms' resources mix as a consequence of the firm's citizenship status. In addition multiple linear regression and correlation analysis was used to rate the significance of the variables with regard to their contributions to construction projects performance.

There are three classes of construction firms in Kenya which were targeted by this study. These are African Construction firms, Citizen construction firms and Non-citizen construction firms. The study sought to answer the following research questions. Does citizenship status have any effect on resource mix practices by construction firms? Does the construction firms technical personnel's' education have any effect in resource mix practices by construction firms? Does citizenship status have any impact on resource mix indicators thereby affecting construction project performance. Do construction firms have any project information management strategy which may impact on construction project performance, Do construction firms embrace manufacturing optimisation techniques in their production process? And lastly, Do construction firms apply Just-in-time philosophy

technique in construction production process? The overall objective of the study was to find out how resources were mixed by construction firms in Kenya in order to improve project performance by the Kenyan construction firms.

The significance of the study was that, the results will help in further understanding the causes of untimely completion of construction projects and contribute to knowledge in the improvement of efficiency and reduction of construction time and cost overruns; the improvement of overall construction industry performance, including savings in profits for the construction firms; and better project management integration by reduction of waste, reduced project costs, increased project value, better workmanship, improved project sustainability, reduced conflicts and risks in construction business. The study targeted construction firms in categories A to C according to the Ministry of Roads and Public Works contractors registration which are based in Nairobi.

In the evaluation of project performance through resource mix practices by construction firms, with respect to the firms technical personnel's' education level and the way it impacts on construction project performance, shows that 37.38% of the respondents had an education level below a university degree. The results were tested at 95% and 99% confidence levels; and in all the seven major construction trades analysed, education was found to have played a major role in resource mix. Non-graduate respondents presented the highest levels of poor resource mix compared to the graduate respondents in this research. This means that more emphasis should be directed to training and educating construction managers and those responsible for resource mix optimisation in construction firms in order to improve projects performance.

On the factors affecting projects performance, and application of manufacturing techniques as embraced by construction firms. The results of this analysis showed that citizenship status has no effect on resource mix as used by construction firms at 95% and 99% confidence levels. On the other hand the results showed that construction project performance was significantly affected by resource mix practices by construction firms at 95% and 99% confidence levels respectively in the Two way analysis of variance. It was also shown that resource mix practices accounted for 81.46% of the variances in construction projects performance, whereas citizenship status accounted for –1.30% of the variances.

The results of the multiple regression analysis showed that finance resource (credit worthiness) and machine time combination were the two most important variables accounting for 86.0% of the causes of poor construction project performance for the African construction firms, whereas in citizen construction firms, the two most important contributors to poor construction project performance were technology advancement and incorrect labour mix accounting for 91.4% of the causes. In non citizen construction firms, technology advancement and incorrect material mix were the two most important variables accounting for 86.5% of the causes of construction projects performance, at 95% confidence levels.

In the project information management strategy, 44.3%, 75% and 62.5% of African, citizen and non-citizen construction firms had an information management strategy respectively.

On the application of optimisation techniques in the construction production process, 48.6%, 57.10% and 27.5% of African, citizen and non-citizen construction firms respectively embraced these techniques. On JIT Philosophy application 37.1%, 48.2% and 27.5% of African, citizen and non-citizen construction firms had embraced this philosophy in their operations respectively.

The study hypothesis was rejected at 95% confidence level, and the alternative hypothesis that "inappropriate matching of construction resources contributed significantly to the causes of poor construction projects performance" was supported. The second hypothesis that citizenship status does not contribute significantly to poor construction performance was supported, as the results were significant at 95% confidence level. The third hypothesis that "Education level does not contribute significantly to poor construction projects performance through resource mix practices was supported as the results were found to be significant at 95% confidence level.

The study recommended that efforts should be directed to the training of the key participants in construction resource management, work studies on construction resources, application of resource optimisation techniques, Just-in-time philosophy to be embraced, project information management strategies to be embraced by construction firms in the construction industry.

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CHAPTER I

INTRODUCTION

1.1 Overview

The construction industry is defined as "that total industry which involves the utilization of human, economic and natural resources in the conception, design, construction, maintenance, alteration and demolitions of both Building and Civil Engineering Works" (Geaney, 1979). From this definition, it is evident that in whatever socio economic structure in place, be it capitalist, communist or even mixed economies the role of the industry is important.

The industry is even of greater importance in developing countries, because it is central to the process of development (The World Bank, Construction Industry Issues 1984). Transportation networks, irrigation systems, educational institutions, residential buildings, health facility buildings, factories, offices and other construction works are the physical foundations upon which development efforts and improved living standards are founded. The prime objective of most governments anywhere in the world are to improve the living standards of her people (Strut, 1982). Therefore, a sound and efficient construction industry in any economy is relied upon as one of the bases for fulfilling the governments objectives.

The importance of the construction industry can be seen from the following statistics in a developed country like United Kingdom (UK). In 1983, it contributed 9-10% of the Gross Domestic Product (GDP); 50-60% of the Gross Domestic Fixed Capital Formation (GDFCF); and 6% of the Total Wage Employment (Hillebrandt, 1985). In 1993, the industry contributed 10% of the Gross Domestic Product (GDP), 50% of the Gross Fixed Domestic Capital Formation (GDFCF) and 14% of the Employed Workforce. These figures are more or less the same in most advanced and developing economies of the world (Kwakye, 1997).

In a developing country like Kenya, for example, the contribution of the construction industry cannot be underestimated. Table 1:1 presents the contribution of the construction industry to GDP, GDPCF, Wage Employment and Labour Earnings, for the period 1994 to 2002.

Table 1:1: Contribution of the Construction Industry Gross Domestic Product; Gross Domestic Product Capital Formation; Wage Employment and Labour Earnings at Current Prices (%)

Year	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
GDP (%)	5.02	4.66	4.47	3..99	4.16	4.24	4.25	4.35	4.47	4.53
GDPCF (%)	7.48	9.02	8.63	10.13	10.79	7.48	9.14	8.78	8.96	9.49
GDPCF by Type of Asset (%)	31.15	35.92	39.12	37.50	35.75	24.52	25.68	25.72	24.59	23.46
Wage Employment (%)	4.87	4.90	4.87	4.85	4.76	4.68	4.63	4.57	4.50	4.43
Labour Earnings (%)	4.37	4.50	4.53	4.53	4.39	4.03	4.04	3.96	3.91	3.92

Source: Statistical abstract: Republic of Kenya, Government Printers, 2004.

However, comparatively the contributions of the industry are lower in the Kenyan context than those of advanced and developed economies of the world. Hence, there is need for a well managed construction industry so that its contributions are enhanced.

It is realized that the industry is responsible for the bulk of the investment goods which are core to economic growth. The government being the main client of the industry plays a very significant role in the affairs of the industry. The government action on national and local level determine the levels of demand for construction activities, costs of production, supply conditions and economic growth.

A slow growth rate in the industry is indicative of poor economic performance in other sectors of the economy. On the other hand, the industry is used by the government for introducing regulatory measures in the economy. For instance, at a time of high inflationary trends, the government can resort to monetary policies such as a cut in public expenditure on new projects. The opposite effect is achieved by the increase in public expenditure whose multiplier effect creates general increase in incomes and investment in the economy. Furthermore, owing to its size, any improvement in the efficiency of the production process and/or in the quality of the finished product has the potential for large cost savings and energy conservation.

1.2 The Statement of the Problem:-

In the last three decades construction projects have advanced in complexity, both internationally and nationally. These projects cost billions of shillings, take longer periods to accomplish, consume vast quantities of resources and involve diverse expertise.(Gidado, 1996)

Complexity is defined by shear size, cost, time and intricacy of construction, when these attributes seem to be larger than usual (Sidwell, 1990; Gidado, 1996). However, complexity of these projects should not only be seen in the light of these defined attributes but also in the light of resources mix by construction firms in these projects. Complex projects by necessity require intricate resource mix for efficient utilization. Complex projects have exerted formidable challenges especially with which construction resources are mixed and managed.

Optimum resource mix will save man hours, machine time, and material wastage. In addition, it will not only improve efficiency but also reduce contractor project financing problems, thereby leading to an overall saving for the construction firm, for any project undertaken. These resources need to be well managed in order to reduce the inherent uncertainty in the construction industry.

The uncertainty in the construction industry arises from the nature of the industry itself. For instance, the competitive tendering process, the company's turnover, site production rates and the weather conditions are all variables (Harris 1983). This compounds the problem of resource mix or combination.

Mbatha (1986), Talukhaba (1988), Kivaa (2000), Mbeche et al (1996), and Talukhaba (1999) have avoided the issue of resource management of construction projects, which directly affects the performance of a project and yet these are very crucial to the success of any project, both in terms of timely completion and completion within the allocated budgets.

These researchers have dwelt on cost overruns, time overruns and the estimation of construction periods.

The Building Industry Advisory Council of South Australia [Business Council of Australia, 1993a] examined the problems relating to failure to achieve timely completion of contracts and observed that delays are caused by the parties to the Building Contract and more so by reluctance or failure to carry out their various responsibilities or commitments in good time. What the council failed to consider is that some delays can be caused by factors beyond the control of any of the parties such as optimization of construction resources.

Nyagah (1989) investigated variations in labour productivity on construction sites in Kenya, with particular emphasis to concreting and walling. The study found out that, human factors are more important determinants of labour productivity than technical factors. The most important factor for workers was wages. Machinery and equipment tended to be the same in most sites, and therefore did not show so much variation. The study showed that labour productivity on sites investigated can be improved through monetary based productivity improvement schemes, such as incentive payments, to motivate the workers.

Mbatha (1986), Talukhaba (1988), and Mbeche et al (1996) established that time and cost performance of projects in Kenya are poor to the extent that, over seventy percent of the projects initiated are likely to escalate in time with a magnitude of over (50%) fifty percent. In addition, over fifty percent of the projects are likely to escalate in cost with a magnitude of over (20%) twenty percent. These studies showed that, although cost performance was not better, time performance was comparatively the worst.

Walker (1994) carried out a study on the factors that determine construction time performance (CTP). Its aim was to find out why some buildings were constructed more quickly than others. The principal gaps in knowledge addressed by this research were those of helping to answer the questions:

"What factors affect construction time"?

"To what extent do these factors affect CTP"?

"Why do particular factors affect CTP while others do not"?

The study showed that construction management team (CM), followed by client representative (CR) team affects CTP, while project scope and complexity factors significantly affected CTP. The least significant factor cluster was found to be the communication performance between the design team and CM and CR teams. These results indicated that, the CM team is the filter through which scope, complexity and impact of other teams performance is passed. It therefore concluded that high CM team performance instigates difficulties and challenges presented to result in high CTP, while poor CM team performance led to poor CTP.

Talukhaba (1999), investigated factors causing project delays in Kenya. The main objective was to identify and establish the significance of the factors, which causes project delays. In addition, the study also investigated the influence of project characteristics on the delay causing factors.

The study revealed that, clients payments and Architects instructions, with percentages of 61.7% and 7.91% respectively were the main contributors to the project delays, and accounted for 70.6% of the variations in percentage of delay. Other 22 factors which were part of the study were found to be significant contributors to delays but with minimal effect. The study identified the real causes of project delays as poor financial management by clients, inadequate designs by the designers and poor management of construction process by the parties involved in the project implementation.

These were compounded by poor resource management such as materials, equipment by contractors, inadequate recognition and response to project risks inherent in both the physical and socio -economic environment of the project; and inadequate regard to the role of the stakeholders by the parties involved in the project implementation process. The study recommended that project management should be concerned with mostly **clients' project financing, and efficient workable project designs and efficient construction process management.**

Ideally in construction projects, the industry would like to see less quantities of materials used, less machine hours used, shorter construction activity durations, less finances used, less manhours used, zero cost overruns and zero time overruns in these construction projects. While all the above cited studies addressed construction projects performance in terms of factors other than optimum resource mix by construction firms, it is necessary to look at the way these resources are mixed because they play a central role in construction projects performance in terms of cost and time overruns.

It is for this reason that the researcher undertook an investigation into the factors that cause poor construction performance through resource mix practices by construction firms in Kenya. This area of research needs to be adequately addressed in order to understand the causes of both time and cost overruns, in construction projects with a view to looking to solutions to reduce these overruns.

It is therefore the proposition of this study that inappropriate resource mix is a major contributor to poor project performance in terms of time and cost overruns.

The wastes of materials, excess time required in activities; idle time for machines and excess man power in activities accumulate in small amounts, but when they are summed up eventually lead to significant cost and time overruns. Hence the need to study the way these resources are mixed or optimized.

1.3. The Objectives of the study

The overall objective of this study is to investigate the causes and impact of resource mix practices in the performance of construction firms in Kenya. The specific objectives are:

a) To analyze and examine the resource mix practices by construction firms, through the following measurable indicators:-

    (i) Crew balance on various construction activities;

    (ii) Men-machine man hours and machine hours combination for the various activities in a construction project;

(iii) Activity times for various construction trades as currently used by construction firms;

(iv) Equipment scheduling for the various activities in different trades (methods).

(v) Materials management on the various construction activities with a view to establishing wastage factors.

b) To examine the effects citizenship status and technical personnel's level of education training has on resource mix practices by construction firms in Kenya in their projects.

c) To examine the effects citizenship status has on construction resource indicators as formulated in the study and project information management strategy on project performance.

d) To examine the application of manufacturing production optimization techniques and just-in-time philosophy production process by construction firms in Kenya.

1.4 The Hypotheses

The thesis tested by this study was that "variance between actual construction project performance and construction firm's resource mix can be substantially explained by construction firms resource mix practices in response to challenges posed by construction firms citizenship status, the level of construction resource managers education training, the resources mix practices with respect to construction project performance; the application of project information management strategies; application of manufacturing techniques, and the application of just-in-time philosophy in the construction production process at the site level.

More specifically, **Three principal hypotheses** were tested by this work.

Citizenship status effectiveness in resource mix.

P1 – H_o: Citizenship status has no effect on resource mix practices by construction firms in their projects.

P1 – H_A Citizenship status has significant effect on resource mix practices by construction firms in their projects.

Technical personnel's education effectiveness in resource mix.

P2 – H_o Technical construction firm's personnel's education has no effect on resource mix practices by construction firms in their projects.

P2 – H_A Technical construction firms personnel's education has significant effect on resource mix practices by construction firms in their projects.

Citizenship status and resource mix indicators effectiveness.

P3 – H_o Citizenship status impact on construction indicators has no effect on construction project performance.

P3 – H_A Citizenship status impact on construction resources has significant effect on construction project performance.

1.5 Study Assumptions

(i) Lack of adequate resources will continue and therefore there is need for optimum resource mix by construction firms.

(ii) Optimum resource mix require a set of national productive hours and material constants adopted for various construction operations/activities.

(iii) Management will continue to seek ways of improving construction project performance in the construction industry.

1.6. Rationale and the Significance of the Study

The completion of a construction project at maximum efficiency of time and cost requires proper financing and the judicious scheduling and optimum resource mix of the available resources. Manpower, equipment, methods, money and materials are important project resources that require management attention. Thus the result of this study will help in:-

(i) Further understanding of the causes of untimely completion of construction projects and would contribute to knowledge in the improvement of efficiency and reduction of construction project time and cost overruns.

(ii) The improvement of the overall construction industry performance, including savings in profits for the construction firms.

(iii) Better project management integration by reduction of waste, reduced project costs, increased project value, better workmanship, improved project sustainability, reduced conflicts and reduced risks in construction business.

1.7. The Scope of the Study

To achieve the objectives of the study, building construction firms in Nairobi were used as a case study. Construction firms in the study involves all the contractors registered by the Ministry of Public Works from category 'A' to 'H'. However, the study restricted itself to those firms which undertake work over 50 million Kenyan Shillings. These are firms in category 'C' and above. The projects handled by these firms require a high degree of complexity, technical know how, vast experience on the job, equipment, high borrowing capacity and a fairly good management input to handle complex construction projects. Table 1.2 presents the registration of contractors by value of work undertaken.

Table 1:2. Registration of Contractors by Value of Work Undertaken

Category Of Contractor	Value Of Work (In KShs.)
A	Unlimited
B	Up to 100,000,000.00
C	Up to 75,000,000.00
D	Up to 50,000,000.00
E	Up to 25,000,000.00
F	Up to 10,000,000.00
G	Up to 5,000,000.00
H	Up to 2,000,000.00

Source: Ministry of Public Works Register of Contractors; 2001.

The study focused on construction firms situated in Nairobi for ease of data collection. It is assumed in this study that, the information collected for activity durations, and the various time-lapse studies have been arrived at through long years of experience gained by these construction firms. This is why categories 'C' and above have been chosen for they posses this type of information.

1.8 Background of the study area.

Nairobi is the largest urban centre in Kenya with a population of about three and half million inhabitants. It is the centre of government business, as well as the headquarters of most companies, government organizations, international institutions and the centre of all communications network in Kenya, with the exception of marine navigation. Most of the industries, international organizations and financial institutions are located here. The city is located 36° 49' East of Greenwich Meridian (approximately 500 kilometres west of the Indian Ocean) and 1°15' South of the Equator (approximately 140 Kilometres south of the equator). The city covers an area of 681 square kilometers. It is approximately 1661 metres (5450 ft) above sea level.

Nairobi was established around the year 1899. At the end of the century the railway line was being constructed between Mombasa and Uganda. Situated at a point where the central highlands of Kenya merge into the Athi plains, Nairobi had an abundant supply of crystal clear water from the highlands. It was therefore selected as an ideal resting place and storage depot after the long construction and haulage from Mombasa through the dry arid areas. On the 16th April 1900 it was made a township and by 8th October 1928 the township committee was raised to the status of a Municipal Council. It attained the status of a city on 30th March 1950.

Building Development in Nairobi.

The current additional annual stock of buildings in the whole country since 1992 and 2004, by main towns, shows that Nairobi has the largest stock of buildings (Table 1.3).

The percentages shown in the table comprise the annual stock of new residential buildings, non-residential buildings and extensions, both residential and non-residential. Residential buildings include housing estates of both bungalows, maisonettes and flats. Non-residential buildings comprise offices, shops and godowns, stores, factories and social buildings such as churches and social halls.

Table 1.3: Current Additional Stock of Buildings in Kenya.

alysis of Building Cost Expenditures by Towns in Kenya By %												
wns/ r	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	Average %
robi	63.85	59.96	57.75	63.85	59.96	43.22	48.54	48.9	55.92	78.0	72.74	59.34
mbasa	26.26	25.47	27.31	26.26	25.47	25.17	29.00	26.7	21.99	11.50	10.27	23.22
er in wns	9.89	14.57	14.94	9.89	14.47	31.61	22.46	29.40	22.08	10.51	16.99	17.89

Source: Central Bureau of Statistics, 2000.

On the average 59.35% of the built environment expenditure have been used in Nairobi for the last 11 years. The lowest expenditure being in 2002 of 78.0% and the highest being in 1993 of 63.85%. Therefore Nairobi was chosen for this study due to the volume of assets it holds.

Other main towns include Kisumu, Nakuru, Eldoret, Kitale, Thika, Machakos, Nyeri, Kakamega, Embu and Meru.

1.9 Research Design and Methodology.

The research strategy used to accomplish the study objectives conformed to ethical standards and legal safeguards for the research participants (Cresswell, 2003 pp 62 – 68; David de Vaus, 2003 pp. 83 – 88; Fowler Jr, 1993 pp. 132 – 135; Mugenda, 2003 pp. 181 – 194, Sekaran Uma 2004 pp. 260). The data collection exercise involved the administration of structured interviews through questionnaires as these were the most appropriate for collecting the information required for the study, from construction firms that had been identified through structured random sampling. Information relating to resources which are used by construction firms for their projects is usually very sensitive and therefore it was necessary to assure the respondents that the information given was to be treated with confidentiality. The data collected included materials mix, man hours, machine/equipment hours, crew/men combination and time constants used in construction activities, by the various construction firms. The way these resources were mixed to form an activity was obtained through the same research tool.

An attempt was also made to get incorrect labour mixes; incorrect machine time combinations, information technology, technology advancement and finance resource (credit worthiness) to construction project performance. Information regarding the use of optimisation techniques as adopted from the manufacturing sector by construction firms was also collected together with the use of the Just-in-time philosophy as used by these construction firms.

The questionnaires were administered to the most informed persons(estimators) in these construction firms who deal with their day to day tendering activities in order for them to get construction work. Triangulation was not necessary as there was only one person who would deal with tendering activities in these firms, coupled with the confidentiality of the data, as these types of data are the lifelines of construction companies in the construction industry. This information should never be divulged to outsiders, other than the persons vested with the responsibility of tendering in these construction companies / firms. It was necessary that the issue of confidentiality be emphasized in the letter seeking permission to obtain information from these construction firms.

The information so obtained was compared/contrasted with information obtained through literature review on the same parameters, which had been used in United Kingdom / Great Britain being one of the countries in the world with a developed construction industry, where related research has been done/conducted. The research utilized both survey and statistical designs. Both of these methodologies were necessary in order to achieve the objectives of this study. The remaining information on the study was obtained from library sources such as books, journals / periodicals, theses, dissertations, handbooks and manufacturers catalogues. The details of the research design are discussed in the subsequent sections of this chapter.

1.9.1 The Population

Evidence shows that construction industry activities in developing countries are concentrated in capital cities, and most construction firms involved in construction activities locate in the capital cities (Talukhaba, 1999; Habitat, 1982: p. iv – 31)

The population of construction firms was within the geographical boundaries of the City of Nairobi, and as per the total population of firms registered by the Ministry of Roads and Public Works under categories A to C or C and above. According to a pilot survey carried out in March 2003, there were 3,251 building contractors and 246 civil engineering contractors as shown in tables 1.4 and 1.5.

Table 1.4: Building Contractors as at March 2003.

Category of Registration	A	B	C	D	E	F	G	H	J	Total
Number in the Category	188	99	123	249	417	620	883	671	1	3251

Source: Ministry of Roads and Public Works Register of Contractors, March 2003.

Table 1.5: Civil Engineering Contractors as at March 2003.

Category of Registration	A	B	C	D	E	F	G	H	J	Total
Number in the Category	91	16	35	34	26	19	18	7	0	246

Source: Ministry of Roads and Public Works Register of Contractors, March 2003.

Further these companies / firms were broken down as per table 1.6, with respect to the value of work they can undertake at any one given project.

Table 1.6: Number and Category of Contractor Registered and the Value of Work Undertaken in KShs. (Millions), as at March 2003.

Category	Number Registered	Value of Work Undertaken (KShs. Millions
A	279	>100.00
B	115	76.0 – 100.00
C	158	51.00 – 75.00
D	283	26.00 – 50.00
E	443	11.00 – 25.00
F	639	6.00 – 10.00
G	901	2.10 – 5.00
H	678	0.60 – 2.00
J	1	≤0.60
Total	**3,497**	

Source: Ministry of Roads and Public Works, March 2003

From the above sampling frame of building and civil engineering contractors, there were 531 construction firms registered under categories A, B and C by the Ministry of Roads and Public Works as at March 2003. There were also 21 construction firms which had registered for both building and civil engineering works categories. Hence the difference between 531 and the total for categories A, B and C in Tables 1.4, 1.5 and 1.6.

Out of the 531 construction firms registered, 410 were based in Nairobi and 121 were based outside Nairobi. That is, Mombasa, Kisumu, Kisii, Nyeri, Nakuru, Machakos, Kitale, Kakamega, Malindi, Kabarnet, Oyugis, Ruiru, Kiambu, Maragoli, Kericho, Marsabit, Kimilili, Iten, Kamiti, Mandera, Bungoma, Karatina, Kerugoya, Nong, Makuyu, Homabay, Kajiado, Lodwar, Thika, Naru moru, Meru, Webuye, Luanda and Nayhururu.

Citizenship status is crucial in financing construction activities, which would translate into credit worthiness of a construction firm. This has a bearing towards timely completion of a project as regards acquisition of resources as per the work performance and enjoyment of maximum cash discounts from material suppliers. Hence this led to a further division of the population into citizenship status and the location of operation as shown in Table 1.7.

Table 1.7: Categories A, B and C by Citizenship Status and Location of Operation

Citizenship Status	Based in Nairobi	Based out of Nairobi (Other Towns)	Total (Nos).
African	188	72	260
Citizen	99	32	131
Non-citizen	123	17	140
Totals	410	121	531
Percentages	77.21	22.79	100

Source: Own Pilot Survey Ministry of Roads and Public Works March 2003.

The results of the pilot survey shows that 77.21% of the target population is located in the City of Nairobi, and the remaining 22.79% is spread out in other areas. Mombasa city had 22 construction firms and the remaining 99 firms were distributed in the other 34 municipalities and towns in Kenya; working out to an average of 3 firms per municipality or township. For this reason the numbers in these other towns were considered not significant and therefore Nairobi was chosen as the location where the research had to be carried out, not only because of the shear size of the target population but also because it is within reach to avoid loss of time in travelling and other related expenses.

1.9.2 Fundamentals of Sampling

Hamburg (1983) argues that sampling is important in most applications of quantitative methods to managerial and other business problems for a number of reasons. In certain instances sampling may represent the only possible or practicable method of obtaining the desired information. For instance in the case of processes, such as manufacturing, in which the universe is conceptually infinite (including all future and current production), a complete enumeration of the population is not possible. On the other hand if sampling is a destructive process, a complete enumeration of the universe may be possible, but it would not be practical to do so. For example, if a military procurement agency wanted to test a shipment of bombs, it could detonate all the bombs in a testing procedure and obtain complete information concerning the quality of the shipment. However, since there would be no usable product remaining, a sampling procedure is clearly the only practical way to assess the quality of the shipment.

Sampling procedures are often employed for overall effectiveness, cost, timeliness and other reasons. A complete census, although it does not have sampling error introduced by a partial enumeration of the universe, nevertheless often contains greater total error than does a sample survey, because greater care can usually be exercised in a sample survey than in carrying out censuses. Errors in collection, classification, and processing of information may be considerably smaller in sample surveys, which can be carried under far more carefully controlled conditions than large-scale censuses. For example it may be possible to reduce response errors arising from lack of information, misunderstood questions, faulty recall, and other reasons only by intensive and expensive interviewing and measurement methods, which may be feasible in the case of a sample but prohibitively costly for a complete enumeration.

The employment of sampling rather than censuses for purposes of timeliness occurs in a variety of areas. A notable example is the array of government data on economic matters such as income, employment, and prices, which are collected on a sample basis at periodic intervals. Timeliness of the publication of these results is of considerable importance. The more rapid collection and processing of data afforded by sampling procedures represents an important advantage over corresponding census methods.

1.9.3 Sampling Procedures

Leedy (2001) and Sekaran (2004) outline sampling procedures as follows:

1.9.3.1 Simple random sampling.

This is the least sophisticated of all sampling procedures. It consists of having a population whose texture is either homogeneous or homogeneously conglomerate. The derivation of the sample is by means of a simple randomization process.

1.9.3.2 Stratified Random Sampling.

In the stratified random sampling design, certain differences between this process and the simpler method is at once apparent. The population, instead of a homogeneous mass, is composed of layers (strata) of discretely different types of individual unit. For example, if we think of grades 4, 5 and 6 in a public school. This is a stratified population. Generally, the stratification layers are somewhat equal - a school room has just so much seating capacity. If we were to sample a population of fourth, fifth and sixth grade children in a particular school, we should probably take equal samples from each of the three grades.

1.9.3.3 Proportional Stratified Sampling

Simple stratified random sampling design has just been examined above. In it, all the strata of the population were essentially equal in size. But a population which is markedly different. For example, we consider how different are the strata of a religions groups within a community which has, for instance 3,000 Catholics, 2000 Protestants and 1000 Muslims. It is now obvious that, instead of an orderly stratification, as in the previous population, here the population is a conglomerate, religiously heterogeneous, proportional mixture in the ratio strength of 3:2:1. Unlike the three public school grades in which the separate homogeneous strata were arranged one above the other, in this population the integral mixture of separate disparate units in conglomerate relationship exists.

The first problem is therefore to effect a separation of the several discrete elements in the total population and from each of the individual groups, then, to select a random sample proportionately representative of the numerical strength of each of the components within the entire conglomerate structure. The proportional stratified design, may, therefore, be the answer to the problem.

1.9.3.4 Cluster or Area Sampling

This is the fourth type of probability sampling, which is usually frequently used in large-scale studies because it is the least expensive sample design (Nachmias and Nachmias, 1996). It involves first selecting larger groupings, called clusters and then selecting the sampling units from the clusters. The clusters are selected by a simple random sample or a stratified sample. Depending on the research problem, researchers can include all the sampling units in these clusters in the sample or make a selection from within the clusters using simple or stratified sampling procedures.

For example, suppose that the research objective is to study the political attitudes of adults in the various election constituencies of a city. No single list containing the names of all the adult residents is available, and it is too expensive to compile such a list. However, a map of the election constituencies does exist. First we can randomly select a number of election constituencies from the list (first - stage cluster sampling). Then within each of the districts we can select blocks at random (second-stage cluster sampling) and interview all the persons on these blocks. We may use a simple random sample within each block selected. In such a case, we would be constructing a three-stage cluster sample. (This sample method is also called area probability sampling or just area sampling). Similarly, a survey of urban households may use a sample of cities or municipalities, within each city or municipality selected, a sample of constituencies; and within each selected constituency, the choice of cluster depends on the research objective and the resources available for the study.

1.9.3.5 Systematic Sampling

This technique consists of selecting a certain item in a series according to a predetermined sequence. The origin of the sequence must be controlled by chance. That is, the first selection is determined by some random process, such as the use of a table of random digits. Using the systematic sampling technique, we would have chosen by a predetermined sequence the clusters for sampling. Suppose we toss a coin, Heads dictate that we begin with the first number in the arithmetic progression of odd numbered clusters. Tails will demand that we begin with the even numbered digit and follow the arithmetic progression in that mode. The coin comes down tails, which means that we shall start with the first even-numbered digit, which is 2, and select systematically sequential clusters 4, 6, 8, 10 and so on till the last number in our population.

Alternatively, the research is designed such that the K^{th} sampling unit of the population after first selecting the first sampling unit at random from the total of sampling units. Thus, if you wish to select a sample of 100 persons from a population of 10,000, you would take every hundredth individual ($K = N/n = 10{,}000 / 100 = 100$).

Systematic sampling is more convenient than simple random sampling. When interviewers untrained in sampling techniques have to conduct their sampling in the field, it is much simpler to instruct them to select every K^{th} person from a list than to have them use a table of random digits. Systematic samples are also more amenable for use with very large populations or when large samples are to be selected.

The sample size depends largely on the degree to which the sample population approximates the qualities and characteristics resident in the general population. For instance, if homogenuity or heterogeneity is the composition of the general population, this will indicate some identity of the same characteristics in the sample. But if the population is markedly heterogeneous, then a large sample will be needed than if the population is more nearly homogeneous. Thus the researcher should consider three factors in making any decision as to sample size:

i) What is the degree of precision required between the sample population and the general population.

ii) What is the variability of the population? (This is commonly expressed as the standard deviation), and

iii) What method of sampling should be employed?

1.10 The Sample

From table 1.8 on page 23, the sample of 241 construction firms which were manageable was used, and considering that they were spread in the three categories of citizenship status, there was no need for sampling. However, there is no minimum and maximum sample size in case study research (Yin Robert K, 1989 pp. 21, 43 & 54); Yin Robert K (2003 pp. 48 – 49). Further, studies on construction projects have in many cases worked with small sample sizes for various reasons. For instance Nkado (1992) investigated information systems for the Building Industry with a sample of 29 cases; Ogunlana, et al (1996) investigated the causes of delay in projects in Thailand basing their research on a sample of 12 projects; Uher (1996) investigated the cost of estimating practices in Australian construction industry using a sample of 10 projects, Talukhaba (1999), investigated causes of project delays in highrise buildings based on 38 projects, Mbatha (1993) analysed building procurement systems features and conception of an appropriate project management system for Kenya based on 32 participants spread in seven categories, ranging from 2 to a maximum of 9 and Walker (1994) argues that sample sizes of 30 – 35 projects have been used for investigations in construction time performance.

Hamburg (1983, pp. 238 – 244) argues, that if an investigator wants to know how a large random sample is required in a research, he must answer two questions in order to specify the sample size. Namely, what degree of precision is required and what probability is attached to obtaining that desired precision. Clearly the greater the degree of desired precision, the larger will be the necessary sample size. Similarly the greater the probability specified for obtaining the desired precision, the larger will be the required sample size.

Alreck, et al (1995, pp. 62 – 63) argue that there are maximum and minimum practical survey sample sizes that apply to all surveys. Ordinarily a sample less than about 30 respondents provides too little certainty to be practical. The minimum limit and maximum limits from experienced researchers are about 100 respondents and 1000 respondents respectively for large populations although there are exceptions. It is further argued that it is necessary to sample more than 10% of the population to obtain adequate confidence, providing the resulting sample size is less than 1000 units; the experienced researcher would probably consider a sample size of about 100 or so. For populations of about 5,000 units, the minimum practical sample size would be 100 or so and the maximum would be approximately 500 or 10%.

For populations of more than 10,000 a sample size between 200 and 1000 respondents would be adequate. Mutai (2000) argues that the sample size depends on the level of precision required in the estimates, the intrinsic level of variability of the variable to be estimated and the sample design to be used. Thus the more precise the estimates are required to be the smaller the standard error, and the larger the sample size must be. Hoinville et al (1978, pp. 60 – 61) argues that the decision on sample size is almost always a matter of judgement than of calculation, and the total sample size is usually governed by the sample size required for the smallest sub-group as a rough guide. The smallest sub-group will need to have between fifty (50) and hundred members (100).

Leedy (1985 pp. 147 – 161); and Mugenda et al (2003 pp. 42 – 44) argue that the rule of thumb should be to obtain as big a sample as possible. However resources and time tend to be the major constraints in deciding on the sample size to use. However in social science research the following formula can be used to determine the sample size (Fisher, Laing and Sloeckel, 1983).

$$n = \frac{Z^2Pq}{d^2};$$

where n = Desired sample size if the population is more than 10,000

Z = the standard normal deviate at the required confidence level

P = the proportion in the target population estimated to have characteristics being measured.

q = 1 – P

d = the level of statistical significance

However Leedy (1985) argues that the researcher should consider three factors in making any decision as to the sample size. Viz, the degree of precision required between the sample population and the general population, what the variability of the population is (standard deviation) and what method of sampling should be deployed.

Rudestam et al (2001 pp. 93) argues that a sample size is a function of the following:

i) variability in the population

ii) the precision or accuracy needed

iii) the confidence level desired

iv) type of sampling plan used (Random or Stratified and the size of the population used)

v) cost and time constraints.

Roscoe (1975) proposes the following rules of thumb for determining sample size.

i) Samples large than 30 and less than 500 are appropriate for most research

ii) Where samples are to be broken into sub-samples (e.g. males/females / juniors/ seniors); a minimum sample size of 30 for each category is necessary.

iii) In multi-variety research (including multiple regression analysis, the sample size should be several times (preferably 10 times or more) as large as the number of variables in the study.

iv) For simple experimental research with tight experimental controls (Matched pairs etc), successful research is possible with samples as small as 10 and 20 in size.

David de vaus (2003 pp. 143 – 144) argues that the sample size varies and depends on the type of research undertaken. It is also argued that the sample size depends on funds, time, access to potential participants, planned method of analysis, and the degree of precision and accuracy required (David de vaus, 2003 pp. 187). In general the larger the sample the better, but beyond a certain point increasing the sample size has smaller and no more marginal benefits.

Fowler, Jr. (1993 pp. 33 – 35) and de Vaus (2003 pp. 187) argue that, there is rarely any particular sample size in any research study. However the size of a sample is a compromise between the funds available for conducting the research, time for the study, access to potential participants, the research design techniques used the degree of precision and accuracy required and finally the nature of the research study itself. From the foregoing the sample sizes in this study are justifiable.

Out of the 410 construction firms in the specified category in Nairobi, 241 had physical addresses in any of the three directories. Namely the telephone directory, the box rental directory and/or the Nation Classified Business Directory. The rest could not be traced in any of those three directories. This represented 85.48% of the target population. Out of the 241 construction firms which were traceable / could be located, 96 of them were of African citizenship status, 65 of them were citizens who were not of African origin, and 80 were of non-citizen construction firms. However, these reduced to 206 construction firms due to various reasons. Some of these reasons responsible for this attrition were: decline to participate due to the sensitive nature of the information, lack of information needed in the research because such information had not been kept; some of the respondents simply refused to participate because they were very busy with office work, others felt that their participation would expose them to unfair competition; and others changed their offices and relocated and could not be traced at all, while others did not respond for purely unco-operative reasons. The attrition therefore occurred for reasons beyond the control of the researcher. Table 1.8 summarises the above information.

Table 1.8: Construction Firms in Categories A-C as per Ministry of Roads and Public Works Registration based in Nairobi.

Citizenship Status	Total No.	Not Traceable in Directories	Population in Sample	Responsive Firms	Response Rate
Africans	188	92	96	80	83.33%
Citizens (Not African)	99	34	65	56	86.33%
Non-Citizen	123	43	80	70	87.5%
Totals	**410**	**169**	**241**	**206**	**85.48%**

Source: Field Survey 2004

1.11 Response Rates

There is no agreed upon standard for a minimum acceptable response rate, however Fowler, Jr. (1993. p. 40) argues that academic survey organizations are able to achieve 75% and above response rates which are considered adequate. In general, however, if response rates are much less than 65% it generally means that the interviewer was not willing to arrange an interview at the respondents convenience, or did not call in advance to make an appointment or did not effectively and accurately present the purposes of the research, or did not assure the respondents of the uses of the data so collected, or the interviewers were not effective and possibly did not understand the importance of response rates. Even when surveys are done with reasonable care, however, response rates often are in the 60% to 75% range (Fowler Jr. 1993 pp. 52). Gay (1983) argues that response rates at 70% are considered a strong basis and also adequate. Mugenda et al (2003 pp. 82 – 83) argues that a response rate of 50% is adequate for analysis and reporting, whereas a response rate of 60% is good and a response rate 70% and over is very good.

The response rates realized by this study for the three different categories of construction firms were 83.3%; 86.15% and 87.5%, with an overall response rate of 85.48%. Hence these response rates are justifiable for this study.

1.12 Sample Characteristics

The sample of 241 construction firms was stratified by African firms, citizen (not Africans) firms and non-citizen firms in terms of ownership as per the Registration details from the Ministry of Roads and Public Works register. These three attributes were important to test whether there were differences in optimisation of resource mixes and performance of construction firms with respect to factors that explain projects performance.

All the 241 construction firms produced an overall positive response rate of 85.48%. This representation in the sample by strata is shown in Table 5.5. In terms of African construction firms the sample size reflected a response rate of 83.33%, citizen construction firms a response of 86.15% and non-citizen construction firms a response rate of 87.5%

1.13 Identification of Variables

Most of the variables were identified through the literature review as indications influencing construction project performance, and the rest from the researchers own experience and involvement and participation in the implementation of construction projects of over a working experience of 26 years in diverse construction projects. The experience proved useful in identification of some of the variables. In total 6 variables were identified as the indicators which influence construction project performance. These are incorrect labour mixes; incorrect material mixes; incorrect machine time mix; information technology; technology advancement and finance as a resource (credit worthiness). Other variables related to construction resources and interrelated to construction activities have also been identified as factors affecting construction projects performance and were included in the research questionnaires. A copy of the questionnaires is shown in the Appendix 'A'

1.14 Questionnaire Design

The questionnaire was designed in such a way that all the activities and the required variables are easy for analysis. The first part of the questionnaire dealt with the background information of the construction firm, followed by excavation and earthwork activities, concrete work activities, walling and block work activities. The questionnaire also had sections dealing with the project performance and its indicators, project information strategy; optimisation techniques as embraced by the manufacturing industry production process and applications of Just-in-Time philosophy in construction production process.

The data required / sought for in these questionnaires were archival based on the past experiences and recorded information by the respondents on construction resource mixes or optimisations for different construction activities. The questions were both open ended and closed ended. The intention was to show how different classifications of construction firms mixed their resources and whether any of them had any advantages over the others which could possibly explain why projects performance by construction firms had been dismal over the years.

1.14.1 Pilot testing of the Questionnaire

The first draft of the questionnaire was given to supervisors and colleagues in the faculty for their comments. The comments were incorporated in the second draft, which was then pre-tested on ten respondents that were involved in tendering for construction projects. They were drawn from samples of those listed in the Ministry of Roads and Public Works register for contractors under Categories C and above. The main aim was not only to receive comments and suggestions on additional information from respective respondents but also to get an indication of the expected responses with a view of detecting and scrutinizing any ambiguities in the asked questions or given answers. The final version of the questionnaire was prepared with the incorporation of all the comments made on the pre-test questionnaire.

1.14.2 Administration of the Questionnaire and Data Collection

A research permit was obtained from the government of Kenya through the Permanent Secretary, Ministry of Education and Technology. This research permit together with a letter from the Department of Building Economics and Management, University of Nairobi were used by the researcher for permission to collect the necessary data from the sampled construction firms. Letters requesting permission to gather information about resource mix optimisation in construction projects by construction firms were delivered by hand to the participating firms. The letters also explained the purpose and the usefulness of the research and the type of information that was needed.

The data collection survey which involved personal interviews was carried out by using a questionnaire with the help of 8 research assistants. The questionnaire was the most suitable method of data collection because of the nature of the data. Talukhaba (1999); Gall et al (1996) and Fowler Jr. (1993), recommend the questionnaire as a convenient and the most suitable instrument for data collection in survey as well as statistical research in social and technical research. The data was predominantly quantitative and this required a method of recording to avoid loss of the data, and to improve on the response rate on the part of the respondents.

The research assistants were trained for three days and were taken through the questionnaire on how to fill and record the data carefully in the same way the researcher would have done. They were also trained on how to conduct a successful research interview. The survey involved visiting each construction firms offices and administering the questionnaires on the most informed person in the organization, especially the person concerned with or in charge of tendering and estimating in that organization. This is the person who keeps all the records on resources which go into construction projects for that organization. The information given by the respondent is then recorded / filled into the questionnaire.

1.14.3 Validity and Reliability of the Data Collection

Resource mixes for all the collected data were compared for the purpose of detecting those that appear to be the odd ones. The data on the various performance indicators were also compared in each of the three categories of the construction firms classification separately to detect any anomalies in the data. As there were no previous studies conducted in construction resource mix it was difficult to discard any data for extremities resulting from very high deviations from the expected results. Hence on this account all the data collected were assumed to be valid and none was discarded.

1.15 Data measurement

The measurement of the data varied with the variable resource in question. Where the resource being measured is the "material", then the measurement was in cubic metres, square metres, linear metres, tonnes or kilogrammes. When the resource under consideration is labour, then the unit of measurement is man hours per any activity related to the unit of execution. A resource like equipment or machines, the unit of measurement used is machine time in the form of hours used to perform that particular activity. Variables such as idle time or contributions made by project performance indicators, the unit of measurement was in the form of percentages. For the project information strategy a Likert scale rating was used to measure how electronic data interchange benefited construction firms. The ratings in the scale adopted were in the order of 1, 2, 3, 4 and 5 in ascending order of maximum benefit. The rest of the information where the research sought to investigate the extent to which construction firms embraced manufacturing techniques were measured by frequencies and statistical averages.

1.16 Study Hypothesis

It was hypothesized that construction project performance (CPP) is significantly affected by inappropriate matching and management of construction resources by construction firms and therefore is a function of the following factors:

a) Labour

b) Materials

c) Equipment

d) Information (Technology)

e) Time

f) Finance (credit worthiness of the firm)

Thus CPP = f(L, M, E, I, T, F)

Where CPP = Construction project performance (time, cost, quality and environmental factors)

L = Labour (staff / men)

M = Materials

E = Equipment (machine time)

I = Information (Technology)

T = Time (Durations of activities)

F = Finance (credit worthiness as a form of resource)

Alternatively it may be stated that proper matching and management of construction resources by construction firms does not significantly affect / contribute significantly to construction project performance.

1.16.1 Testing the Hypothesis Using the Mean Score (μ) When the Population (δ) Standard Deviation is Unknown

All the variables had two hypothesis. The Null (H_0) hypothesis is that the variables are not significant contributors to construction project performance. The alternative Hypothesis (H_A) was that the variables were significant contributors to construction project performance.

The rejection of the Null hypothesis means the acceptance of the alternative hypothesis. It was therefore necessary to set the decision point, at which to accept or reject the Null hypothesis based on the mean variable score.

The decision parameter is the unknown population mean μ. A pivotal level μ_0 is used to define H_0 and H_A. From the literature review the pivotal points for the different resource inputs have been found from studies / research conducted out in the United Kingdom by Enterkin and Reynolds (1978), Buchan et al (1999), Smith (1986), Spence (1979), and Cross (1990) which formed the decision points for the different resource inputs for the three categories of construction firms. The more serious error established which side of μ_o to include under the H_o. The two errors are:

(I) taking the wrong action when $\mu \leq \mu_o$; and (II) taking the wrong action when in fact $\mu \geq \mu_o$.

The second stage was to set the lower limit of the sample mean at which the variable could be classified as significant. This involved a one-tailed lower limit test because any score beyond the mean was already significant. The decision rule was determined by finding the probability of committing a Type I error, that is, concluding that a variable is significant when it is not. Lapin (1987), Mugenda (2003), Mutai (2001), Alreck (1995); argue that Type II error can be avoided by setting a lower confidence level of 95%. In this study committing Type I error was viewed to be less harmful than committing Type II error especially in an environment of construction projects performance by construction firms. Type II error is committed when it is concluded that a variable is not significant when it is [Bryman et al (2005 pp. 136 – 137)].

The variables in the study have caused project cost overruns and time overruns at one particular time in the execution of the projects. Due to the fact that construction firms must use these resources, during project execution, it is only prudent that the managers must be aware of any possible problems that would impact negatively on construction project performance. Hence it is more important to avoid committing Type II error. It is further argued that, Type II error can be avoided by setting a higher confidence level (Lapin 1987; Mugenda 2003; Alreck 1995; and Mutai 2001). However Mutai (2001) and Mugenda (2003) argue that, there is no single standard or universal level of significance for hypothesis testing. But in practice, three of the most commonly used levels of significance are the 0.10, 0.05 and 0.01 levels corresponding to the confidence co-efficient of 0.90; 0.95 and 0.99 respectively. The more confidence the researcher wants to have in the test, the smaller he makes the alpha level. Mugenda (2003, pp. 143) argues that a significance level of 0.01 is therefore higher or more strict than a significance level of 0.05. Significance level of 0.10 is very low because the research is only 90% confident that results are due to treatment or the independent variable. A significant level of 0.10 is only used in exploratory studies because it is too liberal.

In areas where a lot of research has been done, the researcher should aim at being 95% or 99% sure of the results. Most researchers in education and social sciences use a significant level of 0.05 to test the hypothesis. Alreck (2001, pp. 321) and Bryman et al (2005 pp. 139) further argue that most statistical analysis programmes routinely compute the 95% confidence interval. The confidence level set was therefore 95%. This means any variable that scored a sample mean of more than 1.96 standard deviations away from the asserted population mean at the upper tail of the distribution was regarded as a significant contributor to construction project performance.

1.17 Methods of Data Analysis

Four methods were used for data analysis. These are the normal deviate Z test statistic for unknown population standard deviation (δ) for large samples where 'n' > 30 and the normal distribution; the students 't' test for sample sizes n<30 and the student t distribution; two-way analysis of variance; multiple regression and correlation analysis and the mean scores. The justifications of each are discussed in detail in the subsequent sections of this chapter.

1.17.1 Z and the normal Distribution for Large Samples where 'n' > 30 and Student 't' Test

The basic assumption was that the variable score distribution in the sample reflected what could be expected from a normally distributed population having a mean **μ** and a standard deviation δ. Hence the sample distribution for x is also normal, its mean is also **μ** and its standard deviation is $\boldsymbol{\delta x = \delta/\sqrt{n}}$. This is true no matter what the size of the sample happens to be (Lapin, 1987 pp.201). Thus the statistics calculated from the sample such as the mean variable score, and the standard deviations of the sample were estimates of the variable parameters in the population of construction firms' optimum resource mix inputs.

The Z values were obtained from the following formula:

Normal Deviate for the sample mean

$$Z = \frac{\bar{X} - \mu;}{\delta x}$$

Where, $\bar{X}$ = sample mean

μ = Population mean

δx = Standard error of the estimate

The student t – distribution was used with sample strata with less than 30 cases. The student t distribution has a relative frequency curve unlike the normal curve but its shape is determined by the number of degrees of freedom (df) (Lapin (1987 pp. 242 – 245). The (df) is calculated by subtracting one from the sample size. The formula for calculating the t distribution value is as follows

$$t = \frac{x - u}{s / \sqrt{n}}$$

Where x = sample mean

μ = Population mean

s = Standard error of the estimate.

Sub-samples stratified by the different levels of education of the respondents were below 30 cases. The critical values were compared to the mean scores to enable a decision to be taken as to whether a variable was significant or not. These were derived from the student 't' statistic formula as follows:

$$x = \mu + t_{\acute{a}\,(0.05)} \frac{S}{\sqrt{n}}$$

Where x = Critical Value

μ = expected population mean score (from literature review)

S = Standard error of the estimate

n = Size of the sample where $n < 30$

$t_{\acute{a}\,(0.05)}$ = The student 't' test confidence interval at appropriate degrees of freedom.

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

The overall sample and sample strata with n> 30 utilized the Normal Deviate. The critical value at 95% confidence level were calculated using the following formula:-

$$x = \mu + Z_{\alpha}\delta x$$

Where x = Critical value

μ = expected population mean (from literature review)

δx = Standard error of the estimate

$Z_{\alpha\,(0.05)}$ = Z value at the decided confidence interval.

These values were calculated for each resource variable. This exercise helped in the isolation of variables that significantly influence construction project performance in resource mixes.

1.17.2 Two Way Analysis of Variance and the F Distribution

In testing the hypothesis, the test was in the form "Is there a significance difference among the means of the construction firms' resources mix as a consequence of the firms' citizenship status? The analysis of variance (ANOVA) technique can be used to answer this type of research question. If there is a significant difference, for example in the mean value of the resource mixes in different construction company's citizenship status, then it can be concluded at the accepted level of significance that different company's management of resource mixes affect resource optimisation and consequently affects construction project performance. The 95% confidence level was adopted in the study for analysing data using ANOVA technique to determine factors affecting construction project performance.

Analysis of variance uses data to compare several treatments to determine if they achieve different results. Here, the word "treatment" is used in a broad sense that includes not only the medical therapy, but other factors that a researcher might investigate. The theoretical conditions under which analysis of variance applies to our research problem are that;

i) The populations for each sample are normally distributed. However if the sample is large we do not need the assumptions of normality.

ii) Sample observations must be independent of other samples and each sample size 'n' is drawn randomly.

iii) The population from which the samples are drawn have equal means, variances and standard deviations. This means that –

$\delta_1^2 \quad = \quad \delta_2^2 \quad = \delta_3^2 \quad = \quad ...... \delta_k^2$ for K population

ANOVA is most commonly used / employed when there are three or more samples whose means are the subject of comparison (Mutai 2001, pp. 191 and Hinkle et al 1998 pp 348). The objective of two factor analysis (Two-Way) is to isolate the effect of two variables of interest in an experiment. There are two types of Two-Factor ANOVA.

i) The randomised Block design where inferences are made with respect to the factor which is central to the experiment.

ii) The completely randomised design where treatments are randomly assigned units within each block.

In a design with two independent variables, both the Independent variables may be manipulated and the other used as a control variable. If there are variables such as incorrect labour mix, incorrect material mix, incorrect machine time mix; information technology, technology advancement and finance resource (credit worthiness), that are believed to influence construction project performance (the dependent variable) then such variables may be controlled simply by incorporating them into the study as one of the independent variables. The independent variables in such experimental designs are referred to as factors; when there are two factors, the technique is known as a two-way analysis of variance.

1.17.3 Multiple Linear Regression and Correlation Analysis

Another important exercise in the study was to rate the significance of the variables with regard to their contributions to construction project performance. All the other three methods had not brought this important aspect. It is important for construction project managers to be aware of the factors that contribute most to construction project performance when factoring in construction resources with projects so that they know where to devote their efforts in managing construction projects. Also the conceptual construction project performance model which is a function of resources or inputs into the construction project was conceptualised along the cause and effect relationship. The most suitable method or test for rating the significant contributors to construction project performance and developing the conceptual working model on the cause and effect relationship was found to be the Regression method or test.

There are four procedures which can be employed in multiple regression analysis. These procedures are the enter / remove method, stepwise, backward and forward.

In the Enter/Remove method all the predictor variables are initially included in the regression model and individual predictor variable are deleted if they do not contribute to the regression.

The stepwise procedure (Hamberg 1983 pp. 441; Lapin 1987 pp. 467; Bryman 2005 pp. 306) is a versatile regression analysis for which a number of computer programs exist. In this type of analysis, at the first stage, the computer determines which of the independent variables is most highly correlated with the dependent variable. This is the variable that provides the greatest reduction in the unexplained variation, in Y(dependent variable) at each stage.

In doing this the computer performs single regression separately for each independent variable, printing the results for the best one. The next step of the program performs separate multiple regression each combining one of the remaining independent variables for those selected in the previous stages. The process continues in successively higher dimensions either until every variable has been included in a multiple regression involving them all or until no further reduction in the unexplained variation is possible. Such a programme efficiently saves all previous calculations necessary for higher dimensional analysis.

In other words the programme selects the independent variable that accomplishes the greatest reduction in the unexplained variance remaining at the first two variable analysis. The computer printout then displays all the usual statistical measures for the three variable relationships. The programme continues in this stepwise fashion, at each stage entering the "Best" independent variable in terms of ability to reduce the remaining unexplained variance.

In the backward solution (Henkle et al 1998 pp. 504 – 505) all the predictor variables are initially entered into the regression model called the full model), and then individual predictor variables are deleted if they do not make a significant contribution to the regression.

In the forward solution / method the predictor variables are entered **one at a time** until the increase in R^2 is no longer statistically significant or until all predictor variables have been included in the regression model. The fist variable selected for inclusion into the Regression Model is the predictor variable that has the highest correlation with the criterion variable. The next predictor variable selected is the one with the highest partial correlation with the criterion variable with the effect of the first variable partialed out. This variable will result in the greatest increase in R^2 – that is, the predictor variable that accounts for the greatest amount of the remaining variance in the criterion variable after the effect of the first predictor variable has been removed. The next predictor variable is similarly selected. The forward solution is terminated when the increase in R^2 is no longer statistically significant or all the predictor variables are included, whichever comes first.

In the forward solution, unlike the stepwise solution, when a predictor variable enters the regression model, it remains in the model regardless of whether it continues to contribute to the regression as other predictor variables are entered. In the stepwise solution, predictor variables are selected in a similar way, however, at each step after a new predictor variable is added to the model, a second significant test is conducted to determine the contribution of each of the previously selected predictor variables, as if it were the last variable entered. Therefore it is possible for a predictor variable to be deleted if it loses its effectiveness as a predictor when considered in combination with newly entered predictors. As with the forward solution, the stepwise solution is terminated when all the predictor variables, are entered or when the remaining predictor variables do not make a statistically significant contribution to the regression.

Draper (1981 pp. 310) argues that the stepwise solution is one of the best procedures and recommends its use because, it is more economical of computer facilities and it avoids working with more independent variables (X'^s) than are necessary while improving the equation at every stage. Hence the study used stepwise regression analysis.

In the regression analysis the basic assumption was that a linear relationship exists between the dependent variable (CPP) and the independent variables. The dependent variables were the scores on Construction Project Performance (CPP) in construction firms which had been obtained through the interview questionnaires. The independent variables were the significant variables which caused construction performance as measured by the percentage scores contribution to performance.

Stepwise method begins with no independent variables in the regression model (Draper, 1981 pp. 307). It picks variables one at a time, starting with the most promising variable, in reducing the unexplained variation in the dependent variable. It then adds to the model one variable at a time from a pool of the remaining variables depending on whether it passes an F- test at the specified significance level, which was set at 95%. However the variables do not stay in the model in subsequent steps. After a variable is entered, the stepwise method examines all the variables already entered in the model and deletes any variable that does not produce a significant F statistic.

The correlation analysis was used to test the existence of multi-collinearity. A print out of the result of the stepwise regression analysis is shown in the appendix.

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

The other level of testing significance involved the computation of the probability that the sample R is different from Zero. If the same R is zero it means that a linear relationship exists. The computed probability was compared to the critical value of F corresponding to the given degrees of freedom at 95% confidence level or 5% significance. Beta co-efficients were also computed for each significant variable.

1.18 Summary

The four methods were necessary so that conclusions could be made about the various variables. The mean was necessary to isolate the variables that were significant in construction resource mix and construction project performance by the three categories of construction firms. The Z and the normal distribution for large samples where $n > 30$ for hypothesis testing about the mean with unknown standard deviation and known population mean was useful in the analysis, and similarly the student's 't' test statistic for samples where $n \leq 30$.

The two way analysis of variance and the F Distribution were useful in testing the hypothesis as to whether there were differences among the means of the construction firms resource mix as a consequence of the firms' citizenship status. The multiple linear regression and correlation were useful in rating the significance of the variables with respect to their contributions to construction project performance and the construction of the construction project performance model.

1.19 Delimitations of Scope and Key Assumptions.

While it is not possible to study all the activities by construction firms so as to understand performance of construction firms in the context of resource mix combination in explaining performance, it is imperative to have some significant pool of activities for this exercise. The study proposed the following activities which are fundamentally basic significant and essential in any construction project. These activities are:

i) Excavations works which are a must for any building structure

ii) Concrete works which forms the structural component of the buildings

iii) Walling and its constituent binding and bonding materials i.e. cement and sand mortars

iv) Reinforcement which go alongside with concrete work.

All these activities account for an accumulative value of 35% for a Ministry of Works standard type single storey house, 41% for Ministry of Works standard type single storey servants quarters and 58% for Ministry of Works standard type three storey flats respectively, according to a departmental circular No. 02/81 prepared by Ministry of Works, Housing and Physical Planning cost planning unit [Republic of Kenya (1981)].

The activities covered in these broad four categories comprise:-

i) Excavations and earthworks

ii) Concrete work in foundations, ground floor slab, columns, beams and staircases

iii) Hardcore fill

iv) Substructure and superstructure walls and its associated damp proof course

v) Cement and sand wall and floor finishes

On average these activities account for 44.67% of the value of these standard type buildings. This is quite substantial and reinforces the need for the case study in order to understand how construction firms mix and optimise construction resources in furtherance to understanding why construction firms perform dismally in the construction industry as evidenced by various researchers in the industry (Mbatha 1986, Talukhaba 1999, Walker D.T. 1994).

Conversely the study did not attempt to cover openings (which includes doors and windows), all the finishings both external and internal; services (which includes plumbing and mechanical installations, electrical installations; air conditioning, conveyor belts and escalators) all specialist installations and all civil works related to construction projects.

1.20 Operation Definitions.

Success:

In this study, **success is defined as the achievement of the desired results/goals** set by an individual or an organization. According to Naoum et al (1987; p.43) a project may be regarded as successful if the building is delivered at the:

i) Appropriate time
ii) Appropriate price; and
iii) Within the appropriate quality standard.

Increasingly, the achievement of these criteria has been associated with the methods of procurement for the construction. Resources including money are construed to mean the elements that are needed to produce work.

Optimum Resource Mix:

Optimum resource mix will be construed to mean, making of the best of anything or the most. Making as efficient as possible especially by analyzing and planning processes; preparing or revising so as to achieve the greatest possible efficiency (Chambers Dictionary 1990 edition). Optimum Resource mix / smoothing, leveling is construed to mean, a "method" of adjusting the timing of the activities within a plan to_economize on the use of resources by leveling the demand for each resource. Optimum resource mix is derived from the project work programme, whereas resource estimates are based on planned work programme.

Project Delays:

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

Project Time Performance:

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

Project Cost Performance:

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

Construction Project Performance with Respect to Resource Mixes:

It is the eventual completion of a project within the originally set resource targets such as materials, machine hours; man hours; activity durations; finances, zero wastes, zero cost overruns, and zero time overruns in construction projects.

Project Management:

The organization of resources required for a project in terms of materials, equipment (machines), skills (man power), methods, information and time (man-hours) so that the requisite items are available at the right time and right combinations and in the right place, and that the project can be carried out with the maximum efficiency and at the minimum cost. It is concerned with the identification of the clients' objectives in terms of utility, function, quality, time and cost, and the establishment of relationships between resources. The integration, monitoring and control of the contributors, to the project and their output, and the evaluation and selection of alternatives in pursuit of the client's satisfaction with the project outcome are fundamental aspects of construction project management (Walker Anthony; 1984).

Project Procurement:

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

Traditional Project Procurement:

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

Project Planning:

The process of gathering and organizing resources and other details necessary for the implementation of a project, to the set objectives of time, cost and quality.

Project Control:

The process of monitoring and comparing the achieved and planned performance for the purpose of detecting and correcting deviations. It is an integral part of the project management process. It aims at regular monitoring of achievement by comparison against planned progress. When deviations from planned progress occur, plans may have to be changed. Time is all important, and the control process should aim at early discovery of any departure from the planned course so that adjustments can be made in time to be effective.

Control information provides a basis for management decisions and an effective control system should satisfy the following requirements:

- It should draw immediate attention to significant deviations from what is planned.
- True and meaningful comparisons must be possible.
- The information should indicate what corrective action is necessary and by whom the action should be taken;
- It should be expressed in a simple form so that it is readily understood by those who have to make use of it; and
- Key areas of control must be chosen with care so that the results of control are worth the time and effort expended.

Resources:

The Readers Digest Oxford Wordfinder(1996) defines resources as the means available to achieve an end, fulfill a function etc, a stock or supply that can be drawn on; or available assets, or skill in devising expendients or practical ingenuity or quick wit. In this study, resources would be construed to mean materials used in construction projects, labour, machine time, time(duration), Information Technology, Technology advancement and finance in the form of Credit worthiness. All this resources are used and also support construction production activities in construction sites.

1.21 Structure of the thesis report.

This chapter laid the foundation of the thesis. It introduced the research problem, objectives and hypotheses, the research justification, presented operational definitions, described and justified the research design and methodology. The next chapter looks at the concept of construction project performance in the light of time performance, cost performance and production techniques as embraced in the manufacturing industry.

CHAPTER II

THE CONCEPT OF CONSTRUCTION PROJECT PERFORMANCE

2.1 Introduction

Construction project performance is defined as the eventual completion of a project within the originally set contract period and the originally set cost target. Hence the time, and cost achieved at a project completion are the widely used measures of a project success (Mbatha 1986, and Talukhaba, 1988). However, there are other indicators of project performance whose effects have been found to be insignificant by the above cited studies. These were cited by World Bank (1979) Reports as:

- Inefficient technical/economic appraisal
- Poor estimates by the 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 and disruption
- Poor contract management/control
- Bad industrial relations
- Lack of competence by contractors and suppliers
- Poor inter-ministerial communication and rigorous government procedures.

Mbatha (1986) argues that building construction project performance can be measured by using a number of indicators, some of which are:

i) Cost

ii) Time

iii) Productivity

iv) Rate of Return

v) Value for money

vi) Contractor's profit margin

vii) Participants satisfaction

However time and cost are the easiest to measure because empirical data can be obtained on the initial estimate and the final cost and time of the project. He argues that the rest were not easy to measure since architects did not specify the quality of management required to the contractors as they only specify materials and workmanship so as to ascertain the input/output relationship in terms of labour, materials plant, management level or a combination of part or all of these factors together.

The rate of return on invested capital on public utilities 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 specialized skills than available.

Holding workmanship constant, the profit margin of 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 clients satisfaction. The client's satisfaction is very subjective, and its measurements becomes even more complex when one has to consider all the participants. These participants include, the contractor, the professionals, the general public and the ecology. The success in balancing the interests of all these parties would be a success to the project itself. Project performance is essentially an evaluation of the success of the project, in giving the client value for money and achieving his objectives. It is these objectives that contribute to the clients satisfaction, and since satisfaction is not easy to measure, one can determine the level the satisfaction by measuring the separate objectives which contribute to the total satisfaction. Some of these objectives include getting a building in the expected time and within the given budget without sacrificing on the quality.

In order to further the understanding of construction projects performance, it is important to look at performance in three different levels of the construction project. The first (upper) level called the global construction performance comprises project time overruns and project cost overruns.

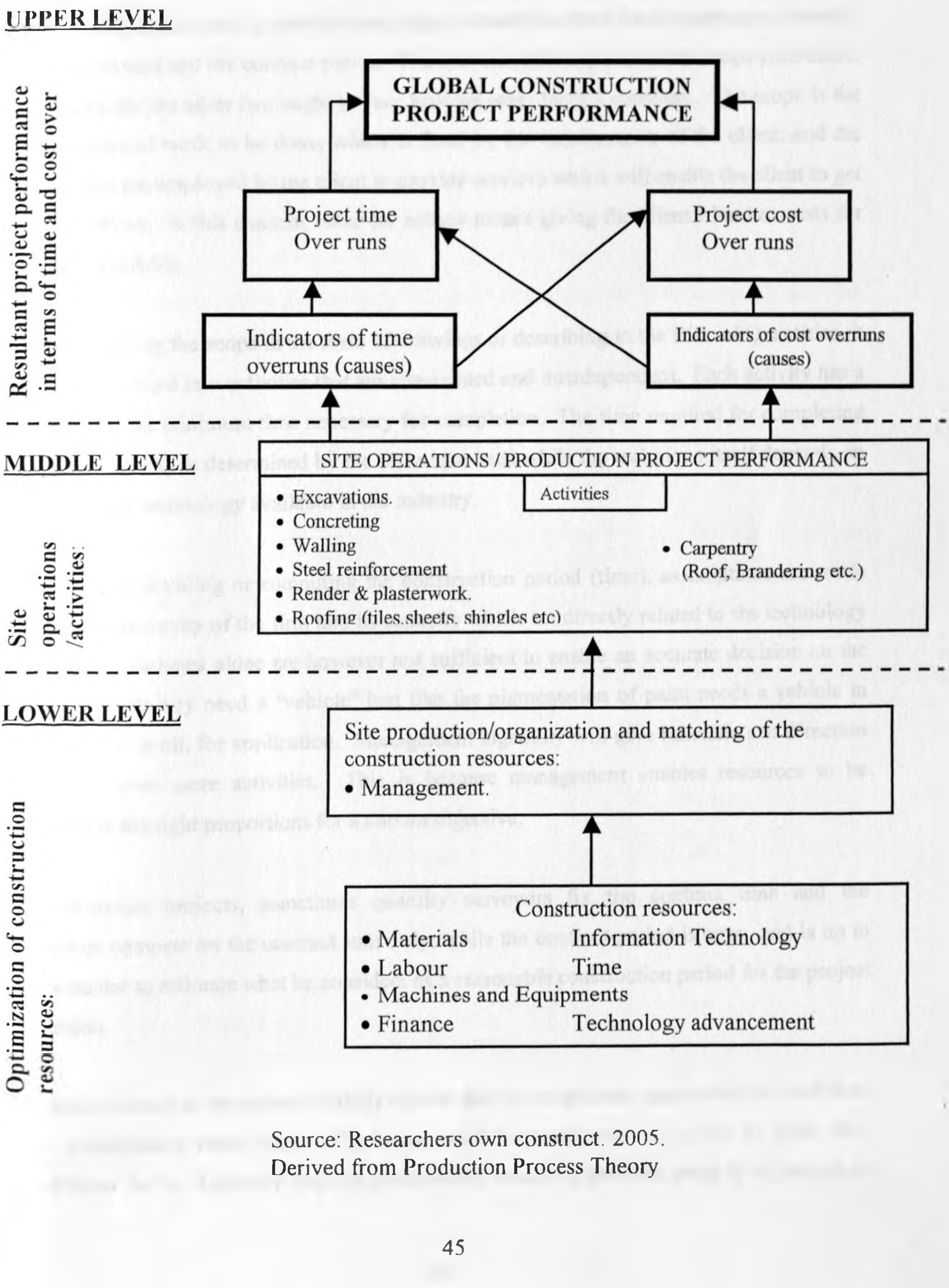
The second (middle) level of the construction project performance comprises the site operations / project performance in the various activities of the project. These activities comprise the various trades in the project. Some of these activities / trades include:

- Excavation
- Concreting
- Walling (masonry & concrete block work)
- Steel reinforcement
- Rendering and plaster work
- Roofing (tilling, sheeting, shingles etc)
- Carpentry work (roof, ceilings, brandering)
- Pavior or floor finishes.

The third (lower) level of a construction project performance comprise the site production or organization and matching of the construction resources (management) with the construction resources themselves. These construction resources comprise materials, labour, machines/equipment, time; information management. Finance, even though largely regarded a construction resource should not strictly be a resource because all the other resources can be expressed in terms of finance to measure project performance in terms of costs. The focus of the study will be on the middle and lower levels, as most studies/researchers have dwelt at the upper level of construction project performance.

Poor resource management, particularly resource mix or optimization on the part of construction firms which are involved in the construction production process at the site has a profound effect on the overall project performance. The wastes in materials, excess time required in activities accumulate in small amounts, but when they are eventually summed up lead to significant cost and time overruns. Hence resulting to poor performance of the project and therefore calling for the need to study the way these resources are mixed. Fig. 2.1 shows the different levels of the construction project performance stages as formulated in this research.

FIG. 2.1. CONSTRUCTION INDUSTRY PROJECT PERFORMANCE LEVELS.



Source: Researchers own construct. 2005.
Derived from Production Process Theory

2.2 The Concept of Time Performance

Mbatha (1986) argues that, a construction project is based on three basic parameters, namely, the scope, the cost and the contract period. The cost and 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; and the professionals are employed by the client to provide services which will enable the client to get value for money. In this context, value for money means giving the client what he wants for the money available.

Apart from giving the scope in the form of 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 for completion. The time required for completing each single activity is determined by the technique used while the technique itself depends on the level of the technology available in the industry.

At the time of deciding or computing the construction period (time), assumptions are made about the productivity of the firm and its capacity which are directly related to the technology level. The techniques alone are however not sufficient to enable an accurate decision on the 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. This is because management enables resources to be combined in the right proportions for a known objective.

In construction projects, sometimes quantity surveyors fix the contract time and the contractors compete on the contract sum only, while the contract period is open, and is up to the contractor to estimate what he considers as a reasonable construction period for the project in question.

The time allocated to the project initially should then be an accurate approximation such that, if the professionals were certain of a future event that can adversely affect the time, they would allow for it. The only way the professional would by-pass the event is to prepare to overcome it in other methods. 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. Predictability of future events depends on measures of perfect knowledge which is very lacking in man; all the estimator does depends on is his own past experience.

If at the end of the contract, 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 unforeseen events at the start of the contract took place and affected the critical path. If in the next contract this delay occurs and subsequently persists in the succeeding contracts, then the estimator and his colleagues have been unable to achieve the desired standard. Since the estimators figure for time is his best approximation to reality and truth of events, then the deviation from the estimate should also be his measurement of error.

2.2.1 Factors Causing Project Delays.

Talukhaba (1999) identified 19 broad variable categories as the factors causing project delays. These categories are:

i) Design changes
ii) Subsoil conditions
iii) Subcontractors
iv) Contractual disputes
v) Industrial disputes
vi) Weather conditions
vii) Sample of materials and approvals
viii) Construction equipment acquisition
ix) Construction materials availability
x) Construction finance availability
xi) Local authorities
xii) Labour availability
xiii) Accidents occurrence
xiv) Politics (interference)
xv) Manufactured components

xvi) Permits and licenses

xvii) Shop drawings (fabrication by subcontractors)

xviii) Materials testing

xix) Others (any other variable which was not covered in the above list).

Bromilow (1969) argues that, late completion in a building contract is a source of inefficiency, financial loss, and intense irritation in the industry. The difference between expectation when the contracts are entered into on the one hand and the reality on the other are substantial and larger than commonly supposed. Of 329 contracts taken from a wide range of environments and building types, but not including housing, only one contract in eight was completed on or before the time originally expected and the overall extra time taken exceeded 40 percent. The study argues that one of the basic difficulties appears to be inadequate communication between the many people concerned in the project. Until the timing of work becomes mentally accepted as a real agreement on a common basis of understanding between the parties concerned, and transfer of information is improved to permit adequate control against undue disruption from unessential changes, there would be continued irritation, frustration and financial losses.

The study established standards for use by contractors, architects and clients to measure their own performance as a basis on which to combat competitors who make unrealistic time schedules for projects on the side of contractors, and the architects are able to advise their clients on what times may reasonably be provided for construction, whereas clients with continuing programmes of work will have realistic estimates of construction time and so can ask their consultants to compute design and documentation sufficiently to allow for this. The study concludes that, if these measures were implemented, a saving of more than 40% in time and 10% in effective cost would result.

Baldwin; et al (1971) carried out an investigation into the causes of delays in the construction industry, which targeted the contractors, architects and engineers in the industry. These three groups felt that weather, labour supply, and subcontractors were the three major causes of delay. The data received in the study suggested that construction delays can be minimized if there is more accurate and detailed weather information, better training programmes and better labour management relations could increase the supply of qualified craftsmen; and more effective job coordination and scheduling could help eliminate delays caused by lack of communication between contractor and sub-contractor.

A survey of building contract time performance between the period 1970 to 1976 (Bromilow, Himids & Moody, 1980) found that, the time to complete government projects averaged 22% and private projects averaged 10% in time overruns. This confirmed findings that in 1969 that government projects tend to perform more poorly than private projects in terms of construction time performance.

Sidwell, (1984) in his study on the time performance of construction projects argues that, there are three critical parameters in the building process viz, time, cost and quality. Of the three parameters, time, cost and quality, it is probably time which may be influenced most by the organization and management of the building process. It also recognized that, time, cost and quality are interrelated and that, to an extent, cost may be saved at the expense of quality and shorter time may save cost through reduced funding requirements. The study concludes that although time is only one of the most important performance criteria, it is of particular significance to many clients particularly those in the commercial and industrial sector to whom time is money. It was revealed that, the client influences project time in the way in which they provide their needs and briefs to the building and the way they are closely involved with the building project. It also revealed that if good control of subcontractors and the numbers of variations and other technical problems are kept to a minimum by the design team, then this will minimize sources of delay in the project. Lastly, and perhaps the most important, the manner in which the building team and the building process is organized and managed has an influence on project time.

Kaka and Price (1991) investigated the relationship between value and duration of construction projects and found that a strong relationship exists. They have argued that this relationship can be used by the client to estimate the approximate duration of a project and compare it with the proposed ones. It can also be used in the contractor's budgeting systems and the corporate financial model developed by Kaka (1990) at Loughborough University. Two samples were collected to model this relationship. Sample 1, contained 661 building projects with a total value exceeding £695 million, which included all types of commercial, industrial, residential and public projects. Sample 2, included 140 road contractors with a total value exceeding £120 million. The average ratio of actual time to the agreed time was found to be 1.0351. The ratio varies between a maximum of 2 and a minimum of a 1/3. The analysis stage involved modeling the relationship for civil engineering and different types of building contracts. The two samples were classified according to type of project, form of contract and type of competition. Seven groups were modeled and tested visually for the difference in these relationships. The type of competition was found to have no effect on the relationship. Finally, six groups were modelled and the results of the constants of the relationships were listed. Public buildings and civil engineering projects were shown to fit accurately, while private buildings varied considerably. The above conclusions were drawn on the logic behind these differences.

Ogunlana, Promkuntong & Jearkjirm (1996) argue that; construction delays impact the time and cost of projects. A survey of delays experienced in 12 highrise building construction projects in Bangkok, Thailand, was undertaken and the result compared with other studies of delays and overruns around the world to determine whether there are special problems that generate delays for construction in developing economies. The study found that, resource supply problems were by far the most acute problems of the Thai construction industry in the boom years. The results of the study support the view that, construction industry problems in developing economies can be nested in three layers:

a) Problems of shortages or inadequacies in the industry infrastructure (mainly supply of resources);

b) Problems caused by clients, and

c) Problems caused by contractor incompetence/inadequacies.

In conclusion, the study recommended the need for focused effort by economy managers and construction industry associations to provide the infrastructure needed for efficient project management. It is argued that the study should be of interest to emerging economies in Europe and Indo-China.

Nkado (1995) carried out preliminary survey of factors affecting construction time (the contractors perspective). The objective of the survey which was conducted in UK was to prioritize factors which are taken into consideration by accomplished contractors in planning the construction time of buildings. A significant degree of consistency in ranking time influencing factors was found. An examination of the consensual ordering of factors showed that those high on the priority list are generally readily identifiable from the project information and directly quantifiable by the contractor. Further their impact on construction time can be assessed explicitly. Factors low on the priority list are those whose effect on construction time are not readily assessed explicitly. Also their influence on construction time is not within the direct control of the main contractor. It is likely that planners could have developed rules of thumb for dealing with the effect of such factors on construction time rather than any form of detailed analysis. The top-ranked factors clearly indicate that contractors are inclined to take into critical consideration every nuance of time limit or constraint imposed on the client or design consultants. This finding supports the assertion that clients can get the time performance they want for their projects from the construction industry. However it behooves clients to impose time constraints on projects from an informed position if sound economies of construction are to be achieved.

Assaf, Al-Khalil and Al-Hazmi (1995) carried out a study on the causes of delay in large building construction projects in Saudi Arabia and their relative importance. The survey of a randomly selected sample of 24 contractors, 15 architectural/engineering firms (A/E) and 9 owners from the Eastern Province of Saudi Arabia was undertaken. The survey included 56 causes of delay and the respondents were asked to indicate their degree of importance. The delay factors were grouped into nine major groups. The level of importance of the causes and the groups were measured and ranked by their index for contractors, owners and A/Es. It was found that contractors, A/Es and owners generally agreed on the ranking of the individual delay factors. Further it was also shown that contractors and A/Es substantially agreed on the ranking of the groups of delay factors whereas contractors and owners, and A/Es and owners do not agree. It was also shown that the financing group of delay factors was ranked the highest by all three parties and environment was ranked the lowest.

Bromilow (1974) found that, the times allowed in the contracts for construction understated the times actually taken to reach practical completion by 32% on average, equivalent to an overrun of 47% over the contract time. The study also found that only 12% of the projects were completed by the completion dates written in the contracts. These proportions varied widely according to the type of building and the contractual procedure adopted. Measures of the variability of the individual projects found to be most useful were the quartile limits (a quarter of the projects took more than 30% longer than normal and a quarter took more than 20% less time than normal).

Mohsini and Davidson (1992) carried out a study to identify the most significant determinants of performance and an evaluation of their relative importance in the traditional building process. The study identified four significant determinants of time performance as:

i) Clarity of the scope of participation (12.2%).

ii) Sufficiency of given information (26.8%)

iii) Time taken to procure further information (18.8% and

iv) Tasks dependence upon others (14.4%).

Kivaa (2000) argues that, the estimators of construction period use intuitive techniques (non-mathematical methods) and not quantitative techniques (mathematical methods). The first method is based on experience gained over the years in construction work, which can not be generalized and used to predict construction periods. The second methods comprise techniques which predict construction period through the use of mathematical or statistical models such as multiple regression analysis as used by Mbatha (1986); Talukhaba (1988); Bromilow (1969); De Leeuw (1988); and Walker (1995). These researchers developed models which expressed construction periods as a function of both scope and non-scope factors. On average the factors considered in their formulae explained construction time upto 73.87%.

2.2.2 Determinants of Time Performance

Bennett (1985) and Walker (1995) have identified the variables affecting time performance as (a) scope, (b) complexity and (c)managerial effectiveness as the key factors.

Ireland (1983) and Sidwell (1982) investigated the impact of managerial action and client decision making upon time performance and identified the above factors as the ones influencing time performance from project inception to completion.

Chauhan and Chiang (1989) found that the performance of a construction project team has been influenced by internal and external factors that could be classified as: project related factors and environment management related factors. These researchers argue that construction time performance is determined by the following factors:

i)	Project scope	}	
ii)	Project complexity	}	Project related factors
iii)	Weather	}	
iv)	Money market	}	
v)	Shortage of materials	}	Environment related factors
vi)	Skills of workers	}	
vii)	Managerial effectiveness.	}	

Ireland (1993) argues that, non-traditional procurement methods e.g. design and build and project management, are likely to lead to better managerial performance than traditional procurement methods. Kivaa (2000) argues that, from the reasons advanced by the above researchers, a reasonable construction period prediction model can be formulated in terms of the three key variables: Scope, complexity and environment.

The measurable units of scope are cost value, floor area, number of floors and volume above and below ground level [Bromilow 1969; chan & Kumaraswany 1995; De Leeuw 1988; Kaka and Price 1991; Walker 1995]. Project complexity (difficulty in handling projects) is best understood by analyzing physical complexity and managerial complexity (Bennett, 1985); Physical complexity refers to the complication arising from design parameters (plan shape, storey heights, partitions, etc), while managerial complexity refers to difficulties of coordination and efficiency within the project.

Nkado (1992) explored another predicitive approach to construction time for the building industry.

Project environment (Ahuja & Nandakumar 1985; Hughes 1989, Walker 1995, and Talukhaba, 1999) is anything outside the boundaries of the project organization system such as e.g. unpredictable, uncertain and dynamic factors including cultural, economical, political, social, physical, aesthetic, financial, legal, institutional and technological factors. These factors interfere with the planned progress and are wasteful both in terms of resources and time.

Mbatha (1993) carried out an investigation into the Building Procurement Systems, features and conception of projects in Kenya, with a view to developing an appropriate project management system for Kenya. His main objective was to find out whether project management was practiced in Kenya by the Consultants. His study revealed that, project performance in Kenya was sub-optimal and could be improved by applying appropriate management approaches. The study also showed that, due to the uniqueness of circumstances in developing countries none of the approaches of project management can be wholly applied in developing countries like Kenya, without modification.

Walker (1994) carried out a study on the factors that determine building construction time performance. Its main aim was to find out why some buildings were constructed more quickly than others. The work exposed a ranked hierarchy of factors which indicate significance and relative strengths upon Construction Time Performance (CTP). The research built on the work of Bromilow, Ireland, Sidwell, and groups and associations including the royal Commission into productivity in the building industry in New South Wales, Construction Industry, Construction Industry Development Association (CIDA) in Australia and National Economic Development Office (NEDO) in U.K.

A model derived from the literature and other studies were tested in this work and a more refined explanation for CTP was derived. The principal gaps in knowledge addressed by this research was that of helping to answer the questions

"What Factors Affect Construction Time Performance"?

To what extent do these factors affect CTP?

Why do particular factors affect CTP while others do not?

The research methodology employed provided a new way of analyzing CTP, widening available tools researchers may use to investigate such lines of inquiry. The research made its contribution by exposing the gaps in the body of knowledge related to CTP. It postulated that CTP is dependent on the scope of the project and its complexity. The research hypothesis was that "variance between actual performance and trend line performance can be substantially explained by managerial effectiveness of the project team in response to challenges posed by factors outside the control of the construction management team".

2.2.2.1 Factors significantly affecting CTP (In Rank Order)

CTP is not dependent on construction level. Construction management team (CM), followed by (CR) client representative team affects CTP, and project scope and complexity factors were also shown to significantly affect CTP. The least significant factor cluster was found to be the communication performance between the design team and CM and CR teams.

The results indicate that the CM team is the filter through which scope, complexity and impact of other teams performance is passed. High CM team performance instigates difficulties and challenges presented to result in high CTP, while poor CM team performance leads to poor CTP.

The contribution that these results made in closing gaps in knowledge is that they provided fertile ground for explaining both what factors affect CTP and why identified factors affect CTP.

Other studies as cited by Walker include Ireland (1983 pp.71) which investigated cost and quality as well as time performance; Naoum (1991, PP. 21-22) and Nahapiet and Nahapiet (1985 PP. 39) indicates but does not offer statistical evidence to explain how or why identified casual factors affect CTP. Other studies that help to identify factors affecting C.T.P. are NEDO 1988, Stacey 1991; CIDA 1993; Walker 1988; BCA 1993a, which emerged during the (1980's)

Talukhaba (1999), investigated factors causing project delays in Kenya. In this study, the main objective was to identify and establish the significance of the factors which cause project delays. In addition, the study also investigated the influence of project characteristics on the delay causing factors.

The study revealed that, client's payments and Architects instructions, with percentages 61.7% and 7.91% respectively were the main contributors to the project delays, and accounted for 70.6% of the variations in delay. Other 22 factors which were part of the study were found to be significant contributors to delays but with minimal effect. The study identified the real causes of project delays as poor financial management by clients, inadequate designs by the designers and poor management of construction process by the parties involved in the project implementation.

These were compounded by poor resource management such as materials, equipment by contractors, inadequate recognition and response to project risks inherent in both the physical and socio -economic environment of the project; and inadequate regard to the role of the stakeholders by the parties involved in the project implementation process. The study recommendations were two- fold. Thus, project management should be concerned with mostly **clients' project financing, and efficient workable project designs and efficient construction process management.**

It is the recommendation of Talukaba's (1999) study, that prompts the researcher to undertake an investigation into the resource mix by construction firms in Kenya, because this area of research needs to be adequately addressed in order to understand the causes of both time and cost overruns in construction projects, with a view to looking to solutions to reduce these overruns. In conclusion, all the above cited studies did not consider the resource optimization by construction firms and yet these play a central role in construction project performance in terms of time and cost overruns.

It is therefore the proposition of this study that the problem of project performance in terms of time and cost overruns relates to:

Poor resource management, particularly, resource mix/or optimization such as man-hours, machine hours/equipment and materials on the part of the construction firms which are involved in the production process. This has a profound effect on the overall project performance. The wastes of materials, excess time required in activities; idle time for machines, and excess manpower in activities accumulate in small amounts, but when they are summed up eventually lead to significant cost and time overruns. Hence the need to study the way these resources are mixed or optimized.

2.3 The Concept of Cost Performance

Mbatha (1986) argues that, the tender sum is an offer by the contractor at which he is willing to erect the building and is subject to acceptance by the client. He further argues that before tenders are invited the professional quantity surveyor makes an estimate to establish the approximate cost of the project. In line with giving value for money the quantity surveyor endeavours to be as accurate as possible by including any foreseeable circumstances at that stage for any sites.

Cost overruns are caused by additions, fluctuations, adjustment of P.C. Sums and provisional Sums, provisional quantities, uncertain ground conditions, wrong designs, claims due to delays from designers, etc. In this respect the contractor cannot cause cost overruns; he can only exert his rights which may mean extra costs to the client. This means then cost overruns should be blamed on the shortsightedness of the design team and the client for their failure to predict correctly 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.

2.3.1 Factors Causing Cost Overruns

Mbatha (1986; pp. 53 - 54) and Abwunza (2001) identified the following factors as responsible for cost overruns in construction projects:

i) Variations (additions)

ii) Fluctuations

iii) Adjustment of prime cost sums

iv) Provisional quantities

v) Uncertain ground conditions

vi) Wrong designs

vii) Claims due to delays from designers

viii) Clients

ix) Design teams

x) Type of projects (building or civil engineering)

xi) Contractors (African, Citizen and Non-citizen)

xii) Category of contractors (experience)

xiii) Method of tendering

xiv) Type of contract (Bills of Quantities vs. non-BQ based contracts).

xv) Provisional sums

xvi) Loss and expense under clause 36.0 of JBC 1999 conditions

xvii) Constrained sites

xviii) Penalties on construction finance and tax penalties - JBC Clause 34.28 of 1999

Bromilow (1970) argues that, 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 these variations add from 0.5 to 2.0 percent to the total cost. The study which investigated 248 building projects worth $186 million showed that variations are unavoidable feature of building and their complete elimination a virtual impossibility. The standards of project design and contract supervision determine the number and magnitude of variations, which vary between wide limits. It is shown, nevertheless, that the average extent to which they occur is predictable, as also are the boundaries within which 50% of all the contracts lie. Detailed examination of 25 projects revealed the nature and principal sources of the more significant variations, as the client as the major contributor followed by the designers. The result of the study showed that, substantial improvement would result if performance equal to or better than the industry's mean standard were aimed at, and if all parties took action to reduce the extent of their own contributions to the changes that occur.

Bromilow (1969) derived a formula expressing relationships for a sample of Australian projects, and commented that variations were the main causes of cost overruns in construction projects. He found that, design and construction duration are a function of cost, size, and complexity. Nevertheless adopting Bromilow's findings in Kenya could be misleading because of the differences between the two countries. In fact relationship finding has been found in other countries (Kharbanda, 1974).

Mbatha (1986) investigated time and cost overruns in relation to size, location and type of project for government projects in Kenya. His major objective of the study was to establish whether or not the performance of government building contracts in terms of cost and time was poor in the period 1967 to 1981. The study found that, the majority of government projects suffered time and cost overruns. Time overruns were more frequent than cost overruns and the two were found not to be related. Big projects were also found to be more prone to both time and cost overruns. Delays were also found to bear no relationship with the contract size.

Talukhaba (1988) investigated time and cost performance of both public and private projects. The primary objective was to investigate the causes of time and cost overruns of construction projects in Kenya. The study established that time performance was the poorest whereby 70% of the projects commenced had a chance of overrunning the time, with a magnitude of 53.3% compared to 53.7% cost overrun with a magnitude of 20.7%. The study also found that, time and cost (overruns) performance were influenced by conditions associated with different types of clients (Government, private sector and parastatals).

The government was found to be the poorest in project management followed by the private sector, while parastatals were performing comparatively better. The study recommended further research in the area of time overruns in construction projects.

Chan and Yeong (1995) in their study for a comparison of strategies for reducing variations in construction projects in Australia and Malaysia argued that contract administrators issue, orders for variations from the original design, which often than not, lead to additional costs and disruption to work already underway, eventually lead to cost and time overruns. Thus the reduction of variations is one of the pre-requisites of keeping cost within the budget and completing the project in time. The study found that, clear and thorough brief was the most useful strategy for reducing variations and avoiding the use of nominated sub-contractors as the least effective measure from both countries. However when rankings of the two countries were compared using the spearman correlation coefficient, it was found that there was significant disagreement between the two sets of ranking. They argued that the significant difference might be attributable to the difference between the two countries in terms of culture, politics, regulations, economic conditions and construction practice. These differences could also be reflected in their attitude towards contract claims.

Chimwaso (2000), carried out a study in an evaluation of cost performance of public projects in Botswana, and observed that, there are many cases of cost overruns as compared to projects that have been completed within budget. The study identified five significant factors that influence construction cost overruns as incomplete design at the time of tender, technical omissions at design stage, additional work at the clients request, adjustment of prime cost and provisional sums and contractual claim, that is, extension of time with cost claims, among 18 factors which were used in the formulation of the research questionnaire. The researcher argued that there were many research projects on cost and time overruns (Kaming, et al., 1997; Cox et al 1999, Radujkovic, 1999; cited by Chimwaso, 2000), whose findings have one thing in common. That is, there were more cases of cost overruns than time overruns. Hence the need to identify the significant factors that may influence construction cost overruns and deal with them from the inception of the project. This will result in significant decrease in the occurrence of cost overruns and improve cost performance of projects.

Bromilow (1971) argues that building contract cost performance is controlled by the use of deletions and substitutions regardless of the effect these changes may have on construction time. The cost performance of building contracts themselves does not correlate with time performance, but it seems probable that cost performance is controlled, by dint of deletions and substitutions to keep close to the original contract price regardless of the effect that these changes may have on construction time. This is to say that contractors are willingly granted time extensions, justified or unjustified, because of such work changes, but the simple truth is that the average construction time exceeds that laid down in the contracts by nearly 50%, whereas examples of the imposition of liquidation damages because of this are rare.

Bromilow (1974) carried out a study on measurement and scheduling of construction time and cost performance in the building industry and found that, cost in the sense of building contract sum was relatively well controlled. The original contract sum was on average equal to the final sum for small projects, and under estimated it by 5% on large ones, the overall average being only 2.5%, inspite of the incidence of variations and other disturbances revealed in the course of the research. The upper and lower quartiles were 3.2% above and below these figures. The more extreme differences were generally the result of changes of plan by clients.

Mohsini and Davidson (1992), in their research/study on the determinants of performance in the traditional building process identified three significant variables as the determinants of cost performance. These were: (i) sufficiency of given information (30.1%) (ii) time taken to procure further information (32.1%) and (iii) tasks dependence upon others (17.3%). The three variables accounted for 79.5% of the variance in the cost performance. It is clear from the analysis that in the traditional building process higher cost performance is very significantly dependent upon the sufficiency of and speedy access to needed information, and that greater interdependence of tasks performed by different organizations has a performance lowering effect.

2.4 Project Performance Indicators

Choudhury (2002) argues that a project will be considered totally successful if it gets completed on:

i) time

ii) within budget and

iii) performs exactly to the designer's specifications

On the other hand, a project may be considered a failure in the following cases:

i) if it is abandoned half-way or kept in abeyance or completed with a changed concept

ii) if it does not produce as specified in terms of quality of product.

iii) if it becomes sick soon after going into commercial production

Very few projects would fall in these categories. Thus, in real life, a project can not be considered either a total success or a total failure. It would fit somewhere in between. The investor, project manager and also the public who are watching the project are all keen to know how the project is being managed, and they must be given some indication about it while the project is still in progress.

At present, time and cost overruns are the most commonly used indicators of project performance. It is almost taken for granted that a project completed with minimum of time and cost overruns is a well managed project. But while this may be partly true, it does not enable any comparison with another project. It also does not tell us whether time and cost targets were unrealistic. It is quite possible for a well managed project to have time and cost overruns. It is unfortunate that those who were not closely associated with such a project may not accept this. It is noted that there are various difficulties in setting targets realistically, and it would not be in the interest of a project to assume them as being sacrosanct. The targets are to be used for direction, co-ordination and control. Overrun, if any, could be as much due to bad estimation as it could be due to bad management.

2.4.1 Time Overrun

Besides, a defective design and subsequent modification /change to suit the projects requirements also increases time and cost. How much time a project eventually takes and who contributed to overruns - these are questions that no one can answer without doing some research. In such circumstances, and this may hold true for most projects, time overruns can not be used as true indicators for project management performance.

2.4.2 Cost Overrun

The situation, however, is not so nebulous regarding cost(Mbatha 1986). While time can be misquoted, cost cannot. Anything done to a project, including time overrun, would be reflected in the cost. If a project is not well managed, its cost will go up; conversely, if a project is managed well, its cost should come down. Therefore, cost can be used as an indicator for project management performance. But cost estimates in a project, are to be revised at various stages to improve their accuracy, and they invariably increase after every revision. Cost overrun, the expression which is used to represent the variance between the original sanctioned cost and the final cost incurred, would then provide no indication of managerial performance.

2.4.3 Project Sickness

An efficient project manager (Choudhury, 2002) is one who makes the best possible use of the resources given to him for achieving the project objectives. Whatever a project manager does with respect to the resources will be reflected in the cost and whatever the project manager provides in return to justify this cost is a plant, which, to be called successful, must produce a saleable output.

The ratio of this output to the cost incurred for putting up the plant could be an indicator of project management performance, which also indicates the state of the health of the plant. The performance of the plant is also dependent on the quality of the project management. Firstly, the quality of plant and equipment selected will decide the cost of utilities, repairs and maintenance. Secondly, depreciation which makes a contribution of almost 33% to the production cost is due to installed cost for which project management alone is responsible.

If a project is implemented at a lower installed cost, the plant performance will be so much better, if not, the plant faces the risk of falling sick. It is, of course, another matter that the plant performance can not be measured till the project goes into commercial production, but the project manager is fully responsible for both the installed cost per tonne and production cost per tonne. If both production and installed cost are not managed well a project may fall sick. The project may also fall sick later due to mismanagement of its operations, but the project manager cannot be held responsible if the installed cost per tonne was at par with the industry average and performance parameters were achieved exactly as per specification.

So the installed cost per tonne is a performance indicator which the project manager must watch. To prevent sickness, a project manager must control the installed cost and also the performance parameters of the plant and machinery.

2.4.4 Productivity as Performance Indicator

Installed cost per tonne also reflects productivity of project execution just as operating cost per tonne reflects the productivity of an operating plant (Choudhury, 2002). A productivity indicator reflects how resources have been utilized either for production of goods and services or for creation of facilities for the same. Since a manager is responsible for utilization of the resources put under his disposal, this indicator can reflect his performance.

Productivity at the project implementation stage affects the productivity of an operating plant. Hence productivity must be measured not merely for evaluating the performance of project management but mainly to ensure profitability of the plant and to ward off sickness.

When one talks of time or cost overruns, the effect of these overruns on the viability of the project does not become immediately apparent, one also starts immediately to question the viability of the original schedule or the original budget. As has universally been accepted in the case of financial management, a ratio of budgeted and actual expenditure is always a better indicator of performance than the deviation figures between budget and actual cost. Thus, even with respect to completion time, a ratio of installed cost to completion time can be a better index which can be used to reflect project management's performance with respect to schedule management. So if one works out the cost index and schedule index of a completed project and compare it with the industry average in the same technological area, one should get a true indication of the project management performance.

2.4.5 Value as a Performance Indicator.

When discussing time and cost indices, it is assumed that the quality of the hardware was maintained at a level which is essential to meet the desired performance i.e. quality remained constant (Choudhury, 2002). Performance of project management was therefore evaluated not in terms of quality but in terms of time and cost. However, in reality project management almost universally gets too occupied with building up quality hardware with no consideration for cost and time. Limitless excellence, without any consideration of time and cost, can only lead to project disasters. The task of project management is to build a plant that works, the hardware, therefore, has always to be the crux within time and cost estimates. And when one has limited time and budget, one has necessarily, to be content with a limited size of hard ware and limited performance. For instance, time overrun in a project will result in increased cost of financing and cost escalation, and consequently cost control will require time control. Again, since the scope of cost control is maximum during the design and engineering phases of a project, cost control will require control of scope and specifications of the project. This is referred to as the value engineering effort. Hence when the cost of the project is controlled, scope, time performance are also controlled, and the total project management framework is also controlled.

Consideration of cost does not imply any compromise on quality, as value engineering encourages increase in quality if it can be attained at no extra cost. Value which can be expressed as performance, improves only when performance is achieved as at no extra cost or when cost can be reduced for the desired level of performance. But gold planting or robust design, as it is called does not improve performance, it merely adds to cost and hence reduces value. This is what may happen if people are concerned only with the production of so called quality hardware without any concern for cost. But if the project is designed and managed using value engineering approach then productivity of project execution or installed cost per tonne of capacity installed will reduce, thus reflecting excellence in project management. Consideration of value is, therefore, the same as consideration of cost or productivity and it is essential for improving project management performance.

In conclusion the literature reviewed so far relates to the global aspect of construction project performance and touches on upper level of a construction project. Performance is measurable in terms of project time overruns and project cost overruns, and lays the foundation for further discussions on site operations / production project performance where it is believed that, the root causes or sources of good or poor project performance lies. Hence the performance evaluation model developed in figure 2.1 should be used in order to understand the real causes of construction projects performance.

CHAPTER III

FACTORS AFFECTING PROJECT PERFORMANCE AT THE SITE PRODUCTION LEVEL

3.1 Introduction

Abrahamson (1989) gives a legal definition of the site as the lands and other places on, under, in or through which the works are to be executed and any other places or lands provided by the employer for the purposes of the contract.

Whereas Fletcher (1981) contends that in the absence of a clear definition from the contract the term site means the place where the permanent construction work is to be located. However he argues that, the term should not be left undefined, since it is often of great importance to know the exact extent of the site, not least so that the contractor can evaluate the problems of access, and security, and so that the owner knows what he is obliged to hand over to the contractor for purposes of the contract works.

The danger is that, physically on the ground, the "Natural and obvious", extent of the site is considered to be quite clear and as a result everyone assumes that, that is what is under the contract. Such a course is most unwise; and the contract should be checked for a definition. If there is one, it should be compared with the "Natural and obvious" site. If there is not, then a suitable definition should be inserted.

From the above definitions it is clear that the site is the area to be or occupied by the contractor or construction company on which to carry out the contract or construction works and where the production process will or takes place. It is defined by the drawings submitted by the architects or engineers, or defined by a title deed on a deed plan, and defined by beacons fixed on the ground by a registered and licensed government surveyor.

3.2 Project Focus

What is special about a construction company is that the production is carried out in projects. And for every new project a new organization is set up. The projects are relatively independent from the rest of the contractors own organization during the production.

The project focus is a limitation that restrains the companies' abilities to develop themselves, and new ideas from the headquarters, geared towards developing the business in reaching out to the projects. Every single project has to be profitable and the business is centralized and shortsighted. The short term planning means that, the business improvement and development can only be possible in short steps. And in the short term the project focused demand on profitability means that actions aiming for long term profits are harder to accept than short term on site problem solving.

The problem from an implementation perspective is that, the site managers are reluctant to try new solutions because they are continuously trying to reduce economic risks for the project. Naim (1997) contends that, a construction site is a dynamic and a fast changing environment with many actors in complex relations, but that the efficiency and effectiveness in the projects suffer from the greater number of participants. However, he states that, the main obstacle to change in the construction sector is attitude. Despite exceptions, the construction industry sees its own environment as "ONE OFF" with little repeatability, and thus considerable knowledge is lost as companies move from one project to the next.

The creation of the construction is central and what happens before or after is of less importance. The fact that the construction is proceeding is seen as more important than how it proceeds, and unexpected compensations that would be described as crisis in other industries are warded as a part of the everyday work. This is what one would call site blindness. The actors on the construction site are so used to the chaotic handling of materials onsite, that they do not experience the situation as a problem.

3.2.1. Customer Orientation

Construction sites are not customer focused and therefore their production systems are push systems which need to be changed to a more pull-oriented system/market.

In a push system the production is planned and controlled without any special concerns of the customers. This forms the general idea that all products would be sold in the market almost regardless of the quality or concerns about the individual customer, which is a reality in most early markets where competition is very low. Therefore customer orientation in such a system is weak and the production is neither based on consumer needs nor demands. When it is the actual demand from the ultimate customer that triggers the production, then it is more like a push system. But on the other hand, the more customer oriented industry only seems to cope with the market where extremely expensive dwellings are in demand. Flexibility and coordination are now more important than large scale thinking and acting. The major challenge appears to be to provide products that meet the very basic demand that is the most crucial to most of the customers; products that are easily affordable. The inability to offer such a product in the market is alarming and should act as a challenge to the industry. But the unwillingness to even try is more confusing and it is hard to detect any sign of serious efforts to significantly reduce costs systematically in the Kenyan construction industry market.

A challenge for the construction industry is now to understand the customer needs in order to offer the right products, efficiently and effectively.

3.3 Qualities that make the Construction Industry Unique from other Manufacturing Industries.

Thomas and Sinha (2003) argue that the factors that distinguish the construction industry from other manufacturing industries with respect to the following issues:

1. Orientation – Orientation in manufacturing seeks to manage the process and focus on the method used, while construction emphasizes producing of products and focuses on the end project.

Cost centers: A manufacturing facility has generally a single cost centre / profit, the facility or plant itself. The construction site has numerous cost centers, one for each cost code.

Activity Integration: On manufacturing the nature of activity integration for production processes are highly sequential, in that a product passes through multiple work stations. Each work station is staffed with the same number of persons each day and the number is based on the nature of the work at the station. The work remains essentially constant and much attention can be focused on the method as the way to improve performance. Construction activities are very different and so are scheduling techniques used to produce a production schedule. For instance a critical path method would have limited or no use at all but a few manufacturing operations. Similarly, the utility of production schedule is limited except for certain construction operations. In concurrent activities, only a fraction of the potential work location is manned each day. Different crews may occupy a work station each day, and the number of crafts men often varies. The nature of the work changes daily, necessitating different skills, information, materials and support services. The phrase "parade of trades" has often been used to describe construction operations. This phrase applies to sequential operations. They occur in construction operations at a macro level, but usually do not occur when a more detailed analysis is made. Thus, construction operations at the activity level are more like modeling a riot than a parade.

Performance measures: The performance of the facility can be equated to the output, because the facility always produces a certain number daily and the input in terms of materials and labour is constant. A work station does not produce products and does not have a budget against which station performance is measured. One way of improving performance is to make the method more efficient. This gives rise to work sampling or activity sampling method. The focus in the method being identification and elimination of unnecessary activities like moving materials or waiting. Another performance enhancement tool is the crew balance chart, which results in a reduction of the number of workers required.

Construction performance is measured on the basis of input (work hours) per unit of output (quantities), the reason being each construction activity is a centre. The aim is to use minimum resources to produce a fixed amount of output. Unlike manufacturing construction methods, output, cycle times, change, sometimes on a minute-by-minute basis. This makes the work sampling and crew balance techniques of limited value in all but few instances. The best and the most lasting way to improve performance is to eliminate disruptions in the work environment.

The work environment: This refers to sequencing, congestion, availability of resources, weather and interruptive events that impair performance. In manufacturing the work is largely steady-state. The resources are available, the sequence of operations is fixed and all work areas are not congested. The work is done indoors so that weather is not a factor. Hence the manufacturer focuses improvement efforts on the method instead of the environment. In a construction site the environment changes throughout the day. Various types and quantities of resources are required to support the crew. Improvement on the methods is often short-lived. Much effort is focused on disruptions because the environment and schedule demands are so dynamic.

Level of Uncertainty. The level of uncertainty in manufacturing is rather less because the environment is stable. Resources are readily available, work routines are established and all generally know the production schedule. Disturbance from weather are not a factor.

Construction is different compared to a factory in that, the environment is very unstable. There are disturbances arising from weather. Additionally other schedule disturbances can result from design errors, equipment breakdowns, lack of materials and other situations. Congestion can also be problematic.

Product diversity: Product diversity in manufacturing are minimal and therefore the work schedule or routine is minimal. Construction is very diverse and must be considered in making crew assignments. The resource requirements can vary widely.

Resource requirements and their characteristics in use. Resource requirements in both manufacturing and construction are similar, but the characteristics surrounding the use of these resources vary widely. These resources are (a) materials whose deliveries involves a large number of items. The delivery schedules can be very tight. (b) Assembly line equipment is usually stationary and is used by a single work team and is designed to perform one function. (c) Information is necessary for all construction and manufacturing operations. The main source of information is customer order detailing of what can be produced. (d) Labour does not require close management because all work stations are manned daily by the same of workers. (e) Work assignments are generally the same in crew relationships, and the work is largely sequential

In construction (Thomas and Sinha, 2003) (a) materials are delivered to site daily. Many are one-of-a kind items that are made specifically for the project. The efforts of vendors, designers, owners, and contractors must be synchronized. The removal of waste is another important concern. (b) Construction equipment is often designed for multiple purposes and is shared by multiple crews. The equipment operates under sometimes harsh conditions and therefore, breakdowns are common. (c) Information resources are plans and specifications. However the work schedule shop drawings, responses to requests for information and other correspondences are important and necessary forms of work communication. The origin of the communication can be the owner, designer, subcontractor, vendor and other sources. (d) On a construction site, the work force level gradually increase and peaks at about the 50 – 70% complete milestone. The work assignments vary daily and the number of workers and the hours worked nearly parallels the amount of work available to perform. (e) Many construction operations are also sequential; but sometimes the crew relationships are cooperative or symbiotic.

3.4 Production techniques as embraced by the manufacturing industries

As in the development of appropriate alternatives for facility design, choices of appropriate technology and methods for construction are often ill structured yet critical ingredients in the success of the project. For example a decision whether to pump or transport concrete in buckets will directly affect the cost and duration of tasks involved in building construction. A decision between these two alternatives, should consider the relative costs, reliabilities and availability of equipment for the two transport methods. Unfortunately the exact implication of the different methods depend upon numerous considerations for which information may be sketchy during the planning phase, such as the experience and expertise of the workers or the particular underground conditions at a site.

In selecting among alternative methods and technologies, it may be necessary to formulate a number of construction plans based on alternative methods or assumptions. Once the full plan is available then the cost, time, and reliability impact of the alternative approaches can be reviewed. This examination of several alternative methods is often made explicit in bidding competitions in which several alternative designs may be proposed or value engineering for alternative construction methods may be permitted. In this case potential contractors may wish to prepare plans for each alternative design using the suggested construction method as well as to prepare plans for alternative construction methods, which would be proposed as part of the value engineering process.

In making a construction plan, a useful approach is to simulate the construction process either in the imagination of the planner or with a formal computer based simulation technique (Paulson, Douglas & Kalk, 1983 & 1979). By observing the result, comparisons among different plans or problems with the existing plan can be identified. For example, a decision to use a particular piece of equipment for an operation immediately leads to the question of whether or not there is sufficient access space for the equipment. Three-dimensional geometric models in a computer-aided-design (C.A.D) system may be helpful in simulating space requirements for operations and for identifying any differences. Similarly problems in resource availability identified during the simulation of the construction process may be effectively forestalled by providing additional resources as part of the construction plan.

3.4.1. Risks in adopting new technologies

While there may be many benefits in acquiring new technologies, several types of risks accompany the acquisition of new technologies. These risks have to be evaluated and traded off against the benefits before they are adopted. Some of these risks are described herein below. Richard B. Chase; Nicholas J. Aquilano & F. Robert Jacobs (2001 5^{th} Ed. Pp.135-136)

i) Technological Risks

An early adopter of a new technology has the benefit of being ahead of the competition, but he also runs the risk of acquiring an untested technology whose problems could disrupt the firms operations. There is also the risk of obsolescence, especially with electronics-based technologies where change is rapid and when the fixed cost of acquiring new technologies or the cost of upgrades is high. Also alternative technologies may become more cost-effective in future, negating the benefits of a technology today.

ii) Operational Risks

There could be risks in applying a new technology to a firm's operations. Installation of a new technology generally results in significant disruptions, at least in the short run, in the form of a plant-wide reorganization, retraining, and so on. Further risks are due to delays and errors introduced in the production process and the uncertain and sudden demands on various resources.

iii) Organizational Risks

Firms may lack the organizational culture and top management commitment required to absorb the short term disruptions and uncertainties associated with adopting a new technology. In such organizations, there is a risk that the firm's employees or managers may quickly abandon the technology when there are short-term failures or that they will avoid major changes by simply automating the firm's old, inefficient process and therefore not obtain the benefits of the new technology.

iv) **Environmental or Market Risks**

A firm may invest in a particular technology only to discover a few years later that changes in some environmental or market factors make the investment worthless in many cases. For instance, in environmental issues auto firms have been reluctant to invest in technology for making electric cars because they are uncertain about future emission standards of state and federal governments, the potential for decreasing emissions from gasoline-based cars, and the potential for significant improvements in battery technology. Typical examples of market risks are fluctuations in currency rates and interest rates.

In conclusion technology has played a dominant role in the productivity growth of most nations and has provided the competitive edge to firms that have adopted it early and implemented it successfully. While each of the manufacturing and information technologies discussed here is a powerful tool by itself and can be adopted separately, their benefits grow exponentially when they are integrated with each other. However, implementing flexible manufacturing systems or complex decision support systems requires a significant commitment for most firms. Such investments may even be beyond the reach of small to medium sized firms. However, as technologies continue to improve and are adopted more widely, their costs may decline and place them within the reach of smaller firms. Given the complex, integrative nature of these technologies, the total commitment of top management and all employees is critical for the successful implementation of these technologies.

3.4.2 Just in-time Production Systems, and Waste Elimination

Just-in-Time (JIT) is an integrated set of activities designed to achieve high volume production using minimal inventories of raw materials, work in progress, and finished goods (Chase, Aquilano, Jacobs, 2001 pp.323-344). Parts arrive at the next work station "Just in Time" and are completed and move through the operation quickly. Just-in-Time is also based on the logic that nothing will be produced until it is needed. Need is created by the actual demand of the product; when an item is sold in theory, the market pulls a replacement from the last position in the system - final assembly in this case. This triggers an order to the factory production line, where a worker then pulls another unit from upstream station in the flow to replace the unit taken. This upstream station then pulls from the next station further upstream and so on back to the release of raw materials. To enable this pull process to work smoothly, JIT demands high levels of quality at each stage of the process; strong vendor relations, and a fairly predictable demand for the end product.

JIT can be viewed colloquially as "big JIT" and "little JIT". Big JIT (often termed James, P. Womack 1990) is the philosophy of operations management that seeks to eliminate waste in all aspects of a firms production activities; human relations, vendor relations; technology, and the management of materials and inventories. Little JIT focuses more narrowly on scheduling goods inventories and providing service resources where and when needed.

Elements of JIT Philosophy:

Just-in-time is a philosophy (Sergio, 1987) of manufacturing excellence based on pursuit of the planned elimination of all waste and consistent improvement of productivity. Just-in-time encompasses the successful execution of all activities required to satisfy customer requirements from product design to delivery. It includes all states from acquisition and conversion of raw material to delivery of the product.

The primary elements of just-in-time may include reduction of:-

Work in progress (WIP) Queue Set up Manufacturing and purchase lead times Lot sizes Transit time Factory floor space Preventing maintenance Supplier program Frequent vendor deliveries Focus processing Group technology	Cellular manufacturing People involvement Point-of-view storage Level schedules Mixed model scheduling Standard containers Zero defects Quality at source Flexible manufacturing Minimum bill of materials levels Housing keeping Line balancing 100% ± Zero schedule attainment

Figure 3.1 Elements of just-in-time philosophy

Source: Sergio, 1987.

In general Jit applies to all forms of manufacturing: Job shop, and process, as well as repetitive.

Akitonye and Chinnyio (2002), argue that, the UK construction taskforce report "Rethinking Construction" sparked the development of a set of key performance indicators in the construction industry. In May 1999, the UK construction industry board published the first set of (KPI's) for the construction industry in which seven indicators relates to project performance and three are measures of company performance. These indicators comprise time, cost, quality, client satisfaction, client changes, business performance, and health and safety. These indicators are designed to provide construction firms and their clients with a means to judge or measure performance and to assess or implement improvements in the industry.

3.4.2.1 The Japanese Approach to Productivity

The Japanese had a national goal of full employment through industrialization since the Second World War (Cartlidge, 2004). Their strategy to gain market dominance has been directed to specific product areas. They chose only those industries which have a competitive edge or advantage. To improve their country's competitive posture, they imported technology, instead of inventing new technology, and thereby bought licensing agreements from U.S. companies. To make these new products, they concentrated their effects on the factory floor to achieve high productivity and lower unit costs. They directed their best engineering talent to the shop floor, not to product design activities. They also worked to improve product quality and reliability above what competitors could supply. Central to this effort were two philosophies, elimination of waste and respect for people.

3.4.2.2 Elimination of Waste

The Japanese are true believers in eliminating waste, and for this reason, they have defined waste as "anything other than the minimum amount of equipment, materials, parts and workers (working time) which are absolutely essential to production." (Toyota's Fujio Cho as cited by Kiyoshi Suzaki, 1987).

Fujio Cho expanded and advanced JIT definition to comprise seven prominent types of waste to be eliminated, namely;

- i) Waste from overproduction
- ii) Waste of waiting time
- iii) Transportation waste
- iv) Inventory waste
- v) Processing waste
- vi) Waste of motion and
- vii) Waste from product defects.

Hence, this definition of JIT leaves no room for surplus or safety stock. No safety stocks are allowed, because if you can not use it, you do not need to make it now. That would be waste. Hidden inventory in storage areas, transit systems, carousels, and conveyors are key target for inventory reduction.

The seven elements that address the elimination of waste are:

- i) Focused factory networks
- ii) Group technology
- iii) Quality at the source
- iv) JIT production
- v) Uniform plant loading
- vi) Kanban production control systems
- vii) Minimized setup times.

Focused factory networks:

Japanese build small specialized plants rather than large vertically integrated manufacturing facilities. They find large operations and their bureaucracies difficult to manage and not in line with their management styles. Plants designed for one purpose can be constructed and operated more economically. The bulk of Japanese plants, some 60,000 have between 30 and 1,000 workers.

Group technology:

While invented in the United States, it was most successfully employed in Japan. Instead of transferring jobs from one department to another to specialized workers, the Japanese consider all the operations required to make a part and group those machines together. The group technology cells eliminate movement queue (waiting) time between operations, reduce inventory and reduce the number of employees required. Workers however, must be flexible to run several machines and processes: Due to their advanced skill level, these workers have increased job security.

Quality at the Source:

This means do it right the first time and when something goes wrong, stop the process or assembly line immediately. Factory workers became their own inspectors, personally responsible for the quality of their outputs. Workers concentrated on one part of the job at a time so quality problems are uncovered such as these air bag crash sensors inspected at the TRW plant in Marshall, Illinois. If the pace is too fast, if the worker finds a quality problem or if a safety issue is discovered, the worker is obligated to push a button to stop the line and turn on a visual signal. People from other areas respond to the alarm and the problem. Workers are empowered to do their own maintenance and housekeeping until the problem is fixed.

This quality at the source includes automation or automated inspection. Japanese prefer to have quality inspections performed by automation or robotics because it is faster, easier, repeatable, and suitable for jobs too redundant for a worker to perform.

JIT Production

JIT means producing what is needed when needed and no more. Anything over the minimum amount necessary is viewed as waste, because effort and material expended for something not needed now can not be utilized now. This is in contrast to relying on extra material just in case something goes wrong.

The figure below shows JIT requirements and assumptions:

What it is:	What it does:
• Management Philosophy • "Pull" system through the plant	• Attacks waste (Time, inventory, Scrap) • Exposes problems and bottle necks. • Achieves streamed production
What it requires:	**What it assumes:**
• Employee participation • Industrial engineering/basics • Continuing improvements • Total quality control • Small lot sizes	• Stable environment.

Figure 3.2: "The What's of Just-in-Time"

Source: Chase, Aquilano, & Jacobs(2001 p. 327)

JIT has been applied to repetitive manufacturing. Such applications do not require large volumes and are not limited to processes that produce the same parts over and over. It can be applied to any repetitive segment of a business regardless of where they appear. Under this system, the ideal lot size is one. A worker completes the task and passes it on to the next worker or processing. While work stations may be geographically dispersed (apart) the Japanese minimize transit time and keep transfer quantities small-typically one-tenth of a days production is a lot size. Vendors even ship several times a day to their customers to keep lot sizes small and inventory low. When all queues are driven to zero, inventory investment is minimized, lead times are shortened, firms can react faster to demand changes, and quality problems are uncovered.

Uniform Plant Loading:

It is the smoothing of the production flow so as to dampen the reaction waves that normally occur in response to schedule variations. When a change is made in a final assembly, the changes are magnified through the line and the supply chain. The only way to eliminate the problem is to make adjustments as small as possible by setting a firm monthly production plan for which the output RATE is frozen. The Japanese found that they could do this by building the same mix of products every day in small quantities. Hence they always have a total mix available to respond to variations in demand.

Kanban Production Control Systems:

This is a system which uses signaling device to regulate JIT flows. Kanban means "sign" or "instruction card" in Japanese. In a paperless control system, containers can be used in lieu of cards. The cards or containers make up the Kanban pull system. The authority to produce or supply additional parts comes from downstream operations: considering the figure below figure 3.3 where, we have an assembly line that is supplied with parts by a machine center. The machine center makes two parts A and B. These two parts are stored in containers that are located next to the assembly line and next to the machine center. Each container next to the machine has withdrawal Kanban, and each container next to the machine center has a production Kanban. This is often referred to as a two card Kanban system. When the assembly line takes the first part A from a full container, a worker takes the withdrawal Kanban from the container, and takes the card to the machine center storage area. In the machine center area, the worker finds a container of part A, removes the production Kanban, and replaces it with the withdrawal Kanban. Placement of this card on the container authorizes the movement of the container to the assembly line. The freed production Kanban is placed on a rack by the machine center, which authorizes the production of another lot of material. The cards on the rack become the dispatch list for the machine center. Cards are not the only way to signal the need for production of a part; other visual methods are possible. Other possible approaches are:

i) Container system, where the container itself may be used as a signal device, in which case an empty container on the factory floor visually signals the need to fill it, with a disc drive (unit).

The amount of inventory is adjusted by simply adding or removing the containers.

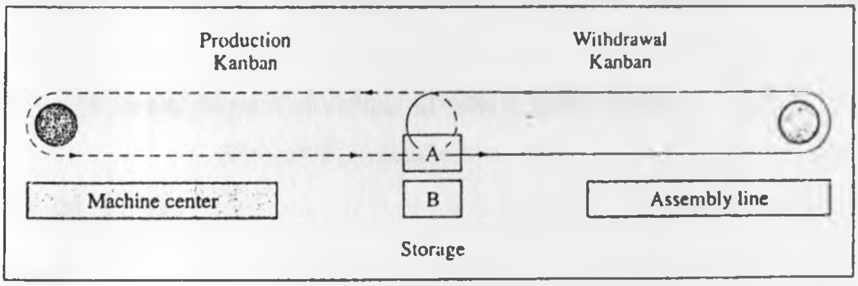


Fig. 3.3: Flow of Kanbans.

Source: Chase, Aquilano & Jacobs (2001).

ii) Kanban squares; where marked spaces on the floor are or on a table are used to identify where materials should be stored. When the square is empty, the supplying operations are authorized to produce, and when the square is full, no parts are needed.

iii) Coloured goofballs; At Kawasaki engine plant, when a part used in a sub assembly is down to its queue limit, the assembler rolls a coloured golf ball down a pipe to the replenishment machine center. This tells the operator which part to make next. Many variations have been developed on this approach.

Determining the number of Kanbans needed:

Setting up a Kanban control system requires the determination of the number of Kanban cards (or containers) needed. In the case of the two card system we are finding the number sets of withdrawal and the production cards. The Kanban cards represent the number of containers of material that flow back and forth between the supplier and the user areas. Each container represents the minimum production lot size to be supplied. The number of containers, therefore directly controls the amount of work-in-progress inventory in the system. An accurate lead time needed to produce a container of parts is the key to determining the number of containers. The lead time is a function of the processing time for the container, any waiting time during the production process, and the time required to transport the material to the user. Enough Kanbans are needed to cover the expected demand during this lead time plus some additional amount for safety stock. The number of Kanban card sets is:-

$$K = \frac{\text{expected demand during lead time + safety stock}}{\text{Size of the container}}$$

$$= \frac{DL\,(1 + S)}{C}$$

Where

K = Number of Kanban card sets.

D = Average number of units demanded over some time period.

L = Lead time to replenish an order (expressed in the same units as demand).

S = Safety stock expressed as a percentage of the demand during the lead time.

C = Container size.

Minimized Setup Times:

Because small lot sizes are the norm, machine setups must be quickly accomplished to produce the mixed models on the line.

3.4.3 Respect for People

Respect for people is a key to the Japanese improvements. They have traditionally stressed lifetime employment for permanent positions within major firms. Companies try to maintain level payrolls even when business conditions deteriorate. Permanent workers, about 1/3 of the workforce have job security and tend to be more flexible, remain with a company; and do all they can to help the company achieve its goals. Company unions in Japan exist to foster a cooperative relationship with management. All employees receive two bonuses a year in good times. Employees know that if the company performs well, they will get a bonus. This encourages workers to improve productivity. Management views workers as assets, not as human machines. Automation and robotics are used extensively to perform dull or routine jobs so employees are free to focus on important improvement tasks. Subcontractor networks are very important in Japan. The specialized nature of Japanese factories features little vertical integration. More than 90 per cent of all Japanese companies are part of the supplier network of small firms. Some suppliers are specialists in a narrow field serving multiple customers. The other more prominent, type are sole-source suppliers that make a small variety of parts for a single customer. Firms have long term partnerships with their suppliers and customers. Suppliers consider themselves part of a customer's family.

Bottom round Management:

They use a bottom-round management style made up of consensus management by committees or teams. This decision process is slow but attempts to reach a consensus (not compromise) by involving all parties, seeking information, and making a decision at the lowest level possible. Quality circles of volunteer employees meet weekly to discuss their (jobs and problems). These small group improvement activities attempts to devise solutions to problems and share the solutions with management. They are led by a supervisor or production worker and typically include employees from a given production area. Others are multidiscipline teams led by a trained group leader or facilitator. These circles are part of the consensus, bottom-round management approach.

3.5 Lean Construction Philosophy Applied To Construction Site Production:

Lean production system comprises a cocktail of ideas, including continuous improvement, leveling of the organization structure, teamwork, cutting of waste, efficient use of the sources and resources (Cartlidge, 2004).

The study of the Japanese automobile industry production model which was introduced in United States of America, boosted by the competitiveness, because the Orientals could sell better and cheaper cars dominated by the American auto market. Even though there are many competitive advantages on the Japanese model, it is argued that (Green, 1999 and others) its applicability in the occident, principally was because of its particularity with the Japanese cultural way of life.

The characteristics of the Japanese industry in the 1970's were that:-

- The quality of management is centered on the human being.
- The conventional management system is composed of a system of methodic and continuous improvement.
- The success of a management centered on the human being is based on the respect of the individual;
- The workers must work to develop their duties and improve their skills during the job.
- The workers should interact with all organization through their work and skills, allowing the development of their intellectual and creative potential.

The Japanese industry has another characteristic that is not found in other countries, which is observed as the central point is its cultural factor. The challenge that shows for the researches and professionals in the civil construction, is to adapt the concepts and principles of the lean production from the orient to the occident, trying to achieve better performance in its production process (Hirota e Formoso, 2000) Koskela (1992) began these studies and called this approach as the new production philosophy for construction. However, it is observed that some aspects related with the human resources are being the focus of this philosophy. The main point of its discussion is that this philosophy is based on control, management stress and exploitation.

The missing issue in the lean construction were discussed by Howell and Ballard (1999) as:-

- The production management is based on how the things are made and not how the persons are treated.
- The lean approach is a different way to manage the physical production, particularly to treat the dependence and variation effects;
- The lean approach tries to reduce waste, but this does not intend to add stress to the production process. It is reasonable to assume that the stress is derived from an inadequate answer for a global competitiveness;

- The lean approach offers a new way to organize the production, however the worker's exploitation could be a result of its application but not a requisite;
- The lean production techniques, as an abstract theory, are nullified in terms of human resources management.
- Furthermore, Womack and Jones (1996); Apud Green (2000) say that it could be applicable beyond the manufacturer sector.

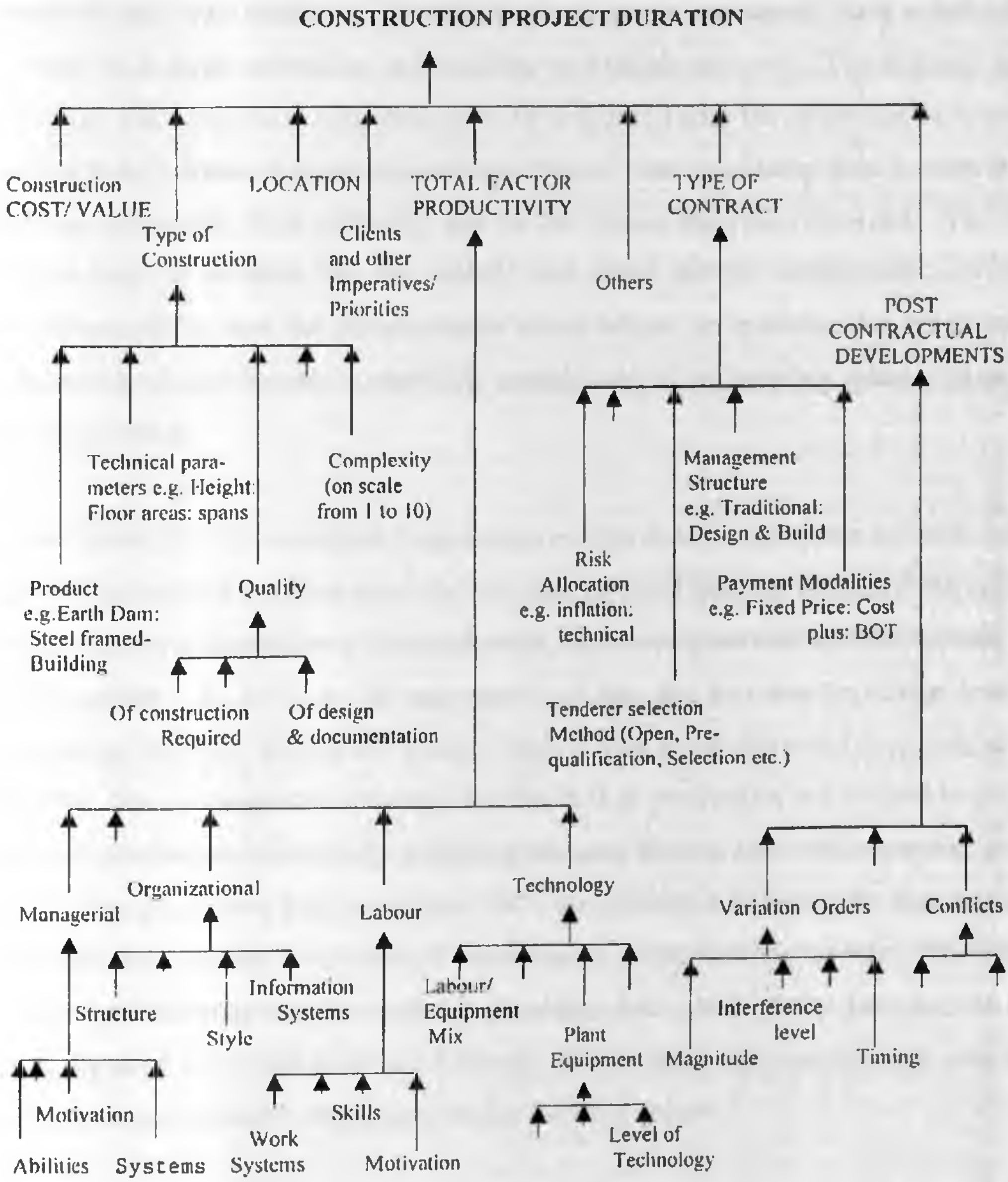
As argued by Green (1999b), the Japanese work in the same company their whole life, it is an honour issue, they live to work and not work to live. There is hierarchy in the organizational structure but all workers have basic knowledge of the work and they love their company.

3.6 Site Productivity

This is broadly defined as a ratio of output to input; viz the arithmetical ratio between the amount produced (output) and the amount of any resources used during the process of production (input). The resources may be land, materials, machinery, labour, capital, energy or, in the general case, a combination of all of them (Heap, 1987).

A case study carried out by Chan and Kumaraswamy (1995) in Hong Kong on 393 buildings indicates that, the choice of construction technology and associated site methodologies and multivation of workers can well be significant in influencing these factors. The study concluded that both plant utilization levels and site labour productivity are significant intrinsic factors affecting the overall construction duration of a project, and therefore merit special attention and control. Further, with a view to completing a construction project in the shortest reasonable time, an optimum mix is necessary not only on plant utilization (as per the study under review) but also on the productivity of the construction workers.

The study also identified factors affecting construction project duration as indicated in the figure 3.4 below:



Note: unlabelled arrows indicate that other factors also contribute . Cost / Value is in turn affected by all other factors listed: whereas some other factors also interact to varying degrees.

Fig. 3.4 Some Factors affecting construction project duration.
Source: Chan & Kumaraswamy(1995).

3.6.1 Unproductive Time In Building Operations

Productivity has been defined as the ratio between output and input. Such a definition can only apply to a single enterprise, and industry or a whole economy. For building, the term productivity has often been misconstrued to be concerned with the utilization of labour only. But even though labour forms a larger proportion of cost in building than in other forms of productive enterprise, it is still only one of the inputs resources involved. The total of resources used is dictated by: the overall and detail design requirements, construction management ability, and the circumstances under which the industry as a whole operates. The influence of such factors is especially complicated in the building industry because it is highly fragmented.

Peer and North (1971), investigated unproductive time in building operations with respect to the use of labour and equipment on the site and revealed that the nature of the commonly occuring sources of inefficiency in construction sites were generated by management, design and the worker. At 4.5% of all unproductive time, the loss due to design errors, fits, tolerances and the like, was small. Loss of time caused by workers was even smaller, being only 2.5%. The process of waiting time is classified as productive, but it could be profitably reduced in some cases by carefully matching the gang sizes to the work sequences involved. Of the total unproductive time, more than 90% was classified as caused by management and by this definition outside the control of the designer, or the building worker. While some of this loss of productivity was due to faulty planning, or to a lack of any planning, the bulk of the loss appeared to be caused by the difficulty of exercising tight management control in an industry as organizationally fragmented as the building industry.

3.6.2 Waste In Production Activity

According to Imai (1997) and Shingo (1989) sources of waste are classified according to seven main categories, as cited by Aquinaldo dos Santos (1999):

i) Overproduction: this type of waste results from "getting a head" with respect to production schedules.

ii) Here the required number of products is disregarded in favour of efficient utilization of the production capacity.

iii) Inventory: final products, semi-finished products, or parts kept in storage do not add any value. Even worse, they normally add cost to the production system by occupying space and financial resources, and, also, by requiring additional equipment facilities and man-power.

iv) Repair/rejects: rejects interrupt production and in general, require expensive rework. Moreover, they may end up discarded or damaging other equipment or generating extra paperwork when dealing with customer complaints.

v) Motion: any motion not related to adding value is unproductive.

vi) Transport: although sometimes this activity seems to be an essential part of production, moving materials or products adds no value at all.

vii) Processing: this waste happens when the use of inadequate technology or poor design results in inefficient processing activities. Sometimes this waste may appear as a consequence of a failure to synchronize processes, where workers achieve performance levels beyond or below the requirements of downstream processes.

viii) Waiting: this waste occurs when the hands of a worker are idle, such as when there are imbalances in schedule, lack of parts, machine down time or when the worker is simply monitoring a machine performing a value-adding job.

This classification could extend further with the inclusion of vandalism, theft and other sources of waste. Koskela (1999) proposes the inclusion of a type of waste that occurs frequently in construction when production operates under "sub-optimal conditions". Congestion of a work station in small places, work out of sequence and excessive stops in the production flow are examples of these conditions that lead to production having sub optimal performance (Ballard and Howell, 1998; Kosketa 1999). Formoso etal (1999) adds that on buildings sites it is possible to find waste due to "substitution". This waste happens when, for instance, there is a monetary loss caused by the substitution of a material by a more expensive one or when the execution of a simple task uses over qualified workers. Another important aspect in production flow is the importance between "process" and "operations" particularly for those who are searching for improvements in production systems. Process flows in production should always receive top priority in improvements activities within production systems. For instance and conventionally, most people simply think that improving transport efficiency refers to the adoption of forklifts, or installing conveyors etc. However, within the process/operation flows, improving transport can also mean reducing or even eliminating the transport altogether. In the case of operations flow the objective of managers/workers involved in the analysis of production should be to reduce the amount of set-up, external and personal operations involved or interfering in the principal operations. At the same time the analysts should attempt to increase the efficiency of the principle operations. Activities such as adjustment, rest or implication, for instance, should be moved out of the main process flow in order to allow smoother and faster process cycle time.

A critical analysis of practice and theory (Aquinaldo dos Santos 1999 pp.80) showed that production systems could be classified according to the relative movement between processes and the operations carried out by work stations, as follows:

i) Production systems with fixed work stations: Operations move in time and space but only within the limits of the work station. The movement of the 'principal operation' is restricted to the physical position of the corresponding part of the process (e.g. assembly line of computers).

ii) Production systems with mobile work stations: The sub-product and materials have a fixed position once they get into the production system. However, in this case the work station has to move across the various work places in order to carry out the principal operations (e.g. ship building, construction).

iii) Production systems with mobile processes and work station (mixed): represent the most complex type. In this type of production, components and materials may change position in time, and the work stations will flow this movement in order to accomplish the "principal operation" (e.g. ice-cream maker).

3.6.3 Materials Handling

Larson (1983), investigated sites in the early 1980's and found out that 15% redundant material or more was bought. The variation in the over consumption was also found to be extensive and notable was also that the construction companies had very little knowledge about their actual consumption. In mid 1990s Lindhe also reinvestigated the field, and showed that the over consumption in the field had reduced to 1-12%.

3.6.4 The Importance of the Site Manager

Larson (1983), investigated the conditions for implementing new techniques at the building site and, surprisingly found the site manager to be a key factor. He found that the site manager often works under hard pressure since the time schedules were tight and disturbances in the production were frequent. It is the site manager who decides why and when to use new solutions and adopt new technology, at the same time dealing with problems on site.

3.6.5 Process Orientations

Melan (1993) identifies processes as: "A bound group of interrelated work activities providing output of greater value than the inputs by means of one or more transformations. Ljungberg (1998) widens the definition to: "A repetitively used network of orderly linked activities using information and resources for transforming inputs to outputs, extending from the point of identification to that of satisfaction of customers needs.

3.6.6 Work Study

Work study is a tool of production management and is the name given to study of work processes to find out if they are being done efficiently and if not to suggest means or alternative methods by which they may be carried out more efficiently (Foster, 1976). The process involves the examination of the way operations are performed, which is called method or motion study; and the time within which they are performed, which is called time study. Both of these studies are extensive but interdependent and are usually carried out concurrently by an executive trained in the technique of work study and called a "studyman" or "work study engineer".

Although in normal building work a very large proportion of individual assembly operations are non-repetitive, in some of the trades there is considerable repetition in the work. In some cases 50 to 65 per cent of the work of a brick layer and carpenter trades may be repetitive and some 40 per cent of work in concreting is repetitive. Work study, establishing standard times and developing correct methods, gives considerable advantages in these spheres.

In addition, methods for new work may be developed by this means and standard derived which are fair and which provide the same incentive to operatives to earn a bonus as the repetitive work.

3.6.7 Relationship between operations of plant and of men

It is essential, particularly in mechanical handling that the number of men working on any operation should be correctly related to the output of the mechanical plant serving them.

This is necessary in order to avoid the plant being idle from time to time while the men use the material already delivered to them. Concreting gangs for example must be related in size and number to the size of concrete mixer used so that each load of concrete can be received and placed by the time the next load is ready for delivery.

The number of men who can work efficiently on any one site, is of course, limited by the size of the job, the nature of the structure and other considerations, so that this will set a limit to the size of mechanical plant capable of being used to advantage.

In conclusion site productivity studies should look at unproductive time in building operations, waste in production activity, materials handling, the importance of the site manager, process orientations, work study techniques, and the combination of men and plant as these have an impact on projects performance.

3.7 Conceptual Framework Working Model

Theories related to resource mix form the foundation of explaining and understanding optimization of resources by construction firms. These theories also have a bearing on time and cost management in construction projects.

Appropriate matching and management of construction resources can be conceptualized as a contributor to construction project performance. Thus, CPP is a function of labour, materials, equipment, finance, time and information.

CPP = f(L,M,E,F,T,I)

Where CPP = Construction project performance

(time, cost, quality and environmental factors)

L = Labour (staff/men)

M = Materials

E = Equipment - hours

F = Finance (Finance of the project by firm i.e. Credit worthiness as a form of resource).

T = Time

I = Information (as a resource)

Hence the following model.

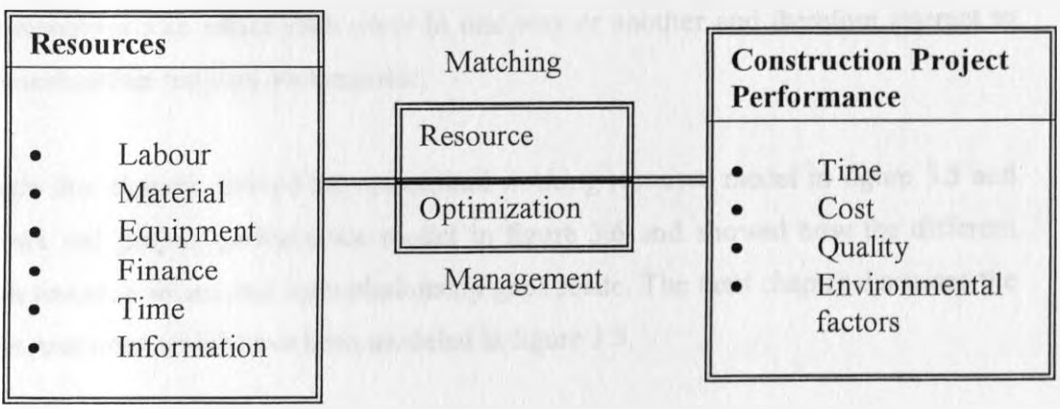


Fig. 3.5: Resource Model.

Source: Own Construct 2005. Derived from Management Theory

The aim of construction management theory is to develop a knowledge base for efficient management of projects with the objective of achieving efficiency in time and quality at minimum cost (Abbott, 1987, p.706 and Talukhaba, 1999, p.15).

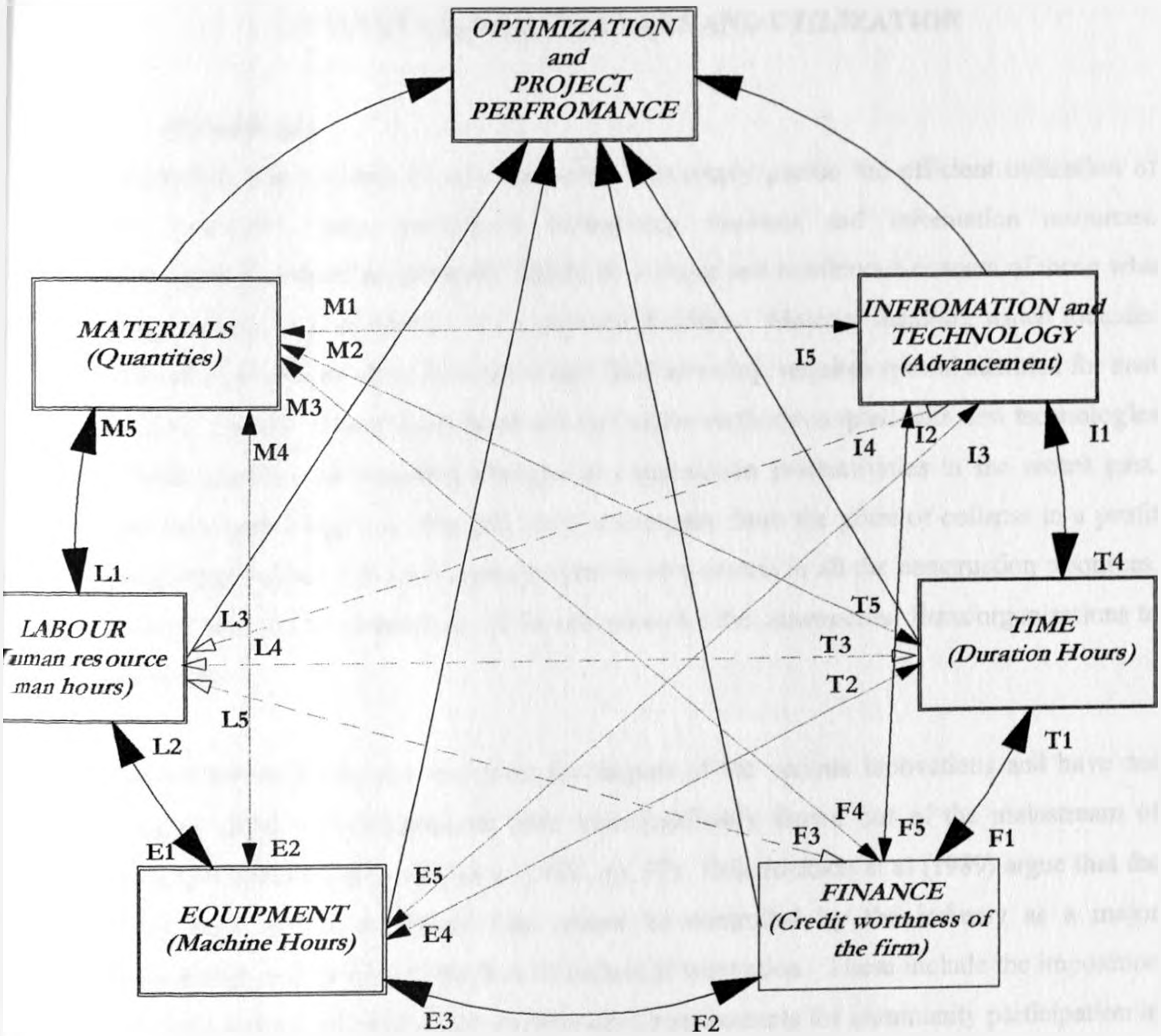
Concepts in this study are derived from construction project management theory which in turn derives its concepts from the general management science. Construction project management has its genesis in construction activities. However, the theories are dynamic and keep on evolving as technology advances. These theories emphasize those tenets of management science that are relevant to the management of construction projects. Some specific theories that relate to optimization of construction resources are found in the broad spectrum of operations research. These concepts underscore the techniques used in operations research in other disciplines for production purposes.

3.8 Resource mix interrelationship gaps that contribute to construction projects performance.

Figure 3.6 shows the resource mix interrelationship gaps that contribute to construction projects performance which arise from the resource model in figure 3.5. The figure shows that, even though the six construction resources in figure 3.5 combine collectively to affect construction project performance of the individual construction firms in terms of resource mix, these resources also affect each other in one way or another and therefore interact to impact on construction projects performance.

In conclusion this chapter derived the conceptual working resource model in figure 3.5 and resources mix and project performance model in figure 3.6 and showed how the different construction resource mixes and interrelationship gaps relate. The next chapter discusses the construction resources which have been modeled in figure 3.5.

Figure 3.6 Resource mix and project performance model.



Key:

Direct resource relationship with project performance

Interrelationships between the resources themselves.

i.e $M_1 - M_5$, $L_1 - L_5$, E_1 - E_5, $F_1 - F_5$, $T_1 - T_5$ & $I_1 - I_5$

Resource Interrelationship Gaps which contribute to project Performance.
Source: Own Construct. 2005.

CHAPTER IV

CONSTRUCTION RESOURCES AND UTILIZATION

4.0 Introduction

Good project management of resources must vigorously pursue the efficient utilization of labour, materials, time, equipment, technology, finances and information resources. Improvement on labour productivity should be a major and continuous concern of those who are responsible for cost control of constructed facilities. Material handling which includes procurement, inventory shop fabrication and field servicing, requires special attention for cost reduction. The use of new equipment and innovative methods coupled with new technologies has made possible far reaching changes in construction productivities in the recent past. Information technology has changed many a company from the point of collapse to a profit making organization. Financial management is very central in all the construction resources, because costs must be reduced in all the resources for the construction firms/organizations to post a profit.

Organizations which do not recognize the impact of the various innovations and have not adapted to changing environments have been justifiably forced out of the mainstream of construction activities (Heindrickson, 1989. pp. 77). Heindrickson et al (1989) argue that the industry often points to factors that cannot be controlled by the industry as a major explanation in cost increases and lack of technical innovation. These include the imposition of restrictions for protection of the environment, requirements for community participation in major construction projects, labour laws that allow union strikes to become a source of disruption, regulatory policies such as building codes, zoning ordinances and tax laws which inhibit construction in other countries (abroad). However, the industry should bear a large share of blame for not earlier realizing that the technological hedge held by construction firms has been eroded in the face of stiff foreign competition. Many practices in the past which were tolerated when contractors had a technological lead, must now be changed in the face of stiff competition. Otherwise the industry will continue to find itself in trouble.

With a strong technological base (Hendrickson, 1989), there is no reason why the construction company can not catch up and reassert itself to meet competition wherever it might be. Individual design and/or construction firms must explore new ways to improve productivity for the future by efficiently using their resources. What is needed most is strategic planning to usher in a revolution which can improve productivity by an order of magnitude or more. It should look at opportunities and ask whether there are potential options along which new goals may be sought on the basis of the existing resources. We cannot be certain about the success of the various development options for the design professions and the construction industry. However with the availability of today's high technology, some options have a good potential of success because of the social and economic necessity which will eventually push barriers aside. Ultimately, decisions for action, not plans, will dictate future outcomes.

4.1 Labour Productivity and Project Performance

Productivity in construction is often broadly defined as output per labour hour (Hendrickson, 1989, p. 79). Since labour contributes a large part of construction and the quantity of labour hours of performing a task therefore it is more susceptible to the influence of management than are materials or capital. Thus productivity measure is often referred to as labour productivity. However, it is important to note that labour productivity is a measure of the overall effectiveness of an ongoing system in utilizing labour, equipment, information, technology and capital to convert labour efforts into useful output and is not a measure of capabilities alone. For instance, by investing into a new piece of equipment to perform certain tasks in construction, output may be increased for the same number of labour-hours, thus resulting in higher labour productivity.

Construction output may be expressed in terms of functional units or constant shillings. In the former case, labour productivity is associated with units of product per labour hour, such as cubic metres of concrete placed, or square metres of walling built per hour, or miles/km of highway paved per hour. In the later case, labour productivity is identified with value of construction in constant Kenyan shillings per hour.

4.1.1 Productivity at the Job Site.

Contractors and owners are often concerned with labour activity at job sites. For this purpose, it is convenient to express productivity as functional units per labour-hour for each type of construction task. However, even for such specific purposes, different levels of measure may be used. For instance, cubic metres of concrete placed per hour is a lower level of measure, than is kilometres/miles of highway paved per hour. Low level measures are more useful for monitoring individual activities, while higher-level measures may be more convenient for developing industry wide standards of performance.

While each construction firm or owner is free to use its own system to measure labour productivity at a site, it is good practice to set up a system which can be used to track up productivity trends over time and in varied locations. Considerable efforts are required to collect information regionally or nationally over a number of years to produce such results.

To develop industry-wide standards of performance, there must be general agreement on the measures to be useful for compiling data. Then the job-site productivity dates collected by various contractors and owners can be correlated and analyzed to develop certain measures for each of the major segments of the construction industry. Thus a contractor, or owner can compare its performance with that of the industry average.

Factors Affecting Job-Site Productivity.

Hendrickson; (1989 pp. 79 – 116) argues that there are two factors, namely project work conditions and/or as non-productive activities that affect job site productivity.

Project Work Conditions.	Non-Productive Activities.
Job size and complexity. Job site accessibility Labour availability Equipment utilization Contractual agreements. Local climate Local cultural characteristics particularly in foreign operations.	Indirect labour requirements to maintain the process of the project. Rework for correcting unsatisfactory work. Temporary work stoppage due to inclement weather or material shortage. Time off for union activities. Absentee time, including late start and early quits. Non working holidays. Strikes. These factors may/may not be paid by the owner, but they never the less take up potential labour resources, which can otherwise be directed to the project.

Figure 4.1 Factors Affecting Job-Site Productivity

Source: Hendrickson: Project Management for construction, 1989 pp. 80.

Both categories of factors affect the productive labour available to a project as well as the on site labour efficiency.

4.1.2 Project Work Conditions.

Job site labour can be estimated either for each craft (carpenter, brick layer; concretor etc.) or for each type of construction (Residential housing; processing plant etc.) under a specific set of work conditions. A base labour productivity may be defined for a set of work conditions specified by the owner or the construction firm who wishes to observe and measure the labour performance over a period of time under such conditions. A labour productivity index may then be defined as the ratio of the job site labour productivity under a different act of work conditions to the base labour productivity and is a measure of the relative labour efficiency of a project under this new set of work conditions. The effects of various factors related to work conditions on a new project can be estimated in advance, some more accurately than others. For instance, for very large construction projects, the labour productivity tends to decrease as the project size and/or complexity increase because of logistic problems and the "learning' that the work force must undergo before adjusting to the new environment. Job site accessibility may reduce labour productivity if the workers must work/perform their jobs in round about ways, such as avoiding traffic in paving the highway surface or maintaining the operation of plant during renovations. Labour availability in the local market is another factor. Shortage of local labour will force the contractor to import labour or schedule for overtime work or do both. In either case labour efficiency will be reduced in addition to incurring additional expenses.

The degree of equipment utilization and mechanization of a construction project clearly will have direct impact on job site labour productivity. Since on-site construction essentially involves outdoor activities, the local climate will influence the efficiency of workers directly. On regional/foreign operations, the cultural characteristics of the host region/country should be observed in assessing the labour efficiency.

4.1.3 Non-Productive Activities.

The non-productive activities associated with a project should also be examined to determine the productive labour yield; which is defined as the ratio of direct labour hours devoted to the completion of a project to the potential labour hours. Thus, the direct labour hours are estimated on the basis of the best possible conditions at a job site by excluding all the factors which may reduce the productive labour yield. For instance, in the repaving of a highway surface, the flaggers required to divert traffic represent indirect labour which does not contribute to the labour efficiency of the paving crew if the highway is closed to the traffic. Likewise, for large projects in remote areas, indirect labour may be used to provide housing infrastructure for the workers hired to supply the direct labour for a project. Furthermore, the labour-hours spent on remedial works to correct unsatisfactory original work represent extra time taken away from potential labour-hours. The labour hours related to such activities must be deducted from the potential labour hours to obtain the actual productive labour yield.

4.1.4 Labour Relations in Construction

The market demand for construction fluctuates greatly, often within short periods and with uneven distributions among geographical regions (Fellows & Longford, 1988; Hendrickson et al, 1989). Even when the volume of construction activity is relatively stable, some types of work may decline in importance while other types gain. Under such circumstances, and more so when the economic environment is unstable, the employers/construction firms in the industry place great value in hiring and laying off workers as their volumes of work increase and decline. On the other hand, because of these actions taken by employers, workers sense the insecurity under such circumstances, and an attempt to limit the impacts of the changing economic conditions are addressed through labour organizations.

There are many crafts in the construction industry, but construction firms hire from only a few of these crafts to satisfy their specialized needs. As a result of these peculiar characteristics of employment conditions, employers and workers are placed in a more intimate relationship than in many other industries in the economy.

Labour and management arrangements in the construction industry comprise both unionized and Non-unionized operations which compete for future dominance. In most developed countries unionized construction is practiced, where craft unions work with construction contractors using unionized labour through various market institutions such as jurisdiction rules, apprenticeship programmes, and referral system (Hendrickson, 1989). These craft unions have specific jurisdiction rules for different trades, set uniformly hourly wage rates and offer formal apprenticeship training to provide common and equivalent skill for each trade. Construction firms through contractors associations, enter into legally binding collective bargaining agreements with one or more of the craft union in the construction trade. This system which binds both parties to a collective bargaining agreement is referred to as the "Union Shop". These agreements obligate a contractor to comply with the work jurisdictions of the various unions and to hire employees through a union operated referral system commonly known as the "hiring hall". Such referral systems operated by union organizations are required to comply with several conditions. Some of these conditions are:

1. All qualified workers registered with the referral system must be made available to the contractor without discrimination on the basis of Union membership or other relationship to the union. The "Closed Shop" which limits referral to union members only is now illegal.
2. The contractor/construction firm reserves the right to hire or refuse to hire any worker referred by the union on the basis of his or her qualifications.
3. The referral plan must be posted in public including any priorities of referrals or required qualifications.

Whereas, these principles must prevail, referral systems operated by labour organizations differ widely in the construction industry. In the Kenyan situation the same referral systems are operated by the Ministry of Labour through their different regional labour offices.

Contractors/construction firms and craft unions must negotiate not only wage rates and working conditions, but also hiring and apprentice training practices. The primary goal of trade jurisdiction is to encourage construction firms to invest in apprentice training on the part of the Union, so that the contractor will be protected by having only qualified workers perform the job even though such workers are not permanently attached to the construction firm and thus may have no sense of security or loyalty. The referral system is both useful and a rapidly dependable source of workers, particularly for a construction firm which moves into a new geographical area or starts a new project which has high fluctuations in demand for labour. By and large the referral system should form the basis of training in the provision of qualified workers to construction firms, even though some other aspects of union operations may not be acceptable by construction firms.

Likewise in developed countries, non union contractors have joined the fray of unionized labour force in the construction industry whose operations are referred to as "Open shops". However, in the absence of collective bargaining agreements, many construction companies operate under policies adopted by non-union contractors associations. This practice is referred to as the 'merit shop", which follows substantially the same policies and procedures as collective bargaining although under the control of a non-union contractors' association without union participation. Other contractors may choose to be totally "un-unionized" by not following either the 'Union shop" or merit shop practices.

The operations of the merit shop are national in scope, except for state apprenticeship and training plans. The comprehensive plans of all the Contractors' Association apply to all employees and crafts of a contractor regardless of their trades. Under such operations workers have full rights to move through the nation among member Contractors of the organization. Thus the non-union segment of the industry is organized by contractors Associations into an integral part of the construction industry. However, since merit shop workers are employed directly by the construction firms, they have a greater loyalty to the firm and recognize that their own interest will be affected by the financial health of the firm. The advantages of merit shops as acclaimed by its proponents are five fold; namely:-

- The ability to manage their own workforce.
- Flexibility in making timely management decisions.
- The emphasis on encouraging individual work advancement through continued development of skills.
- The emphasis on making maximum usage of local labour force and;
- The shared interest that management and workers have in seeing an individual firm prosper.

By shouldering the management responsibility for producing skilled workers, the merit shop contractors have deflected the most serious complaints of users and labour that used to be raised against the open shop. Likewise, the use of mixed crews of skilled workers at the job site by merit shop contractors enables them to remove a major source of inefficiencies caused by the exclusive jurisdiction practiced in the union shop, namely, the idea that only members of a particular union should be permitted to perform any given task in construction. As a result, merit shop contractors are able to exert a beneficial influence on productivity and cost effectiveness of construction projects.

The un-organized form of open shop is primarily prevalent in informal housing construction where a large percentage of the workers are characterized as unskilled helpers. The skilled workers in various crafts are developed gradually through informal apprenticeships while serving as helpers (village polytechnics). This form of open shop is not expected to expand beyond the type of construction projects in which highly specialized skills are not required or informal housing in the rural areas as in Kenya. In conclusion any issues related to labour will have a direct impact on resource optimization and consequently the performance of the project.

4.2 Materials Management Mix and Project Performance

Materials represent a major expense in the construction. So minimizing procurement or purchase costs presents important opportunities for reducing costs. Poor materials management can also result in large and unavoidable costs during construction (Hendrickson, 1989).

- First, if materials are purchased early, capital may be tied up and interest charges incurred on the excess inventory of materials.
- Even worse, materials may deteriorate during storage or stolen unless special care is taken e.g. electrical equipment must always be stored in waterproof locations and cement is no exception either.
- Second, delays and extra expenses may be incurred if materials required for particular activities are not available.

Accordingly, ensuring a timely flow of materials is an important concern of project managers. Material management is not just a concern during the monitoring stage in which construction is taking place, but decisions about material procurement may also be required during the initial planning and scheduling stages e.g. activities can be inserted in the project schedule to represent purchasing of major items such as elevators for buildings. The availability of materials may greatly influence the schedule in projects with a fast track or a very tight time schedule. Sufficient time for procuring the necessary materials must be allowed. In some cases more expensive suppliers or shippers may be employed to save time.

Materials management is also a problem at the organization level, if central purchasing and inventory control are used for standard items. This organizational materials management problem is analogous to inventory control in any organization facing continuing demand for particular items. In the manufacturing realm the use of automated materials requirements planning systems is common, in which, the master production schedule, inventory records and product component lists are merged to determine what items must be ordered, when they should be ordered, and how much of each should be ordered in each particular (time) period. The heart of these calculations is simple arithmetic: the projected demand for each material item in each period is subtracted from the available inventory. When the inventory becomes too low, a new order is recommended. For items that are non-standard or not kept in inventory, the calculation is even simpler, since no inventory must be considered with a materials requirement system, much of the record keeping is automated, and project managers are alerted to purchasing requirements.

4.2.1 Material Procurement and Delivery

The main sources of information for feedback and control of materials procurement are requisitions, bids and quotations, purchase orders and subcontracts, shipping and receiving documents, and invoices. For large projects involving the large-scale use of critical resources, the owner may initiate the procurement procedure even before the selection of a contractor to avoid delays and shortages (Hendrickson, 1989). The materials for delivery to and from a construction site may be broadly classified as:

1. Bulk materials
2. Standard off-the shelf materials and;
3. Fabricated members or units.

The process of delivery, including transportation, field storage, and installation, will be different for these classes of materials. The equipment needed to handle and haul these classes of materials will also be different.

Bulk materials refer to materials in their natural or semi-processed state, such as earthwork to be excavated, wet concrete mix, sand, ballast and so on, which are usually encountered in large quantities on construction sites. Such materials such as earthwork or gravels are measured bank (solid in situ) volume.

Standard piping and valves are typical examples of standard off-the shelf materials which are used extensively in chemical processing industry. Since standard off-the shelf materials can be easily stockpiled, the delivery process is relatively simple. Fabricated members such as steel beams and columns for buildings are pre-processed in a shop to simplify the field erection times and procedures. Welded and bolted connections are partially attached to the members which are cut to precise dimensions for adequate fit. Similarly, steel tanks and pressure vessels are often partly or fully fabricated before shipping to the field. In general, if the work can be done in the shop where the working conditions can better be controlled; it is advisable to do so, provided that the fabricated members or units can be shipped to the construction site in a satisfactory manner at a reasonable cost.

A further step is to simplify field assembly, an entire wall panel including plumbing and wiring or even an entire room may be fabricated and shipped/transported to the site.

4.2.2 Inventory Control

Once goods are purchased they represent an inventory used during construction process. the general objective is to minimize the total cost of keeping the inventory while making trade-offs among the major categories of costs: viz.:

1. Purchase costs
2. Order costs
3. Holding costs and
4. Unavailable costs.

These cost categories are interrelated since reducing costs in one category may increase cost in others. The costs in all categories are subject to considerable uncertainty.

4.2.2.1 Purchase Costs:

The purchase costs of an item is the unit (cost) purchase price from an external source including transporting and freight costs. For construction materials, it is common to receive discounts for bulk purchasers, so the unit purchase cost declines as quantity increases. These reductions may reflect manufacturers marketing policies, economies of scale in the material production and/or scale economies in transportation. These are also advantages in having homogeneous materials e.g. a bulk order to ensure the same colour or size of items such as bricks may be desirable. Besides it is usually desirable to make a limited number of large purchases of materials. In some cases organizations may consolidate small orders from a number of different projects to capture such bulk discounts; this is a basic saving to be derived from a central purchasing office.

4.2.2.2 Order Costs

The order cost reflects the administrative expense of issuing a purchase order to an outside supplier. Order costs include expenses of making requisitions, analyzing alternative vendors, checking on orders, and maintaining records of the entire process. Order costs are usually a small proportion of total costs for material management in construction projects, although ordering may require substantial time.

4.2.2.3 Holding Costs

The holding costs or carrying costs are primarily the result of capital costs, handling, storage, obsolescence, shrinkage, and deterioration. Capital cost stems from the opportunity costs or financial expense of capital tied up in inventory. Once payments for goods are made, borrowing costs are incurred or capital must be diverted from other productive uses. Consequently, a capital carrying cost is incurred equal to the value of the inventory during a period multiplied by the interest rate obtainable or paid during that period. It is worthy noting that capital costs accumulate only when payment for materials actually occurs, and many organizations attempt to delay payments as long as possible to minimize such costs. Handling and storage represent the movement and protection charges incurred for materials. Storage costs also include the disruption caused to other project activities by large inventories of materials that get in the way. Obsolescence is the risk that an item will lose value because of changes in specifications.

Shrinkage is the decrease in inventory over time due to theft, or loss. Deterioration reflects a change in material quality due to age or environmental degradation. Many of these holding cost components are difficult to predict in advance; and the project manager knows only that there is some chance that specific categories of cost will occur. In addition to these major categories of cost, there may be ancillary cost of additional insurance, taxes, (many states in USA treat inventories as taxable property) or fire hazards. As a general rule, holding costs will typically represent 20 to 40 percent of the average inventory value over the course of a year.

4.2.2.4 Unavailability Cost:

The unavailability cost is incurred when a desired material is not available at the desired time. In manufacturing industries, this cost is called the stock out or depletion cost. Shortages may delay work, thereby wasting labour resources and machine time or delaying the completion of the entire project. Again, it may be difficult to forecast in advance exactly when an item may be required or when a shipment will be received. In conclusion any problems in materials management will result in poor resource optimization and therefore affect the construction project performance.

4.3 Construction Equipment and Project Performance

The selection of the appropriate size and type of construction equipment often affects the required amount of time and effort, and through the job-site productivity of a project. It is therefore important for site managers and construction planners to be familiar with the characteristics of the major types of equipment most commonly used in construction (Hendrickson, 1989).

4.3.1 Excavation and Loading.

One family of construction machines used for excavation is broadly classified as crane-shovel, denoting a variety of machines comprising three major components, namely:

1. A carrier or mounting which provides mobility and stability for the machine.
2. A revolving deck or turntable which contains the power and control units.
3. A front-end attachment which serves the special functions in an operation.

Examples of these are crane (hook); clamshell; dragline, back hoe, shovel and pile-driver (Hendrickson (1989). These examples are referred to as crawler mounting, which are particularly suitable for crawling over relatively rugged surfaces at a job site. Other types include truck mounted and wheel mounted machines, which provide greater mobility between job sites but require better surfaces for their operation.

A tractor consists of a crawler mounting and a non-revolving cab. When an earth-moving blade is attached to the front end of a tractor, the assembly is called a bulldozer. When a bucket is attached to its front, the assembly is called (known) as a loader or bucket loader. There are different types of loaders designed to handle most efficiently materials of different weights and moisture contents. Scrapers are multiple units of tractor-truck and blade-bucket assemblies with various combinations to facilitate the loading and hauling of earthwork. The major types of scrapers include single engine scrapers, elevating scrapers and push-pull scrapers. Each type has different characteristics of rolling resistance, maneuverability, stability and speed in operation.

4.3.2 Compaction and Grading.

The function of compaction equipment is to produce higher density in soil mechanically. The basic forces used in compaction are static weight, kneading, impact, and vibration. The degree of compaction that may be achieved depends on the properties of the soil, its moisture content, the thickness of the soil layer for compaction and the method of compaction. Some major types of equipment include rollers with different operating characteristics. Hence towed sheeps foot roller, grid roller, self-propelled segmented steel wheel roller; self-propelled tamping foot roller and self-propelled vibratory tamping foot roller.

The function of the grading equipment is to bring the earthwork to the desired shape and elevation. Major types of grading equipment include motor graders and grade trimmers. The former is an all-purpose machine for grading and surface finishing; the latter is used for heavy construction because of its higher operating speed.

4.3.3 Drilling and Blasting

Rock excavation is an audacious task requiring special equipment and methods (Peurifoy, et al, 1985). The degree of difficulty depends on physical characteristics of the rock type to be excavated, such as grain size, planes of weakness, weathering brittleness and hardness. The work of rock excavation includes, loosening, loading, hauling and compacting. Loosening is a specialized operation which is performed by drilling; blasting and ripping.

The major types of drilling equipment are percussion drills, and rotary percussion drills. A percussion drill penetrates and cuts the rock by impact while it rotates without cutting on the up-stock. Common types of percussion drills include the jackhammer which is hand-held and others which are mounted on a fixed frame or on a wagon or crawl for mobility. A rotary drill cuts by turning a bit against the rock surface, whereas a rotary percussion drill combines the two cutting movements to provide a faster penetration in rock.

Blasting requires the use of explosives, the most common of which is dynamite. Generally, electric blasting caps are connected in a circuit with insulated wires. Power sources may be power lines or blasting machines designed for firing electric cap circuits.

Non-electrical blasting systems are also used, which combine the precise timing and the flexibility of electrical blasting and the safety of non-electrical detonation. The tractor mounted rippers are capable of penetrating and prying loose most rock types. The blade or ripper is connected to an adjustable shank which controls the angle at the tip of the blade as it is raised or lowered. Automated ripper control may be installed to control ripping depth and tie angle. In rock tunneling, special tunnel machines equipped with multiple cutter heads and capable of excavating full diameter of the tunnel are now available. Their use has increasingly replaced the traditional methods of drilling and blasting.

4.3.4 Lifting and Erecting.

Derrick cranes are commonly used to lift equipment of materials in industrial or building construction (Peurifoy, et al, 1985). A derrick consists of a vertical mast and inclined boom sprouting from the foot of the mast. The mast is held in position by guys or stiff legs connected to a base while a topping lift links the top of the mast and the top of the inclined boom. A hook in the road line hanging from the top of the inclined boom is used to lift loads. Guy derricks may easily be moved from one floor to the next in a building under construction while stiff leg derricks may be mounted on tracks for movement within a work area.

Tower cranes are used to lift loads to great heights and facilitate the erection of steel building frames. Horizontal boom type tower cranes are most common in high-rise building construction. Inclined boom-type tower cranes are also used for erecting steel structures.

4.3.5 Mixing and Paving

Basic types include machines for dispensing concrete and bituminous materials for pavement surfaces. Concrete mixers may also be used to mix cement, sand and gravel/ballast and water in batches for other types of construction work other than paving. A truck mixer refers to a concrete mixer mounted on a truck, which is capable of transporting ready-mixed concrete from a central batch plant to construction sites (Foster, 1976).

A paving mixer is a self-propelled concrete mixer equipped with a boom and a bucket to place concrete at any desired point within a roadway. It can be used as a stationery mixer or used to supply slip form pavers that are capable of spreading, consolidating and finishing a concrete slab without the use of forms.

A bituminous distributor is a truck mounted plant, for generating liquid bituminous materials and applying them to road surfaces through spray bar connected at the end of the truck. Bituminous materials include both asphalt and tar which have similar properties except that tar is not soluble in petroleum products. While asphalt is most frequently used for road works (surfacing), tar is used when the paving is likely to be heavily exposed to petroleum spills.

4.3.6 Construction Tools and Other Equipment.

Air compressors and pumps are widely used (Hendrickson, 1989) as the power sources for construction tools and equipment. Common pneumatic construction tools include drills; hammers; grinders, saws; wrenches, stapple guns, sand blasting guns and concrete vibrators.

Pumps are used to supply water or to dewater at construction and to provide water jets for some types of construction.

4.3.7 The Choice of Equipment and Standard Production Rates.

Construction equipment is used to perform repetitive operations and can be broadly classified according to two basic functions (Hendrickson, 1989 and Foster, 1976).

1. Operators such as cranes, graders, and so on that stay within the confines of a construction site and;
2. Haulers such as dump trucks, ready mixed concrete trucks and so on that transport materials to and from the site.

In both cases the cycle of a piece of equipment is a sequence of tasks which is repeated to produce a unit of output. For example, the sequence of the tasks for a crane might be to fit and install a wall panel (or a package of eight wall panels) on the side of a building. Similarly, the sequence of tasks of a ready mixed concrete truck might be to load, haul and unload two cubic metres or one truck load of fresh concrete.

Hendrickson (1989) argues that, to increase job-site productivity, it is beneficial to select equipment with proper characteristics and a size most suitable for the work conditions at a construction site. In excavation for building construction, for example, factors that could affect the selection of excavators include;

1. Size of Job: Larger volumes of excavation will require larger excavators or smaller excavators in greater number.
2. Activity time Constraints: Shortage of time for excavations may force contractors to increase the size or numbers of equipment for activities related to excavation.
3. Availability of Equipment: Productivity of excavation activities will diminish if the equipment used to perform them is available but not the most adequate.
4. Cost of Transportation of the Equipment: This cost depends on the size of the job, the distance of transportation, and the means of transportation.
5. Type of Excavation : Principal types of excavation in building projects are cut and/or fill, massive excavation, and excavation for the elements of foundation. The most

adequate equipment to perform one of these activities is not the most adequate to perform the others.

6. Soil Characteristics: The type and condition of the soil is important when choosing the most adequate equipment since each piece of equipment has different outputs for different soils. Moreover, one excavation pit could have different characteristics at different strata.

7. Geometric characteristics of Elements to be Excavated: Functional characteristics of different types of equipment makes such considerations necessary.

8. Space Constraints: The Performance of equipment is influenced by the spatial limitations for the movement of excavators.

9. Characteristics of haul Units: The size of an excavator will depend on the haul units if there is a constraint on the size and/or number of these units.

10. Location of Dumping areas: The distance between the construction site and the dumping areas could be relevant not only for selecting the type and number of haulers, but also the type of excavators.

11. Weather and Temperature: Rain, snow and severe temperature conditions affect the job site productivity of labour and equipment.

Various types of machines for excavation can be compared for efficiency. For instance, power shovels are generally found to be most suitable for excavating from a level surface and for attacking an existing digging surface or one created by the power shovel. Furthermore, they have the capability of placing the excavated material directly onto the haulers. Another alternative is to use bulldozers for excavation.

The choice and the type of haulers is based on the consideration that the number of haulers selected must be capable of disposing of the excavated materials expeditiously.

Factors that affect this selection include (Hendrickson, 1989):

1. Output of excavators: The size and characteristics of the excavators selected will determine the output volume excavated per day.

2. Distance to dump site. Sometimes part of the excavated materials may be piled up in a corner at the job site for use as back fill.

3. Probable average speed. The average speed of the haulers to and from the dumping site will determine the cycle time for each hauling trip.

4. Volume of excavated materials: The volume of excavated materials including the part to be piled up should be hauled away as soon as possible.

5. Spatial and weight constraints: The size and weight of the haulers must be feasible at the job site and over the route from the construction site to the dumping area.

Dump trucks are usually used as haulers for excavated materials as they can move freely and with relatively high speeds on city streets as well as on highways. The cycle capacity 'C' of a piece of equipment is defined as "the number of output units per cycle of operation under standard work conditions". The capacity is a function of output units used in the measurement as well as the size of the equipment and the material to be processed. The cycle time 'T' refers to the unit of time per cycle operation. The standard production rate 'R' of a piece of construction equipment is defined as the number of output units per unit time (Hendrickson, 1989). Hence:

$$R = \frac{C}{T} \qquad \text{(i)}$$

or

$$T = \frac{C}{R} \qquad \text{(ii)}$$

The daily standard production rate $\mathbf{P_e}$ of an excavator can be obtained by multiplying its standard production rate $\mathbf{R_e}$ by the number of operating hours $\mathbf{H_e}$ per day. Thus,

$$P_e = R_e H_e = \frac{C_e H_e}{T_e} \qquad \text{(iii)}$$

Where Ce and Te are cycle capacity (in units of volume) and cycle time (in hours) of the excavator respectively. In determining the daily standard production rate of a hauler, it is necessary to determine first the cycle time from the distance 'D' to a dump site and the average speed 'S' of the hauler. Let Tt be the travel time for the round trip to the dump site. To be the loading time and Td the dumping time. Then the travel time for the round trip is given by:

$$T_t = \frac{2D}{S} \qquad \text{(iv)}$$

The loading time is related to the cycle time of the excavator Te and the relative capacities C_h and C_e of the hauler and the excavator respectively. In the optimum or standard case,

$$T_o = T_e \frac{C_h}{C_e} \quad \text{.................................} \quad (v)$$

For a given dumping time Td, the cycle time of the hauler is given by:

$$T_h = \frac{2D}{S} + T_e \frac{C_h}{Ce} + T_d \quad \text{................................} \quad (iv)$$

The daily standard production rate of a hauler, P_h of a hauler can be obtained by multiplying its standard production rate R_h by the number of operating hours H_h per day. Hence:

$$P_h = R_h H_h = \frac{Ch\,H_h}{T_h} \quad \text{....................} \quad (vii)$$

This expression assumes that haulers begin loading as soon as they return from the dump site. The number of haulers required is also of interest.

Let W denote the swell factor of the soil such that "WP_e" denotes the daily volume of loose excavated materials resulting from the volume P_e. Then the approximate number of haulers required to dispose of the excavated materials is given by:

$$N_h = \frac{WP_e}{P_h} \quad \text{...............................} \quad (viii)$$

While the standard production rate of a piece of equipment is based on "standard" or ideal conditions, equipment productivities at job sites are influenced by actual work conditions and a variety of inefficiencies and work stoppages. As an example various factor adjustments can be used to account in an approximate fashion for actual site conditions. If the conditions that lower the standard production rate are denoted by "n" factors, F_1, F_2 ..... F_n each of which is smaller than 1, then the actual equipment productivity 'R' at the job site can be related to the standard production rate R as follows:

$$R^1 = R\,F_1, F_2 \,.....\, F_n \quad \text{.................................} \quad (ix)$$

On the other hand the cycle time T' at the job site will be increased by these factors, reflecting, the actual work conditions. If only these factors are involved, T' is related to the standard cycle time T as

$$T = \frac{T}{F_1, F_2 \,.....\, F_n} \quad .... \quad (x)$$

The argument is that each of these various adjustment factors must be determined from experience or observation of job sites. For instance, a bulk composition factor is derived for bulk excavation in building construction because the standard production rate for general bulk excavation is reduced when an excavator is used to create a ramp to reach the bottom of the bulk and to open up a space in the bulk to accommodate the hauler.

In addition to the problem of estimating the various factors F_1, F_2 ..... F_n , it may also be important to account for interactions among the factors and the exact influence of particular site characteristics.

In conclusion, construction equipment plays a major role in construction resources and therefore if it is not well managed and combined with other construction resources could have dire consequences on construction projects performance.

4.4 Information as a Construction Resource and Information Communications Technology Systems and Projects Performance.

Frank Harris, et al (2001 pp. 341 – 362) states that in order to stay competitive, construction organizations have to efficiently exploit every resource they manage and utilize for their operations. Executives in the industry implicitly accept that information is a key management resource and underlies the processes and operations of every construction company. However the management of this resource rarely receives adequate attention from senior executives.

The construction company's business in principle is not different from that of any other company. It is basically composed of four main aspects.

i) It must obtain sufficient workload or orders (marketing).

ii) It must execute whatever workload that it has acquired efficiently and profitably.

iii) It must sustain the first two aspects of workload acquisition and execution against competition from other construction and competing companies and any changes imposed by the market (i.e. clients, economic conditions; resource availability; and environmental issues etc.).

iv) It must provide the administrative mechanism and organizational structure that will ensure the attainment of the above three aspects (goals).

To achieve the already set goals construction companies implement various processes that address the different functions required for the operational activities. These processes include:

- Marketing
- Estimating
- Tendering
- Design
- Construction
- Research and development
- Administration.

In all these activities, information and its associated technology provide the vehicle that links the activities with each process and within processes. The activities of each of the functional and operational processes listed above can therefore be viewed as an information process.

4.4.1 Changing Role of Information in Construction.

Until the 1980s, managers in the construction industry generally did not concern themselves with how information was collected, processed and distributed within their organizations (Harris et al, 2001). The reliance on paper based communication formed an essential part of most construction organizations, and often got in the way of real productive work. The use of information within construction has seen a significant change from this position. The concept of information for construction has shifted from this role of general support for the contractor's operations, to its use as a means for more effective managerial decision making. The driving force for this shift in the role of information is to improve and speed up the decision-making processes of specific managers and executives in a broad range of tasks both at the project and company level. The strategic importance of this new role for information in construction derives from the simple fact that its activities at design, site project and business level are dominated by information. The information is often in form of documentation, such as drawings, specifications, and conditions that are communicated between parties. As a major resource for sustaining competitiveness, information and associated technologies need effective management if contractors are to benefit from the deployment of this resource.

Construction organizations have to rely on information from various sources for their operations. These sources of information can be grouped into two broad categories of internal and external sources. Internal sources cover both the formal and informal reporting mechanisms employed by construction companies to manage and control their projects and other corporate activities. They range from documents that have company-wide impact such as circulars, policy statements, to ones that address specific projects or issues. Internal information is often of a stable nature and requires less frequent revision. External information addresses the interaction between a construction company and its business environment. The sources of external information available to a construction company are diverse and the nature of information they yield are of less stable nature. This means that construction companies need a systematic approach for updating the information they use from these sources.

4.4.2 Management of Contractors' Information Resources.

Harris et al(2001) argues that information can enable the effective integration of a contractor's operations, which are often spread over a large geographical location. This often involves transfer of knowledge when used in relation to a construction company usually encompasses features such as *experience, concepts, values, beliefs, and ways of working* that can be shared and communicated. Knowledge management means attending to processes for creating, sustaining, applying, sharing and renewing knowledge to enhance a contractor's performance and create value. It involves developing appropriate strategy and processes that will enable the creation and flow of relevant knowledge throughout a contractor's organization in order to create a value for both the company and its stakeholders (for example clients, designers, end-users). Knowledge management is therefore the broad process of locating, organizing, transferring, and using the information and expertise within construction organizations.

Four key enablers influence the management of knowledge resources in construction companies; leadership, culture, technology, and measurement. The embodiment of knowledge resources is therefore the executive and staff that make up the organization. Knowledge for the construction company is not limited only to information, but can also be awareness, experience, skill, insight, tainty, and so on. As such knowledge for the construction company can be summed up as information that is relevant to its competitiveness and operational efficiency. The knowledge is normally actionable, and at least partially based on experience.

For the construction contractor such knowledge transfers would normally occur between head office and a project, or between two projects. It could also involve information transactions between a contractor on the one hand and a supplier, subcontractor, the client, designer, or other stakeholders and third parties to a project. Real-time access to the knowledge resources and information enables the effective and efficient management of processes involved in the project. To continually improve themselves, construction organizations have to develop a systematic approach for capturing and applying such knowledge resources. Timely feedback of such information and knowledge, on for example the process or performance of a project, should allow for incremental self-correction of processes. Similarly, access to comprehensive historical information should enable simulation and optimization modeling of processes in major re-design efforts. The availability of such timely information for the contractor is captured in an *information system* (IS).

Although knowledge is recognized as a key resource and the need to manage it efficiently is well established, curiously the construction industry has not yet taken the step of appointing a Director of Knowledge to the company board. This role is still fragmented amongst several other functions. Given the increasing relevance of knowledge resources to the competitiveness of construction contractors, this position should become a reality within the foreseeable future.

4.4.3 The Construction Information Manager.

A new role emerging in construction among contractors, especially for large projects, is that of construction information manager. The functions performed by the information manager include the following:

- Advise on an IT system for the project.
- Develop an information management plan for the project
- Attend design coordination meetings.
- Receive information from design team and distribute.
- Receive all information from design sub-contractors and distribute.
- Monitor and review the flow of information
- Inspect and comment on details, obtain project team's input and relay back to designers.
- Assist in the preparation of sub-contract enquiry packages.
- Review sub-contract quotations for compliance with design.
- Review design alternatives
- Prioritize and process information requests with designers
- Process comments and clarifications.
- Monitor and collate information for HSE file
- Co-ordinate design sub-contractor's drawings
- Obtain design sub-contractor's risk assessment
- Maintain project archives.

4.4.4 Using IT Resources in Construction.

There has been a growth in use of ICT resources within construction. The effective exploitation of these resources can often lead to the following benefits:

- It saves employee time, lost phone messages, and the three-day time delay often associated with surface mail.
- It avoids circuitous means of transferring data, for example printing a document, faxing it, and then re-typing the data at the receiving end in order to save it as an electronic file.
- It allows the company and individuals to publish and distribute their work efficiently, while attaining a high and consistent quality in textual or graphical appearance.
- It provides access to information, allows communication and distribution of documents in a single, uniform fashion.

Besides acting as a means of general management and processing of project and company information, there are other ways in which ICT has been taken on by construction. These developments affect the construction process itself and can be categorized into four main areas. They are standardization (examples include the use of EDI and bar coding), visualization (comprising CAD, VR, and Augmented Reality), communication (including video/data conferencing, intranets), and integration (employing info bases and project specific data bases). The impact of these developments is leading to a new agenda for the construction industry.

In summary this chapter has reviewed construction resources and utilization at the site level, in terms of labour productivity and project performance, productivity at the job site, materials management mix and project performance, construction equipment and project performance, information as a construction resource and information communications technology systems and projects performance. These resources affect construction firms project performance in the way these resources are matched and managed.

CHAPTER V

IMPACT OF RESOURCE MIX AND EDUCATION TRAINING ON CONSTRUCTION PROJECTS PERFORMANCE

5.1 Introduction

This chapter discusses in detail the factors affecting performance under the other variables related to construction resources and interrelated construction activities affecting construction project performance.

The discussions refer to the observed frequencies of variable occurrences and the mean scores of these variables with respect to the identified overall sample and sample strata in appendices 'B' and 'C'. Appendix 'C' contains the optimum resource mixes applied by construction firms in developed countries, resource mixes by Kenyan construction firms and factors that affect resource mix practices in Kenyan construction firms; and statistical significance tests for the hypotheses. These resources are material, labour, machine time, activity durations; time wastes; water; and production out-puts. These included the category of construction firm in the respective citizenship status, the training level of education of the interviewees (respondent) of these construction firms and the effect it has on construction project performance.

5.2 Composition of Construction Firms in the Respective Citizenship Status

The samples comprised construction firms registered in categories A, B and C by the Ministry of Roads and Public Works. Table 5.1 shows the sample composition and the percentages thereof in the respective citizenship strata.

5.1: Citizenship Status and Construction Firm Registration Category

Citizenship Status	Number firms in each Category and Magnitude (%)			Total
	A	B	C	
African Construction Firms	14 / 20%	11 / 15.71%	45 / 64.29%	70 / 100%
Citizen Construction Firms	31 / 55.36%	12 / 21.43%	13 / 23.21%	56 / 100%
Non-Citizen Construction Firms	57 / 71.25%	17 / 21.25%	6 / 7.5%	80 / 100%

Source: Analysis of Field Survey 2005.

The highest number of firms registered in Category A was observed in Non-citizenship status, with 71.25% of the sample strata, followed by citizen firms with 55.36% in the sample strata and the least observation of 20% found in the African Construction firms. Likewise the numbers registered in Category B had the citizenship construction firms leading with 21.43%, followed by non-citizens with 21.25% and finally the African construction firms with 15.71% of the sample strata. Category C was the reverse of Category A, with the highest number of firms of the strata lead by African Construction firms with 64.29%, followed by citizen firms with 23.21% and lastly the non-citizen construction firms with 7.5%.

Table 5.2: Education Level and Citizenship Status of Staff/Interviewee in Construction Firms.

Citizenship Status and Sample Size	Respondents Level of Education					
	Certificate & Others i.e. A-Level, Accountants.	Ordinary Dip. Building & Civil Engineering	Higher National Diploma Building & Civil Engineering	Graduate Architects	Graduate Civil Engineers	Graduate Quantity Surveyors
African Construction Firms (70)	3 (4.29%)	38 (54.29%)	6 (8.57%)	2 (2.86%)	17 (24.29%)	4 (5.71%)
Citizen Construction Firms (56)	4 (7.14%)	33 (58.92%)	8 14.29%)	0 (0%)	8 (14.29%)	3 (5.36%)
Non-Citizen Construction Firms (80)	1 (1.25%)	27 (33.75%)	9 (11.25%)	0 (0%)	35 (43.75%)	8 (10%)
Overall (206)	3.88%	47.57%	11.16%	0.97%	29.13%	7.28%
Total	8	98	23	2	60	15

Source: Field Survey 2005.

From table 5.2, it is observed that the least number of respondents with the lowest level of education was found in the non-citizen construction firms with 1.25% of the respondents in that strata, followed by African construction firms and then the citizen firms with 4.29% and

7.14% of the respondents in the respective sample strata respectively. The next level of education was the Ordinary Diploma in Building and Civil Engineering which accounted for 54.29%, 58.92% and 33.75% for the African Construction firms, citizen construction firms and non-citizen construction firms respectively.

The Higher National Diploma in Building and Civil Engineering works is the third higher level of education observed from the field data with 8.57%; 14.29% and 11.25% accounting for the respondents in African Construction firms, citizen construction firms and non-citizen construction firms respectively.

The fourth level of education observed from the respondents was the graduate degree level in the three different disciplines of architecture, civil engineering and quantity surveying which are all related to construction projects and the industry. Architects accounted for 2.86%, civil engineers 24.29%, and quantity surveyors 5.71% of the respondents in the African Construction firms sample strata, whereas the other two sample strata did not have an Architect respondent. Civil Engineers and Quantity Surveyors respondents accounted for 14.29% and 5.36% respectively for the citizen construction firms; whereas 43.75% and 10% respectively were recorded for the non-citizen construction firms.

The mode for the education training level of the respondents observed was the ordinary diploma in building and civil engineering which recorded 58.92% and 54.29% for citizen construction firms and African Construction firms respectively. This is greater than the overall percentage magnitude of 47.57% observed from the overall sample size of construction firms.

The next level of education which is predominant in the construction firms respondents is graduate civil engineering degree, which accounted for 29.13% overall; 43.75% for non-citizen construction firms, 24.29% for African construction firms and 14.29% for citizen construction firms. Of some lesser importance in the overall education level of the respondents is the Higher National Diploma in Building and Civil Engineering which accounted for 11.16% overall and as 7.28%, 3.88% and 0.97% were recorded for graduate quantity surveyors, certificates etc. and graduate architects respectively.

In summary the respondents with a degree level of education recorded was 32.86% against 67.14% of those respondents below this level of education for the African construction firms; 19.65% against 80.35% respondents below the degree level of education for the citizen construction firms and 53.75% against 46.25% of those respondents below the degree level of education for the non citizen construction firms. Finally 37.38% of the respondents in the overall sample had attained university degree level of education and 62.62% of the respondents had an education level below the University degree.

5.3 Effect of Education on Resource Mix Practices by Construction Firms on Projection Performance.

Table 5.3 shows the contributions made by resource mix indicators and the impact these variables have on project performance by showing the different percentage contributions attached to project performance by

Table 5.3: Impact of Resource Mix Practices on Construction Project Performance Due to Different Levels of education.

Construction Firms Citizenship Status	**Contributions Made by Resource Mix Indicators / Variables to Project Performance %**					
Graduates (No)	**Incorrect Labour Mix**	**Incorrect Material Mix**	**Incorrect Machine Time Mix (Combination)**	**Information Technology**	**Technology Advancement**	**Finance Resource Credit Worthiness**
African Construction Firms (23)	20.87	28.48	23.26	22.83	29.57	36.30
Citizen Construction Firms (11)	18.64	18.64	17.27	20.91	20.91	27.27
Non-Citizen Construction Firms (43)	23.95	25.47	22.67	26.16	26.98	33.60
Overall Average %	***22.27***	***25.39***	***22.07***	***24.42***	***26.89***	***33.50***

Non Graduates (No.)						
African Construction Firms (47)	20.39	21.97	21.05	21.84	23.29	26.45
Citizen Construction Firms (45)	21.62	22.22	21.44	21.89	31.22	32.44
Non-Citizen Construction Firms (37)	12.19	24.46	23.65	22.70	24.73	25.27
Overall Average %	***18.48***	***22.77***	***21.93***	***22.10***	***26.47***	***28.20***

Source: Analysis of Field Survey 2005.

the graduates respondents and non-graduate respondents in the three different categories of construction firms in Kenya. From the graduates respondents category, finance resource (credit worthiness) takes the leading position with 33.5% impact on project performance followed by technology advancement with 26.8%, then incorrect material mix taking the third position with a mean score of 25.39%; then information technology taking the fourth position with 24.42% and incorrect labour mix with 22.27% and lastly incorrect machine time mix (combination) with 22.07% contribution towards project performance. From the non-graduates category, finance and technology takes the first two slots with 28.2% and 26.4% respectively, while incorrect material mix takes the third position with 22.77%, followed by information technology with 22.10%, then incorrect machine time mix (combination) taking the fifth position with 21.93% and lastly incorrect labour mix with 18.48%. The respondents concur on the most important contributors to project performance as finance, technology advancement, incorrect material mix, information technology in that order of importance but disagree on the last two variables namely incorrect labour mix and incorrect machine time mix (combination) as to which is more important than the other in its effect on project performance.

5.4 The Effect of Education Levels on Resource Mix in Excavation and Earthworks Construction Related activities by Construction Firms.

The following section shows how firms registered under / or in the Ministry of Roads and Public Works have combined their resources with respect to different education levels and citizenship status. The scores were tested at 95% and 99% confidence levels for sensitivity analysis. The hypothesis was tested about the mean (μ_o) because the population standard deviation δ_0 is unknown.

Table 5.4: The Effect of Education Levels on Resource Mix Variables in Excavation and Earthworks Construction Related activities by Construction Firms in Kenya.

Number of Variables in Excavation and Earth Works = 47								
Construction Firms	Results tested at 95% Confidence Level about the Population Mean (μ_o)				Results Tested at 99% Confidence Level about the Population Mean (μ_o)			
	Reject H_0		Accept H_0		Reject H_0		Accept H_0	
Africans	**No.**	**%**	**No.**	**%**	**No.**	**%**	**No.**	**%**
Graduates	26/47	55.32	21/47	44.68	22/47	46.81	25/47	53.19
Non-Graduates	39/47	82.98	8/47	17.02	34/47	72.34	13/47	27.66
Citizens								
Graduates	30/47	63.83	17/47	36.17	27/47	57.45	20/47	42.55
Non-Graduates	39/47	82.98	8/47	17.02	33/47	70.21	14/47	29.79
Non-Citizens								
Graduates	39/47	82.98	8/47	17.02	35/47	74.47	12/47	25.53
Non-Graduates	39/47	82.98	8/47	17.02	38/47	80.85	9/47	19.15

Source: Analysis of Field Survey 2005.

Excavations and earthworks section had 47 variables whose results were tested at 95% and 99% confidence levels against the population mean (μ_o) using a two tailed test for the normal deviate (Z) for samples whose size (n) is greater than 30, and the students t-test whose sample sizes were less than 30 respondents.

The null hypothesis was tested about the population mean (μ_o) as the population standard deviation (δ) was unknown. The two levels of education which were considered in the three respective categories of citizenship status were the graduate respondents and the non-graduate respondents in resource mix optimisation. The variables (activities) analysed for this section were ordinary ground hand excavation in hours per cubic metre of excavation to reduce levels, basement excavation from ≤ 1.50 deep to 6.0 m deep in stages of 1.50 metres depth; 150 mm vegetable top soil excavation, wheeling and depositing 100 metres away by 1 No. labourer; surplus spoil wheeling and depositing 100 metres away by 1 No. labourer; surplus spoil wheeling and depositing 100 metres away; bulkage factor in excavated materials in percentage of the original ground; trench excavations, backfill and disposal of excavated materials including disposal by $5m^3$ lorry loads; bulkage of black cotton soil, red/loam soils, gravel, sand and murram. The same activities were repeated using machines to excavate in ordinary ground. Non-ordinary ground machine excavations which comprise excavation in plain concrete using a compressor with more than one outlet and the same for reinforced concrete and hard rock in basements and in foundation trenches. Other related activities were hard core fill in layers less than 300 mm thick and in layers more than 300 mm thick including compaction using 5 tonne and 10 tonne compaction rollers in hours per cubic metre of hardcore; hardcore compaction factor in percentage and density of hardcore in tonnes per cubic metre.

5.4.1 The Graduates:

H_o : The Null hypothesis states that; "There are no significant differences between the resources mean scores by Kenyan Construction firms and the expected population means as identified in the literature review".

H_A: The Alternative hypothesis states that; "There are significant differences between the resource mix mean scores by Kenyan construction firms and the expected population means as identified in the literature Review".

From Table 5.4; 55.32%, 63.83% and 82.98% of the activities had their null hypothesis rejected by the graduates of the African citizenship category; citizenship category and non-citizenship category respectively at 95% confidence level. Thus their mean resource mix levels fell outside the critical values and therefore rejected the null hypothesis that there were no significant differences between the mean resource mix scores by constructions in Kenya and the expected resource mix mean by construction firms as identified in the literature review in the developed countries (Great Britain and Others in the Appendix).

Likewise 46.81%, 57.45% and 74.47% of the activities had their null hypothesis rejected by the same graduates in the three different categories of construction firms citizenship – respectively at 99% confidence level. Also 44.68%, 36.17% and 17.02% of the activities had the null hypothesis accepted by the graduates of African, Citizen and Non-citizen construction firms respectively at 95% confidence level, whereas 53.19%, 42.55% and 25.53% of the same activities had their null hypothesis accepted by the same graduates in the three categories of construction firms citizenship at 99% confidence level. Hence their resource mix means scores fell within the critical values of the normal deviate (Z) or the student 't-test' values.

5.4.2 The Non-Graduates.

H_o : The Null hypothesis states that; "There are no significant differences between the resources mean scores by Kenyan Construction firms and the expected population means as identified in the literature review".

H_A: The Alternative hypothesis states that; "There are significant differences between the resource mix mean scores by Kenyan construction firms and the expected population means as identified in the literature Review".

From table 5.4; 82.98% of the activities had the null hypothesis rejected by the non-graduates in the African citizenship, citizenship and non-citizenship construction firms categories respectively at 95% confidence level; and 72.34%, 70.21% and 80.85% respectively at 99% confidence level. Likewise 17.02% of the activities fell within the acceptance region of the hypothesis testing at 95% confidence level, whereas 27.66%, 29.79% and 19.15% of the three categories of construction firm citizenship fell within the acceptance region of the hypothesis testing at 99% confidence level respectively.

From the above analysis the non-graduates had a higher rejection level of the activities at 82.98% compared to the graduates rejection level of 53.32%, 63.83% and 82.98% for the three categories of construction firm citizenship respectively. The worst performance being registered in the non-citizenship firms category of non-graduates followed by citizen and lastly the African firms category respectively at 95% confidence level. Likewise at the 99% confidence level, the hypothesis testing rejection level of the activities by non-graduates were higher at 72.34%; 70.21% and 80.85% respectively as compared to the graduates level of hypothesis test rejections at 46.81%, 57.45% and 74.47% respectively for the three categories of the firms citizenship status. The worst performance being registered in the non-citizen firms category, followed by African and lastly the citizen category of firms.

5.5 The Effect of Education Levels on Resource Mix for Site Mixed Insitu Concreting and its Related construction activities by Construction Firms in Kenya.

This section shows how firms registered under/or in the Ministry of Roads and Public Works have combined their resources with respect to different levels of education and citizenship status. The scores were tested at 95% and 99% confidence levels for sensitivity analysis. The hypothesis was tested about the mean (μ_o), because the population standard deviation (δ) is unknown.

Site mixed insitu concrete work section had 93 variables whose results were tested at 95% and 99% confidence levels against the population mean (μ_o), using a two tailed test for the normal deviate (Z) for respondent samples size (n) greater than 30, and the students t-test whose sample sizes were less 30 respondents.

The two levels of education which were considered in the respective categories of firms citizenship status, were the graduate respondents and the non-graduates respondents in resource mix optimisation. The activities variables analysed for this section were material mixes, labour combination, time taken in these activities; machine time used in these activities, idle time for both labour and machines; material waste factors, and water cement ratios.

Some of these variables are, material contents for concrete mixes 1:4:8, 1:3:6; 1:2:4; 1: 1½:3; 1:1:3; (cement, sand ballast and water) outputs and men combination for concrete mixer(s) types with the following sizes 7/5; 10/7; 14/10; and 18/12; cleaning and idle times; gang sizes for these mixers (operators, labourers and concrete placers). Form work to columns, beams and suspended floor slabs at different locations, some of which require strutting below 3.50 metres high and others above these figure; stripping the same form work in terms of man hours of both skilled and unskilled labour; steel fixing, cutting and bending per tonne including the waste factors allowed and idle time on the part of the labour force; waste factors allowed by the respondents on different types of materials used in concreting work.

Table 5.5: The Effect of Education Levels on Resource Mix in Site Mixed Insitu Concreting and Its Related Construction activities by Construction Firms in Kenya.

No. of Variables in Concreting Works = 93								
	Results tested at 95% Confidence Level about the Population Mean (μ_o)				Results Tested at 99% Confidence Level about the Population Mean (μ_o)			
Construction Firms	Reject H_o		Accept H_o		Reject H_o		Accept H_o	
Africans	No.	%	No.	%	No.	%	No.	%
Graduates	82/93	88.17	11/93	11.83	77/93	82.80	16/93	17.20
Non-Graduates	86/93	92.47	7/93	7.53	80/93	86.02	13/93	13.98
Citizens								
Graduates	53/93	56.99	40/93	43.01	51/93	54.84	42/93	45.16
Non-Graduates	76/93	81.72	17/93	18.28	72/93	77.42	21/93	22.58
Non-Citizens								
Graduates	76/93	81.72	17/93	18.28	71/93	76.34	22/93	23.66
Non-Graduates	75/93	80.65	18/93	19.35	69/93	74.19	24/93	25.81

Source: Analysis of Field Survey 2005.

5.5.1 The Graduates.

H_o : The Null hypothesis states that; "There are no significant differences between the resources mean scores by Kenyan Construction firms and the expected population means as identified in the literature review".

H_A: The Alternative hypothesis states that; "There are significant differences between the resource mix mean scores by Kenyan construction firms and the expected population means as identified in the literature Review".

From Table 5.5; 88.17%, 56.99% and 81.72% of the activities had their null hypothesis rejected by the graduates of the African, citizen category and non citizenship categories of the construction firms at 95% confidence level respectively and thereby accepted the alternative hypothesis by the same magnitudes. Thus their mean resource mix levels fell outside the critical values and therefore rejected the null hypothesis that, there were no significant differences between the mean resource mix scores by Kenyan construction firms and the expected resource mix mean as identified in the literature review in the developed countries (Great Britain and Others in the Appendix).

Likewise 82.8%, 54.84% and 76.34% of the activities had the null hypothesis rejected by the same graduates in the three different categories of construction firm's citizenship at 99% confidence level and thereby accepted the alternative hypothesis by the same magnitudes. Also, the null hypothesis was accepted in 11.83%, 43.01% and 18.28% of the activities by the three categories of construction firms at 95% confidence level respectively; whereas 17.20%, 45.15% and 23.66% of the same activities had their null hypothesis accepted by the same graduates of the African, citizen and non-citizen construction firms at 99% confidence level respectively. Hence their resource mix mean scores fell within the critical values of the two tailed Normal Deviate (Z) or the two tailed student 't' test values.

5.5.2 The Non Graduates

H_o : The Null hypothesis states that; "There are no significant differences between the resources mean scores by Kenyan Construction firms and the expected population means as identified in the literature review".

H_A: The Alternative hypothesis states that; "There are significant differences between the resource mix mean scores by Kenyan construction firms and the expected population means as identified in the literature Review".

From Table 5.5, the non-graduates rejected the null hypothesis in 92.47%, 81.72% and 80.65% of the activities at 95% confidence level; and 86.02%, 77.42% and 74.19% of the activities at 99% confidence level in the three categories of construction firms respectively and accepted the alternative hypothesis by the same magnitudes. Likewise 7.53%; 18.28% and 19.35% of the activities fell within the acceptance region of the hypothesis testing at 95% confidence level, whereas 13.98, 22.58 and 25.81% of the activities in the three categories of the construction firm's citizenship status fell within the acceptance region of the hypothesis testing at 99% confidence level respectively.

From the above analysis the non-graduates had a high hypothesis rejection level than the graduates of 92.47%, 81.72% and 80.65% against 88.17%, 56.99% and 81.72% for the graduates at 95% confidence level respectively, and 86.02%, 77.42% and 74.19% against 82.8%, 54.84% and 76.34% at 99% confidence level respectively. The worst performance being registered in the Africans citizenship firms category followed by citizen firms category and lastly the non-citizen firms category at 95% confidence level respectively. Likewise at the 99% confidence level the worst performance was registered in the African category followed by citizens, whereas the graduates registered a poor performance in resource mix in the non-citizen category of construction firms at 99% confidence level.

5.6 The Effect of Education Levels on Resource Mix in Walling and its Related Construction activities by Construction Firms in Kenya.

The following section shows how firms registered under/or in the Ministry of Roads and Public Works have combined their resources with respect to different education levels and firms citizenship status. The results were tested at 95% and 99% confidence levels for sensitivity analysis. The hypothesis was tested about the mean (μ_o) because the population standard deviation (δ) is unknown.

The walling section had 82 variables whose results were tested at 95% confidence and 99% confidence levels for sensitivity analysis, using a two tailed test for the normal deviate (Z) for respondent samples size (n) greater than 30 and the students 't' test whose sample sizes were less than 30 respondents.

The levels of education which were considered in the three respective categories of firm citizenship status were the graduate respondent and the non graduate respondents in resource mix optimisation.

The activities (variables) analysed in this section were materials quantities in concrete block walling for 200 mm thick walls, 150 mm thick walls, and 100 mm thick walls. Stone walls in the same wall thickness as those for concrete blocks, mortar for the walls; damp proof courses for these walls, waste factors in all the materials related to walling and mortar mixing; outputs from different mortar mixers per hour; machine time inputs including idle machine time during mortar mixing and at the site while working; outputs of walling in square metres per hour; materials content per square metre of walling; water current ratios for mortar mixing; damp proof course outputs per hour including gang size and waste factors and labour idle time during the activity operations.

Table 5.6: The Effect of Education Levels on Resource Mix in Walling and Its Related Construction activities by Construction Firms in Kenya.

Number of Variables in Walling = 82								
Construction Firms	**Results tested at 95% Confidence Level**				**Results Tested at 99% Confidence Level**			
	Reject H_0		**Accept H_0**		**Reject H_0**		**Accept H_0**	
Africans	**No.**	**%**	**No.**	**%**	**No.**	**%**	**No.**	**%**
Graduates	62/82	75.61	20/82	24.39	55/82	67.07	27/82	32.93
Non-Graduates	69/82	84.15	13/82	15.85	65/82	79.27	17/82	20.73
Citizens								
Graduates	56/82	68.29	26/82	31.71	52/82	63.41	30/82	36.59
Non-Graduates	73/82	89.02	9/82	10.98	69/82	84.15	13/82	15.85
Non-Citizens								
Graduates	70/92	85.37	12/82	14.63	71/82	86.59	11/82	13.41
Non-Graduates	70/82	85.37	12/82	14.63	72/82	87.80	10/82	12.20

Source: Analysis of Field Survey 2005

5.6.1 The Graduates.

H_o: The Null hypothesis states that; "There are no significant differences between the resources mean scores by Kenyan Construction firms and the expected population means as identified in the literature review".

H_A: The Alternative hypothesis states that; "There are significant differences between the resource mix mean scores by Kenyan construction firms and the expected population means as identified in the literature Review".

From table 5.6; 75.61%, 68.29% and 85.37% of the activities had their null hypothesis rejected by the graduates of the African, citizen and non-citizen category of the construction firms at 95% confidence level respectively, and thereby accepted the alternative hypothesis by the same magnitudes. Thus their mean resource levels fell outside the critical values and therefore rejected the null hypothesis that, there were no significant differences between the mean resource mix scores by Kenyan Construction firms and those identified in the literature review from the developed countries (Great Britain and Others in the Appendix).

Likewise 67.07%, 63.41% and 86.59% of the activities had the null-hypothesis rejected by the same graduates in the three different categories of construction firms citizenship at 99% confidence level and thereby accepted the alternative hypothesis by the same magnitudes. Also, the null hypothesis was accepted in 24.39%; 31.71% and 14.63% of the activities by the three categories of construction firms at 95% confidence level respectively; whereas 32.93%, 36.59% and 13.41% of the same activities had their null hypothesis accepted by the same graduates of the African, citizen and non-citizen construction firms at 99% confidence level respectively. Hence their resource mix mean scores fell within the critical values of the two tailed Normal Deviate (Z) test and the two tailed student 't' test values.

5.6.2 The Non-Graduates.

H_o: The Null hypothesis states that; "There are no significant differences between the resources mean scores by Kenyan Construction firms and the expected population means as identified in the literature review".

H_A: The Alternative hypothesis states that; "There are significant differences between the resource mix mean scores by Kenyan construction firms and the expected population means as identified in the literature Review".

From table 5.6; the non-graduates rejected the null hypothesis in 84.15%; 89.02% and 85.37% of the activities at 95% confidence level; and 79.27%, 84.15% and 87.80% of the same activities at 99% confidence level in the three categories of construction firms respectively and accepted the alternative hypothesis by the same magnitudes. Likewise 15.85%, 10.98% and 14.63% of the activities fell within the acceptance region of the hypothesis testing at 95% confidence level, whereas 20.73%, 15.85% and 12.20% of the activities in the three categories of construction firms citizenship status fell within the acceptance region of the hypothesis testing at 99% confidence level respectively.

From the above analysis the non-graduates had a higher hypothesis rejection level than the graduates of 84.15%, 89.02% and 85.37% against 75.61%; 68.29% and 85.37% for graduates at 95% confidence level respectively, and 79.27%; 84.15% and 87.80% against 67.07%; 63.41% and 86.59% at 99% confidence level respectively.

The worst performance was registered in citizen construction firms of 89.02% followed by non-citizen firms of 85.37% and lastly African firms of 84.15% respectively. Likewise at the 99% confidence level the worst performance was recorded in non-citizen firms of 87.80%, followed by citizen firms at 84.15% and lastly the African firms at 79.27%.

5.7 The Effect of Education Levels on Resource Mix in Plasterwork and its Related Construction activities by Construction Firms in Kenya.

This section shows how construction firms have combined their resources with respect to different education levels and firms citizenship status. The results were tested at 95% and 99% confidence levels for sensitivity analysis. The hypothesis was tested about the mean (μ_o) because the population standard deviation (δ) is unknown.

The plasterwork section had 13 activities or variables whose results were tested about the mean using a two tailed test for the Normal Deviate (Z) for respondent samples whose size (n) is greater than 30 and the students 't' test for sample sizes less than 30 respondents. The levels of education which were considered in the three respective categories of construction firms citizenship status were the graduate respondents and the non-graduate respondents in the resource mix optimisation. The activities (variables) analysed were the gang size/day for carrying 15 mm thick plaster work and 20 mm - 25 mm thick plasterwork to walls, the outputs per day; 15 mm thick render to walls and 15 mm thick plaster work to soffits of suspended slabs complete with their respective outputs per day; percentage of idle time per day and material waste factor during the plaster work.

5.7.1 The Graduates.

H_o: The Null hypothesis states that; "There are no significant differences between the resources mean scores by Kenyan Construction firms and the expected population means as identified in the literature review".

H_A: The Alternative hypothesis states that; "There are significant differences between the resource mix mean scores by Kenyan construction firms and the expected population means as identified in the literature Review".

From table 5.7; 92.31%; 61.54% and 84.62% of the activities had their null hypothesis rejected by the graduates of the African, citizen and non-citizen categories at 95% confidence level respectively and thereby accepted the alternative hypothesis by the same magnitudes. Thus their mean resource levels fell outside the critical values and therefore rejected the null hypothesis that, there were no significant differences between the mean Resource mix scores by Kenyan construction firms and those identified in the literature review from the developed countries (Great Britain and others in the Appendix).

Likewise 69.23%, 61.54% and 69.23% of the activities had their null hypothesis rejected by the same graduates in the three categories of the construction firms at 99% confidence level and consequently accepted the alternative hypothesis by the same magnitudes. The null hypothesis was accepted in 7.69%, 38.46% and 15.38% of the activities at 95% confidence level respectively and 30.77%; 38.46% and 30.77% at 99% of the same activities confidence level respectively by the same graduates in the three categories of the construction firms. Hence their mean resource mix scores fell within the critical values of the two tailed normal Deviate (Z) test and the two tailed student 't' test values.

Table 5.7: The Effect of Education Levels on Resource Mix in Plasterwork and its Related Construction activities by Construction Firms in Kenya.

Number of Variables in Plaster Work = 13								
Construction Firms	Results tested at 95% Confidence Level				Results Tested at 99% Confidence Level			
	Reject H_0		Accept H_0		Reject H_0		Accept H_0	
Africans	**No.**	**%**	**No.**	**%**	**No.**	**%**	**No.**	**%**
Graduates	12/13	92.31	1/13	7.69	9/13	69.23	4/13	30.77
Non-Graduates	12/13	92.31	1/13	7.69	11/13	84.62	2/13	15.38
Citizens								
Graduates	8/13	61.54	5/13	38.46	8/13	61.54	5/13	38.46
Non-Graduates	11/13	84.62	2/13	15.38	8/13	61.54	5/13	38.46
Non-Citizens								
Graduates	11/13	84.62	2/13	15.38	9/13	69.23	4/13	30.77
Non-Graduates	10/13	76.92	3/13	23.08	10/13	76.92	3/13	23.08

Source: Analysis of Field Survey 2005.

5.7.2: The Non-Graduates.

H_0: The Null hypothesis states that; "There are no significant differences between the resources mean scores by Kenyan Construction firms and the expected population means as identified in the literature review".

H_A: The Alternative hypothesis states that; "There are significant differences between the resource mix mean scores by Kenyan construction firms and the expected population means as identified in the literature Review".

From Table 5.7, the non-graduates rejected the null hypothesis in 92.31%; 84.62% and 76.92% of the activities at 95% confidence level; and 84.62%, 61.54% and 76.92% of the same activities at 99% confidence level in the three categories of construction firms respectively and accepted the alternative hypothesis by the same magnitudes. Likewise 7.69%, 15.38% and 23.08% of the activities fell within the acceptance region of the null hypothesis at 95% confidence level, whereas 15.38%, 38.46% and 23.08% of the activities in the three categories of construction firms fell within the acceptance region of the hypothesis testing at 99% confidence level respectively.

From the above analysis the non-graduates had a higher level of hypothesis rejection of 84.62% against 61.54% for the graduates in the citizenship category at 95% confidence level, and 84.62% in the African category followed by 76.92% in the non-citizen category at 99% confidence levels respectively.

The poorest performance was registered by both graduates and non-graduates of the African citizenship category at 95% confidence level, followed by both graduates and non-graduates in the non-citizen category of construction firms and lastly the citizenship category of construction firms non-graduates with 84.62% rejection of the null hypothesis at 95% confidence level. The results were not better either for both groups in the three categories of construction firms at 99% confidence level.

5.8 The Effect of Education Levels on Resource Mix in Floor Paving and its Related construction activities by Construction Firms in Kenya.

This section shows how firms registered under or in the Ministry of Public Works have combined their resources with respect to different levels of education and the firm's citizenship status. The results were tested at 95% and 99% confidence levels for sensitivity analysis. The hypothesis was tested about the mean (μ_o) because the population standard deviation (δ) is unknown. The floor paving section had 17 variables (activities whose results were tested at 95% and 99% confidence levels, using a two tailed test for the normal deviate (Z) for sample sizes greater than 30 and the students 't' test for sample sizes of less than 30. The levels of education considered in the three respective categories of construction firms were the graduate respondents and the non-graduate respondents in resource mix optimisation. The activities (variables) analysed in this section were materials for 25 mm and 40 mm thick steel trowelled floor finishes, 2 mm thick PVC paving and its fixing adhesive; labour/gang size for the different materials used and the outs per day; material waste factors and idle time on the part of labour component.

5.8.1 The Graduates.

H_o: The Null hypothesis states that; "There are no significant differences between the resources mean scores by Kenyan Construction firms and the expected population means as identified in the literature review".

H_A: The Alternative hypothesis states that; "There are significant differences between the resource mix mean scores by Kenyan construction firms and the expected population means as identified in the literature Review".

From table 5.8, 82.35%, 70.59% and 88.24% of the activities had their null-hypothesis rejected by the graduates from the African citizen category, citizen category and non-citizen category of the construction firms at 95% confidence level respectively, and thereby accepted the alternative hypothesis by the same magnitudes. Thus their mean resource score levels fell outside the critical values region and therefore rejected the hypothesis that, there were no significant differences between the mean resource mix scores by Kenyan construction firms and those expected mean scores as identified in the literature review from the developed countries (Great Britain and others in the Appendix). Likewise 70.59%, 64.71% and 76.47% of the activities had the null hypothesis rejected by the same graduates in the three different levels of construction firms citizenship at 99% confidence level, and thereby accepted the alternative hypothesis by the same magnitudes. The null hypothesis was accepted in 17.65%, 29.41% and 11.76% of the activities by the three categories of construction firms at 95% confidence level respectively. Whereas 29.41%, 8.96% and 23.53% of the same activities had the null hypothesis accepted by the same graduates at 99% confidence level in the three categories of construction firms respectively. Hence their resource mix mean scores fell within the critical values of the two tailed Normal Deviate (Z) test and the two tailed students 't' test values.

Table 5.8: The Effect of Education Levels on Resource Mix in Floor Paving and its Related Construction activities by Construction Firms in Kenya.

Number of Variables in Floor Paving = 17								
Construction Firms	**Results tested at 95% Confidence Level**				**Results Tested at 99% Confidence Level**			
	Reject H_0		**Accept H_0**		**Reject H_0**		**Accept H_0**	
Africans	**No.**	**%**	**No.**	**%**	**No.**	**%**	**No.**	**%**
Graduates	14/17	82.35	3/17	17.65	12/17	70.59	5/17	29.41
Non-Graduates	15/17	88.24	2/17	11.76	15/17	88.24	2/17	11.76
Citizens								
Graduates	12/17	70.59	5/17	29.41	11/17	64.71	6/17	8.96
Non-Graduates	14/17	82.35	3/17	17.65	14/17	82.35	3/17	17.65
Non-Citizens								
Graduates	15/17	88.24	2/17	11.76	13/17	76.47	4/17	23.53
Non-Graduates	13/17	76.47	4/17	23.53	13/17	76.47	4/17	23.53

Source: Analysis of Field Survey 2005.

5.8.2 The Non-Graduates.

H_0: The Null hypothesis states that; "There are no significant differences between the resources mean scores by Kenyan Construction firms and the expected population means as identified in the literature review".

H_A: The Alternative hypothesis states that; "There are significant differences between the resource mix mean scores by Kenyan construction firms and the expected population means as identified in the literature Review".

From Table 5.8, the non-graduates rejected the null hypothesis in 88.24%, 82.35% and 76.47% of the activities at 95% confidence level; and 88.24%, 82.35% and 76.47% of the same activities at 99% confidence level respectively, in the three categories of construction firms, and consequently accepted the alternative hypothesis by the same magnitudes.

Likewise 11.76%, 17.65% and 23.53% of the activities fell within the acceptance region of the hypothesis testing at 95% confidence level, whereas 11.76%, 17.65% and 23.53% of the activities in the three categories of construction firms fell within the acceptance region of the hypothesis testing at 99% confidence level respectively.

From the above analysis, the non-graduates had higher hypothesis rejection levels than graduates of 88.24%, 82.35% and 76.47%; against 82.35%, 70.59% and 88.24% for graduates at 95% confidence level respectively and 88.24%, 82.35% and 76.47% against 70.59%, 64.71% and 76.47% of graduates at 99% confidence level respectively.

The worst performance was registered in Africans citizenship category of 88.24% followed by citizen category of 82.35% and lastly the non-citizen category of 82.35% and lastly the non-citizen category of 76.47% at 95% confidence level respectively. Likewise at 99% confidence level the worst performance was recorded in the Africans, citizens and non-citizen categories in magnitudes of 88.24%, 82.24% and 76.47% respectively.

5.9 The effect of Education Levels on Resource Mix in Wood Block Floor Finishes and its Related Construction activities by Construction Firms in Kenya.

The following section shows how construction firms registered under or in the Ministry of Roads and Public Works have combined their resources with respect to different education levels and firms citizenship status. The results were tested at 95% and 99% confidence levels for sensitivity analysis. The hypothesis was tested about the population mean (μ_o) because the population standard deviation (δ) is unknown. The wood block section had 12 variables (activities) whose results were tested at 95% confidence level and 99% confidence levels using a two-tailed test for the Normal Deviate (Z) for respondent sample sizes greater than 30 and the students 't' test for sample sizes less than 30 respondents.

The levels of education considered in the three categories of construction firms were the graduate respondents and the undergraduate respondents in resource mix optimisation. The variables analysed in this section were stronghold fixing adhesive, 8 mm thick parquet flooring and two pack polish on the parquet; the labour gang size, idle time, and the out puts for the various material operations per day; machine time required for sanding the parquet floor finish together with its outputs per hour and its associated machine idle time; and lastly material waste factors.

5.9.1 The Graduates.

H_o: The Null hypothesis states that; "There are no significant differences between the resources mean scores by Kenyan Construction firms and the expected population means as identified in the literature review".

H_A: The Alternative hypothesis states that; "There are significant differences between the resource mix mean scores by Kenyan construction firms and the expected population means as identified in the literature Review".

From Table 5.9, 58.33% 66.67% and 75.0% of the activities had their null hypothesis rejected by the graduates of the African, citizen and non-citizen category of construction firms at 95% confidence level respectively, and thereby accepted the alternative hypothesis by the same magnitudes. Thus their mean resource score levels fell outside the critical values and therefore rejected the null-hypothesis that, there were no significant differences between the mean resource mix scores by Kenyan construction firms from those expected and identified in the literature review from developed countries (Great Britain and others in the Appendix).

Likewise 33.33%, 58.33% and 58.33% of the activities had the Null hypothesis rejected by the same graduates at 99% confidence and thereby accepted the alternative hypothesis by the same magnitudes. The null hypothesis was accepted in 41.67%, 33.33% and 25.0% of the activities by the three construction firms at 95% confidence level, whereas 50.0%, 50.0% and 50.0% of the same activities had their null-hypothesis rejected by the same graduates at 99% confidence level in the three categories of construction firms respectively. Hence their resource mix mean scores fell within the critical values of the two tailed test for the Normal Deviate (Z) and the students two tailed 't' test values.

5.9.2 The Non-Graduates.

H_0: The Null hypothesis states that; "There are no significant differences between the resources mean scores by Kenyan Construction firms and the expected population means as identified in the literature review".

H_A: The Alternative hypothesis states that; "There are significant differences between the resource mix mean scores by Kenyan construction firms and the expected population means as identified in the literature Review".

From the Table 5.9, the non-graduates rejected the null-hypothesis in 66.67%, 58.33% and 50.0% of the activities at 95% confidence level; and 50.0% of the same activities at 99% confidence levels in the three categories of construction firms respectively and accepted the alternative hypothesis by the same magnitudes. Likewise 33.33%, 41.67% and 50% of the activities fell within the acceptance region of the null hypothesis at 95% confidence level, whereas 50% of the activities in the three categories of construction firms fell within the acceptance region of the hypothesis testing at 99% confidence level respectively.

Table 5.9: The Effect of Education Levels on Resource Mix in Wood Block Floor Finishes and its Related Construction activities by Construction Firms in Kenya.

Number of Variables in Wood Block Floor Finishes = 12								
Construction Firms	**Results tested at 95% Confidence Level**				**Results Tested at 99% Confidence Level**			
	Reject H_0		**Accept H_0**		**Reject H_0**		**Accept H_0**	
Africans	**No.**	**%**	**No.**	**%**	**No.**	**%**	**No.**	**%**
Graduates	7/12	58.33	5/12	41.67	4/12	33.33	8/12	66.67
Non-Graduates	8/12	66.67	4/12	33.33	6/12	50.00	6/12	50.00
Citizens								
Graduates	8/12	66.67	4/12	33.33	7/12	58.33	5/12	41.67
Non-Graduates	7/12	58.33	5/12	41.67	6/12	50.00	6/12	50.00
Non-Citizens								
Graduates	9/12	75.00	3/12	25.00	7/12	58.33	5/12	41.67
Non-Graduates	6/12	50.00	6/12	50.00	6/12	50.00	6/12	50.00

Source: Analysis of Field Survey 2005.

From the above analysis the non-graduates rejected the null-hypothesis with magnitudes of 66.67%, 58.33% and 50% at 95% confidence level against the graduates magnitudes of 58.33%, 66.67% and 75.0% respectively; whereas at 99% confidence level the magnitudes of hypothesis rejection by non graduates were 50% against 33.33%, 58.33% and 58.33% for the graduates respectively for the three categories of construction firms.

The worst performance at 95% confidence level was recorded in non-citizen construction firm's graduates of 75% followed by citizen firms and lastly African citizenship firms, while the non graduates recorded their worst performance of 66.67% in both the African and citizen construction firms at 95% confidence level.

5.10 The Effect of Education Levels on Resource Mix in Ceramic Floor and Wall Tiling and its Related Construction activities by Construction Firms in Kenya.

This section shows how firms registered under or in the Ministry of Roads and Public Works have combined their resources with respect to different levels of education and citizenship status. The scores were tested at 95% and 99% confidence levels for sensitivity analysis. The hypothesis was tested at 95% and 99% confidence levels about the population mean (μ_o) because the population standard deviation (δ) is unknown.

The floor and wall tiling section had 36 (variables) activities whose results were tested at 95% and 99% confidence levels using a two tailed test for the Normal Deviate (Z) for respondent sample sizes (n) greater than 30, and the students two tailed 't' test for sample sizes less than 30 for the two Levels of education considered in the three categories of construction firms were the graduate and the non-graduate respondents in resource mix optimisation.

The variables (activities) analysed for this section comprised outputs / day in square metres for different sizes of tiles both to floors and walls. Namely 150 mm x 150 mm x 6 mm tiles; 200 x 200 x 8 mm thick ceramic tiles, and 300 x 300 x 8 mm ceramic tiles: labour / gang size and idle time were also analysed; material waste factors and quantities per square metre were also analysed.

Table 5.10: The Effect of Education Levels on Resource Mix in Ceramic Floor and Wall Tiles and its Related Construction activities by Construction Firms in Kenya.

Number of Variables in Ceramic Floor and Wall Tiling = 36								
Construction Firms	**Results tested at 95% Confidence Level**				**Results Tested at 99% Confidence Level**			
	Reject H_0		**Accept H_0**		**Reject H_0**		**Accept H_0**	
Africans	**No.**	**%**	**No.**	**%**	**No.**	**%**	**No.**	**%**
Graduates	25/36	69.44	11/36	30.56	20/36	55.56	16/36	44.44
Non-Graduates	34/36	94.44	2/36	5.56	32/36	88.89	4/36	11.11
Citizens								
Graduates	27/36	75.0	9/36	25.0	23/36	63.89	13/36	36.11
Non-Graduates	29/36	80.56	7/36	19.44	27/36	75.0	9/36	25.0
Non-Citizens								
Graduates	32/36	88.89	4/36	11.11	32/36	88.89	4/36	11.11
Non-Graduates	31/36	86.11	5/36	13.89	29/36	80.56	7/36	19.44

Source: Analysis of Field Survey 2005.

5.10.1 The Graduates.

H_0: The Null hypothesis states that; "There are no significant differences between the resources mean scores by Kenyan Construction firms and the expected population means as identified in the literature review".

H_A: The Alternative hypothesis states that; "There are significant differences between the resource mix mean scores by Kenyan construction firms and the expected population means as identified in the literature Review".

From Table 5.10, the graduates rejected the null-hypothesis in 69.44%, 75% and 88.89% of the activities at 95% confidence level in the three categories of construction firms respectively, and thereby accepted the alternative hypothesis by the same magnitude. Thus their mean resource scores fell outside the critical values and therefore rejected the null-hypothesis that, there were no significant differences between the mean resource mix by Kenya construction firms and the expected mean scores identified in the literature review from developed countries (Great Britain and others in the Appendix). Likewise 55.56%, 63.89% and 88.89% of the activities had the null-hypothesis rejected by the same graduates at 99% confidence level in the three categories of construction firms respectively, and thereby accepted the alternative hypothesis by the same magnitudes. The null hypothesis was accepted in 30.56%, 25.0% and 11.11% of the activities at 95% confidence level by the three categories of construction firms respectively, whereas 44.44%, 36.11% and 11.11% of the same activities had the null hypothesis accepted by the same graduates of the three respective construction firm categories at 99% confidence level. Hence their resource mix mean scores fell within the critical values of the two tailed test for the normal deviate (Z) and the two tailed students 't' test values.

5.10.2 The Non-Graduates.

H_o: The Null hypothesis states that; "There are no significant differences between the resources mean scores by Kenyan Construction firms and the expected population means as identified in the literature review".

H_A: The Alternative hypothesis states that; "There are significant differences between the resource mix mean scores by Kenyan construction firms and the expected population means as identified in the literature Review".

From Table 5.10, the non-graduates rejected the null hypothesis in 94.44%, 80.56% and 86.11% of the activities at 95% confidence level in the three categories of construction firms respectively and accepted the alternative hypothesis by the same magnitudes. Likewise at 99% confidence level 88.89%, 75.0% and 80.56% of the activities were rejected through the hypothesis testing and the alternative hypothesis accepted by the same magnitudes respectively. 5.56%, 19.44% and 13.89% of the activities had fell within the acceptance region of the hypothesis testing at 95% confidence level, whereas in 11.11%, 25.0% and 19.44% of the same activities fell within the acceptance region of the hypothesis testing at 99% confidence level in the three categories of construction firms respectively.

From the above analysis the non-graduates have recorded 94.44%, 80.56% and 86.11% rejection of the null hypothesis at 95% confidence level as compared to 69.44%, 75% and 88.89% rejection of the null hypothesis for the graduates respectively, and 88.89%, 75.0% and 80.56% rejection of the null hypothesis at 99% confidence level respectively by the three categories of construction firms. The worst performance was recorded in the African construction firms by non-graduates of 94.44%, followed by non-citizen construction firms with 80.56% at 95% confidence level. At 99% confidence level the non-graduates performance was dismal with hypothesis rejection magnitudes of 88.89% for African Construction firms, 80.56% for non-citizen construction firms and 75.0% for citizen construction firms.

5.11 The Effect of Education Levels on Resource Mix in Brick Facing and its Related Construction activities by Construction Firms in Kenya.

This section shows how firms have combined their resources with respect to different education levels and citizenship status. The results were tested at 95% and 99% confidence levels for sensitivity analysis. The hypothesis was tested about the population mean (μ_o) because the population standard deviation (δ) is unknown.

The brick facing section has 18 variables (activities) whose results were tested about the mean, using a two tailed test for the Normal Deviate (Z) for respondent samples whose size (n) is greater than 30 and the students 't' two tailed test for sample sizes less than 30 respondents. The education levels which were considered in the three respective categories of construction firm's citizenship status were the Graduate and the non-graduate respondents in the resource mix optimisation. The variables (activities) analysed were the materials for various sizes of facing Bricks in terms of content per square metre, the wastage factor and coverage per gang size; gang size combination and its output in square metres per day and labour idle time per day.

5.11.1 The Graduates.

H_o: The Null hypothesis states that; "There are no significant differences between the resources mean scores by Kenyan Construction firms and the expected population means as identified in the literature review".

H_A: The Alternative hypothesis states that; "There are significant differences between the resource mix mean scores by Kenyan construction firms and the expected population means as identified in the literature Review".

From Table 5.11, the graduates rejected the null-hypothesis in 66.67%, 72.22% and 66.67% of the activities by the African, citizen and non-citizen categories of construction firms at 95% confidence level respectively, and thereby accepted the alternative hypothesis by the same magnitudes. Thus their mean resource mix scores fell outside the critical values and therefore rejected the null hypothesis that, "there were no significant differences between the mean resource mix scores by Kenyan construction firms and the expected mean values as identified in the literature review" from developed countries (Great Britain and others). Likewise 66.67%, 55.56% and 66.67% of the activities had their null hypothesis rejected by the same graduate respondents in the three categories of construction firms at 99% confidence levels, and consequently accepted the alternative hypothesis by the same magnitudes. The null hypothesis was accepted in 33.33%, 27.78% and 33.33% of the activities at 95% confidence level respectively and 33.33%, 44.44% and 33.33% of the same activities at 99% confidence level respectively by the same graduate respondents in the three categories of construction firms. Hence their mean resource mix scores fell within the critical values of the two tailed Normal Deviate (Z) test and the two tailed students 't' test values.

Table 5.11: The Effect of Education Levels on Resource Mix in brick Facing and its Related Construction activities by Construction Firms in Kenya.

Number of Variables in Brick Facing Works = 18								
Construction Firms	Results tested at 95% Confidence Level				Results Tested at 99% Confidence Level			
	Reject H_0		Accept H_0		Reject H_0		Accept H_0	
Africans	No.	%	No.	%	No.	%	No.	%
Graduates	12/18	66.67	6/18	33.33	12/18	66.67	6/18	33.33
Non-Graduates	12/18	66.67	6/18	33.33	12/18	66.67	6/18	33.33
Citizens								
Graduates	13/18	72.22	5/18	27.78	10/18	55.56	8/18	44.44
Non-Graduates	14/18	77.78	4/18	22.22	13/18	72.22	5/18	27.78
Non-Citizens								
Graduates	12/18	66.67	6/18	33.33	12/18	66.67	6/18	33.33
Non-Graduates	13/18	72.22	5/18	27.78	12/18	66.67	6/18	33.33

Source: Analysis of Field Survey 2005.

5.11.2 The Non-Graduate Respondents.

H_0: The Null hypothesis states that; "There are no significant differences between the resources mean scores by Kenyan Construction firms and the expected population means as identified in the literature review".

H_A: The Alternative hypothesis states that; "There are significant differences between the resource mix mean scores by Kenyan construction firms and the expected population means as identified in the literature Review".

From Table 5.11, the non graduate respondents rejected the null hypothesis in 66.67%, 77.78% and 72.22% of the activities at 95% confidence level; and in 66.67%, 72.22% and 66.67% of the same activities at 99% confidence level in the three categories of construction firms respectively, and accepted the alternative hypothesis by the same magnitudes. Likewise 33.33%, 22.22% and 27.78% of the activities fell within the acceptance region of the null hypothesis at 95% confidence level, whereas 33.33%, 27.78% and 33.33% of the same activities of the three categories of construction firms fell within the acceptance region for the null hypothesis testing at 99% confidence level respectively.

From the above analysis the non-graduate respondents had a higher level of the null-hypothesis rejection of 66.67%, 77.78% and 72.22% at 95% confidence level against 66.67%, 72.22% and 66.67% for the graduate respondents respectively and 66.67%, 72.22% and 66.67% at 99% confidence level against 66.67%, 55.56% and 66.67% for the graduate respondents at 99% confidence level respectively.

The poorest performance was registered by non-graduate respondents who rejected the null hypothesis in 77.78% of the activities in the citizen category of construction firms followed by non-citizen construction firms with 72.22% and lastly the African category of construction firms at 95% confidence level respectively. On the other hand non graduate respondents recorded poor performance at 99% confidence level, with citizen category of firms taking the lead with 72.22% and both the African and non-citizen categories taking the second position with 66.67% rejection of the null hypothesis.

5.12 The Effect of Education Levels on Resource Mix in Construction Projects Performance by Construction Firms in Kenya according to Citizenship Status

This section shows how construction firms registered under or in the Ministry of Public works have performed according to African, citizen and non-citizen construction firms categories. This is spread over the seven sections already analysed on the impact of education levels on resource mix practices by construction firms in Kenya.

5.12.1 Excavation and Earthworks

Table 5.12 shows how the 47 variables in excavations and earthworks have combined together to impact on project performance through the rejection of the null hypothesis after the results were tested at 95% and 99% confidence levels using the two tailed test for the normal deviate (Z) for sample sizes (n) over 30 respondents and the two tailed students 't' test for sample sizes of less than 30 respondents. African construction firms have rejected the null hypothesis in 89.36% of the variables at 95% confidence level, citizen construction firms rejected the null hypothesis in 87.23% of the activities at 95% confidence level and non citizen construction firms rejected the null-hypothesis in 85.11% of the activities respectively, and thereby accepted the alternative hypothesis by the same magnitudes. Likewise at 99% confidence level the null hypothesis was rejected in 80.85%, 78.72% and 78.72% of the same activities by the same categories of construction firms respectively, and thereby accepted the alternative hypothesis by the same magnitudes at 99% confidence level. Thus their mean resource mix scores fell outside the critical values and therefore rejected the null hypothesis that, there were no significant differences between the mean resource mix scores by Kenyan construction firms and the expected population mean resource values as identified in the literature review from developed countries (Great Britain and others). The null hypothesis was accepted in 10.64%, 12.77% and 14.89% of the activities at 95% confidence level respectively and in 19.15%, 21.28% and 21.28% of the activities at 99% confidence level respectively for the three categories of construction firms in Kenya.

The poorest project performance was registered by the African Construction firms at both 95% and 99% confidence levels by 89.36% and 80.85% hypothesis rejection levels respectively; followed by citizen construction firms with 87.23% and 78.72% at 95% and 99% confidence levels respectively, and finally the non citizen construction firms with 85.11% and 78.72% hypothesis rejection levels at 95% and 99% confidence levels respectively.

Table 5.12: The Effect of Resource Mix on Construction Projects Performance by Construction Firms in Kenya according to Citizenship Status.

No. of Variables in Excavation and Earthworks = 47								
Construction Firms	**Results tested at 95% Confidence Level**				**Results Tested at 99% Confidence Level**			
	Reject H_0		**Accept H_0**		**Reject H_0**		**Accept H_0**	
Citizenship	**No.**	**%**	**No.**	**%**	**No.**	**%**	**No.**	**%**
African	42	89.36	5	10.64	38	80.85	9	19.15
Citizen	41	87.23	6	12.77	37	78.72	10	21.28
Non-Citizen	40	85.11	7	14.89	37	78.72	10	21.28

Source: Analysis of Field Survey 2005.

5.12.2 Insitu Site Mixed Concrete Works

Table 5.13 shows that, out of the 93 variables considered in the concrete work section, the African construction firms rejected the null hypothesis in 82.8% and 83.87% of the activities at 95% and 99% confidence levels respectively; citizen construction firms rejected the null hypothesis in 82.8% and 86.02% of the same activities at 95% and 99% confidence levels respectively and non-citizen construction firms likewise rejected the null hypothesis in 80.65% and 81.72% of the same activities respectively at 95% and 99% confidence levels. The alternative hypothesis was accepted by the three categories of firms by the same magnitudes of hypothesis rejection respectively. The null hypothesis was accepted in 17.20%, 17.20% and 19.35% at 95% confidence level and in 16.13%, 13.98% and 18.25% at 99% confidence level respectively by the three categories construction firms. The three categories of construction firms performed poorly in project performance both at 95% and 99% confidence levels respectively.

Table 5.13: The Effect of Resource Mix on Construction Projects Performance by Construction Firms in Kenya according to Citizenship Status.

Number of Variables in Insitu Site Mixed Concrete Work = 93								
Construction Firms	Results tested at 95% Confidence Level				Results Tested at 99% Confidence Level			
	Reject H_0		Accept H_0		Reject H_0		Accept H_0	
Citizenship	**No.**	**%**	**No.**	**%**	**No.**	**%**	**No.**	**%**
African	77	82.80	16	17.20	78	83.87	15	16.13
Citizen	77	82.80	16	17.20	80	86.02	13	13.98
Non-Citizen	75	80.65	18	19.35	76	81.72	17	18.28

Source: Analysis of Field Survey 2005.

5.12.3 Walling

Table 5.14: The Effect of Resource Mix on Construction Projects Performance by Construction Firms in Kenya according to Citizenship Status.

Number of Variables in Walling activity = 82								
Construction Firms	Results tested at 95% Confidence Level				Results Tested at 99% Confidence Level			
	Reject H_0		Accept H_0		Reject H_0		Accept H_0	
Citizenship	**No.**	**%**	**No.**	**%**	**No.**	**%**	**No.**	**%**
African	75	91.46	7	8.54	73	89.03	9	10.97
Citizen	69	84.15	13	15.85	68	82.93	14	17.07
Non-Citizen	69	84.15	13	15.85	70	85.37	12	14.63

Source: Analysis of Field Survey 2005.

From Table 5.14, there are 82 activities in walling considered in the analysis. The African construction firms rejected the null hypothesis in 91.46% and 89.03% of the activities at 95% and 99% confidence levels respectively; citizen construction firms rejected the null hypothesis in 84.15% and 82.93% of the activities at 95% and 99% respectively, while the non-citizen construction firms rejected the null hypothesis in 84.15% and 85.37% of the activities at 95% and 99% respectively. The alternative hypothesis was accepted by the same magnitudes at 95% and 99% confidence levels respectively.

The null hypothesis was accepted in 8.54%, 15.85% and 15.85% of the activities respectively and 10.97%, 17.07% and 14.63% of the activities at 95% and 99% confidence levels by the three categories of construction firms respectively. The three categories of construction firms performed poorly with the African construction firms taking the lead.

5.12.4 Plasterwork to Walls:

Table 5.15: The Effect of Resource Mix on Construction Projects Performance by Construction Firms in Kenya According to Citizenship Status.

No. of Variables in Plasterwork Activity = 13								
Construction Firms	**Results tested at 95% Confidence Level**				**Results Tested at 99% Confidence Level**			
	Reject H_0		**Accept H_0**		**Reject H_0**		**Accept H_0**	
Citizenship	**No.**	**%**	**No.**	**%**	**No.**	**%**	**No.**	**%**
African	13	100	0	0	13	100	0	0
Citizen	13	100	0	0	13	100	0	0
Non-Citizen	13	100	0	0	13	100	0	0

Source: Analysis of Field Survey 2005.

Table 5.15 shows that, out of the 13 activities analysed the null hypothesis has been rejected in all the activities investigated by 100%, by the three categories of construction firms at 95%

and 99% confidence levels respectively. The alternative hypothesis has been accepted in 100% of the activities in all the categories of constriction firms. The null hypothesis that there were no significant differences between the Kenyan construction firms mean resource mix scores and the expected population mean as identified in the literature review in developed countries (Great Britain and others in the Appendix) was rejected. All the construction firms performed very poorly at 95% and 99% confidence levels respectively.

5.12.5 Floor Paving Finishes:

Table 5.16: The Effect of Resource Mix on Construction Projects Performance by Construction Firms in Kenya according to Citizenship Status.

No. of Variables on Floor Paving Activity = 17								
Construction Firms	Results tested at 95% Confidence Level				Results Tested at 99% Confidence Level			
	Reject H_0		Accept H_0		Reject H_0		Accept H_0	
Citizenship	No.	%	No.	%	No.	%	No.	%
African	16	94.12	1	5.88	14	82.35	3	17.65
Citizen	14	82.35	3	17.65	14	82.35	3	17.65
Non-Citizen	15	88.24	2	11.76	13	76.47	4	23.53

Source: Analysis of Field Survey 2005.

Table 5.16, shows that out of the 17 activities / variables analysed, the African construction firms rejected the null hypothesis in 94.12% of the activities at 95% confidence level and 82.35% of the activities at 99% confidence level. Citizen and non-citizen construction firms rejected the null hypothesis at 95% and 99% confidence level in 82.35% and 88.24% of the activities and 82.35% and 76.47% of the activities respectively. Consequently the alternative hypothesis was accepted by the same magnitudes of the rejection of the null hypothesis. The null hypothesis was accepted in 5.88%, 17.65% and 11.76% of the activities at 95% confidence level and 17.65%, 17.65% and 23.53% at 99% confidence level respectively by the three categories of construction firms respectively.

The null hypothesis that there were no significant differences between the Kenyan construction firms mean mix scores and the expected population mean as identified in the literature review in developed countries (Great Britain and others in the Appendix) was rejected by all categories of the construction firms. All the construction firms' categories performed very poorly at 95% and 99% confidence levels respectively.

5.12.6 Wood Block Floor Finishing

Table 5.17: The Effect of Resource Mix on Construction Projects Performance by Construction Firms according to Citizenship Status.

Number of Variables in Wood Block Floor Paving = 12								
Construction Firms	Results tested at 95% Confidence Level				Results Tested at 99% Confidence Level			
	Reject H_o		Accept H_o		Reject H_o		Accept H_o	
Citizenship	No.	%	No.	%	No.	%	No.	%
African	8	66.67	4	33.33	8	66.67	4	33.33
Citizen	7	58.33	5	41.67	7	58.33	5	41.67
Non-Citizen	8	66.67	4	33.33	8	66.67	4	33.33

Source: Analysis of Field Survey 2005.

Table 5.17 shows that, out of the 12 activities / variables analysed, the African construction firms rejected the null hypothesis in 66.67% of the activities, at 95% confidence level and 99% confidence intervals respectively; the citizen construction firms rejected the null hypothesis in 58.33% of the activities at 95% and 99% confidence intervals respectively, while the non-citizen construction firms have rejected the null hypothesis in 66.67% of the activities. Consequently the alternative hypothesis has been accepted by the same magnitudes of hypothesis rejection by the three categories of construction firms.

The null hypothesis was accepted in 33.33% of the activities at 95% and 99% confidence levels respectively by African construction firms and non-citizen construction firms respectively; and 41.67% of the activities by the citizen construction firms at 95% and 99% confidence levels respectively. The null hypothesis that there were no significant differences between the Kenyan construction firms mean resource mix scores and the expected population mean as identified in the literature review in developed countries (Great Britain and others) was rejected by all the three categories of construction firms by at least 82.35% at 95% and 76.47% at 99% confidence levels. Hence all the firms performed very poorly.

5.12.7 Ceramic Floor and Wall Tiling:

Table 5.18 shows how construction firms have combined their resources to perform in the 36 activities analysed in ceramic floor and wall tiling in terms of performance. The null hypothesis was rejected in 97.22%, 94.44% and 91.67% of the activities / variables by the three categories of construction firms respectively at 95% confidence level and 99% confidence level. The alternative hypothesis was accepted by these firms by the same magnitudes of the hypothesis rejection. The null hypothesis was accepted in 2.78%, 5.56% and 8.33% of the activities by African construction firms, citizen construction firms and non-citizen construction firms respectively, at both the 95% and 99% confidence levels. The null hypothesis that, there were no significant differences between the Kenyan construction firms mean resource mix score and the expected population mean as identified in the literature review in developed countries (Great Britain and others in the Appendix) was rejected by all the three categories of construction firms by at least 97.22%, 94.44% and 91.67% at 95% and 99% confidence levels respectively. Thus their project performance scored very poorly.

Table 5.18: The Effect of Resource Mix on Construction Projects Performance by Construction Firms according to Citizenship Status.

No. of Variables in Ceramic Floor and Wall Tiling = 36								
Construction Firms	**Results tested at 95% Confidence Level**				**Results Tested at 99% Confidence Level**			
	Reject H_o		**Accept H_o**		**Reject H_o**		**Accept H_o**	
Citizenship	**No.**	**%**	**No.**	**%**	**No.**	**%**	**No.**	**%**
African	35	97.22	1	2.78	35	97.22	1	2.78
Citizen	34	94.44	2	5.56	34	94.44	2	5.56
Non-Citizen	33	91.67	3	8.33	33	91.67	3	8.33

Source: Analysis of Field Survey 2005.

5.12.8. Brick Facing

Table 5.19: The Effect of Resource Mix on Construction Projects Performance by Construction Firms according to Citizenship Status.

Number of Variables in Brick Facing Activity = 18								
Construction Firms	**Results tested at 95% Confidence Level**				**Results Tested at 99% Confidence Level**			
	Reject H_o		**Accept H_o**		**Reject H_o**		**Accept H_o**	
Citizenship	**No.**	**%**	**No.**	**%**	**No.**	**%**	**No.**	**%**
African	12	66.67	6	33.33	12	66.67	6	33.33
Citizen	13	72.22	3	27.78	13	72.22	3	27.78
Non-Citizen	12	66.67	6	33.33	12	66.67	6	33.33

Source: Analysis of Field Survey 2005.

Table 5.19 shows how construction firms have combined their resources to perform in the 18 activities or variables analysed in brick facing activities. The null hypothesis was rejected in

66.67% of the activities by the African construction firms category and the non citizen construction firms category at 95% and 99% confidence levels respectively. It was also rejected in 72.22% of the activities by citizen construction firms category and 95% and 99% confidence levels respectively.

The alternative hypothesis was accepted by these firms by the same magnitudes of the hypothesis rejection and at the same confidence levels used for testing the hypothesis. The null hypothesis that there were no significant differences between the Kenyan construction firms mean resource mix score and the expected population mean as identified in the literature review in developed countries (Great Britain and others in the Appendix) was rejected by all the three categories of construction firms by at least 66.67%, 72.22% and 66.67% at 95% and 99% confidence levels respectively. Thus their project performance levels have been poor.

5.13 Application of Manufacturing Industry Optimisation Techniques into the Construction Industry Production Process.

Optimisation refers to the act of getting the best results under given circumstances. It is defined as the process of finding the conditions that give the maximum and minimum value of a function. There is no single method available for solving all optimisation problems efficiently. Therefore, as seen in the chapter on literature review, a number of optimisation methods have been developed for solving different types of optimisation problems. These methods comprise linear programming techniques, the transportation problem techniques, the assignment problem techniques, simulation techniques, management games techniques, critical path methods (C.P.M.) and project evaluation review techniques (PERT).

The purpose of this section was to find out whether construction firms in Kenya are aware of these techniques and whether they embrace them.

Table 5.20 shows what percentages of construction firms are aware of the existence of these techniques, their applications, knowledge of applying them and their willingness to be trained on how to use them in case they do not know how to use them.

Table 5.20: Awareness of Optimisation by Construction Firms

Awareness		*Construction Firms by Citizenship Status*								
		Africans (70No.)			Citizens (56 No.)			Non-Citizens (80 No.)		
		Responded		No Response	Responded		No Response	Responded		No Response
		No%	Yes%	%	No %	Yes%	%	No%	Yes%	%
1	Firms aware of optimisation techniques	17.1	78.6	4.3	21.4	75.0	3.60	25.0	70.0	5.00
2	Application of Optimisation techniques	31.4	48.6	20.0	26.80	57.10	16.10	55.0	37.50	7.50
3	Knowledge of Applying These Techniques	42.9	50.0	7.10	44.60	58.60	1.80	57.50	36.30	6.30
4	If No, do you wish to be trained how to use / apply these Techniques?	45.7	41.4	12.9	16.10	48.20	35.70	15.0	56.30	28.80

Source: Analysis of Field Work 2005

On awareness, 78.6%, 75% and 70% of the African, citizen and non-citizen construction firms respectively were aware of these techniques, whereas 17.1%, 21.4% and 25% respectively were not aware of the existence of these techniques. The non-response rates were 4.3%, 3.6% and 5% for the African, citizen and non-citizen construction firms respectively.

On application of these techniques, 48.6%, 57.10% and 37.5% of African, citizen and non-citizen construction firms respectively said that their companies applied them in production process, whereas, 31.4%, 26.8% and 55% of the firms did not apply these techniques in the production process respectively. The non-response rates were 20%, 16.10% and 7.5% for African, citizen and non-citizen construction firms.

On whether they knew how to apply these techniques in construction production process, 50%, 53.6% and 36.3% respectively of the Africans, citizens and non-citizens construction firms said yes, they knew how to use them, whereas 42.9%, 44.6% and 57.5% respectively of the firms did not know how to apply these techniques. The non-response rates were 7.10%, 1.80% and 6.3% respectively for these construction firms.

On training, 41.4%, 48.2% and 56.3% of the African, Citizen and non-citizen construction firms respectively said that they would like to be trained on how to apply these optimisation techniques, whereas 45.7%, 16.10% and 15.0% respectively did not wish to be trained. Likewise the non-response rates were 12.9%, 35.7% and 28.8% for the African, citizen and non-citizen construction firms respectively.

Tables 5.21, 5.22, 5.23 and 5.24 shows the reasons for not using optimisation techniques, the benefits derived from the use of optimisation techniques, benefits of applying these techniques and the reasons for not wanting to be trained on how to use these techniques. 5.71%, 8.93% and 10% of the respondents in African, citizen and non-citizen construction firms generated the reasons for not wanting to use optimisation techniques in construction production process. These are low response rates. The benefits derived from optimisation techniques were articulated by 38.57%, 48.21% and 27.5% of African, citizen and non citizen construction firms. The response rate for benefits shows an improved awareness from those on Table 5.21.

Table 5.21: Reasons for Not Using Optimisation Techniques

		African Contractors	**Citizen Contractors**	**Non-Citizen Contractors**
1	Not known	2	1	4
2	Lack of Expertise	1	1	1
3	Still in the process of implementation	1		
4	Information not accessible		1	
5	Lack of Resources		1	
6	It is costly		1	1
				2
	Totals	**4/70 (5.71%)**	**5/56 (8.93%)**	**8/80 (10%)**

Source: Analysis of Field Survey 2005

Table 5.22: Benefits Derived from Optimisation

		African Contractors	Citizen Contractors	Non-Citizen Contractors
1	Saves time and cost	3	2	4
2	Meets set time target	1	3	2
3	Controls resources, facilitates faster completion, quality control and planning of resources	10	13	7
4	Maximizes profits, achieves set goals and flexibility in management	4	2	7
5	Optimises operations	8	7	2
6	Solving problems facing the firm	1		
	Totals	**27/70 (38.57%)**	**27/56 (48.21%)**	**22/80 (27.5%)**

Source: Analysis of Field Survey 2005

Table 5.23: Benefits of Applying Optimisation Techniques

		African Contractors	Citizen Contractors	Non-Citizen Contractors
1	Cuts time and cost	7	9	7
2	Efficiency improved	4	3	6
3	Benefits from large stocks	1		
4	Optimises resources	18	12	12
5	Not known	3		
6	Management and control	5	6	3
7	Maximum production achieved			1
	Totals	**38/70 (54.29%)**	**30/56 (53.57%)**	**29/80 (36.25%)**

Source: Analysis of Field Survey 2005

Table 5.23 shows the articulated benefits of applying these techniques in the production process by 54.29%, 53.57% and 36.25% of African, citizen and non-citizen construction firms. The response rate is above 50% for the first two categories of construction firms and below 50% for the third class of construction firms.

Table 5.24 shows the reasons given by these construction firms for refusing to be trained on how to use these optimisation techniques. 7.14%, 8.93% and 2.5% of African citizen and non-citizen construction firms gave reasons as to why they were not willing to be trained on how to use optimisation techniques. These numbers forms small percentages of the total population of construction firms in the study. This could be ignored as they do not seem to understand what these techniques are, as it can be inferred from the answers / reasons they gave against the need for being trained.

Table 5.24: Reasons for not wanting to be trained on how to use Optimisation Techniques in Construction Activities

	Reasons	African Contractors	Citizen Contractors	Non-Citizen Contractors
1	Lack of resources for training	2	2	
2	To train later (lack of time)	1	1	1
3	Because we still get better results without these techniques	1		
4	Optimisation problems are not faced by construction firms	1		
5	Costly and time wasting		2	
6	Not informed			1
	Totals	**5/70 (7.14%)**	**5/56 (8.93%)**	**2/80 (2.5%)**

Source: Analysis of Field Survey 2005

5.14 Application of Just-in-Time (J.I.T.) in Construction Production Process by Construction Firms

JIT philosophy refers to an integrated set of activities designed to achieve high volume production using minimum inventories of raw materials, work in progress, and finished goods. Parts arrive in the next work station just-in-time and are completed and move through the operation quickly. It is also based on the logic that nothing will be produced until it is needed, and need is created by the actual demand of the product when an item is sold in the market. It is a philosophy of management that seeks to eliminate waste in all aspects of firm's production activities; human relations; vendor relations, technology and the management of materials and inventories. Waste to be eliminated comprise waste from over production, waste of waiting time, transportation waste, inventory waste, waste of motion and waste from product defects.

The purpose of this section was to find out whether construction firms are aware of JIT philosophy, apply it in their organizations, and whether they know how to use it.

Table 5.25 shows awareness and application of the JIT philosophy by construction firms. 71.4%, 83.9% and 61.3% of African, citizen and non-citizen construction firms respectively are aware of the existence of JIT Philosophy, whereas 20%, 12.5% and 36.30% of the construction firms are not aware of the JIT philosophy respectively. The non-response rates were 8.6%, 3.6% and 2.5% of African, citizen and non-citizen construction firms. These are small proportions of construction firms, which are not aware of JIT philosophies. On application of JIT philosophy by construction firms, 37.10%, 48.2% and 27.5% African, citizen and non-citizen construction firms said that they apply JIT in their organizations, While 30%, 39.3% and 53.80% respectively did not apply JIT in their organizations. The non response rates were 32.9%, 12.5% and 18.8% respectively for these construction firms. As to the willingness to learn more about JIT philosophy, 37.10, 5.4% and 53.8% expressed the willingness to be knowledgeable, whereas 5.7%, 33.9% and 6.3% respectively did not want to know more about JIT. The non-response rates were 57.1%, 60.70% and 40% for African, citizen and non-citizen construction firms.

Table 5.25: Application of Just-in-Time (JIT) in Construction Firms Production Process

Awareness		***Construction Firms by Citizenship Status***								
		Africans (70No.)			**Citizens (56 No.)**			**Non-Citizens (80 No.)**		
		Responded		**No Response**	**Responded**		**No Response**	**Responded**		**No Response**
		No%	**Yes%**	**%**	**No %**	**Yes%**	**%**	**No%**	**Yes%**	**%**
1	Is your Firm aware of JIT Philosophy in Production Process	20.0	7.14	8.6	12.50	83.90	3.60	36.30	61.30	2.50
2	If yes, does your firm apply it in Construction Process?	30.0	37.10	32.9	39.30	48.20	12.50	53.80	27.50	18.80
3	If your company is not aware of JIT, Are you willing to Learn more about it?	5.7	37.10	57.10	33.90	5.40	60.70	6.30	53.80	40.0

Source: Analysis of Field Work 2005

Table 5.26, 5.27 and 5.28 shows the reasons given by construction firms for the application of JIT, how JIT is applied in the construction firms and the reasons why construction firms would not be willing to learn more about it. 48.57%, 48.21% and 20% of African, citizen and non-citizen construction firms respectively gave reasons as to why JIT philosophy was applied by construction firms. This response rate is below 50% for all the three categories of construction firms.

Table 5.26: Reasons for the Application of JIT Philosophy by Construction Firms

	Reasons	African Contractors	Citizen Contractors	Non-Citizen Contractors
1	Unreliable resources	3		
2	Unreliable transport	3	2	
3	Uncertainty of market availability	3		
4	Avoid unnecessary time wastage	6	1	2
5	Improve company cash flow	1		
6	To avoid losses	8	12	3
7	Optimise production	10	4	5
8	Counter waste, speed up construction and save cost		8	6
	Totals	**34/70 (48.57%)**	**27/56 (48.21%)**	**16/80 (20%)**

Source: Analysis of Field Survey 2005

5.27: How JIT Philosophy is Applied by Construction Firms

	JIT Application	African Contractors	Citizen Contractors	Non-Citizen Contractors
1	Timely ordering of materials, equipment and labour requisition	7	12	
2	Improving on management	3	2	6
3	By reducing waste in time and materials	4	3	2
4	By producing as per demand	6	8	6
	Totals	**20/70 (28.5%)**	**25/56 (44.64%)**	**14/80 (17.5%)**

Source: Analysis of Field Survey 2005

Table 5.28: Reasons why Construction Firms Respondents would not be willing to learn more about JIT Philosophy

	Reasons	African Contractors	Citizen Contractors	Non-Citizen Contractors
1	Need for training in seminars, government subsidy on seminars information flow from specialists sub-contractors, manufacturers and professionals is a problem	1		
2	We do not deal with production	2	1	1
3	It is expensive to buy finished products	1		
4	No reasons at all		3	
5	We do not face problems of timely ordering of materials equipment and labour requisition			1
6	It will take too long to learn			1
7	Our transportation is well planned.			1
	Totals	**4/70 (5.71%)**	**4/56 (7.14%)**	**4/80 (5%)**

Source: Analysis of Field Survey 2005

Table 5.27 shows how and where JIT is applied by Construction firms. 28.5%, 44.64% and 17.5% of African, citizen and non-citizen construction firms respectively generated the information in Table 5.27. Again these response rates are below 50% of the total number of construction firms.

The reasons given by the firms in Table 5.28 were obtained from 5.71% of African construction firms, 7.14% of citizen construction firms and 5% of non-citizen construction firms. The seven reasons given by these firms for not being willing to learn more about JIT philosophy show little knowledge on the JIT philosophy and its benefits to any production process by these construction firms. In any case these represents below 8% of the construction firms who participated in the study.

5.15 Citizenship status, Education Training and resources mix practices by construction firms in the 318 construction activities sampled for the study.

From table 5.29, it has been show that the Null hypothesis had been rejected in 89.15% of the 318 activities by African construction firms, 85.54% of the activities in citizen construction firms and 84.75% of the activities by Non-citizen construction firms. It can only be concluded that citizenship status did not contribute significantly towards the improvement of construction projects performance through resource mix practices.

Table 5.29: Significance for rejection of the Null hypothesis at 95% confidence level for the resource mix practices in the 318 construction activities in the study sample.

Sections	Number of activities	Rejection in (%) Significance at 95% confidence level		
		African Firms	**Citizen Firms**	**Non-citizen Firms**
Excavation and earthworks.	47	89.36%	87.23%	85.11%
Concreting works.	93	82.80	82.80	80.65
Walling	82	91.46	84.15	84.15
Plaster work	13	100	100	100
Floor paving Screeding	17	94.12%	82.35	88.24
Wood block finishing	12	66.67%	58.33	66.67
Ceramic floor and wall tiling	36	97.22%	94.44%	91.67
Brick facing on walls	18	97.22%	94.44	91.67
Total / Overall Average %	318	89.15%	85.54%	84.75%

Source: Analysis of Field survey 2005.

Table 5.30: The contribution of education on the significance for rejecting the Null hypothesis at 95% confidence level for the resource mix practices in the 318 construction activities in the study sample.

Sections	Activities no.	Rejection in (%) Significance at 95% confidence level					
		African Firms		Citizen Firms		Non – citizen Firms	
		Graduates	Non-Graduates	Graduates	Non-Graduates	Graduates	Non-Graduates
Excavations And Earthworks	47	53.32	82.98	63.83	82.98	82.98	82.98
Concreting works	93	88.17	92.47	56.99	81.72	81.72	80.65
Walling	82	75.61	84.15	68.29	89.02	68.29	85.37
Plasterworks	13	92.31	92.31	61.54	84.62	84.62	76.92
Floor paving Screeding	17	70.59	88.24	64.71	82.35	76.47	76.47
Wood block finishing	12	58.33	66.67	66.67	58.33	75	50
Ceramic floor and wall tiling	36	69.44	94.44	75	80.56	88.8	86.11
Brick – facing on walls.	18	66.67	66.67	72.22	77.88	66.67	72.22
Total / overall average %	318	74.55%	86.48%	64.78%	82.71%	77.98%	80.82%

Source: Analysis of Field Survey 2005.

From Table 5.30: It has been shown that non-graduates have performed poorly in resource mix than graduates in African Construction firms, citizen and Non citizen construction firms respectively. Graduates have performed relatively better in the three categories of construction firms. Although they have relatively performed better, comparatively they have performed very poorly in construction resource mix practices.

CHAPTER VI

IMPACT OF OWNERSHIP ON RESOURCE MIX AND ON CONSTRUCTION PROJECTS PERFORMANCE

6.1 The Relationship Between Construction Firms Citizenship Status and Resource Mix Indicators on Construction Project Performance

This chapter attempts to examine how resource mix practices by construction firms affect project performance using construction performance indicators. The construction firms under consideration in this study are African indigenous construction firms, Kenyan citizen based construction firms and non-citizen based construction firms.

On the other hand are the indicators of the project performance which have been identified in the literature review as incorrect labour mix, incorrect material mix, incorrect machine time, information technology, technology advancement and finance resource (credit worthiness) of the construction company. These have been identified in the literature review as the resources used in the construction industry.

The null hypothesis states that, "citizenship" status has no effect on resource mix used by construction firms in their projects" designated as H_o. The alternative hypothesis states that "citizen status has some significant effect on resource mix used by construction firms in their projects" as designated as H_A. In testing the hypothesis, the test was in the form "Is there a significant difference among the means of the construction firm's resources mix as a consequence of the firm's citizenship status". To answer this question, the analysis of variance (ANOVA) technique was used.

If there is a significant difference, for example in the mean value of the resource optimums in the different construction company's citizenship status, then it can be concluded at the accepted level of significance that different company's management of resource mixes affect resource optimisation and consequently affects construction project performance. The 95%

confidence level was adopted in the study for data analysis when using the ANOVA technique to determine the factors affecting construction project performance (This has been discussed in the chapter dealing with research design and methodology). The test for the hypothesis is then carried out as follows:

Table 6.1: Contingency Table For a Two-Way Analysis of Variance

The Effect Of Resource Mix On Construction Firms Project Performance Using Construction Performance Indicators (%).

Indicators of Project Performance (Resources) **Factor "B" (SSB)**	***Factor A – Treatments*** Citizenship Status of Construction Firms			Total $T_{i.}$	Means $\bar{X}i.$ (%). Factor B
	African Indigenous	Kenyan Citizenship	Non-citizens		
Incorrect (1) labour Mix	21.79	21.88	23.75	67.42	$\bar{X}_{1.}$ =22.47
Incorrect (2) Material Mix	24.97	22.05	25.0	72.02	$\bar{X}_{2}$ =24.01
Incorrect (3) Machine Time Mix (combination)	22.0	19.82	21.94	63.76	$\bar{X}_{3}$ =21.25
Information (4) Technology	22.74	22.86	25.31	70.91	$\bar{X}_{4}$ = 23.64
Technology (5) Advancement	25.86	30.36	26.19	82.41	$\bar{X}_{5}$ =27.47
Finance (6) Resource (Credit Worthiness)	31.00	32.23	31.0	94.23	$\bar{X}_{6}$ = 31.41
Totals $T_{.j}$	148.36	149.20	153.19	T_{ij}= 450.75	
MEANS $\bar{X}_{.j}$ Effects in (%). Factor T.	$\bar{X}_{.1}$ =24.73	$\bar{X}_{.2}$ =24.87	$\bar{X}_{.3}$ =25.53		$\bar{\bar{X}}$ =25.04

Source: Analysis of Field survey 2005

Variation due to sum of squares in columns (due to treatment = MST)

$$SST = r\sum_{j=1}^{C}(\bar{X}j - \bar{\bar{X}})^2; \bar{\bar{X}} = 25.04$$

	Difference	Difference^2
$\bar{X}_{\cdot 1} = 24.73$	0.31	0.0961
$\bar{X}_{\cdot 2} = 24.87$	0.17	0.0289
$\bar{X}_{\cdot 3} = 25.53$	-0.49	0.2401

Total 0.3651

x (r=6)

SST (variation among treatments) = 2.1906

SUM OF SQUARES:SS= TOTAL VARIATION $= \sum_{j=1}^{c} \sum_{i=1}^{r} (Xij - \bar{\bar{X}})^2$

C(1)	C(2)	C(3)
$(21.79-25.04)^2 = 10.5625$	$(21.88-25.04)^2 = 9.9856$	$(23.75-25.04)^2=1.6641$
$(24.97-25.04)^2 = 0.0049$	$(22.05-25.04)^2=8.9401$	$(25.0-25.04)^2 = 0.0016$
$(22.0-25.04)^2= 9.2416$	$(19.82-25.04)^2 =27.2484$	$(21.94-25.04)^2=9.61$
$(22.74-25.04)^2=5.290$	$(22.86-25.04)^2 =4.7524$	$(25.31-25.04)^2= 0.0729$
$(25.86-25.04)^2 = 0.6724$	$(30.36-25.04)^2=28.3024$	$(26.19-25.04)^2=1.3225$
$(31.00-25.04)^2 = 35.5216$	$(32.23-25.04)^2 = 51.6961$	$(31.0-25.04)^2 = 35.5216$
61.293+	130.925+	48.1927
SUM OF SQUARES: SS = 240.4107		

Variation Due To Squares In Rows: SSB (Factor B)

$$SSB = c\sum_{i=1}^{r} (\bar{X}i - \bar{\bar{X}})^2; \bar{\bar{X}} = 25.04$$

	Difference	(Difference)^2
$\bar{X}_1 = 22.47$	-2.57	6.6049
$\bar{X}_2 = 24.01$	-1.03	1.0609
$\bar{X}_3 = 21.25$	-3.79	14.3641
$\bar{X}_4 = 23.64$	-1.40	1.96
$\bar{X}_5 = 27.47$	+2.43	5.9049
$\bar{X}_6 = 31.41$	+6.37	40.5769
	Total Sum Of Squares:	70.4717
		x 3
		211.4151

In Two Way Analysis of Variance

SS = SST + SSB + SSE

Therefore SSE = (240.4107 – 2.1906-211.4151) = 26.805

(a) (i) H_0: $\mu_1 = \mu_2 = \mu_3$: The Null hypothesis. Citizenship status has no effect on resource mix used by construction firms in their projects.

(ii) H_A: $\mu_1 \neq \mu_2 \neq \mu_3$: The alternative hypothesis. Citizenship status has some significant effect on resource mix used by construction firms in their projects.

(b) (i) $H_o/_B$: $\mu_1 = \mu_2 = \mu_3 .... \mu_6$. Project performance is not affected by resources mix as used by construction firms as measured through the project performance indicators.

(ii) $H_A/_B$: $\mu_1 \neq \mu_2 \neq \ldots \mu_6$: Resources mix as used by construction firms and measured through the project performance indicators has a statistically significant effect on project performance.

(c) The results are tested at 95% confidence level

C=0.95; Therefore $\alpha = 0.05$

For sensitivity analysis, three levels are used each time in each of the variables to ascertain whether indeed the results were obtained by chance. Thus the expected values for each of the two variables were used for comparison.

d) The two types of degrees of freedom for TWO WAY ANOVA are as follows:

(i) Treatment df.V_1 = c-1

(ii) Error df. (Two dimensions, on the treatment and the blocking dimension)

V_2 = (c-1) (r-1). Our expected value F_T is therefore sought from the F-distribution tables at the appropriate alpha level and V_1 and V_2 degrees of freedom.

F_T 0.0.5; 0.025 & 0.01 [(c-1); [(c-1) (r-1)]

2 ; 2 x 5

(iii) The Blocking variable degrees of freedom are:-

V_1= (r-1); V_2=(r-1) (c-1)

F_B = F0.05;0.025 & 0.01; [(r-1); (r-1) (c-1)]

[5 ; 5 x 2]

(e) (i) $MST = \frac{SST}{(C-1)} = \frac{2.1906}{2} = 1.0953$

Variance explained by differences in Treatments. (Citizenship status)

ii) $MSB = \frac{SSB}{(r-1)} = \frac{211.4151}{5} = 42.28302$

Variance explained by the Blocking variable (Resource mixes)

iii) $MSE = \frac{SSE}{(C-1)(r-1)} = \frac{26.805}{10} = 2.6805$

2 5

Gives the Unexplained Variance after we have accounted for variation caused by treatment and variation caused by blocks. (Resource mixes)

Table: 6.2: ANOVA Table for a Two Way Analysis of Variance

Variation Source	**df**	**Sum of squares**	**Mean Squares**	**Fc Square**
Explained by Factor A (Treatment – Citizenship	c-1 =3-1 =2	SST = 2.1906	MST= $\frac{2.1906}{2}$ =1.0953	$\frac{MST}{MSE} = \frac{1.0958}{2.6805} Ftc = 0.4086$
Explained by Factor B- (Resource mix)	r-1 = 6-1 =5	SSB=211.4151	MSB $= \frac{211.4151}{5}$ =42.28302	$\frac{MSB}{MSE} = \frac{42.2830}{2.6805} FBc = 15.7743$
Error Unexplained due to Chance (sampling error)	(c-1) x (r-1) 2x5 = 10	SSE=26.805	$MSE = \frac{26.805}{10}$ =2.6805	
Totals		SS=240.4107		

Source: Analysis of Field survey 2005

f) The "F" Statistic

(i) $F_{TC} = 0.4086$; $F\alpha$ 0.05; [2;10] = 4.1028

0.025;[2;10] = 5.4564

0.01 [2;10] = 7.5594

Therefore $F_{TC} < F\alpha$ 0.05, 0.025 } 0.01

We accept the Null Hypothesis that citizenship status of the construction firms has no effect on Resource mix used by construction firms in their projects. And therefore reject the alternative hypothesis that citizenship status has significant effect on resource mix by construction firms.

ii) $F_{BC} = 15.7743$

$F\alpha$ 0.05;(5,10)=3.3258
0.25;(5;10)=4.2361
0.01;(5,10)=5.6363

Therefore, since $F_{BC} > F\alpha$ 0.05; 0.025 & 0.01

Then we reject the Null Hypothesis that the blocking variable (i.e. project performance is not affected by resource mix used by construction firms as measured through the project performance indicators) as the results are statistically significant at all the three levels of confidence level. Hence we accept the alternative hypothesis that; Resources mix as used by construction firms and measured through the formulated project indicators have statistical significance effect on project performance.

6.1.1 The Strength of Association

Rejecting the null hypothesis in ANOVA indicates that there are significant differences among sample means than would be expected on the basis of chance. However, with large sample sizes (where n>30), these statistically significant differences have little practical significance (Hinkle, et al 1998 pp. 368 – 369). A measure of the strength of association between the independent and dependent variables in ANOVA is ω^2, omega squared (Hays as cited by Hinkle 1981 pp. 382).

The dependent variable in the study is construction project performance variable (CPP); whereas the independent variables were construction firms resource mix indicators and citizenship ownership status of these construction firms.

Omega squared indicates the proportion of the variance in the dependent variable (CPP) that is accounted for by the levels of variance in the independent variable. This is analogous to the coefficient of determination in correlation analysis (r^2).

A Measure of Association ω^2

$$\omega^2 = \frac{SSeffect - (dfeffect)(MSE)}{SS + MSE}$$

1. For rows main effect the formular is:

   (Explained by Resource Mix SSB)

$$\omega^2 = \frac{SSB - (r-1)(MSE)}{SS + MSE} x100\%$$

2. For columns main effect the formular is: variation: explained by treatments - citizenship (SST)

$$\omega^2 = \frac{SST - (c-1)(MSE)}{SS + MSE} x100\%$$

For Rows (explained by Resource mix)

$$\omega^2 = \frac{211.4151 - (6-1)(2.6805)}{240.4107 + 2.6805} x100\%$$

$$= \frac{(211.4151 - 13.4025)}{243.0912} = \frac{198.0126}{243.0912} x100\%$$

$$= 81.456\%$$

Resources mix (Accounts for 81.46% of the variances)

For Columns (explained by citizenship status)

$$\omega^2 = \frac{2.1906-(3-1)(2.6805)}{240.4107+2.6805}x100\%$$

$$\frac{(2.1906-5.361)}{243.0912}x100\%$$

$$=-1.31\%$$

[Citizenship status accounts for – 1.31% of the variances)

6.2 Significant Factor Contribution to Construction Projects Performance

The results in the data analysis discussed so far do not show which factors among the 6 construction project resources are more important in impacting / affecting the construction firms' project performance. To answer this question, it became necessary to use correlation co-efficients and the stepwise regression analysis. The dependent variable is the percentage of effect achieved in each construction firm in the sample. The independent variables are the 6 resource construction mix indicators identified in the literature review and used in construction projects by construction firms.

The dependent variable is the overall sum of percentage scores obtained from the scores given by the respondents on the contributions made by the resources on construction firms project performance. The independent variables are the variables identified in the literature review as those responsible for and or used by construction firms in projects and which are likely to affect the performance of that project.

These are the incorrect labour mix, incorrect material mix, incorrect machine time combination, information technology; technology advancement and finance resource in the form of credit worthiness. All these were regressed against project performance at 95% confidence interval.

6.2.1 Correlation Co-efficient

Interpretation of the multiple regression models depends on the assumption that the independent variables themselves are not strongly interrelated. A correlation analysis was carried out using SPSS 12 computer programme for the 6 variables in the model at 95% confidence level for the three citizenship levels of construction firms, giving a probability significance (p) of P = 0.00, except for the variables incorrect labour mix and technology advancement which had P = 0.07, incorrect material mix and information technology with P = 0.04; and incorrect material mix and technology advancement with P = 0.01 in the African construction firms category.

In the citizenship status category of construction firms, the probability significance of the 6 variables were P = 0.00, except incorrect labour mix and finance resource whose (p) was P=0.02.

In the non-citizenship category of construction firms the probability significance (P) was P=0.00, except incorrect labour mix and information technology whose (P) was P=0.435; incorrect labour mix and technology advancement whose (P) was P=0.294, incorrect labour mix and finance resource whose (P) was P = 0.214, incorrect material mix and information technology whose (P) was P = 0.011; incorrect material mix and technology advancement whose (P) was P = 0.053, incorrect material mix and finance resource whose (P) was P = 0.040 and incorrect machine time combination and finance resource whose (P) was P = 0.12.

Bryman and Cramer (2005 pp. 302) argue that each pair of independent variables should not produce a correlation co-efficient in excess of 0.80; otherwise the independent variables that show a relationship at or in excess of 0.80 may be suspected of exhibiting multi-collinearity. Multicollinearity is usually regarded as a problem because it means that the regression co-efficients may be unstable. This implies that they are likely to be subject to a considerable variability from sample to sample. In any case where two variables are very highly correlated, there seems little point in treating them as separate entities. They also argue that multicollinearity can be quite difficulty to detect where there are more than two independent variables, however SPSS provides some diagnostic tools that can be used to solve this problem.

Information about multicollinearity is given in the table with the heading "Coefficients". This information can be sought in the column Tolerance for model 6. The tolerance statistic is derived from 1 minus the multiple (R) correlation co-efficient for each independent variable. The multiple (R) with each independent variable is made up of its correlation with all the other independent variables. In the case of the three categories of construction firms the multiple correlation coefficients generated through SPSS were as shown in the Table 7.3 below.

Table 6.3: Collinearity Statistics for the 6 Independent Variables used in the Regression Against Construction Firms Performance

Independent Variables (Resources)	Tolerances (Collinearity Statistics)		
	African Construction Firms	**Citizen Construction Firms**	**Non-citizen Construction Firms**
Incorrect Labour Mix	0.472	0.298	0.468
Incorrect Material mix	0.385	0.323	0.489
Incorrect Machine Time Mix Combination	0.367	0.476	0.547
Information Technology	0.463	0.490	0.480
Technology Advancement	0.432	0.281	0.338
Finance Resource (Credit Worthiness)	0.424	0.383	0.500

Source: Analysis of Field survey 2005

From the table 6.3, the correlation coefficients between the independent variables ranged from 0.453 (1-0.547) to 0.719 (1.0-0.281) which are below 0.80, suggesting that high mulitcollinearity is unlikely. It was therefore concluded that although multicollinearity existed to some extent, it did not have a direct impact on the result of the analysis in such a way as to affect the outcome of the model. Multicollinearity was therefore ignored.

6.2.2 Regression Analysis

6.2.2.1 African Construction Firms

For the stepwise regression analysis the results were as in the following discussion. The first variable to be picked is Finance Resource (credit worthiness) showing that this construction resource was the most promising contributor to reducing unexplained variation in the percentage of construction projects poor performance. The result of the first run (model) is as follows:

Const. Pr. Performance	=	55.996 + 2.976F			
t	=	7.18 t = 13.159			
Sig.t	=	0.00 sig.t =	0.00		
Rsquare	=	0.718			
Adjusted Rsquare	=	0.714			
F(calculated) 1,68	=	173.156 sig.F	=	0.000	
F(critical point) 1,68	=	4.00 12			

The above result shows that finance as a resource is a highly significant variable in affecting construction project performance. The R square of 0.718 shows that this variable alone affects construction project performance with a magnitude of 71.8%.

In the second run/model the second most significant and promising contributor to the reduction of unexplained variation in the percentage of construction project poor performance was incorrect machine time combination. This variable affected construction performance by increasing R^2 to 0.860, that is, it accounted for (0.860 – 0.718) = 0.142 or 14.2% of the variations in projects poor performance. The equation changed as follows:

Construction project Performance (CPP) = 23.859 + 1.066F + 2.888 MTC

t	= 3.530	t	=	9.735	t =	8.264
Sig.t	= 0.001	sig.t	=	0.000	sig.t =	0.000

R square= 0.860

Adjusted R square = 0.856

F(calculated 2,67 = 206.412 sig.F = 0.000

F critical point 2,67 = 3.1504

Thus the two variables account for 86.0% of construction project performance (CPP) in African construction firms.

The third most important and significant variable to be picked was Information Technology (I_T) which reduced the unexplained variation in construction projects poor performance by increasing R^2 to

0.917, that is, it accounted for (0.917 – 0.860) = 0.057 or 5.7% of the variations in projects poor performance. The equation changed as follows:

CPP = $12.385 + 1.38F + 2.752\ M_{TC} + 1.436\ I_T$

t = 2.244; t = 7.685; t = 10.114 t = 6.718

sig.t = 0.028 sig.t = 0.000; sig.t = 0.000; sig.t = 0.000

R^2 = 0.917 adjusted R^2 = 918

Rsquare = 0.917; adjusted Rsquare = 0.913; F.calc.3;66=243.286; sig.F = 0.000;

Fcritical point 3,66 = 2.7581

Thus the three variables accounted for 91.7% of the poor CPP in African construction firms.

The fourth most important variable to be picked was the incorrect material mix (M) which increased R^2 to 0.962, and accounted for (0.962 – 0.917) = 0.045 OR 4.5% of the variations in poor project performance by African construction firms.

The equation changed as follows;

CPP = $5.116 + 1.233F + 1.499M_TC + 1.667\ I_T + 1.367M$

t = 1.334; t = 10.027; t = 6.438; t = 11.304; t= 8.842

Sig.t = 1.87; = 0.000; = 0.000; = 0.000; = 0.000

Rsquare = 0.962

Adjusted Rsquare = 0.960

F(calculated) (4,65) = 415.366 sig.F = 0.000

F(critical point) (4,65) = 2.5252

Thus the four variables accounted for 96.2% of the poor CPP in African construction firms.

The fifth variable to be picked was Technology Advancement (T_{Ad}.) which increased R^2 to 0.983; and accounting for (0.983 – 0.962) = 0.021 or 2.1% of the variations in poor project performance in African construction firms. Hence the equation changed as follows:

CPP = $3.821 + 0.984F + 1.295M_{TC} + 1.246\ I_T + 1.442M + 0.818\ T_{Ad}$.

t = 1.465; 11.167; 8.106; 11.235; 13.702; 8.780

Sig.t = 0.148; 0.000; 0.000; 0.000; 0.000 0.000

Rsquare = 0.983

Adjusted Rsquare = 0.982

F(calculated) (5,64) = 736.714 sig.F = 0.000

F(critical point) (5,64) = 2.4495

Thus the five variables together accounted for 98.3% of the poor CPP in African construction firms at 95% confidence level. Approximately 1.7% variations in poor project performance is accounted for by the last variable included in the equation i.e. incorrect labour mix. The overall predictor model or predictive equation can thus be given as;

CPP_{Afr} = 3.821 + 0.984F + 1.295 MTC + 1.246 I_T + 1.442M + 0.818 T_{Ad}.

The model summary for the total regression analysis is as shown below.

Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Change Statistics				
					R Square change	F change	df1	df2	Sig. F Change
1	.847[a]	.718	.714	28.44	.718	173.156	1	68	.000
2	.928[b]	.860	.856	20.16	.142	68.298	1	67	.000
3	.958[c]	.917	.913	15.66	.057	45.13	1	66	.000
4	.981[d]	.962	.960	10.63	.045	78.174	1	65	.000
5	.991[e]	.983	.982	7.22	.021	77.093	1	64	.000
6	1.000[f]	1.000	1.000	5.86E-07	.017	0.0	1	63	.000

a. Predictors: (Constant), Finance resource credit worthiness
b. Predictors: (Constant), Finance resource credit worthiness, Incorrect machine time mix combination
c. Predictors: (Constant), Finance resource credit worthiness, Incorrect machine time mix combination, Information technology.
d. Predictors: (Constant), Finance resource credit worthiness, Incorrect machine time mix combination, Information technology, Incorrect material mix.
e. Predictors: (Constant), Finance resource credit worthiness, Incorrect machine time mix combination, Information technology, Incorrect material mix, Technology Advancement.
f. Predictors: (Constant), Finance resource credit worthiness, Incorrect machine time mix combination, Information technology, Incorrect material mix, Technology Advancement., Incorrect Labour mix.

Although the strength of multiple regression lies primarily in its use as a means of establishing the relative importance of independent variables to the dependent variable, we can not say that simply because the regression coefficient of incorrect machines time combination is larger than that for finance as a resource, this means that incorrect machine time mix is more important to support for construction projects performance than finance. This is because finance and incorrect materials mix derive from different units of measurement that cannot be directly compared.

In order to effect a comparison it is necessary to standardise the units of measurement involved. This can be done by multiplying each regression coefficient by the product of dividing the standard deviation of the relevant independent variable by the standard deviation of the dependent variable ($\frac{\delta_x}{\delta_y} \times r = \beta$).

The result is known as the standardized regression coefficient or beta weight.

The standardized regression coefficients in a regression equation employ the same standard of measurement and therefore can be compared to determine which of two or more independent variables is the more important in relation to the dependent variable. They essentially tell us by how many standard deviation units the dependent variable will change for one standard deviation change in the independent variable.

Table 6.4: Comparison of Unstandardized and Standardized Regression Coefficients with Construction Project performance as the Dependent Variable (African Construction Firms)

Independent Variables	**Unstandardized Regression Coefficients**	**Standardized Regression Coefficients**
Finance Resource Credit Worthiness	0.984	0.280
Incorrect machine time combination	1.295	0.213
Information Technology	1.246	0.260
Incorrect Material Mix	1.442	0.319
Technology Advancement	0.818	0.212
[Intercept]	3.821	-

Source: Analysis of Field Survey 2005

Although incorrect materials mix provides both the largest unstandardized and standardized regression coefficients, the case of incorrect machine time (mix) combination and finance as resource demonstrates the hazardousness of using unstandardized coefficients in order to infer the magnitude of the impact of independent variables on dependent variables. The variable finance resource provides the second smallest unstandardized coefficient (0.984), but the second largest standardized coefficient. Likewise incorrect machine time combination variable provides the second largest unstandardized coefficient, but the second smallest standardized coefficient.

6.2.2.2 Citizen Construction Firms

For the stepwise regression analysis the results were as in the following discussion. The first variable to be picked is Technology advancement showing that this particular construction resource as the most promising contributor to reducing unexplained variation in the percentage of construction projects poor performance. The result of the first run /model is as follows:

(Construction Projects Performance)

CPP = $45.165 + 3.427\ T_{Ad}$

t = 4.936; t = 12.426

sig.t = 0.000; sig.t = 0.000

R^2 (square) = 0.741

Adjusted R^2 = 0.736

F(calculated) 1,54 = 154.404. Sig.F = 0.000

F(critical point) (1,68) = 4.0848

The above result shows that technology advancement as a construction resource is a highly significant variable in affecting / impacting on Construction project Performance. The R^2 of 0.741 shows that this variable alone affects CPP by a magnitude of 74.1%. In the second run/model the second most significant and promising contributor to the reduction of unexplained variation in the percentage of CPP was incorrect labour mix (L). This variable affected CPP by increasing R^2 to 0.914, that is, it accounted for (0.914 – 0.741) = 0.173 or 17.3% of the variations in the construction projects poor performance.

The equation changed as follows:

CPP = $12.304 + 2.759\ T_{Ad} + 2.430L$

t = 1.985; t = 15.952; t = 10.330

sig.t = 0.052; sig.t = 0.000; sig.t = 0.000

R^2 (square) = 0.914

Adjusted R^2 = 0.911

F(calculated) (2,53) = 281.676. Sig.F = 0.000

F(critical point (2,53) = 3.2317.

Thus the two variables accounted for 91.4% of CPP in citizen construction firms.

The third most important and significant variable to be picked was Finance credit worthiness (F) which reduced the unexplained variation in CPP by increasing R^2 to 0.953, and therefore it accounted for (0.953 – 0.914) = 0.039 or 3.9% of the variations in projects poor performance. The equation changed as follows:

CPP	=	$7.361 + 1.780\, T_{Ad} + 2.472L + 1.047F$
t	=	1.570; t = 9.025; t = 14.067; t = 6.565
sig.t	=	0.122; ; sig.t = 0.000; sig.t = 0.000; sig.t = 0.000
R^2 (square)	=	0.953
Adjusted R^2	=	0.950

F(calculated) 3,52 = 351.315: Sig.F = 0.000

F(critical point) 3,52 = 2.8387

Thus the three variables accounted for 95.3% of the poor construction projects performance in citizen construction firms.

The fourth most important variable to be picked was Information Technology (I_T); which increased R^2 to 0.977, and accounted for 0.977 – 0.953) = 0.024 or 2.4% of the variations in poor CPP by citizen construction firms.

The equation changed as follows –

CPP	=	$3.765 + 1.339\, T_{Ad} + 2.043L + 1.202F + 1.076I_T$
t	=	1.133; t = 8.715; t = 14.701; t = 9.664; t = 7.152
sig.t	=	0.271; ; sig.t = 0.000; sig.t = 0.000; sig.t = 0.000; sig.t = 0.000;
R^2 (square)	=	0.977
Adjusted R^2	=	0.975

F(calculated) 4,51 = 530.417; Sig.F = 0.000

F(critical point) 4,51 = 2,6060

Thus the four variables accounted for 97.7% of the poor CPP in citizen construction firms.

The fifth variable to be picked was incorrect machine time combination (MTC) which increased R2 to 0.989, and accounted for (0.989 – 0.977) = 0.012 or 1.2% of the variations in the poor construction project performance by the citizen construction firms. Hence the equation changed as follows:

CPP	=	$1.324 + 1.125\, T_{Ad} + 1.733L + 1.101F + 0.911I_T + 0.984M_{TC}$
t	=	0.560; t = 10.221; t = 16.551; t = 13.942; t = 8.562; t = 7.508
sig.t	=	0.578; ; sig.t = 0.000; sig.t = 0.000; sig.t = 0.000; sig.t = 0.000; sig.t = 0.000

R^2 (square) = 0.989

Adjusted R^2 = 0.988,

F(calculated) 5,50 = 896.275; Sig.F = 0.000

F(critical point)5,50 = 2.4495

Thus the five variables together accounted for 98.9% of the poor CPP in citizen construction firms at 95% confidence level. Approximately 1.1% unexplained variations in poor project performance is accounted for by the last variable included in the equation i.e. incorrect material mix

The overall predictor model or predictive equation can thus be given as:-

$$CPP\ citz = 1.324 + 1.125\ T_{Ad} + 1.733L + 1.101F + 0.911I_T + 0.984M_{TC}$$

The model summary for the total regression analysis is as shown below.

Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Change Statistics				
					R Square change	F change	df1	df2	Sig. F Change
1	.861[a]	.741	.736	27.64	.741	154.404	1	54	.000
2	.956[b]	.914	.911	16.07	.173	106.704	1	53	.000
3	.976[c]	.953	.950	12.00	.039	43.100	1	52	.000
4	.988[d]	.977	.975	8.56	.024	51.156	1	51	.000
5	.994[e]	.989	.988	5.93	.012	56.367	1	50	.000
6	1.000[f]	1.000	1.000	0.00	.011	0.00	1	49	.000

a. Predictors: (Constant), Technology Advancement.

b. Predictors: (Constant), Technology Advancement, Incorrect Labour mix.

c. Predictors: (Constant), Technology Advancement, Incorrect Labour mix, Finance resource credit worthiness.

d. Predictors: (Constant), Technology Advancement, Incorrect Labour mix, Finance resource credit worthiness, Information technology.

e. Predictors: (Constant), Technology Advancement, Incorrect Labour mix, Finance resource credit worthiness, Information technology, Incorrect machine time mix combination.

f. Predictors: (Constant), Technology Advancement, Incorrect Labour mix, Finance resource credit worthiness, Information technology, Incorrect machine time mix combination, Incorrect material mix.

As earlier pointed out in the analysis for African construction firms, the standardized regression coefficients in a regression equation employ the same standard of measurement and therefore can be compared to determine which of the independent variables is the more important in relation to the dependent variable. These essentially tell us by how many standard variation units the dependent variable will change for one standard variation change occasioned by the independent variable.

Table 6.5: Comparison of Unstandardized and Standardized Regression Coefficients with Construction Project Performance as the Dependent Variable [Citizen Construction Firms]

Independent Variables	Unstandardized Regression Coefficients	Standardized Regression Coefficients
Technology Advancement	1.125	0.283
Incorrect Labour Mix	1.733	0.320
Finance Resource	1.101	0.329
Information Technology	0.911	0.180
Incorrect Machine Time Mix Combination	0.984	0.162
[Intercept]	1.324	-

Source: Analysis of Field Survey 2005

The variable finance resource (Credit worthiness) provides the third largest unstandardized regression coefficient (1.101) but the largest standardized regression coefficient; while the variable with the smallest unstandardized regression coefficient provides the fourth largest standardized regression coefficient.

6.2.2.3 Non-Citizen Construction Firms

The stepwise regression results were as in the following discussion. The first variable to be picked is technology advancement showing that this particular construction resource was the most significant and promising contributor to reducing the unexplained variation in the percentage of construction projects performance. The results of the first run/model are as follows:

CPP	=	$79.198 + 2.825\ T_{Ad}$
t	=	10.453; t = 10.697;
sig.t	=	0.000; sig.t = 0.000;
R^2 (square)	=	0.595
Adjusted R^2	=	0.589

$F(\text{calculated})_{1,78} = 114.419$; Sig.F = 0.000

$F(\text{critical point})_{1,78} = 4.0012$

The above result shows that technology advancement as a construction resource is a highly significant variable in affecting construction project performance. The R^2 of 0.595 shows that this variable alone affects CPP by a magnitude of 59.5%.

In the second run/model the second most significant promising contributor to the reduction of unexplained variation in the percentage of CPP was incorrect material mix (M). This variable reduced the variation by increasing R^2 to 0.865, and accounted for (0.865 – 0.595) = 0.270 or 27% of the variations in construction projects poor. The equation changed as follows:

CPP	=	$32.288 + 2.472\ T_{Ad} + 2.247M$
	=	5.564; t = 15.834 t = 12.410;
sig.t	=	0.000; sig.t = 0.000; sig.t = 0.000
R^2 (square)	=	0.865
Adjusted R^2	=	0.861
F(calculated) 2,77	=	246.441; Sig.F = 0.000
F(critical point) 2,77	=	3.1504

Thus the two variables accounted for 86.5% of the variation in CPP in non-citizen construction firms.

The third most important and significant variable to be picked was incorrect machine time combination (M_{TC}); which reduced the unexplained variation in CPP by increasing R^2 to 0.907, and accounted for (0.907 – 0.805) = 0.042 or 4.2% of the variations in CPP. This changed the equation as follows:

CPP	=	$21.113 + 2.171T_{Ad} + 1.768M + 1.413M_{TC}$
t	=	4.053; t = 15.492; t = 10.289; t = 5.859
sig.t	=	0.000; sig.t = 0.000; sig.t = 0.000; sig.t = 0.000;
R^2 (square)	=	0.907
Adjusted R^2	=	0.903

F(calculated) 3,76 = 246.848; Sig.F = 0.000
F(critical point) 3,76 = 2,7581.

Thus the three variables accounted for 90.7% of the poor construction projects performance in non-citizen construction firms.

The Fourth most important variable to be picked was Finance Resource (credit worthiness) (F), which increased R^2 to 0.958, and accounted for (0.958 – 0.907) = 0.051 or 5.1% of the variations in construction projects performance by non-citizen construction firms. The equation changed as follows:

$$CPP = 15.064 + 1.354\,T_{Ad} + 1.617M + 1.572M_{TC} + 0.896F$$

t = 4.205; t = 10.586; t = 13.77; t = 9.576; t = 9.532
sig.t = 0.000; sig.t = 0.000; sig.t = 0.000; sig.t = 0.000; sig.t=0.000

R^2 (square) = 0.958
Adjusted R^2 = 0.956
F(calculated) 4,75 = 426.766; Sig.F = 0.000
F(critical point) 5,75 = 2.5252

Thus the four variables accounted for 95.8% of the poor CPP in non-citizen construction firms.

The fifth variable to be picked was incorrect labour mix (L); which increased R2 to 0.976 and accounted for (0.976 – 0.958) = 0.018 or 1.8% of the variation in the poor performance of construction projects by non-citizen construction firms. Hence the equation changed as follows:

$$CPP = 8.098 + 1.481\,T_{Ad} + 1.168M + 1.247MTC + 0.977F + 0.818L$$

t = 2.810; t = 14.992; t = 10.843; t = 9.430; t = 13.510; t = 7.451
sig.t = 0.06; ; sig.t = 0.000; sig.t = 0.000; sig.t = 0.000; sig.t = 0.000; sig.t = 0.000
R^2 (square) = 0.976

Adjusted R^2 = 0.974
F(calculated) 5,74 = 600.678; Sig.F = 0.000
F(critical point) 5,74 = 2.3683

Thus the five variables together accounted for 97.6% of the poor construction projects performance in Non-citizen construction firms. Approximately 2.4% unexplained variation is accounted for by the last variable included in the equation i.e. information technology. The overall predictor model or predictive equation can thus be given as;

$CPP_{NC} = 8.098 + 1.481\ T_{Ad} + 1.168M + 1.247\ M_{TC} + 0.977F + 0.818L$

The model summary for the total regression analysis is as shown below.

Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Change Statistics				
					R Square change	F change	df1	df2	Sig. F Change
1	.771[a]	.595	.589	27.6550	.595	114.419	1	78	.000
2	.930[b]	.865	.861	16.0696	.270	154.010	1	77	.000
3	.952[c]	.907	.903	13.4248	.042	34.328	1	76	.000
4	.979[d]	.958	.956	9.0873	.051	90.866	1	75	.000
5	.988[e]	.976	.974	6.9152	.018	55.515	1	74	.000
6	1.000[f]	1.000	1.000	0.0000	.024	0.00	1	73	.000

a. Predictors: (Constant), Technology Advancement.

b. Predictors: (Constant), Technology Advancement, Incorrect Material mix.

c. Predictors: (Constant), Technology Advancement, Incorrect Material mix, Incorrect machine time mix combination.

d. Predictors: (Constant), Technology Advancement, Incorrect Material mix, Incorrect machine time mix combination, Finance resource credit worthiness.

e. Predictors: (Constant), Technology Advancement, Incorrect Material mix, Incorrect machine time mix combination, Finance resource credit worthiness, Incorrect Labour mix.

f. Predictors: (Constant), Technology Advancement, Incorrect Material mix, Incorrect machine time mix combination, Finance resource credit worthiness, Incorrect Labour mix, Information technology.

Just as it was pointed out in the regression analysis for the African Construction firms and the citizen construction firms, the standardized regression coefficients employ the same standard of measurement and therefore can be compared to determine which of the independent variables is the more important in relation to the dependent variable. This in essence simply tells us by how many standard deviation units the dependent variable will change for one standard deviation change in the independent variable.

Table 6.6: Comparison of Unstandardized and Standardized Regression Coefficients with Construction Project Performance as the Dependent Variable [Non-citizen Construction Firms]

Independent Variables	Unstandardized Regression Coefficients	Standardized Regression Coefficients
Technology Advancement	1.481	0.404
Incorrect Material Mix	1.168	0.275
Incorrect machine Time Combination	1.247	0.225
Finance Resource	0.977	0.344
Incorrect Labour Mix	0.818	0.193
[Intercept]	8.098	-

Source: Analysis of Field Survey 2005

Finance resource (credit worthiness) provides the second smallest unstandardized regression coefficient (0.977) but the second largest standardized regression coefficient (0.344), while technology advancement provides both the largest unstandardized and standardized regression coefficient of (1.481) and (0.404) respectively.

6.3 Hypothesis Testing in the Overall Multiple Regression Based on the Three Categories of Construction Firms Citizenship Status

The null-hypothesis Ho; states that "all the six (6) independent variables considered together do not explain a significant amount of variation in construction projects performance" at 95% confidence level. The alternative hypothesis H_A states that "All the 6 independent variables considered together explain significantly the variation in construction projects performance by construction firms at 95% confidence level.

In order to perform this test the ANOVA Table for construction projects performance regressed on Finance Credit Worthiness (F); Incorrect Machine Time (M_{TC}) combination; information technology (I_T), correct material (M) mix; technology and advancement (T_{Ad}) and incorrect labour mix: (L) was constructed.

Table 6.7 ANOVA Table for CPP Regressed on F, M_{TC}, I_T, M, T_{Ad} and L (African Construction Firms)

Source	Sum of Squares	df	Mean Squares	F	sig
Regression	195,086.10	K = 6	32,154.345	7.7E+16	0.000
Residual	2.166E–11	n-k-1 = 63	3.438E - 13		
Total	195,086.10	n-1 = 69			

Source: Analysis of Field Survey 2005

From the F – Distribution tables the F critical point for $V_1 = 6$ and $V_2 = 63$ is 2.254.

Since the F calculated 7.7E + 16 is greater than F critical 2.2540, then the null hypothesis Ho is reject at $\alpha = 0.05$, that is the probability P-Value is less than 0.05. In interpreting the results of this test, it is concluded that, taken together the variables F; M_{TC}; I_T, M; T_{Ad} and L, for African construction firms significantly helps to predict CPP based on the observed data. The alternative hypothesis (H_A) is accepted.

Table 6.8: ANOVA table for CPP Regressed on T_{ad}, L, F, I_T M_{TC}, and M, (Citizen Construction Firms)

Source	Sum of Squares	df	Mean Squares	F	sig
Regression	159,188.80	K = 6	26,531.473	α	0.000
Residual	0.00	n-k-1 = 49	0.00		
Total	159,188.80	n-1 = 55			

Source: Analysis of Field Survey 2005

From the F-Distribution tables the F – Critical for $V_1 = 6$ and $V_2 = 49$ is 2.3359.

Since the F calculated α is greater than the F critical 2.3359 then the null hypothesis H_o is rejected at α = 0.05, that is, the probability p – value is less than 0.05. In interpreting the results of this test, it is concluded that, taken together the variables T_{Ad}, L, F, I_T; M_{TC}; and M for the citizen construction firms significantly helps to predict CPP based on the observed data. Thus the alternative hypothesis (H_A) is accepted.

Table 6.9: ANOVA Table for CPP Regressed on T_{Ad}, M; M_{TC}; F, L and I_T; [Non-Citizen Construction Firms]

Source	Sum of Squares	df	Mean Squares	F	sig
Regression	147,162.20	K = 6	24527.031	α	0.000
Residual	0.00	n-k-1 = 73	0.00		
Total	147,162.20	n – 1 = 79			

Source: Analysis of Field Survey 2005

From the F-Distribution tables, the F critical for $V_1 = 6$ and $V_2 = 73$ is 2.2540.
Since the F calculated α is greater than the F critical of 2.2540, then the null hypothesis Ho is rejected at α = 0.05, that is, the probability P–value is less than 0.05. In interpreting the results of this test, it is concluded that, taken together all the variables T_{Ad}; M, M_{TC}, F, L and I_T for the non-citizen construction firms significantly helps to predict CPP based on the observed data. Thus the alternative hypothesis H_A is accepted.

6.4 Project Information Management Strategy by Construction Firms

Project Information Management Strategy in construction projects is about the way in which information is stored, retrieved and passed on from the clients to consultants to contractors, and from sub-contractors to other participants, in the project environment. It comprises materials, plant, labour and technological data constants; and the exchange of these data between contractors and subcontractors, contractors and materials or plant suppliers, between contractors' regulatory bodies; and subcontractors and designers.

These information transactions help to facilitate the coordination and timely delivery of the project. The effective management of information resources in construction therefore impacts on both the success of the projects and the overall performance of the individual construction companies.

From Table 6.10, 44.3%, 75% and 62.5% of the construction firms in the categories of African firms, citizen firms and non-citizen firms respectively have information management strategies in their organizations; whereas 11.4%, 12.5% and 6.3% of the same firms have information managers in their organizations respectively. Electronic data interchange by construction firms was upheld by 40%, 55.4% and 61.3% respectively of African Construction Firms, citizens and non-citizens.

Table 6.10: Project Information Management Strategy by Constructions

	Information Management Strategies:	*Construction Firms by Citizenship Status*								
		Africans (70No.)			Citizens (56 No.)			Non-Citizens (80 No.)		
		Responded		No Response	Responded		No Response	Responded		No Response
		Yes%	No%	%	Yes%	No%	%	Yes%	No%	%
1	Information Strategy	44.3	50	5.70	75	23.2	1.8	62.5	36.3	1.3
2	Information Managers	11.40	80	8.6	12.5	60.7	26.8	6.3	90.0	3.8
3	Electronic Data Interchange by Firms	40.0	28.6	31.4	55.4	35.7	8.9	61.3	36.3	2.5
4	Applies the Data on Construction Activities	34.3	50.0	15.70	51.8	23.20	25.0	55.0	36.25	8.75

5	Does it make savings on production costs	47.1	37.1	15.7	62.5	8.9	28.6	12.5	71.3	16.3
6	Percentage in Cost Savings	5% 10% 15% 20% 25% 30% 35% 40% 50% 60% 70% 80% 85%	0 5.70 5.70 10.00 1.40 5.70 0 7.10 11.40 0 0 0 0	52.9%	1.80 7.10 3.60 7.10 3.60 16.10 3.60 5.40 7.10 0 5.40 0 0		39.30	0 2.5 1.3 11.3 2.5 10.0 7.5 7.5 23.8 2.5 0 1.30 1.30		28.80
7	Better Services to the Firm as Benefit 1 = Strongly disagree 2 = Disagree 3 = neutral 4 = Agree 5 = Strongly Agree	1 2 3 4 5	1.4% 1.4% 18.6% 34.30 2.90	41.4%	0 1.80 8.90 55.40 5.40		28.60	0 1.3 5.0 70.0 2.50		21.30
8	Cuts time in ordering material quantities 1 = Strongly disagree 2 = Disagree 3 = neutral 4 = Agree 5 = Strongly Agree	1 2 3 4 5	1.40% 0 15.70 40.00 1.40	41.4%	0 1.80 10.70 51.80 7.10		28.60	0 1.3 6.3 63.8 7.50		21.30
9	Support just-in-time production Relationships 1 = Strongly disagree 2 = Disagree 3 = neutral 4 = Agree 5 = Strongly Agree	1 2 3 4 5	1.4% 0 11.4 41.4 4.3	41.4%	0 1.80 8.90 57.10 3.60		28.60	0 0 5.0 67.50 6.30		21.30

Source: Analysis of Field Survey 2005

34.3% of African construction firms, 51.8% of citizen construction firms and 55% of the non-citizen construction firms applied data obtained from the internet on construction activities. African, citizen and non-citizen construction firms reported savings in production cost sin 47.1%, 62.5% and 12.5% of their firms respectively. The percentage in cost savings ranged from 10% to 50% for African construction firms, 5% to 70% for citizen firms and 10% to 85% in non-citizen construction firms respectively. The non response rate was 52.9%, 39.3% and 28.8% for African, citizen and non citizen construction firms respectively.

On how the electronic data interchange helps the administration to better serve the production process, 34.3%, 55.4% and 70% of the African, Citizen and non-citizen construction firms scored 4 on a rating scale of 1 to 5; while the non-response rate was 41.4%, 28.6% and 21.3% respectively for these firms in the same order. On cutting time in ordering of materials 40%, 51.8% and 63.8% of the construction firms scored 4 on a rating scale of 1 to 5, in the order of Africans, citizens and non-citizens respectively. On the question of support in just-in-time production relationships, 41.4%, 57.1% and 67.5% of African, citizen and non-citizen construction firms respectively scored 4 on a rating scale of 1 to 5. The non-response rate was 41.4%, 28.60% and 21.3% for African, citizen and non-citizen construction firms respectively.

On the issue of the functions of information managers, 71.4%, 16.07% and 6.25% of African, citizen and non-citizen construction firms stated 24 duties of these managers respectively. This shows that only a small proportion of these firms have information managers as shown in Table 6.11.

Table 6.12 shows how the construction firms responded to the question on the types of information obtained from the internet which could be used to assist these firms in resource optimisation.

On labour constants, 48.6%, 60.7% and 72.5% of African, citizen and non-citizen construction firms agreed that they source their information from the internet, whereas 25.7%, 23.2% and 22.5% of these firms did not source for labour constants form the internet respectively. The non response rates were 25.7%, 16.10% and 5% for African, citizen and non-citizen construction firms respectively.

On material constants, 54.3%, 67.9% and 75% of the African, citizen and non-citizen construction firms agreed that they source for this information from the internet, whereas 20%, 16.10% and 17.5% did not source for this information from the internet. The non-response rates were 25.7%, 16.10% and 7.5% for African, citizen and non-citizen construction firms.

On machine time constants, 52.9%, 67.9% and 75.0% for African, citizen and non-citizen construction firms respectively sourced for these constants from the internet, whereas 21.4%, 16.10% and 16.10% of these firms did not source this information from the internet.

Table 6.11: Functions of Information Managers in African, Citizen and Non-Citizen Construction Firms

		African Contractors	Citizen Contractors	Non-Citizen Contractors
i)	Keep and analyse information	}		
ii)	Acquire latest information in Construction	}		
iii)	Interpret information for use on the site	} 1		
iv)	Liase with consultants and client	}	1	
v)	Finding optimal ways of construction	}		
vi)	Optimises on material and purchases	}		
vii)	Store information on prices of materials used	} } 1		
viii)	Keep tender results on tender opening			
ix)	Research on construction operations	}		
x)	Analyse information on completed construction projects	} 1 }		3
xi)	Store and disseminate information			
xii)	To look for new ideas internationally	}		
xiii)	Look for clients through the website	} 1		1
xiv)	To get to know different plans and techniques	}		
xv)	Arranging the next project	}		

xvi xvii) xviii)	Giving project details Providing cost information Providing production information	} 1 } }		1
xix) xx) xxi)	Keeps information data base Source and communicate information Participate in tendering process		} } 1 }	
xxii) xxiii)	Keeps contractors records on materials, stocks; tender information Work marketing		} } 1 }	
xxiv)	Construction production records keeping and dissemination		2	
xxv) xxiv)	Production information keeping for construction companies Manage resources	} } }	 1 3	
		5/70 (7.14%)	9/56 (16.07%)	5/80 (6.25%)

Source: Analysis of Field Survey 2005

Table 6.12: Information Obtained from the Internet to Assist in Resource Optimisation by Construction Firms

Information Obtained from the Internet		Construction Firms by Citizenship Status								
		Africans (70No.)			Citizens (56 No.)			Non-Citizens (80 No.)		
		Responded		No Response	Responded		No Response	Responded		No Response
		No%	Yes%	%	No %	Yes%	%	No%	Yes%	%
1	Labour Constants	25.70	48.6	25.70	23.20	60.7	16.10	22.5	72.5	5
2	Material Constants	20.0	54.3	25.70	16.10	67.9	16.10	17.5	75.0	7.5
3	Machine time constants	21.40	52.9	25.70	16.10	67.9	16.10	17.5	75.0	7.5
4	Activity Duration	20.0	54.3	25.70	16.10	67.9	16.10	17.5	75.0	7.5
5	Material Waste Factors	30.00	45.70	24.30	42.9	41.10	16.10	45	45	10

6	Effect of Electronic data interchange (% Cost overruns performance)	10% 30% 50% 70% 80%	12.9 22.9 25.7 1.4 0	37.10%	19.6 35.7 14.3 1.8 1.8	26.80	13.8 23.8 46.8 2.5 0	13.8
7	Effect of Electronic data interchange on completion time performance (%)	10% 30% 50% 70%	14.3 21.7 22.9 4.3	37.10%	19.6 25 25 3.6	26.8	13.8 16.3 50.0 5.0	15.0
8	Effect of Electronic data interchange on Quality and workman-ship	5% 10% 30% 50% 70%	1.4 10.0 14.30 28.60 8.60	37.10	0 12.5 23.20 30.40 7.10	26.80	0 6.3 20.0 48.8 11.3	13.8
9	Effect of electronic data interchange on Environment and other related factors e.g. weather, money markets, workers skills etc. (%)	5% 10% 30% 50% 70% 80%	1.4 15.7 10.0 27.1 8.60 0	37.10	0 2.5 16.1 23.2 7.1 1.8	26.80	0 8.8 23.8 45.0 8.80 0	13.80

Source: Analysis of Field Survey 2005

On material waste factors, 45.7%, 41.10% and 45% of the African, citizen and non-citizen construction firms' source for these data from the internet, while 30%, 42.9% and 45% did not source for this information from the internet. The non response rates were 24.3%, 16.10% and 10% for African, citizen and non-citizen construction firms.

On activity durations, 54.3%, 67.9% and 75% of African, citizen and non-citizen construction firms obtained these data from the internet respectively, while 20%, 16.10% and 17.5% for the construction firms did not source for this data from the internet. The non-response rates were 25.7%, 16.10% and 7.5% for the African, citizen and non-citizen construction firms. On the effect for electronic data inter change on cost overruns performance 25.7% African construction firms agreed that this interchange affected cost overruns performance by 50%, and 22.9% they agreed that the data interchange affected cost overruns performance by 30%. 14.3% of citizen construction firms said that the data interchange affects cost overruns by 50% while 35.7% of these firms agreed that the impact was 30%. 46.8% of non-citizen construction firms agreed that the data interchange affected project cost overruns by 50%, whereas 23.8% of them said that the impact was 30%. On the overall the non-response rates were 37.10%, 26.8% and 13.8% for African, citizen and non-citizen construction firms.

On completion time performance, 22.9% and 27.1% of the African construction firms agreed that electronic data interchange affected project completion time by 50% and 30% respectively. 50% of citizen construction firms showed that 50% and 30% of project completion times were affected by electronic data interchange. 50.0% and 16.3% of non-citizen construction firms agreed that project time completion was affected by this data interchange respectively. The non-response rates were 37.10%, 26.8% and 15.0% for African, citizen and non-citizen construction firms.

On quality and workmanship, 28.60% and 14.3% of African construction firms said that the electronic data interchange had 50% and 30% impact on the quality and workmanship respectively. Whereas 30.4% and 23.2% of the citizen firms agreed that the impact was 50% and 30% respectively. 48.8% and 20% of non-citizen construction firms concurred that the impact was 50% and 30% respectively. The non response rates were 37.10, 26.8% and 13.8% for African, citizen and non-citizen construction firms respectively.

On environmental and other related factors, 27.10% and 10% of the African construction firms agreed that the data interchange had 50% and 30% impact on these factors respectively. 23.2% and 16.1% of citizen construction firms said that data interchange had 50% and 30%

impact on these factors respectively. 45% and 23.8% of non-citizen firms said that the data interchange had 50% and 30% impact on these factors respectively. The non-response rates were 37.10%, 26.8% and 13.8% for African, citizen and non-citizen construction firms.

Table 6.13: Application of Electronic Data Interchange between a Central Data Centre and itself or other International Construction Firms on Construction Activities by Construction firms.

	Activities Where the Data is Applied	African Contractors	Citizen Contractors	Non-Citizen Contractors
i)	Time and cost management	2	3	1
ii)	On tendering and sites	1	2	1
iii)	Prices for speculation	1		1
iv)	Coordination and timely delivery and optimality in production	5	1	9
v)	Resource mix	13	7	15
vi)	Applied in the whole construction production	1	7	8
vii)	Applied in production techniques	2	2	1
viii)	In ordering materials and keeping in touch with supplies.	1	3	5
ix)	Research and communication		3	1
	Totals	**26/70 (37.14%)**	**28/56 (50%)**	**42/80 (52.5%)**

Source: Analysis of Field Survey 2005

Table 6.13 shows that 37.14%, 50% and 52.5% of African, citizen and non-citizen construction firms have generated the areas where electronic data obtained from a central data centre or other international construction firms which are linked to the Kenya construction firms is used. Some of the notable areas where these data is applied are time and cost management, resource mix, production techniques and research and communication. The others are as listed in the Table 6.13.

6.5 Summary

The results of the two way analysis of variance shows that citizenship status of the construction firms has no effect on resource mix practices used by construction firms in the Kenyan construction industry. The blocking variables which were resource mix variables affects project performance as the results were found to be statistically significant at 95% confidence level.

The results also showed that resource mixes accounted for 81.46% of the variances in construction project performance, whereas citizenship status accounted for –1.31% of the variances in construction project performance. This shows a negative relationship with construction project performance. This was measured through Omega squared (ω^2) which indicates the proportion of the variances in the dependent variable that is accounted for by the variances in the independent variables.

The stepwise regression analysis shows that finance resource (credit worthiness) and machine time combination were the two most important variables accounting for 86.0% of the causes of poor construction project performance for the African construction firms, whereas in citizen construction firms, the two most important contributors to poor construction project performance were Technology Advancement and Incorrect Labour mix accounting for 91.4% of the causes. In non-citizenship category of construction firms, the two most important management variables causing poor construction performance were Technology Advancement and incorrect material mix, accounting for 86.5% of the causes. In the project information strategy 44.3%, 75% and 62.5% of African, citizen and non-citizen construction firms had an information management strategy respectively.

CHAPTER VII

SUMMARY FINDINGS, RECOMMENDATIONS AND AREAS OF FURTHER RESEARCH

7.1 Summary of the Research findings

The study set out to investigate into the causes and impact of resource mix practices in the performance of construction firms in Kenya through citizenship status, education training of the personnel employed by those construction firms and inappropriate matching and mixing of construction Resources by construction firms.

An analysis of the citizenship status and Resource mix practices by construction firms showed that, the citizenship status for three categories of construction firms had no significant effect on construction projects performance through the formulated resource mix indicators by these firms at 95% and 99% confidence levels.

The education training of the personnel, employed by these construction firms, had a minimal impact on resource mix as practiced by these construction firms on construction projects performance. Non- graduates recorded the highest level of poor resource mix by significantly rejecting the Null hypothesis H_o in at least 82.98% of the construction activities in Excavations and Earthworks, in 92.47%,81.72% and 80.65% of the concreting activities in all the three categories of construction firms respectively, in 84.15%, 89.02% and 85.37% of the walling construction activities, by the three categories of construction firms respectively, in 92.31%, 84.62% and 76.92% of the plasterwork activities for the three categories of construction firms respectively, in 94.12%, 82.35% and 88.24% of the floor paving activities for the three categories of construction firms respectively; in 66.67%, 58.33% and 50% of the wood block floor finish construction activities for the three categories of construction firms respectively, and in 66.67% of the Brick facing construction activities for African, citizen and Non-citizen construction firms respectively, and in 66.67% of the Brick facing construction activities for African, citizen and Non citizen construction firms respectively.

On the other hand the graduates rejected the Null – hypothesis Ho in 53.32%, 63.83% and 82.98% of the construction activities in Excavation and Earth Works for African, citizen and Non-citizen construction firms respectively; in 88.17%, 56.99% and 81.72% of the concreting activities for African, citizen and Non-citizen construction firms respectively; in 75.61%, 68.29% and 85.37% of the walling activities for the three categories of construction firms respectively, in 92.31%, 61.54% and 84.62% of the plasterwork activities for the three categories of construction firms respectively, in 70.59%, 64.71% and 76.47% of the floor paving activities for the three categories of construction firms respectively, in 58.33%, 66.67% and 75% of the wood block floor finish activities for the three categories of construction firms respectively, in 55.56%, 63.89% and 88.89% of the activities in ceramic floor and wall tiling for the three categories of construction firms respectively, and in 66.67%, 72.22% and 77.88% of the Brick facing activities for the three categories of construction firms respectively. All these results were tested at 95% confidence level. From the above results it is concluded that education had a significant impact on the way construction Resources are combined in order to improve construction projects performance by construction firms.

On the relationship between construction firms status and resource mix, the analysis revealed that the results were not significant at 95% and 99% confidence levels respectively for all the three categories of construction firms. On the other hand, the blocking variable in the two-way analysis of variance which was represented by the six construction resources (project performance indicators) used in construction activities showed that the results were significant at 95% and 99% confidence levels respectively. Hence rejecting the Null Hypothesis and consequently accepting the alternative hypothesis.

The results of the correlation analysis showed that, the six independent variables or project performance indicators (construction Resources) when regressed against the Dependent variable (construction projects performance) at 95% confidence level did not exhibit high multi collinearity so as to have a direct impact on the results of the multiple correlation analysis

The results of the multiple regression analysis for African construction firms showed that finance (credit worthiness) and incorrect machine time combination were the two most important causes of poor construction projects performance, accounting for 86% of the variations in projects performance.

The major causes of poor construction projects performance in citizen construction firms were Technology advancement and incorrect labour mix which accounted for 91.4% if the variations in construction projects performance.

The two most important causes of projects poor performance in Non citizen construction firms were Technology Advancement and incorrect material mix accounting for 86.5% of the variations in the Dependent variable (CPP).

7.2 Conclusions

7.2.1 The education training and construction projects performance with respect to the importance attached to construction Resources by construction firms.

The education training had an impact on Resource mix practices by construction firms on project performance with graduates showing that finance was the most important variable with 33.5% overall impact on the construction projects performance against non- graduates whose scores were 28.2% impact on same variable. The second most important contributor, to project performance was Technology advancement for both groups, with graduates as scoring 26.89% and non-graduates 26.47% respectively. The third most important contributor to construction projects performance was incorrect material mix with graduates scoring 25.39% and non-graduates scoring 22.77% respectively. The fourth most important contributor to construction project performance for both groups was information technology, with graduates scoring 24.42% and non-graduates 22.10% respectively. The fifth and six variables in importance to project performance was incorrect labour mix with 22.20% and incorrect machine time combination with 22.07% for the graduates, while the Non-graduates regarded incorrect machine time as amore important variable than incorrect labour mix, and scored them with 21.93% and 18.48% impact construction project performance respectively.

7.2.2 Citizenship status and Construction project performance with respect to resource mix practices by construction firms.

The three categories of construction firms citizenship concurred that finance as a resource was the most important variable, followed by Technology Advancement, then incorrect materials mix for Non citizen and African construction firms, while citizen construction firms placed information technology in the third position of importance to the effects it has on construction projects performance. These three variables accounted for 82.13%, 80.69% and 79.15% on resource mix impact on construction projects performance for citizen, Non-citizen and African Construction firms respectively. These differences are not very significant and hence the conclusion that citizen status does not play a very important role towards the improvement of construction projects performance by construction firms in Kenya. In any case they draw their construction resources from the same Kenyan market.

7.2.3 Relationship between construction firm's citizenship status and Resource mix indicators on construction projects performance.

From the two-way analysis of variance tests, it can be concluded that citizenship status has no effect or impact on construction project performance as the results were not significant at 95% confidence level.

The blocking variable in the two-ways analysis of variance comprised the six resources used by construction firms as identified in the literature review. The results were significant as 95% confidence level, and therefore these resources affect construction project performance for they account for 81.46% of the variations.

7.2.4 Multiple Regression analysis on construction projects performance.

The results of regression analysis shows that the three most important variables for African construction firms were finance as a resource accounting for 71.8% of the variations, incorrect machine time combination accounting for 14.2% and information technology accounting for 5.7% for the variations in constructions project performance. All the three variables explained 91.7% of the variations. For the citizens construction firms, Technology Advancement, incorrect labour mix and finance were the three most important variables in explaining variations in construction projects performance. Technology Advancement accounted for 74.1%, incorrect labour mix accounted for 17.3% and finance accounted for 3 9% of the variations respectively. All the three taken together accounted for 95.3% of the variations in construction projects performance by citizen construction firms.

In the Non-citizens construction firms category, Technology Advancement accounted for 59.5%, incorrect material mix accounted for 27% and incorrect machine dine mix accounted for 27% and incorrect machine time mix accounted for 4.2% of the variations in construction projects performance. All the three times taken together accounts for 90.7% of the variations in constructions performance. All the three taken together accounts for 90.7% of the variations in constructions performance.

It can be concluded that African Construction firms attach a lot of importance in finance as a resource compared to citizens and Non-citizens construction firms whose most important resource was Technology Advancement. This means that without adequate financial resources African Construction firms will never improve construction projects performance.

7.2.5 Embracing manufacturing techniques in construction production process.

7.2.5.1 Project information management strategy by construction firms.

It can be concluded that most of the African construction firms do not embrace project information management strategies, whereas citizen and Non citizen construction firms embrace project information management strategies in about 50% of their organizations in the study sample.

7.2.5.2 Application of optimization techniques in construction firms production process.

From the results of the study it is clear that less than at least 55% of construction firms do not embrace optimization techniques in their production process, although less than 49% these firms expressed their willingness to be trained on how to use these techniques. It could be concluded that construction managers should embrace optimization production techniques in their organizations in order to improve projects performance.

7.2.5.3 Application of just in time philosophy in construction production process.

From the results of the study only 37.6% of the firms used JIT in production and only 8% of these firms are aware of JIT philosophy in production. It can therefore be concluded that the majority of construction firms do not apply JIT philosophy in their organizations, and therefore construction managers should embrace it in order to improve projects performance.

7.3 Fulfillment of the study objectives.

The objectives of the study have therefore been substantially accomplished. This has been achieved through the analysis of construction firms resource mix practices in the three categories of construction firms' citizenship status. The education training contribution towards construction projects performance has been analyzed in view of the 318 construction activities in the study sample. The significant variables which cause poor construction projects performance have been identified and analyzed. Lastly construction firm's application of information technology techniques, optimization techniques and JIT philosophy techniques has been analyzed.

7.4 The study of hypothesis

The first study hypothesis that inappropriate matching of construction Resource does not contribute significantly to the causes of poor construction projects performance has been rejected and the alternative hypothesis that "inappropriate matching of construction Resources contributes significantly to the causes of poor construction performance have been accepted as the results were found to be significant at 95% confidence level.

The second hypothesis that citizenship status does not contribute significantly to poor construction projects performance has been supported for the results were not significant at 95% confidence level. Hence the alternative hypothesis that citizenship status contributes significantly to poor construction performance was rejected.

The third hypothesis for the study that, the level of Education does not contribute significantly to poor construction projects performance through resource mix practices by construction firms was accepted as the results were found to be significant at 95% confidence level. Hence the alternative hypothesis that Education contributes significantly to poor construction projects performance through resource mix practices by construction firms was rejected at 95% confidence level.

7.5 Contribution to Knowledge.

i.) It has established material constants, labour constants, machine time constants, waste factors, activity durations, gang sizes and machine men combinations which are applicable in the Kenya construction industry.

ii.) The study has also established that inappropriate matching of construction resources at the site production level is the root cause of poor construction projects performance.

iii.) The study also established that citizenship status does not contribute to poor construction projects performance contrary to the belief that it plays a major role in performance of construction projects.

iv.) The study has also informed the Kenyan construction managers on which areas in resource mix practices should be emphasized.

v.) The study has contributed to further understanding of the causes of poor construction projects performance through resource mix practices by construction firms in the Kenyan context, in addition to time and cost overrun studies conducted in Kenya and the developed countries such as Great Britain.

vi.) The study has also formulated a theoretical model for construction, resource mix practices and interrelationship gaps which contribute to construction projects performance.

7.6 Recommendations

To improve construction projects performance by the Kenyan construction firms more efforts should be directed at the key participants in construction resource management, work studies on construction resources, Resource optimization techniques, just in time philosophy techniques in the construction production process, project information management strategy in construction firms, and the relevant training of construction resource organizers.

7.6.1 Key participants in construction Resource management.

The people entrusted with this responsibility in construction firms are the contracts/project managers in most construction companies. These personnel needs to be well trained in the management and appropriate matching of the construction resources at their disposal so that performance of construction projects can be improved in terms of reduction in cost over runs arising from inefficient production processes and time over runs arising from unrealistic estimations of activity durations.

7.6.2 Work studies on construction resources.

The industry should come up with work study programmes where resources used in production activities are Quantified and recorded for each particular construction activity so as to eliminate wastes in materials, time, labour, supervisory services, machine time and inefficient resource combinations leading to low outputs.

7.6.3 Just-in-time philosophy in construction production process by construction firms.

Construction firms should integrate sets of activities designed to achieve high volume production using minimum inventories of raw materials, work in progress and finished goods. Parts arrive in the next work station just in time and are completed and move through the operation quickly. It is also based on the logic that nothing will be produced until it is needed, and need is created by the actual demand of the product when an item is sold in the market. It is a philosophy of management that seeks to eliminate waste in all aspects of firm's production activities human relations, vendor relations, technology and the management of materials and inventories. Waste to be eliminated comprise waste from over production, waste of waiting time, transportation waste, inventory waste, waste of motion and waste from product defects.

7.6.4 Projects information management strategies.

Construction firms should make an effort to create a department in their organizations or to employ project information managers. These personnel will be able to set up projects information management strategies. This will deal with the storage, retrieval and dissemination of information from clients to consultants; to contractors and from sub contractors to other participants in the project environment. It comprises materials, plant, labour and technological data constants, and the exchange of this data between contractors and sub contractors, contractors and materials or plant suppliers, between contractors and materials or plant suppliers, between contractors and Regulatory bodies, and sub contractors and designers. These information transactions help to facilitate the coordination and timely delivery of the project. The effective management of the information resources in construction therefore impacts on both the success of the projects and the overall performance of the individual construction companies.

7.7 Areas of further Research

1. Further research needs to be carried out on contractor's project financing to establish how it is done and examine whether it meets the universal project financing theory and the international project financing practice. The influence of construction projects external players such as financiers and suppliers need to be studied so that they are understood and sustainable models of relationships recommended.
2. Observations site studies are necessary in order to understand how construction resources are optimized/mixed on construction sites, with a view to improving these methods so as have efficiently run construction sites.
3. There is need for research in the areas of project Resource estimating and pricing strategies by construction firms in order to improve construction projects performance by these firms.
4. Further research is necessary in order to understand how construction firms deal with information technology as a resource in their day-to-day activities.
5. There is need for a detailed study on how construction firms embrace manufacturing techniques in their production process.

The future and improvement of the construction projects performance by construction firms in Kenya with respect to Resource mix and other areas of construction lies in Research. This study has provided a direction of research towards this end. Indeed the challenge ahead is to provide a Research framework and entrench research in it, and use the results there from for the benefit of the construction industry and the Kenyan Economy as a whole.

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APPENDIX A: QUESTIONNAIRE

UNIVERSITY OF NAIROBI

DEPARTMENT OF BUILDING ECONOMICS & MANAGEMENT
P.O. Box 30197, 00100 Nairobi, KENYA, ***Tel: No. +254-2-2724525/9; Fax: +254-2-2718548***
E-mail: *Land_dev@uonbi.ac.ke*

Date:......................

____
____
____
____

Dear Sir/Madam,

RE: **Ph.D. Research Project Title: *"An Investigation into the Rsource Mix in Construction Projects in Kenya"***

I am a registered Ph..D. student in the Department of Building Economics & Management in the University of Nairobi undertaking a Ph.D. Research Project entitled: ***"An Investigation into the Resource Mix in Construction Projects in Kenya".*** I am conducting interviews on construction resource optimization by construction companies or firms located within Nairobi City. The name of your firm was obtained from the list of contractors registered under Categories A to C by the Ministry of Roads, Public Works and Housing.

Your firm has been selected out of the many firms involved in the building industry to provide the information needed in the study. Your wide experience is a representation of the majority of actors participating in the building industry in Kenya.

I kindly write to you to provide the information required by completing the accompanying questionnaire.

The information will be used for research purposes only and your identity will remain confidential.

A copy of my research permit from the Government of Kenya and the letter from the Chairman of Department is attached.

Your assistance is highly appreciated.

Yours faithfully,

Mr. Sylvester M. Masu
B/80/8316/2000

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PAGE 2

THIS IS TO CERTIFY THAT:

Prof./Dr./Mr./Mrs./Miss SYLVESTER MUNGUTI MASU

of (Address) NAIROBI UNIVERSITY

P.O. BOX 30197, NAIROBI

has been permitted to conduct research in ______________

______________ Location,

NAIROBI District,

NAIROBI Province,

on the topic RESOURCES OPTIMIZATION BY CONSTRUCTION FIRMS IN KENYA(NAIROBI)

for a period ending 30th March , 19 2004

PAGE 3

Research permit No. MOEST 13/001/15C 191

Date of issue 12th April, 2001

Fee received Shs. 1000

Applicant's Signature

For Permanent Secretary
Ministry of Education Science and Technology
P. O. Box 30040, Nairobi

A. KAARIA
Permanent Secretary,
Office of the President
EDUCATION

CONDITIONS

1. You must report to the District Commissioner of the area before embarking on your research. Failure to do that may lead to the cancellation of your permit.
2. Government Officers will not be interviewed without prior appointment.
3. No questionnaire will be used unless it has been approved.
4. Excavation, filming and collection of biological specimens are subject to further permission from the relevant Government Ministries.
5. You are required to submit at least ~~four~~ (4) bound copies of your final report.
6. The Government of Kenya reserves the right to modify the conditions of this permit including its cancellation without notice.

GPK 7092—6m—11/96

REPUBLIC OF KENYA

RESEARCH CLEARANCE PERMIT

(CONDITIONS—*see* back page)

UNIVERSITY OF NAIROBI

DEPARTMENT OF BUILDING ECONOMICS & MANAGEMENT
P.O. Box 30197, 00100 Nairobi, KENYA, **Tel: No. +254-2-2724525/9; Fax: +254-2-2718548**
E-mail: Land_dev@uonbi.ac.ke

Thursday, September 18, 2003

TO WHOM IT MAY CONCERN

Conducting of Research for a Ph.D Thesis by Mr. Sylvester M. Masu Registration No. B/80/8316/2000 under the Title: "An Investigation into the Resource Mix in Construction Projects in Kenya"

We write to confirm that Sylvester M. Masu **Registration No. B/80/8316/2000** is a registered Ph.D. Candidate in the Department of Building Economics & Management in the University of Nairobi undertaking a Ph.D. Research Project entitled: **"An Investigation into the Resource Mix in Construction Projects in Kenya". Sylvester M. Masu employed as a full time Lecturer** in the Department of Building Economics & Management and is conducting interviews on construction resource optimization by construction companies or firms located within Nairobi City. The Candidate has the necessary Research permit No. MOEST & 13/001/15C 191 issued by the Government of Kenya to carry out the research in the relevant Districts.

Your assistance to the Candidate to access the relevant information will be highly appreciated by the University of Nairobi.

Yours faithfully,

Dr. W. H. A. Olima
Senior Lecturer and Chairman
Department of Building Economics and Management
University of Nairobi.

A:\masuletter of support.doc

QUESTIONNAIRE

This Questionnaire Attempts to Investigate
Optimum Combination of Resources in projects by construction Firms in Kenya.

DECLARATION

ANSWERS TO QUESTIONS CONTAINED IN THIS QUESTIONNAIRE WILL BE KEPT CONFIDENTIAL

TOPIC

An Investigation into the Resource Mix in Construction Projects in Kenya.

A Case Study of the Construction Firms in Nairobi in Categories (A-C) Ministry of Public Works Registration

Addressed to:

The most informed person in the construction firm.

QUESTIONNAIRE NUMBER ______________________________

ENUMERATOR NUMBER ______________________________

DATE ______________________________

PART A: BACKGROUND INFORMATION

1. Name of Construction Firm ....
2. Registration by Ministry of Public Works (Tick where applicable)
   a) Building Works .... [ ]
   b) Civil Engineering Works .... [ ]
   c) Building and Civil Engineering Works .... [ ]
   d) Category for which you are registered
      (i.e. A, B and C) Insert.. [ ]
3. Date of Company Registration ....
4. Date of registration under Category C ....
5. Years of Operation since Registration under Category C ....
6. Citizenship Status: (Tick Where Applicable)
   a) African Origin .... [ ]
   b) Citizen but not of African Origin .... [ ]
   c) Non-Citizen .... [ ]
7. Name of Interviewee: ....
8. Level of Education (Tick where applicable)
   a) Polytechnic Ordinary Diploma.................. ....[ ]
   b) HND ....[ ]
   c) University Graduate
      i) Civil Engineer.................................. [ ]
      ii) Architect .... [ ]
      iii) Quantity Surveyor .... [ ]
   d) Any Other (Specify) ....

9. Designation/Position in the Company (Tick whichever is applicable)
   a) Contracts Project Manager .... [ ]
   b) Site Agent .... [ ]
   c) Foreman ....[ ]
   d) Any other Specify... [ ]

10. Indicate the number of years you have worked as:
    a) Contracts Project Manager ....
    b) Site Agent ....
    c) Foreman ....

PART B: EXCAVATION AND EARTHWORK ACTIVITIES

From Your Long and Treasured Working Experience indicate the average resources inputs used per m^3 of output in unskilled hours

a)

Hand Excavation (Ordinary Ground)		
Operation		**Number of Unskilled Hours Required to excavate 1 M^3 of soil.**
i)	Excavate to reduce Levels	Hrs/m^3
ii)	Excavate basement ≤ 1.50 metres deep	Hrs/m^3
iii)	Ditto 1.50 m - 3.0 m deep	Hrs/m^3

iv)	Ditto 3.0 m - 4.50 metres deep		Hrs/m^3
v)	Ditto 4.50 - 6 metres deep		Hrs/m^3
vi)	Excavate 150 mm deep top soil, wheel 100 m using hand and wheel barrows	1. Excavation by1No. labourer / m3.......................................	Hrs/m^3
		2. 1 No. Labourer to Wheel 1 m3 of soil per 100 m	Hrs/m^3
		3. Excavated material bulkage (%)....	Per/m^3
vii	Excavate foundation trench ≤ 1.50 metres deep		Hrs/m^3
viii	Ditto 1.50 - 3.0 metres deep		Hrs/m^3
ix)	Backfilling in layers and compacting around foundations	1 No Labourer / m3......................	Hrs
x)	Remove surplus excavated material by hand and load into lorries.	1.).No. of men required to load 5m^3 of loose spoil .... 2.) No. of Hours these men will take to load 5 m^3 of loose spoil	No Hrs
xi)	**Increases in bulk of materials after excavation**	**Percentages (%)**	
	1. Black cotton soil		
	2. Red soil / loam soil		
	3. Gravel		
	4. Sand		
	5. Clay soil		
	6. Murram		

b)

Machine Excavation (Ordinary Ground)		**Specify the type of Excavators**	
Type of Excavation		**Output of Machine per Hour in m^3**	
i)	Site stripping of (Machine type ....)		m^3/hr
ii)	Reduce levels: Using 1/4 m^3 excavator and load directly into lorries		m^3/hr
iii)	Ditto basement ≤ 1.50 m ditto		m^3/hr
iv)	Ditto basement 1.50 - 3.0 m ditto		m^3/hr
v)	Ditto basement 3.0 - 4.5 m ditto		m^3/hr
vi)	Ditto basement 4.50 - 6.0 ditto		m^3/hr
vii	Excavate foundation trenches ≤ 1.50 m deep; using 1/4 m3 excavator and load directly into lorries		m^3/hr
viii	Ditto .50 - 3.0 metres ditto		m^3/hr
ix)	Excavate foundation pits ≤ 1.50 metres deep; using 1/4 m3 excavator and load directly into lorries.		m^3/hr
x)	Ditto 1.50 - 3.0 metres deep		m^3/hr

c)

Other (Non-ordinary ground) material Encountered in Reduced Level Excavation (Removing Material Per m³) (Number of Hours)		
Type of Material		Using 1 No. compressor with .... No. outlets (Specify No.) .... Operators (Specify No.) .... Labourers in Attendance (Specify No.) ....
i)	Plain concrete	(Hrs)
ii)	Reinforced concrete	(Hrs)
iii)	Hard rock	(Hrs)

d)

Other Non-ordinary ground material Encountered in Trench Excavation. Removing Material per m³ (Number of Hours)		
Type of Material		Using 1 No. compressor with .... No. outlets (Specify No.) .... Operators (Specify No.) .... Labourers in Attendance (Specify No.) ....
i)	Plain Concrete	(Hrs)
ii)	Reinforced concrete	(Hrs)
iii)	Hard rock	(Hrs)

e)

Average Outputs for Barrowing and Filling Hardcore		
Operation		No. of Hours Required m³ of Fill
i)	Barrowing and filling bulk hardcore ≤ 300 mm thick (deep)	Hrs/m³
ii)	Ditto > 300 mm thick (deep)	Hrs/m³
iii)	Compacting in 150 mm thick layers with	1. Vibrating Roller < 5 Tonnes...... Hrs/m³ 2. 10 Tonnes Roller.................. Hrs/m³
iv)	What is the average consolidation of hardcore per m³ .... %	
v)	1m3 of hardcore weighs approximately .... Tonnes	

f) How does inappropriate resource combination affect Construction performance in terms of in the following indicators: (Tick) Rank in order of magnitude

Rank	<5%	<10%	<15%	<20%	<25%	<30%	<35%	<40%	<45%	<50%	Other (Specify
Time											

Cost											
Quality											
Environmental Factors											

g) How does information technology affect construction project performance in terms of the following indicators: (TICK)✓.(Project information technology refers to the methods and techniques of storing, retrieving and managing of knowledge facts, news, data, reports or information acquired and used on construction sites and projects.)

Rank	<5%	<10%	<15%	<20%	<25%	<30%	<35%	<40%	<45%	<50%	Other (Specify
Time											
Cost											
Quality											
Environmental Factors											

h) How does work environment affect construction project performance in terms of the following indicators: (TICK)✓.(Work environment refers to sequencing, congestion; availability of resources; weather; managerial effectiveness; and other disruptive events that impair performance.)

Rank	<5%	<10%	<15%	<20%	<25%	<30%	<35%	<40%	<45%	<50%	Other (Specify
Time											
Cost											
Quality											

i) How do advances in technology affect construction project performance in terms of the following indicators: (TICK)✓.(Advances in technology refers to the development of new methods and techniques of achieving ones purpose through the use of skills acquired through training, or the use of machines and New methods of executing construction works resulting to savings in time cost and better quality finished buildings.)

Rank	<5%	<10%	<15%	<20%	<25%	<30%	<35%	<40%	<45%	<50%	Other (Specify
Time											
Cost											
Quality											
Environmental Factors											

PART C: INSITU CONCRETE WORK (MIXING ON SITE)

a) Materials required to produce 1 m^3 of dry concrete in the following mixes by weight batching.

Mixes	Cement in Bags (50 Kg)	Sand in Tonnes	Ballast in Tonnes	Water Cement Ratio: Litres / Bag of Cement
1:4:8				
1:3:6				
1:2:4				
1:11/2:3				
1:1:3				

b) Machine Time Required in Mixing 1 m^3 of Concrete

Type of Mixer	Output per Hour	Time off for starting	Time off for cleaning at the end of the day	Any Idle Time while on Site per day
7/5(0.2/0.14)				
10/7(0.28/0.20)				
14/10(0.40/0.28)				
18/12(0.51/0.34)				

c) Labour Requirements per m^3 of Concrete

Concrete Mixer	Gang Size	Idle time (%)
7/5(0.2/0.14)	1. Operators .... No 2. Labourers .... No. 3. Wheelers .... No.	
10/7(0.28/0.20)	1. Operators .... No 2. Labourers .... No. 3. Wheelers .... No.	
14/10(0.40.0.28)	1. Operators .... No 2. Labourers .... No. 3. Wheelers .... No.	
18/12(0.51/0.34)	1. Operators .... No 2. Labourers .... No. 3. Wheelers .... No.	

d) Formwork: Requirements per /m^2 of Surface

Labour Outputs for fixing and stripping form work in square metres per hour or output in m^2 per day (8 Hrs).

	Location	Fixing	Stripping	Gang size (No.s)
i)	Soffits < 3.50 m high slabs			Carpenters .... Labourers ....
ii)	Soffits & Sides of beams < 3.50 m			Carpenters .... Labourers ....
iii)	Sides of columns			Carpenters .... Labourers ....
iv)	Sides of Foundations			Carpenters .... Labourers ....
v)	Soffits > 3.50 m high of			Carpenters ....

	slabs			Labourers ………
vi)	Soffits and sides of beams > 3.50 m high			Carpenters …….. Labourers ………

e) Materials Requirements

Timber Sizes	**Length in m per/ m2 of formwork**	**Waste Factor (%) allowed**
i) 50 x 50 mm		
ii) 50 x 75 mm		
iii) 50 x 100 mm		
iv) 50 x 150 mm		

f) Reinforcement (all bar sizes) from 6 mm Diameter to 32 mm Diameter Bars

Material	**Unit (Kg)**	**Amount of Waste (%) allowed**
i) 6 mm - 10 mm bars	1 Kg	
ii) 12 mm - 16 mm Bars	1 Kg	
iii) 20 mm - 32 mm Bars	1 Kg	
iv) Black tying wire / per tonne of reinforcement	No. of Rolls: Of 50 kg ………………… Of 25 kg …………………	

Labour	**Gang Size / Per Tone of Reinforcement**	**Output (Time Taken per Gang (Hrs)**	**Possible Idle Time / Tonne (Hrs)**
Qualified Steel Fixers Labourers	No…………….. No……………..		
Machine time taken for bending reinforcement etc.			
Cutting and bending one tone of reinforcement	Gang size/Tone of Reinforcement.	Output (Time taken by the gang using cutting & bending equipment.	Possible idle time / Tonne (hrs)
Qualified Steel Fixers Labourers	No……………. No……………	Hrs	Hrs

PART D: WALLING AND BLOCK WORK

a)	**Materials required to produce 1M² of Walling in the following thicknesses of walls: (Fill in)**		
Precast Concrete Blocks		**Number / M²**	**Waste in % /M²**
i)	200 mm Thick walls (200 x 200 x 390 mm long)		
ii)	150 mm thick walls (150 x 200 x 390 mm long)		

iii)	100 mm Thick walls(100 x 200 x 390 mm long)		
Stone/Masonry Walls (Dressed)		**Running Feet / M^2**	**Waste in % per M^2**
i)	200 mm Thick walls		
ii)	150 mm Thick Walls		
iii)	100 mm Thick walls		

b) Labour Requirements per M^2 of Walling / Block Work

Gang Size

1. Masons: No. .... (Fill in / indicate)
2. Labourers: No. .... (Fill in / indicate)

Output per (8 Hr) day on the following wall types in M^2

Precast Concrete Blocks		**Output in M^2**	**Idle Time**	
			Per m^2	Per day
i)	200 mm Thick walls			
ii)	150 mm thick walls			
iii)	100 mm Thick walls			
Stone/Masonry Walls (M^2)				
i)	200 mm Thick walls			
ii)	150 mm Thick Walls			
iii)	100 mm Thick walls			

(c) MORTAR REOUIREMENT / M^2 OF WALLING

i) Material requirements to produce $1M^3$ of dry mortar in the following mixes by weight batching:

Mixes	**Cement in 50 Kg bags (No)**	**Sand in Tonnes (No)**	**Water cement ratio: Litres per bag of Cement L)**	**Waste factor in %**
1:3				
1:4				

ii) Machine time required in mixing $1M^3$ of Mortar

Type of Mixer	**Output per Hour**	**Time off for starting (Hrs)**	**Time for cleaning at the end of the day (Hrs)**	**Any idle time while on site per day (Hrs)**
7/5 (0.20/0.14)				
10/7 (0.28/0.20)				
14/10(0.40/0.28)				
18/12(0.51/0.34)				

iii) Labour requirements per M^3 of mortar or output per day......................(Indicate)

Concrete Mixer	**Gang Size**	**Idle Time %**
7/5 (0.20/0.14)	Operators ....; Labourers............; wheelers	
10/7 (0.28/0.20)	Operators ....; Labourers............; wheelers	
14/10(0.40/0.28)	Operators ....; Labourers............; wheelers	

18/12(0.51/0.34)	Operators ……………; Labourers…………; wheelers ………………………	

iv) **Damp proof courses: Material / M**

	Material	**Waste %**
i) 100 mm Wide damp proof course laid under walls horizontally	1M	
ii) 150 mm wide ditto	1M	
iii) 200 mm wide ditto	1M	
Labour requirements / Roll and or M/(Roll = Hessian based bituminous felt 1.0 m x 7.0 m long.)		
	Roll (Hours)	Metre (Hrs)
Masons ______________ No Labourers ______________ No		

PART E: PLASTER WORK AND FLOOR PAVINGS

PLASTERWORK

a)	Material requirements: Already mixed mortar cement and sand (1:3) and (1:4) respectively as in part D (c).
b)	Amount of material waste during plastering __________________ (waste %)
c)	Labour Requirements for 8 Hr day work output: Work output per day in m^2 ………………………………………………… m^2 Gang size: Masons / plasterers ………………………………………… (No) Labourers ……………………………………………………………(No)

(d)	**Activity per Gang in (c) above.**	**Output in M^2 per Day (8 hrs)**	**Idle Time %**
i)	15 mm Plaster on walls (internal)		
ii)	20 - 25 mm plaster on stone walls (Internal)		
iii)	15 mm External render to walls		
iv)	20mm - 25 mm Render to External surfaces of stone walls.		
v)	15 mm cement and sand plaster to ceilings of suspended slabs		
vi)	**25 mm cement sand (1:3) steel trowelled floor paving / screeded bed**	**Output in M^2 per Day (8 hrs)**	**Amount of materials waste when laying the finish (%)**
Gang size: Spreaders ____________ No. Labourers ______________ No.			
vii) 40 mm cement and sand paving Spreaders ____________ (No) Labourers ____________ (No.)			

viii) 2 mm thick PVC tiles size 300 mm x 300 mm	Material / M^2 No. of Tiles	Output in M2 / Hr	Waste %
Gang size: Layers _________ (No.) Labourers _____________ (No.)			

ix) Strong hold fixing adhesive 4 kg Tins.	Coverage in M2 per 4 kg tin	Waste %
Gang size: Layers _______ (No) Labourers ______________ (No.)		

PART F: CARPENTRY: ROOFING AND TRUSSES

Roof Structure	Materials (metres)	Waste (%)	Output per Hour	Idle Time (%)
i) 50 mm x 25 mm roofing batterns per m^2 of tiled roofing				
ii) 50 x 100 mm Struts / Tie/m^2				
iii) 50 x 150 mm Rafter / joist /m^2				
iv) 75 mm x 100 mm Wall Plate Bolted	1.0			
v) 50 mm x 50 mm ceiling brandering per M^2 of Ceiling				

Labour: Gang Size; Carpenters ....; Labourers ....

Output per 8 Hour Day for Fixing	Linear metre	Waste %	Idle Time %	
i) 50 mm x 25 mm roofing battens (roofing)				
ii) 50 x 100 mm Struts / Tie				
iii) 50 x 150 mm Rafter / joist				
iv) 75 mm x 100 mm Wall Plates				

Roof Tiles Material / M^2
Labour: Gang Size
Skilled Operative .... Labourers ....
Output /Day ....M^2

Type of Covering	No. of tiles / M^2	Waste %	Output (M^2)	Idle Time %
i) Mareba concrete roofing tiles size 420 mm x 335 mm				
ii). Mangalore Clay roofing tiles (250 mm x 400 mm)				
iii) Portuguese clay roofing tiles (410 mm x 250 mm)				
iv) Browsley tiles (150 mm x 250 mm)				
v) Roman tiles				
vi) Pan tiles (300 x 200 mm)				
vii) Chicken to wire				
viii) 1000 gauge polythene sheeting				
Sheet Roofing ix) Resincoat IT 4 & LT5 roofing sheets				
xi) G.C.I. roof Sheeting				
Ridge Capping	**No. of Pieces**	**Waste %**	**Output/Day Same Gang**	**Idle Time %**
Roof Tiles /LM				
Roofing Sheets Ridge Capping /LM				

PART G: JOINERY

Gang size: **Skilled Operative ………………………Labourers: ………………………………**

Joinery Work(Hard Wood)	Materials per LM	Waste %	Output/Day in Running Metres	Idle Time %
i) 100 x 25 mm Skirting plugged.				
ii) 75 mm x 50 mm cornice nailed				
iii) 100 mm x 50 mm Door frame / transome / millions				
iv) 150 mm x 50 mm Frame / Ditto				
v) 50 mm x 25 mm Architraves				
vi) 20 mm Quandrants				
vii) 300 mm x 35 mm Fascia / eaves / barge boards				
viii)100 mm x 25 mm T&G boarding /M2				

If soft wood is used, by what (%) percentage would it affect the output/Day……………..

PART H: CERAMIC WALL/FLOOR TILES

Ceramic Wall / Floor tiles			Gang size: Skilled Operative ………….. Labourers: …………………	
Size and Type of Tiles	**Material per M2 (No. tiles)**	**Waste %**	**Output in M2/Day**	**Idle Time %**
i) 150 mm x 150 mm x 6 mm white glazed wall tiles				
ii) 200 mm x 200 x 6 mm wall tiles				
iii) 300 mm x 300 mm x 6 mm wall tiles				
iv) 150 mm x 150 mm x 8 mm Thick floor tiles				
v) 200 mm x 200 mm x 8 mm thick floor tiles				
vi) 300 mm x 300 mm x 8 mm thick floor tiles				

PART I: FACING BRICKWORK FINISHES

Gang size: **Skilled Operative …………………… Labourers: ……………………………**

Finish	Material per M2 (No of Units)	Waste %	Output/Day (8 Hrs)	Idle Time %
1. 230 x 75 mm x 25 mm hand scratched smooth bricks				
2. 230 x 75 mm x 50 mm ditto				
3. 230 mm x 65 mm x 65 mm ditto				

PART K: WOOD BLOCK FLOOR FINISH

Gang size: Skilled Operative ....Labourers:						
	Material per M^2 (Kgs)	Waste %	Output/ Day (8 Hrs)	Idle Time % Labour	Machine time (Hrs) / M^2	Machine idle / M2 of sanding (%)
1. Fixing adhesive in 4 kg stronghold / m^2 (stronghold)						
2. Parquet flooring /m^2						
3. Two pack polish litres /m^2						

PART L: GLAZING (4mm) THICKNESS

Gang size: Skilled Operative ....Labourers:						
Materials /m^2	Material required per m^2	Waste %	Putty required per M^2	Waste %	Output/ Day (8 Hrs)	Idle Time %
1. In panes not exceeding 0.10 square metres each						
2. In panes over 0.10 m^2 but not exceeding 0.50 m^2 each						

3. In panes over 0.50 m2 but not exceeding 1.0 m^2 each						
4. In panes over 1.0 m^2 and not exceeding 1.50 m^2 each						
5. In panes over 1.50 m^2 and not exceeding 2.0 m^2 each						
6. In panes over 2.0 m^2 but not exceeding 2.50 m^2 each.						

How does 6mm Thick glass affect the output/day (8hrs)....................................%
(Increase or Decrease output in percentage.)

PART M: PROJECT PERFORMANCE AND ITS INDICATORS:

i) The construction Project Performance is defined as the eventual completion of a Project within the originally set contract period, set cost target and the set specifications and standards of workmanships or the contract period, the set cost target (contract sum) and the set specifications and standards of workmanships.

ii) Project time performance (Late; Early or completion of the project on time as per the contract agreement).

iii) Project cost performance (Completions of the project within the agreed contract sum, or completion with extra and additional costs or completion below the agreed contract sum).

iv) Project quality performance (This refers to the compliance to the specifications in the contract documents, and the quality of the workmanships by the contractor as a result of the supervision provided by the consultants).

Indicate by what magnitude is project performance affected by the following factors:-(Methodologies of setting the targets are outside the scope of this study.)

a) Incorrect labour combination or requirement on the overall project performance : (Tick appropriately)

Factors;	≤5%	≤10%	≤15%	≤20%	≤30%	≤40%	≤50%	Other % Specify
i) Project Time								
ii) Project Cost								
iii) Quality Performance								

b) Incorrect material combinations or resources on the overall project performance: (Tick appropriately)

Factor	≤5%	≤10%	≤15%	≤20%	≤30%	≤40%	≤50%	Other % Specify

i) Project Time								
ii) Project Cost								
iii) Quality Performance								

c) Incorrect machine time combinations i.e. idle time etc on the overall project performance. (Tick appropriately)

Factor	≤5%	≤10%	≤15%	≤20%	≤30%	≤40%	≤50%	Other % Specify
i) Project Time								
ii) Project Cost								
iii) Quality Performance								

d) By what magnitude does project information technology affect project performance in terms of the following factors:(Project information technology refers to the methods and techniques of storing, retrieving and managing of knowledge, facts, news, data, reports or information acquired and used on construction sites and projects). (Tick appropriately)

Indicator Variable	**≤5%**	**≤10%**	**≤15%**	**≤20%**	**≤30%**	**≤40%**	**≤50%**	**Other % Specify**
i) Project time (timely completion (performance)								
ii) Cost performance (within cost allowed)								
iii) Intended use and standard of the project (Quality Performance)								

e) How does technology affect project performance in terms of the following indicators:-(Technology refers to techniques of achieving ones purpose through the use of skills acquired through training , or the use of machines and new methods of executing construction works resulting to savings in time and cost; and the better quality finished buildings.) (Tick appropriately)

Factor Variable	**≤5%**	**≤10%**	**≤15%**	**≤20%**	**≤30%**	**≤40%**	**≤50%**	**Other % Specify**
i) Timely completion								
ii) Completion within the original allowed cost								
iii) Quality Performance								

f) By what magnitude does finance as a resource affect project performance in terms of the following indicators: - (Finance refers to credit worthiness of a construction firm and not the media through which the other construction resources are expressed.) (Tick appropriately)

Factor Variable	≤5%	≤10%	≤15%	≤20%	≤30%	≤40%	≤50%	Other % Specify
i) Timely completion								
ii) Completion within the original allowed cost								
iii) Quality Performance								

g) How would you rate the contributions made by (a) to (f) above to project performance in percentages OR rank/rate the contributions made by the indicators of project performance in (a) to (f).

Factor Variable	≤5%	≤10%	≤15%	≤20%	≤30%	≤40%	≤50%	Other % Specify
i) Incorrect labour combination (hrs)								
ii) Incorrect material combination								
iii) Incorrect machine time combination								
iv) Information technology								
v) Technology advancement								
vi) Finance as a construction resource.(credit worthiness)								

PART N: PROJECT INFORMATION STRATEGY

Information Management Strategy in Construction Projects is about the way in which information is stored, retrieved, and passed on from the clients to consultants to contractors, and from sub-contractors to other participants, in the other project environment. It comprises materials, plant, labour and technological data constants; and the exchange of these data between contractors and subcontractors, Contractors and material or plant suppliers; between contractors' regulatory bodies; and sub-contractors and designers.

These information transactions help to facilitate the coordination and timely delivery of the project. The effective management of information resources in construction therefore impacts on both the success of the projects and the overall performance of the individual construction companies.

1. Does your company have a project information management strategy? Please tick [✓]

    Yes [ ] No. [ ]

2. If yes, do you have an information manager? Please tick [✓]

    Yes [ ] No. [ ]

3. If yes, what are the functions of the construction information manager? Please list these functions.

    i) ....
    ii) ....
    iii) ....
    iv) ....
    v) ....
    vi) ....
    vii) ....
    viii) ....
    ix) ....
    x) ....

4.

i) Does your company have any electronic data interchange between a central data centre and itself OR other construction firms internationally?

    Yes [ ] No. [ ]

ii) If yes, where do you apply it in your construction activities?

....

....

iii) Does it make savings in production costs?

    Yes [ ] No. [ ]

iv) If yes, by how much in terms of savings ....%

v) How does electronic data interchange benefit your firm: Rate in a scale of 1, 2, 3, 4 and 5 (Tick).

KEY:-1= Strongly disagree; 2=Disagree; 3=Neutral; 4=Agree; 5=Strongly Agree

a) It helps the administration to better serve the production process (please tick)

    1, 2, 3, 4, 5,
    [ ] [ ] [ ] [ ] [ ]

b) It cuts time and results in optimum order of material quantities (please tick) 1, 2, 3, 4, 5

    [ ] [ ] [ ] [ ] [ ]

c) It supports just-in-time relationships with suppliers that are so important for efficient production (please tick)

    1, 2, 3, 4, 5
    [ ] [ ] [ ] [ ] [ ]

vi) What information do you get from the internet which assists your firm in Resource Optimization (please tick)

a) Labour constants for particular project activities Yes [ ] No [ ]

b) Material constants for construction activities in form of material requirements, machine time constants, and activity duration (Please tick)
Yes [ ] No. [ ]

c) Material waste factors in construction.(Please tick)
Yes [ ] No. [ ]

vii) How does the above information in (i) - (vi), affect the performance of projects which your firm has undertaken in the past in terms of the following indicators set out below (Please tick)

	Indicators of Project Performance	10%	30%	50%	70%	Other % Specify
a)	Cost overruns (performance) [Completion within the contract sum]					
b)	Time performance (Initial time overruns) [Completion within the initial contract period]					
c)	Quality performance (functional use) Good workmanship and the intended use of the project.					
d)	Environmental factors and project related factors (i.e. Weather, Money market, Skills of Workers; Managerial effectiveness.)					

PART P: OPTIMIZATION TECHNIQUES IN THE MANUFACTURING INDUSTRY PRODUCTION PROCESS:-

Optimization refers to the act of getting the best results under given circumstances. It is defined as the process of finding the conditions that give the maximum or minimum value of a function. There is no single method available for solving all optimizations problems efficiently.

Hence a number of optimizations problems methods have been developed for solving different types of optimizations problems. These methods comprise the following:-

i) Linear Programming techniques
ii) The transportation Problem techniques
iii) The assignment Problem techniques
iv) Simulations techniques
v) Management games techniques
vi) Critical path methods (CPM) and
vii) Project Evaluation Review Techniques.(PERT)

1) Are you aware of the existence of the above optimization techniques in use in the manufacturing Industry? (Please tick)

Yes [ ] No. [ ]

2) If yes, does your company apply any of them in the construction production process? (Please tick)

Yes [ ] No. [ ]

3) If the answer to question 1 is NO, what are the reasons for not using these techniques?

i) ....
ii) ....
iii) ....
iv) ....
v) ....
vi) ....

4) If the answer to question 2 is YES, why does your company use these techniques?

i) ....
ii) ....
iii) ....
iv) ....
v) ....
vi) ....

5) Do you know how to apply the above techniques in construction production process? (Please tick)

Yes [ ] No. [ ]

6) If no, would you like to be trained on how to apply or use them in the construction production process. (Please tick)

Yes [ ] No. [ ]

7) If the answer to question No. 6 is yes, what are the benefits of using these techniques in the construction production process?

i) ....
ii) ....
iii) ....
iv) ....
v) ....
vi) ....

8) If the answer to question 6 is NO, what are the reasons for not wanting to use these optimization techniques?

i) ....
ii) ....
iii) ....
iv) ....
v) ....

PART Q: APPLICATIONS OF (J.I.T.) JUST –IN –TIME PHILOSOPHY IN CONSTRUCTION PRODUCTION PROCESS

JIT philosophy refers to an integrated set of activities designed to achieve high volume production using minimum inventories of raw materials, work in progress, and finished goods. Parts arrive at the next work station "just in time" and are completed and move through the operation quickly. It is also based on the logic that nothing will be produced until it is needed , and need is created by the actual demand of the product when an item is sold in the market.

It is a philosophy of operational management that seeks to eliminate waste in all aspects of firm's production activities; human relations; vendor relations; technology and the management of materials and inventories.

Wastes to be eliminated comprises:-

i) Waste from over production
ii) Waste of waiting time
iii) Transportation waste
iv) Inventory waste
v) Waste of motion
vi) Waste from product defects.

1. Is your firm aware of JIT philosophy in the construction production process? (Please tick)

   Yes [ ] No. [ ]

2. If yes, does your firm apply it in the construction process? (Please tick)

   Yes [ ] No. [ ]

3. If yes, why does your company apply it? Give reasons

   i) ....
   ii) ....
   iii) ....
   iv) ....
   v) ....
   vi) ....

4. How does your company apply this system (J.I.T)?

   i) ....
   ii) ....
   iii) ....
   iv) ....
   v) ....
   vi) ....

5. If the answer to questions No. 1 is NO, would your firm or you be willing to learn more about it? (Please tick)

   Yes [ ] No. [ ]

6. If NO, give reasons: If YES, proceed to question No. 7

   i) ....
   ii) ....
   iii) ....
   iv) ....
   v) ....
   vi) ....

7. Give reasons as to why you or your firm would not be willing to learn more about it

   i) ....
   ii) ....
   iii) ....

iv) ....

v) ....

vi) ....

APPENDIX B:

THE EFFECT OF EDUCATION TRAINING ON PROJECT RESOURCE MIX BY CONSRUCTION FIRMS.

African-Graduates

Statistics

		Incorect labour mix	Incorect material mix	Incorect machine time mix combination	Information technology	Technology advancement	Finance Resource credit worthnes
N	Valid	23	23	23	23	23	23
	Missing	0	0	0	0	0	0
Mean		20.87	28.48	23.26	22.83	29.57	36.30
Std. Deviation		9.49	12.38	8.87	11.26	15.22	14.79
Variance		90.12	153.26	78.66	126.88	231.62	218.68

Citizen-Graduates

Statistics

		Incorect labour mix	Incorect material mix	Incorect machine time mix combination	Information technology	Technology advancement	Finance Resource credit worthnes
N	Valid	11	11	11	11	11	11
	Missing	0	0	0	0	0	0
Mean		18.64	18.64	17.27	20.91	20.91	27.27
Std. Deviation		8.97	8.09	8.47	10.44	9.95	13.30
Variance		80.45	65.45	71.82	109.09	99.09	176.82

Non-cit graduates

Statistics

		Incorect labour mix	Incorect material mix	Incorect machine time mix combination	Information technology	Technology advancement	Finance Resource credit worthnes
N	Valid	43	43	43	43	43	43
	Missing	0	0	0	0	0	0
Mean		23.95	25.47	22.67	26.16	26.98	33.60
Std. Deviation		9.73	11.06	8.33	10.34	11.03	14.36
Variance		94.71	122.40	69.46	106.95	121.59	206.34

African-non graduates

Statistics

		Incorect labour mix	Incorect Material4 mi:	Incorect machine time mix combination	Information technology	Technology advancement	Finance Resource credit worthnes
N	Valid	47	47	47	47	47	47
	Missing	0	0	0	0	0	0
Mean		20.39	21.97	21.05	21.84	23.29	26.45
Std. Deviation		8.96	10.17	9.02	10.23	12.04	13.55
Variance		80.25	103.43	81.29	104.62	144.97	183.66

Citizen-Non graduates

Statistics

		Incorect labour mix	Incorect material mix	Incorect machine time mix combination	Information technology	Technology advancement	Finance Resource credit worthnes
N	Valid	45	45	45	45	45	45
	Missing	0	0	0	0	0	0
Mean		21.62	22.22	21.44	21.89	31.22	32.44
Std. Deviation		10.65	10.31	8.77	10.68	13.32	16.08
Variance		113.42	106.31	76.84	113.96	177.45	258.66

Non -citi-Nongraduates

Statistics

		Incorect labour mix	Incorect material mix	Incorect machine time mix combination	Information technology	Technology advancement	Finance Resource credit worthnes
N	Valid	37	37	37	37	37	37
	Missing	0	0	0	0	0	0
Mean		12.19	24.46	23.65	22.70	24.73	25.27
Std. Deviation		8.30	10.59	9.25	7.87	10.40	12.91
Variance		68.94	112.20	85.62	61.94	108.26	166.59

APPENDIX C:

RESOURCE MIX PRACTICES BY CONSTRUCTION FIRMS.

6.4: The effect of education levels on resource mix in Ordinary ground hand excavation and Earthworks construction related activities by construction firms in Kenya

[Where A = African Firms, C = Citizen Firms, N = Non-citizen Firms; G= Graduate; NG= Nongraduates]

$$s = \sqrt{\frac{\sum (X - \bar{X})^2}{n-1}}$$ = sample standard deviation.

$$Z = \frac{\bar{X} - \mu o}{s / \sqrt{n}} \quad \text{or} \quad t = \frac{\bar{X} - \mu o}{s / \sqrt{n}}$$

activity: Excavations and Earthworks

	Activity	Sample Size (n)		μ_o	$\bar{X}$	S	$\delta_{\bar{X}} = \frac{s}{\sqrt{n}}$	Critical (e) $Z_{0.025}$ $t_{0.025}$	Critical (e) $Z_{0.005}$ $t_{0.005}$	Actual Z_a t_a	DECISION : TWO TAILED TEST $Z_e > Z_a$: Accept H_0: Reject H_a $Z_a < Z_e$: Confidence 95%	Confidence 99%
1	Excavate to Reduce levels (Hrs/m³)	A	G=23	2.50	2.82	1.55	0.32	2.074	2.819	1.00	Accept Ho RejectHA95%	Accept Ho Reject HA 99%
			NG=47	"	2.73	1.45	0.21	1.96	2.54	1.10	"	"
		C	G=11	"	2.89	0.81	0.24	2.28	3.16	1.65	"	"
			NG=45	"	2.65	1.38	0.21	1.96	2.57	0.71	"	"
		N	G=43	"	2.55	1.07	0.16	"	"	0.31	"	"
			NG=37	"	3.08	1.23	0.20	"	"	2.90	Reject Ho Accept HA 95%	Reject Ho Accept HA 99%
2	Ditto basement ≤1.50m (Hrs/m³)	A	G=23	2.75	3.94	1.73	0.36	2.074	2.819	3.31	"	"
			NG=47	"	3.90	1.78	0.26	1.96	2.57	4.42	"	"
		C	G=11	"	4.30	1.47	0.44	2.28	3.16	3.52	"	"
			NG=45	"	3.72	1.64	0.24	1.96	2.57	4.04	"	"
		N	G=43	"	3.76	1.36	0.21	"	"	4.81	"	"
			NG=37	"	3.93	1.30	0.21	"	"	5.62	"	"
3	Ditto 1.50m-3.0m (Hrs/m³)	A	G=23	3.00	5.45	2.17	0.45	2.074	2.819	5.44	"	"
			NG=47	"	5.33	1.74	0.25	1.96	2.57	9.32	"	"
		C	G=11	"	6.03	1.74	0.52	2.28	3.16	5.83	"	"
			NG=45	"	5.08	1.82	0.27	1.96	2.57	7.70	"	"
		N	G=43	"	5.23	1.39	0.21	"	"	10.62	"	"
			NG=37	"	5.66	1.31	0.22	"	"	12.09	"	"
4	Ditto 3.0m-4.50m (Hrs/m³)	A	G=23	4.50	6.35	2.82	0.59	2.074	2.819	3.14	"	"
			NG=47	"	6.38	1.85	0.27	1.96	2.57	6.96	"	"
		C	G=11	"	6.75	1.01	0.30	2.28	3.16	7.50	"	"
			NG=45	"	6.46	1.83	0.27	1.96	2.57	7.26	"	"
		N	G=43	"	6.04	1.36	0.21	"	"	7.33	"	"
			NG=37	"	6.71	1.81	0.30	"	"	7.37	"	"
5	Ditto 4.50-6.0m (Hrs/m³)	A	G=23	6.00	7.90	4.33	0.90	2.074	2.819	2.11	"	Accept Ho, Reject HA
			NG=47	"	7.88	2.43	0.35	1.96	2.57	5.37	"	Reject Ho, Accept HA
		C	G=11	"	8.57	1.80	0.54	2.28	3.16	4.76	"	"
			NG=45	"	8.02	2.16	0.32	1.96	2.57	6.31	"	"
		N	G=43	"	7.30	1.72	0.26	"	"	5.00	"	"
			NG=37	"	7.80	2.58	0.42	"	"	4.29	"	"
6	Excavate 150 mm top soil wheel & deposit 100mm away 1No. Labourer (Hrs/M³)	A	G=23	2.00	2.34	1.92	0.40	2.074	2.819	0.85	Accept Ho Reject HA 95%	Accept Hp Reject HA 99%
			NG=47	"	2.17	1.28	0.19	1.96	2.57	0.89	"	"
		C	G=11	"	2.30	1.62	0.49	2.28	3.16	0.16	"	"
			NG=45	"	2.11	1.03	0.15	1.96	2.57	0.73	"	"
		N	G=43	"	1.90	0.91	0.14	"	"	-0.71	"	"
			NG=37	"	2.45	1.98	0.33	"	"	1.36	"	"
7	Wheel & deposit surplus spoil 100m away 1No. labourer (Hrs/M³)	A′	G=23	1.00	1.76	1.03	0.21	2.074	2.819	3.62	Reject Ho Accept HA 95%	Reject Hp Accept HA 99%
			NG=47	"	1.53	0.66	0.10	1.96	2.57	5.30	"	"
		C	G=11	"	1.45	0.94	0.28	2.28	3.16	1.61	Accept Ho Reject HA 95%	Accept Ho Reject HA 99%
			NG=45	"	1.78	0.96	0.14	1.96	2.57	5.57	Reject Ho Accept HA 95%	Reject Ho Accept HA 99%
		N	G=43	"	1.50	0.56	0.09	"	"	5.56	"	"
			NG=37	"	1.48	0.77	0.13	"	"	3.69	"	"

All μ_o values 1- 47. Source Smith R. C. (1986) Source: Own Field Survey 2005

Table 6.4: The effect of education levels on resource mix in Ordinary ground hand excavation and Earthworks construction related activities by construction firms in Kenya [Where A = African Firms, C = Citizen Firms, N = Non-citizen Firms; G= Graduate; NG= Nongraduates]

$$s = \sqrt{\frac{\sum (X - \bar{X})^2}{n-1}}$$ = sample standard deviation.

Activity: Excavations and Earthworks

No.	Activity	Sample Size (n)		μ_o	$\bar{X}$	S	$\delta_{\bar{x}} = \frac{s}{\sqrt{n}}$	Critical (e)		Actual Z_e	DECISION : TWO TAILED TEST	
								$Z_{0.025}$ $t_{0.025}$	$Z_{0.005}$ $t_{0.005}$	t_e	$Z_e > Z_a$: Accept H_0; Reject H_a $Z_e < Z_e$:	
											Confidence 95%	Confidence 99%
	Bulkage of excavated materials /M³ (%)	A	G=23	25	24	11.77	2.45	2.074	2.819	-0.41	Accept Ho Reject HA 95%	Accept Ho Reject HA 99%
			NG=47	"	25.35	9.28	1.35	1.96	2.57	0.26	"	"
		C	G=11	"	24.09	7.34	2.21	2.28	3.16	-0.41	"	"
			NG=45	"	23.85	7.78	1.16	1.96	2.57	0.99	"	"
		N	G=43	"	23.21	5.66	0.86	"	"	-2.08	Reject Ho Accept HA 95 %	"
			NG=37	"	21.68	7.46	1.23	"	"	-2.70	"	"
9	Trench excavation ≤ 1.50m (Hrs/M³)	A	G=23	2.50	3.28	2.01	0.42	2.074	2.819	1.86	Accept Ho Reject HA 95%	Accept Ho Reject HA 99%
			NG=47	"	3.05	1.32	0.19	1.96	2.57	2.89	Reject Ho Accept HA 95%	Reject Ho Accept HA 99%
		C	G=11	"	2.88	0.93	0.28	2.28	3.16	1.36	Accept Ho Reject HA 95%	Accept Ho Reject HA 99%
			NG=45	"	3.93	4.35	0.65	1.96	2.57	2.20	Reject Ho Accept HA 95%	"
		N	G=43	"	2.78	1.21	0.18	"	"	1.56	Accept Ho Reject HA 95%	"
			NG=37	"	3.14	1.33	0.22	"	"	2.91	Reject Ho Accept HA 95%	Reject Ho Accept HA 99%
10	Ditto 1.50-3.0m (Hrs/M³)	A	G=23	3.25	4.20	2.36	0.49	2.074	2.819	1.94	Accept Ho Reject HA	Accept ho Reject HA
			NG=47	"	3.86	1.64	0.24	1.96	2.57	2.54	Reject Ho Accept HA	"
		C	G=11	"	3.59	1.08	0.33	2.28	3.16	1.03	Accept Ho Reject HA	"
			NG=45	"	3.91	1.36	0.20	1.96	2.57	3.30	Reject Ho Accept HA	Reject Ho Accept HA
		N	G=43	"	3.88	1.39	0.21	"	"	3.00	Reject Ho Accept HA	Reject Ho Accept HA
			NG=37	"	3.51	1.31	0.22	"	"	1.82	Accept Ho Reject HA	Accept Ho Reject HA
11	Backfill in fdns 1No. labourer (Hrs/m³)	A	G=23	1.50	1.43	0.74	0.15	2.074	2.819	-0.47	Accept Ho Reject HA 95%	Accept Ho Reject HA 99%
			NG=47	"	2.08	1.61	0.23	1.96	2.57	2.52	Reject Ho Accept HA 95%	"
		C	G=11	"	1.64	0.88	0.27	2.28	3.16	0.52	Accept Ho Reject HA 95%	"
			NG=45	"	1.99	1.83	0.27	1.96	2.57	1.81	"	"
		N	G=43	"	1.52	0.77	0.12	"	"	0.17	"	"
			NG=37	"	1.65	0.41	0.07	"	"	2.14	Reject Ho Accept HA 95%	"
12	Disposal of excavated materials: No. of men per 5m³ lorry load	A	G=23	2.0	2.88	1.53	0.32	2.074	2.819	2.75	"	Reject Ho Accept HA 99%
			NG=47	"	3.07	2.06	0.30	1.96	2.57	3.57	"	"
		C	G=11	"	2.09	0.69	0.21	2.28	3.16	0.43	Accept Ho Reject HA 95%	Accept Ho Reject HA 99%
			NG=45	"	1.95	0.74	0.11	1.96	2.57	-0.45	"	"
		N	G=43	"	2.11	0.83	0.13	"	"	0.85	"	"
			NG=37	"	2.18	1.15	0.19	"	"	0.95	"	"

All μ_i values 1- 47. Source Smith R. C. (1986)   Source: Own Field Survey 2005

Table 6.4: The effect of education levels on resource mix in Ordinary ground hand excavation and Earthworks construction related activities by construction firms in Kenya

[Where A = African Firms, C = Citizen Firms, N = Non-citizen Firms; G= Graduate; NG= Nongraduates]

$$s = \sqrt{\frac{\sum (X - \bar{X})^2}{n-1}}$$ = sample standard deviation.

Main activity: Excavations and Earthworks

No.	Activity	Firm	Sample Size (n)	μ_0	$\bar{X}$	S	$\delta_{\bar{x}} = \frac{s}{\sqrt{n}}$	Critical (e) $Z_{0.025}$ $t_{0.025}$	Critical (e) $Z_{0.005}$ $t_{0.005}$	Actual Z_e	DECISION : TWO TAILED TEST ($Z_e > Z_e$: Accept H_0: Reject H_a $Z_e < Z_e$:) Confidence 95%	Confidence 99%
13	Disposal of excavated materials: Time taken by these men to load 5m³ (Hrs)	A	G=23	2.0	1.98	1.00	0.21	2.074	2.819	-0.10	"	"
			NG=47	"	2.90	1.81	0.26	1.96	2.57	3.46	Reject Ho Accept HA 95%	Reject Ho Accept HA 99%
		C	G=11	"	1.86	0.64	0.19	2.28	3.16	-0.74	Accept Ho Reject HA 95%	Accept Ho Reject HA 99%
			NG=45	"	3.01	2.45	0.37	1.96	2.57	2.73	Reject HO Accept HA 95%	Reject Ho Accept HA 99%
		N	G=43	"	1.96	1.03	0.16	"	"	-0.25	Accept Ho Reject HA 95%	Accept Ho Reject HA 99%
			NG=37	"	2.15	1.16	0.19	"	"	0.79	"	"
14	Bulkage of excavated black cotton soil/m³ (%)	A	G=23	35	28.26	7.81	1.63	2.074	2.819	-4.13	Reject Ho Accept HA	Reject Ho Accept HA
			NG=47	"	31.31	8.43	1.23	1.96	2.57	-3.0	"	"
		C	G=11	"	28.36	6.91	2.08	2.28	3.16	-3.19	"	"
			NG=45	"	28.78	8.24	1.23	1.96	2.57	-5.06	"	"
		N	G=43	"	26.53	6.94	1.06	"	"	-7.99	"	"
			NG=37	"	28.0	8.45	1.39	"	"	-5.04	"	"
15	Bulkage ditto red/loam soil/m³ (%)	A	G=23	25	25.17	10.88	2.27	2.074	2.819	0.07	Accept Ho Reject HA	Accept Ho Reject HA
			NG=47	"	22.89	8.13	1.19	1.96	2.57	-1.77	"	"
		C	G=11	"	27.46	19.83	5.98	2.28	3.16	0.41	"	"
			NG=45	"	25.28	6.20	0.92	1.96	2.57	0.30	"	"
		N	G=43	"	25.63	5.66	0.86	"	"	0.73	"	"
			NG=37	"	26.08	5.99	0.98	"	"	1.10	"	"
16	Bulkage of excavated gravel/m³ (%)	A	G=23	10	16.48	9.02	1.88	2.074	2.819	3.45	Reject Ho Accept HA 95%	Reject Ho Accept HA 99%
			NG=47	"	15.58	6.32	0.92	1.96	2.57	6.07	"	"
		C	G=11	"	18.91	3.16	0.95	2.28	3.16	9.38	"	"
			NG=45	"	16.09	7.12	1.06	1.96	2.57	5.75	"	"
		N	G=43	"	15.18	5.66	0.86	"	"	6.02	"	"
			NG=37	"	16.72	6.59	1.08	"	"	6.22	"	"
17	Ditto sand /m³ (%)	A	G=23	12.5	15.61	10.55	2.20	2.074	2.819	1.41	Accept Ho Reject HA 95%	Accept Ho Reject HA 99%
			NG=47	"	15.72	6.32	0.92	1.96	2.57	3.50	Reject Ho Accept HA 95 %	Reject Ho Accept HA 99%
		C	G=11	"	15.45	4.95	1.49	2.28	3.16	1.98	Accept Ho Reject HA 95%	Accept Ho Reject HA 99%
			NG=45	"	14.91	6.69	0.99	1.96	2.57	2.43	Reject Ho Accept HA 95%	"
		N	G=43	"	12.79	5.55	0.85	"	"	0.34	Accept Ho Reject Ha 95 %	"
			NG=37	"	17.35	8.59	1.41	"	"	3.41	Reject Ho Accept HA 95%	Reject HO Accept HA 99%

All μ_0 values 1- 47. Source Smith R. C. (1986)   Source: Own Field Survey 2005

Table 6.4: The effect of education levels on resource mix in Ordinary ground hand excavation and Earthworks construction related activities by construction firms in Kenya

[where A = African Firms, C = Citizen Firms, N = Non-citizen Firms; G= Graduate; NG= Nongraduates]

$$s = \sqrt{\frac{\sum (X - \bar{X})^2}{n-1}}$$ = sample standard deviation.

Main activity: Excavations and Earthworks

	Activity	Sample Size (n)		μ_o	$\bar{X}$	S	$\delta_{\bar{x}} = \frac{s}{\sqrt{n}}$	Critical (e)		Actual Z_e	DECISION : TWO TAILED TEST $Z_e > Z_a$: Accept H_0; Reject H_a $Z_e < Z_a$:	
								$Z_{0.025}$ $t_{0.025}$	$Z_{0.005}$ $t_{0.005}$		Confidence 95%	Confidence 99%
1	Ditto clay M³ (%)	A	G=23	33.33	23.9	8.66	1.81	2.074	2.819	-5.21	"	"
			NG=47	"	27.80	7.91	1.15	1.96	2.57	-4.81	"	"
		C	G=11	"	24.7	9.14	2.76	2.28	3.16	-3.13	"	"
			NG=45	"	26.4	8.75	1.30	1.96	2.57	-5.33	"	"
		N	G=43	"	22.5	8.88	1.35	"	"	-8.02	"	"
			NG=37	"	24.6	9.30	1.53	"	"	-5.82	"	"
9	Ditto murram/m³ (%)	A	G=23	33.33	24.30	11.73	2.45	2.074	2.819	-3.69	"	"
			NG=47	"	26.28	7.85	1.15	1.96	2.57	-6.13	"	"
		C	G=11	"	27.45	9.63	2.90	2.28	3.16	-2.03	Accepted Ho Reject HA	Accept Ho Reject HA
			NG=45	"	26.62	7.84	1.17	1.96	2.57	-5.74	Reject Ho Accept HA	Reject Ho Accept HA
		N	G=43	"	25.42	5.12	0.78	"	"	-10.14	"	"
			NG=37	"	26.44	10.30	1.69	"	"	-4.08	"	"
20	Machine site stripping output/ hr in (M³)	A	G=23	14.0	24.86	44.42	9.26	2.074	2.189	1.17	Accept Ho; 95% Reject Ha	Accept Ho; 99%Reject Ha
			NG=47	"	13.02	20.84	3.04	1.96	2.57	-0.32	"	"
		C	G=11	"	12.2	10.54	3.18	2.28	3.16	-0.57	"	"
			NG=45	"	11.16	8.36	1.25	1.96	2.57	-2.27	"	"
		N	G=43	"	2.55	1.07	0.16	"	"	-71.56	Reject Ho Accept Ha	Reject Ho Accept Ha
			NG=37	"	8.21	3.41	0.56	"	"	-10.34	"	"
21	Reduce levels 1/4m3 Excavator & load into lorries (M³/hr)	A	G=23	15.0	17.34	21.73	4.53	2.074	2.819	0.52	Accept Ho Reject Ha	Accept Ho Reject Ha
			NG=47	"	11.86	19.99	2.92	1.96	2.57	-1.08	"	"
		C	G=11	"	8.40	2.36	0.71	2.28	3.16	-9.30	Reject Ho Accept Ha	Reject Ho Accept Ha
			NG=45	"	9.76	6.39	0.95	1.96	2.57	-5.52	"	"
		N	G=43	"	3.76	1.36	0.21	1.96	2.57	-53.52	"	"
			NG=37	"	8.83	4.26	0.70	1.96	2.57	-8.81	"	"
22	Ditto basement ≤ 1.50m ditto (m³/hr)	A	G=23	15.0	11.98	11.46	2.39	2.074	2.819	-1.26	Accept Ho Reject Ha	Accept Ho Reject Ha
			NG=47	"	1057	17.01	2.48	1.96	2.57	-1.79	"	"
		C	G=11	"	6.59	2.60	0.78	2.28	3.16	-10.78	Reject Ho Accept Ha	Reject Ho Accept Ha
			NG=45	"	8.69	6.21	0.93	1.96	2.57	-6.78	"	"
		N	G=43	"	5.23	1.39	0.21	1.96	2.57	-46.52	"	"
			NG=37	"	7.69	2.96	0.49	1.96	2.57	-14.92	"	"
23	Ditto basement 1.50-3.0 ditto (m³/hr)	A	G=23	15.0	10.68	10.97	2.29	2.074	2.819	-1.89	Accept Ho Reject Ha	Accept Ho Reject Ha
			NG=47	"	9.31	17.01	2.48	1.96	2.57	-2.29	Reject Ho Accept Ha	"
		C	G=11	"	5.59	1.44	0.43	2.28	3.16	-21.88	"	Reject Ho Accept Ha
			NG=45	"	7.80	5.47	0.82	1.96	2.57	-8.78	"	"
		N	G=43	"	6.04	1.36	0.21	1.96	2.57	-42.67	"	"
			NG=37	"	6.57	2.68	0.44	1.96	2.57	-19.16	"	"
24	Ditto 3.0-4.50 m ditto (m³/hr)	A	G=23	15.0	8	6.22	1.30	2.074	2.819	-5.38	"	"
			NG=47	"	8.60	17.13	2.50	1.96	2.57	-2.56	"	Accept Ho Reject Ha
		C	G=11	"	4.73	1.58	0.51	2.28	3.16	-20.14	"	Reject Ho Accept Ha
			NG=45	"	7.20	5.04	0.75	1.96	2.57	-10.40	"	"
		N	G=43	"	7.30	1.72	0.26	1.96	2.57	-29.62	"	"
			NG=37	"	5.61	3.15	0.52	1.96	2.57	-18.06	"	"

Values of μo : Source Smith R.C. (1986) Source: Field Survey 2005

Table 6.4: The effect of education levels on resource mix in Ordinary ground machine excavation and Earthworks construction related activities by construction firms in Kenya

[Where A = African Firms, C = Citizen Firms, N = Non-citizen Firms; G= Graduate; NG= Nongraduates]

$$s = \sqrt{\frac{\sum (X - \bar{X})^2}{n-1}}$$ = sample standard deviation.

Main activity: Excavations and Earthworks

No.	Activity	Sample Size (n)		μ_o	$\bar{X}$	S	$\delta_{\bar{x}} = \frac{s}{\sqrt{n}}$	Critical (e)		Actual Z_a	DECISION : TWO TAILED TEST	
								$Z_{0.025}$ $t_{0.025}$	$Z_{0.005}$ $t_{0.005}$	t_a	$Z_e > Z_a$: Accept H_0; Reject H_a $Z_e < Z_a$	
											Confidence 95%	Confidence 99%
25	Ditto basement 4.50-6.0m ditto (M³/hr)	A	G=23	15.0	6.11	5.88	1.23	2.074	2.819	-7.23	Reject Ho; Accept HA 95%	Reject Accept 99%
			NG=47	"	7.62	17.23	2.51	1.96	2.57	-2.94	"	"
		C	G=11	"	3.91	1.22	0.37	2.28	3.16	-29.97	"	"
			NG=45	"	6.60	4.95	0.74	1.96	2.57	-11.35	"	"
		N	G=43	"	1.92	0.90	0.14	1.96	2.57	-93.43	"	"
			NG=37	"	4.99	3.27	0.54	1.96	2.57	-18.53	"	"
26	Excavate tfdn trench ≤50m; ¼ m³ Excavator and load into lorries (M³/hr)	A	G=23	11.00	9.77	11.43	2.38	2.074	2.819	-0.52	Accept Ho; Reject HA	Accept Ho/ Reject Ha
			NG=47	"	6.07	3.56	0.52	1.96	2.57	-9.48	Reject Ho; Reject Ha;	Reject Ho/ Accept Ha
		C	G=11	"	5.59	2.33	0.70	2.28	2.57	-7.73	"	"
			NG=45	"	6.31	4.30	0.64	1.96	3.16	-7.33	"	"
		N	G=43	"	1.50	0.57	0.09	1.96	2.57	-105.57	"	"
			NG=37	"	5.14	1.44	0.24	1.96	2.57	-24.42	"	"
27	Ditto 1.50-3.0m ditto (M³/hr)	A	G=23	11.00	8.34	11.86	2.47	2.074	2.819	-1.08	Accept Ho; Reject HA	Accept Ho/ Reject Ha
			NG=47	"	4.99	3.23	0.47	1.96	2.57	-12.79	Reject Ho; Reject Ha	Reject Ho/ Accept Ha
		C	G=11	"	3.77	1.71	0.52	2.28	3.16	-13.90	"	"
			NG=45	"	5.23	4.29	0.64	1.96	2.57	-9.02	"	"
		N	G=43	"	23.2 1	5.66	0.86	1.96	2.57	14.20	Reject Ho; Accept Ha 95%	Reject Ho; Accept Ha 99%
			NG=37	"	3.76	1.66	0.27	1.96	2.57	-26.81	"	"
28	Ditto pits ≤ 1.50m ditto (M³/hr)	A	G=23	8.00	7.75	7.79	1.62	2.074	2.819	-0.15	Accept Ho/ Reject Ha	Accept Ho/ Reject Ha
			NG=47	"	4.73	2.53	0.37	1.96	2.57	-8.84	Reject Ho/Accept Ha	Accept Ha
		C	G=11	"	4.55	2.08	0.63	2.28	3.16	-5.48	"	"
			NG=45	"	6.05	6.31	0.94	1.96	2.57	-2.07	Reject Ho/Accept Ha	Accept Ho/ Reject Ha
		N	G=43	"	2.78	1.22	0.18	1.96	2.57	-29.0	"	Reject Ho/ Accept Ha
			NG=37	"	4.69	2.38	0.39	1.96	2.57	-8.49	"	"
29	Ditto pits 1.50-3.0m ditto (M³/hr)	A	G=23	8.00	6.59	7.67	1.60	2.074	2.819	-0.88	Accept Ha/ Reject Ha	Accept Ho/ Reject Ha
			NG=47	"	4.29	2.29	0.33	1.96	2.57	-11.24	Reject Ho/ Accept Ha	Accept Ho/ Reject Ha
		C	G=11	"	3.65	1.17	0.35	2.28	3.16	-12.43	"	"
			NG=45	"	5.30	3.03	0.59	1.96	2.57	-4.57	"	"
		N	G=43	"	3.88	1.40	0.21	1.96	2.57	-19.62	"	"
			NG=37	"	4.19	2.47	0.41	1.96	2.57	-9.29	"	"
30	Excavate in plain concrete: compressor (Hours/m³)	A	G=23	1.50	3.5	1.60	0.35	2.074	2.819	5.71	Reject Ho; Accept Ha	Reject Ho; Accept Ha
			NG=47	"	3.49	1.32	0.19	1.96	2.57	10.47	"	"
		C	G=11	"	3.27	1.56	0.47	2.28	3.16	3.77	"	"
			NG=45	"	3.92	1.17	0.17	1.96	2.57	14.24	"	"
		N	G=43	"	3.96	1.71	0.26	"	"	9.46	"	"
			NG=37	"	3.84	1.28	0.21	"	"	11.14	"	"

All μ_o values 1- 47. Source Smith R. C. (1986)   Source: Own Field Survey 2005

Table 6.4: The effect of education levels on resource mix in non-ordinary ground machine excavation and Earthworks construction related activities by construction firms in Kenya

[where A = African Firms, C = Citizen Firms, N = Non-citizen Firms; G= Graduate; NG= Nongraduates]

$$s = \sqrt{\frac{\sum (X - \bar{X})^2}{n-1}}$$ = sample standard deviation.

Main activity: Excavations and Earthworks

	Activity	Sample Size (n)		μ_o	$\bar{X}$	S	$\delta_{\bar{x}} = \frac{s}{\sqrt{n}}$	Critical (e) $Z_{0.025}$ $t_{0.025}$	Critical (e) $Z_{0.005}$ $t_{0.005}$	Actual Z_a t_a	Decision : TWo Tailed Test $Z_e > Z_a$: Accept H_0; Reject $H_a Z_a < Z_e$: Confidence 95%	Confidence 99%
[illegible]	Ditto R.C. concrete. Compressor (Hours/ m³)	A	G=23	3.60	5.39	2.44	0.51	2.074	2.819	3.51	"	"
			NG=47	"	5.25	1.53	0.22	1.96	2.57	7.50	"	"
		C	G=11	"	4.91	1.45	0.44	2.28	3.16	2.98	"	Accept Ho; Reject Ha;
			NG=45	"	5.91	1.53	0.23	1.96	2.57	10.04	"	Reject Ho; Accept Ha 99%
		N	G=43	"	5.59	1.76	0.27	"	"	7.37	"	"
			NG=37	"	5.45	1.21	0.20	"	"	9.25	"	"
32	Ditto Hard Rock compressor (Hours/ m³)	A	G=23	2.90	6.74	3.70	0.77	2.074	2.819	4.99	"	"
			NG=47	"	6.36	1.66	0.24	1.96	2.57	14.42	"	"
		C	G=11	"	6.18	1.73	0.52	2.28	3.16	6.31	"	"
			NG=45	"	6.85	1.69	0.25	1.96	2.57	15.80	"	"
		N	G=43	"	6.83	2.26	0.35	"	"	11.23	"	"
			NG=37	"	6.73	1.46	0.24	"	"	15.96	"	"
33	Compressor outlets (No)	A	G=23	1	2	0.21	0.04	2.074	2.819	25.0	"	"
			NG=47	"	2	0.44	0.06	1.96	2.57	16.67	"	"
		C	G=11	"	2	0.31	0.09	2.28	3.16	11.11	"	"
			NG=45	"	2	0.29	0.04	1.96	2.57	25.00	"	"
		N	G=43	"	2	0.15	0.02	"	"	50.0	"	"
			NG=37	"	2	0	0	"	"	α	"	"
34	Operator required for the compressor (No) men	A	G=23	1	2	0.96	0.20	2.074	2.819	5.00	Reject Ho; Accept HA	Reject Ho; Accept Ha 99%
			NG=47	"	2	0.49	0.07	1.96	2.57	14.29	"	"
		C	G=11	"	2	0.52	0.16	2.28	3.16	6.25	"	"
			NG=45	"	2	0.54	0.08	1.96	2.57	12.50	"	"
		N	G=43	"	2	0.39	0.06	1.96	2.57	16.67	"	"
			NG=37	"	2	0.36	0.06	1.96	2.57	16.67	"	"
35	Labourers working with the operators (No) Men	A	G=23	1	3	1.37	0.29	2.074	2.819	6.90	"	"
			NG=47	"	3	0.93	0.14	1.96	2.57	14.29	"	"
		C	G=11	"	2	0.63	0.19	2.28	3.16	5.26	"	"
			NG=45	"	3	1.41	0.21	1.96	2.57	9.52	"	"
		N	G=43	"	2	0.34	0.05	1.96	2.57	20.00	"	"
			NG=37	"	2	0.91	0.15	1.96	2.57	6.67	"	"
36	Plain concrete in trenches compressors (Hrs/m³)	A	G=23	2.90	5.01	2.43	0.51	2.074	2.819	4.14	"	"
			NG=47	2.90	4.88	1.77	0.26	1.96	2.57	7.62	"	"
		C	G=11	2.90	4.34	1.76	0.53	2.28	3.16	2.72	"	Accept Ho; Reject Ha;
			NG=45	2.90	5.18	1.60	0.24	1.96	2.57	9.50	"	Reject Ho; Accept Ha
		N	G=43	2.90	4.87	1.70	0.26	1.96	2.57	7.58	"	"
			NG=37	2.90	5.45	1.88	0.31	1.96	2.57	8.23	"	"
37	R.C. concrete Exc. Ditto trenches (Hrs/m³)	A	G=23	7.20	6.42	3.11	0.65	2.074	2.819	-1.20	Accept Ho; Reject Ha;	Accept Ho; Reject Ha 99%
			NG=47	7.20	6.19	1.88	0.27	1.96	2.57	-3.74	Reject Ho/Accept Ha	Reject Ho/Accept Ha
		C	G=11	7.20	5.38	1.96	0.59	2.28	3.16	-3.08	"	"
			NG=45	7.20	6.90	1.74	0.26	1.96	2.57	-1.15	Accept Ho; Reject Ha;	Accept Ho; Reject Ha
		N	G=43	7.20	6.18	1.93	0.29	1.96	2.57	-3.52	Reject Ho/Accept Ha	Reject Ho/ Accept Ho
			NG=37	7.20	6.71	1.73	0.28	1.96	2.57	-1.75	Accept Ho/ Reject Ha	Accept Ho/ Reject Ha

[illegible] 6.4: The effect of education levels on resource mix in excavation and Earthworks construction related activities by construction firms in [illegible]
[Where A = African Firms, C = Citizen Firms, N = Non-citizen Firms; G= Graduate; NG= Nongraduates]

$$s = \sqrt{\frac{\sum (X - \bar{X})^2}{n-1}}$$ = sample standard deviation.

[illegible] activity: Excavations and Earthworks

	Activity	Sample Size (n)		μ_o	$\bar{X}$	S	$\delta_{\bar{x}} = \frac{s}{\sqrt{n}}$	Critical (e)		Actual Z_e	Decision : TWo Tailed Test $Z_t > Z_e$: Accept H_0; Reject H_a $Z_e < Z_t$:	
								$Z_{0.025}$ $t_{0.025}$	$Z_{0.005}$ $t_{0.005}$		Confidence 95%	Confidence 99%
3[illegible]	Hard rock Exc. In trenches compressors: (Hrs/m³)	A	G=23	5.90	7.40	4.38	0.91	2.074	2.819	1.65	Accept Ho/ Reject Ha 95%	Accept Ho/ Reject Ha 99%
			NG=47	"	7.46	2.45	0.36	1.96	2.57	4.33	Reject Ho Accept Ha	Reject Ho Accept Ha 99%
		C	G=11	"	6.50	2.51	0.76	2.28	3.16	0.79	Accept Ho/ Reject Ha	Accept Ho/ Reject Ha 99%
			NG=45	"	8.01	2.48	0.37	1.96	2.57	5.70	"	"
		N	G=43	"	7.48	2.46	0.38	1.96	2.57	4.16	"	"
			NG=37	"	7.98	2.19	0.36	1.96	2.57	5.78	"	"
3[illegible]	Compressor outlets (No) Trench	A	G=23	1	2	0.20	0.04	2.074	2.819	23.98	"	"
			NG=47	"	2	0.49	0.07	1.96	2.57	13.99	"	"
		C	G=11	"	2	0	0	2.28	3.16	α	"	"
			NG=45	"	2	0.34	0.05	1.96	2.57	19.73	"	"
		N	G=43	"	2	0.15	0.02	1.96	2.57	50.00	"	"
			NG=37	"	2	0	0	1.96	2.57	α	"	"
4[illegible]	Operators required: Compressor (Trench) (No) men	A	G=23	1	2	1.19	0.25	2.074	2.819	4.00	"	"
			NG=47	"	2	0.77	0.11	1.96	2.57	9.09	"	"
		C	G=11	"	2	0.85	0.26	2.28	3.16	3.85	"	"
			NG=45	"	2	0.41	0.06	1.96	2.57	16.67	"	"
		N	G=43	"	2	0.34	0.05	1.96	2.57	20.00	"	"
			NG=37	"	2	0.82	0.13	1.96	2.57	7.69	"	"
41	Labourers working with operators (Trench) (No) men	A	G=23	1	2	1.34	0.28	2.074	2.819	3.57	"	"
			NG=47	"	2	1.02	0.15	1.96	2.57	6.67	"	"
		C	G=11	"	2	0.49	0.15	2.28	3.16	6.67	"	"
			NG=45	"	3	1.45	0.22	1.96	2.57	9.09	"	"
		N	G=43	"	2	0.44	0.07	1.96	2.57	14.29	"	"
			NG=37	"	2	0.79	0.13	1.96	2.57	7.69	"	"
42	Bulk hard core ≤ 300mm thick (Hrs/m³)	A	G=23	1.20	2.24	1.62	0.34	2.074	2.819	3.06	Reject Ho; Accept Ha;	Reject Ho; Accept Ha
			NG=47	"	2.60	1.25	0.18	1.96	2.57	7.78	"	"
		C	G=11	"	2.43	2.00	0.60	2.28	3.16	2.05	Accept Ho; Reject Ha;	Accept Ho; Reject Ha
			NG=45	"	3.19	1.86	0.28	1.96	2.57	7.11	Reject Ho; Accept Ha;	Reject Ho; Accept Ha;
		N	G=43	"	2.72	1.63	0.25	"	"	6.08	"	"
			NG=37	"	2.71	1.57	0.26	"	"	5.81	"	"
43	Ditto> 300mm thick (Hrs/m³)	A	G=23	1.20	2.58	1.57	0.33	2.074	2.819	4.18	"	"
			NG=47	"	3.31	1.34	0.20	1.96	2.57	10.55	"	"
		C	G=11	"	2.55	1.50	0.45	2.28	3.16	3.00	"	Accept Ho; Reject Ha;
			NG=45	"	3.83	1.67	0.25	1.96	2.57	10.52	"	Reject Ho; Accept Ha;
		N	G=43	"	3.09	1.36	0.21	"	"	9.00	"	"
			NG=37	"	3.46	1.63	0.27	"	"	8.37	"	"

Values of μo; Source R.C. Smith (1986) ;
Sources: Field survey 2005

... 6.4: The effect of education levels on resource mix in excavation and Earthworks construction related activities by construction firms in [illegible]

... A = African Firms, C = Citizen Firms, N = Non-citizen Firms; G= Graduate; NG= Nongraduates]

$$s = \sqrt{\frac{\sum (X - \bar{X})^2}{n-1}}$$ = sample standard deviation.

	Activity	Sample Size (n)		μ_o	$\bar{X}$	S	$\delta_{\bar{x}} = \frac{s}{\sqrt{n}}$	Critical (e)		Actual Z_e	DECISION : TWO TAILED TEST	
								$Z_{0.025}$ $t_{0.025}$	$Z_{0.005}$ $t_{0.005}$	t_α	$Z_\alpha > Z_e$: Accept H_0: Reject H_a $Z_e < Z_\alpha$:	
											Confidence 95%	Confidence 99%
	Hard core compaction roller ≤ 5 tonnes (Hrs/m³)	A	G=23	1.60	1.10	1.48	0.31	2.074	2.819	-1.61	Accept Ho; Reject Ha; 95%	Accept Ho; Reject Ha; 99%
			NG=47	"	0.72	0.82	0.12	1.96	2.57	-7.33	Reject Ho/ Accept Ha	Reject Ho/ Accept Ha
		C	G=11	"	0.81	0.49	0.15	2.28	3.16	-5.27	Reject Ho/ Accept Ha	"
			NG=45	"	0.63	0.70	0.10	1.96	2.57	-9.70	Reject Ho/ Accept Ha	"
		N	G=43	"	0.82	0.48	0.07	"	"	-11.14	Reject Ho/ Accept Ha	"
			NG=37	"	0.86	0.83	0.14	"	"	-5.29	Reject Ho/ Accept Ha 95%	Accept Ho; Reject Ha; 99%
45	Hard core compaction roller > 10 tonnes (Hrs/m³)	A	G=23	0.08	1.46	2.49	0.52	2.074	2.819	2.65	"	Reject Ho; Accept Ha 99%
			NG=47	"	0.56	0.93	0.14	1.96	2.57	3.43	"	"
		C	G=11	"	0.51	0.40	0.12	2.28	3.16	3.58	"	Accept Ho; Reject Ha; 99%
			NG=45	"	1.06	3.06	0.46	1.96	2.57	2.13	"	Accept Ho; Reject Ha; 99%
		N	G=43	"	0.79	0.76	0.12	"	"	5.92	"	Reject Ho; Accept Ha 99%
			NG=37	"	0.85	0.93	0.15	"	"	5.13	"	"
46	Hard core consolidation factor/m³ (%)	A	G=23	25	19.84	13.73	2.86	2.074	2.819	-1.80	Accept Ho; Reject Ha 95%	Accept Ho; Reject Ha 99%
			NG=47	"	19.35	8.43	1.23	1.96	2.57	-4.59	Reject Ho/ Accept Ha	Reject Ho/Accept Ha 99%
		C	G=11	"	23.64	20.19	6.09	2.28	3.16	-0.22	Accept Ho/ Reject Ha	Accept Ho/ Reject Ha
			NG=45	"	20.59	9.45	1.41	1.96	2.57	-3.13	Reject Ho/ Accept Ha	Reject Ho/ Accept Ha
		N	G=43	"	19.61	6.89	1.05	"	"	-5.13	"	"
			NG=37	"	20.32	7.89	1.30	"	"	-0.36	Accept Ho/ Reject Ha	Accept Ho/ Reject Ha
47	Density of hardcore per m³ (Tonnes)	A	G=23	1.60	1.71	0.37	0.08	2.074	2.819	1.38	"	"
			NG=47	"	1.52	0.32	0.05	1.96	2.57	-1.60	"	"
		C	G=11	"	1.54	0.31	0.09	2.28	3.16	-0.67	"	"
			NG=45	"	1.75	0.46	0.07	1.96	2.57	2.14	Reject Ho' Accept Ha 95%	"
		N	G=43	"	1.72	0.34	0.05	"	"	2.40	"	"
			NG=37	"	1.75	0.60	0.10	"	"	1.50	Accept Ho; Reject Ha; 95%	"

Values of μo: Source; R-C. Smith (1986)
Source: Field Survey 2005

INSITU CONCRETE WORK (MIXING ON SITE

$$Z = \frac{\bar{X} - \mu o}{s / \sqrt{n}} \text{ or } t = \frac{\bar{X} - \mu o}{s / \sqrt{n}} \quad ; n < 30$$

Table 6.5: The effect of education levels on resource mix in Site Mixed Insitu Concreting and its related construction activities by construction firms in Kenya [Where A = African Firms, C = Citizen Firms, N = Non-citizen Firms; G= Graduate; NG= Nongraduates]

$$s = \sqrt{\frac{\sum (X - \bar{X})^2}{n-1}} = \text{sample standard deviation.}$$

	Activity	Sample Size (n)		μ_o	$\bar{X}$	S	$\delta_{\bar{x}} = \frac{s}{\sqrt{n}}$	Critical (e)		Actual Z_a	DECISION : TWO TAILED TEST	
								$Z_{0.025}$ $t_{0.025}$	$Z_{0.005}$ $t_{0.005}$	t_a	$Z_e > Z_a$: Accept H_0: Reject H_a $Z_e < Z_a$:	
											Confidence 95%	Confidence 99%
1	Materials: Concrete mix (1:4:8) Cement in (Bags)/M³	A	G=23	3.60	2.96	0.78	0.16	2.074	2.819	-4.0	Reject Ho at 95% Accept Ha	Reject Ho at 99% Accept Ha
			NG=47	"	3.28	0.61	0.09	1.96	2.57	-3.56	"	"
		C	G=11	"	2.95	0.69	0.21	2.28	3.16	-3.10	"	"
			NG=45	"	3.38	1.06	0.16	1.96	2.57	-1.38	Accept Ho; Reject Ha	Accept Ho; Reject Ha
		N	G=43	"	2.86	0.89	0.14	1.96	2.57	-5.29	Reject Ho Accept Ha	Reject Ho; Accept Ha
			NG=37	"	3.36	0.83	0.14	1.96	2.57	-1.71	Accept Ho; Reject Ha	Accept Ho; Reject Ha
2	Materials: Concrete mix (1:4:8) Sand in Tonnes/M³	A	G=23	0.72	0.71	0.10	0.21	2.074	2.819	-0.05	"	"
			NG=47	"	0.69	0.12	0.02	1.96	2.57	-1.50	"	"
		C	G=11	0.72	0.70	0.05	0.02	2.28	3.16	-1.0	"	"
			NG=45	"	0.75	0.10	0.01	1.96	2.57	3.00	Reject Ho, Accept Ha	Reject Ho; Accept Ha
		N	G=43	"	0.76	0.08	0.01	1.96	2.57	4.00	"	"
			NG=37	"	0.72	0.15	0.02	1.96	2.57	0.00	Accept Ho; Reject Ha	Accept Ho; Reject Ha
3	Materials: Concrete (1:4:8) Ballast in Tonnes/M³	A	G=23	1.43	1.26	0.18	0.04	2.074	2.819	-4.25	Reject Ho, Accept Ha	Reject Ho; Accept Ha
			NG=47	1.43	1.29	0.13	0.02	1.96	2.57	-7.00	"	"
		C	G=11	1.43	1.36	0.20	0.06	2.28	3.16	-1.17	Accept Ho; Reject Ha	Accept Ho; Reject Ha
			NG=45	1.43	1.35	0.13	0.02	1.96	2.57	-4.00	Reject Ho, Accept Ha	Reject Ho; Accept Ha
		N	G=43	1.43	1.38	0.17	0.03	1.96	2.57	-1.67	Accept Ho; Reject Ha	Accept Ho; Reject Ha
			NG=37	1.43	1.36	0.12	0.02	1.96	2.57	-3.50	Reject Ho, Accept Ha	Reject Ho; Accept Ha
4	Water cement ratio: Litres/Bags of Cement	A	G=23	0.80	0.64	0.09	0.02	2.074	2.819	-8.0	"	"
			NG=47	0.80	0.70	0.36	0.05	1.96	2.57	-2.0	"	Accept Ho; Reject Ha
		C	G=11	0.80	0.64	0.17	0.05	2.28	3.16	-3.20	"	Reject Ho; Accept Ha
			NG=45	0.80	1.23	3.71	0.55	1.96	2.57	0.78	Accept Ho; Reject Ha	Accept Ho; Reject Ha
		N	G=43	0.80	0.69	0.12	0.02	1.96	2.57	-5.50	Reject Ho, Accept Ha	Reject Ho; Accept Ha
			NG=37	0.80	0.68	0.08	0.01	1.96	2.57	-12.0	"	"
5	Materials/ M³ Cement (bags) Concrete mix (1:3:6)	A	G=23	4.54	3.81	0.85	0.18	2.074	2.819	-4.06	"	"
			NG=47	"	4.11	0.63	0.09	1.96	2.57	-4.78	"	"
		C	G=11	"	4.10	0.65	0.20	2.28	3.16	-2.20	Accept Ho; Reject Ha	Accept Ho; Reject Ha
			NG=45	"	4.16	0.73	0.11	1.96	2.57	-3.46	Reject Ho, Accept Ha	Reject Ho; Accept Ha
		N	G=43	"	3.78	1.11	0.17	1.96	2.57	-4.47	"	"
			NG=37	"	4.20	0.98	0.16	1.96	2.57	-2.13	"	Accept Ho; Reject Ha,

All μ_o-values Source: (1-20) Spence Geddes: (1976) Source: Field Survey 2005

Table 6.5:. The effect of education levels on resource mix in Site Mixed Insitu Concreting and its related construction activities by construction firms in Kenya [Where A = African Firms, C = Citizen Firms, N = Non-citizen Firms; G= Graduate; NG= Nongraduates]

$$s = \sqrt{\frac{\sum (X - \bar{X})^2}{n-1}}$$ = sample standard deviation.

Main activity: Insitu Concrete Work (Mixing on Site)

	Activity	Sample Size (n)		μ_o	$\bar{X}$	S	$\delta_{\bar{x}} = \frac{s}{\sqrt{n}}$	Critical (e) $Z_{0.025}$ t0.025	Critical (e) $Z_{0.005}$ t0.005	Actual Z_e	DECISION : TWO TAILED TEST $Z_e > Z_e$: Accept H_0; Reject $H_a Z_e < Z_e$: Confidence 95%	Confidence 99%
6	Concrete mix (1:3:6) Materials: sand in Tonnes/M³	A	G=23	0.68	0.67	0.07	0.01	2.074	2.819	-1.00	Accept Ho' Reject Ha 95%	Accept Ho; Reject Ha; 99%
			NG=47	"	0.68	0.10	0.01	1.96	2.57	0.00	"	"
		C	G=11	"	0.68	0.04	0.01	2.28	3.16	0.00	"	"
			NG=45	"	0.69	0.12	0.02	1.96	2.57	0.50	"	"
		N	G=43	"	0.71	0.08	0.01	"	"	3.00	Reject Ho; Accept Ha	Reject Ho; Accept Ha;
			NG=37	"	0.70	0.08	0.01	"	"	2.00	"	
7	Concrete mix (1:3:6) Materials: Ballast in Tonnes/M³	A	G=23	1.36	1.23	0.23	0.05	2.074	2.819	-2.60	"	
			NG=47	"	1.28	0.12	0.02	1.96	2.57	-4.00	"	
		C	G=11	"	1.29	0.22	0.07	2.28	3.16	-1.00	Accept Ho; Reject Ha	Accept Ho Reject Ha
			NG=45	"	1.33	0.11	0.02	1.96	2.57	-1.50	"	"
		N	G=43	"	1.33	0.14	0.02	"	"	-1.50	"	"
			NG=37	"	1.31	0.09	0.01	"	"	-5.0	Reject Ha Accept Ha	Reject Ho Accept Ha
8	Water cement Ratio: Litres/Bag of cement	A	G=23	0.75	0.65	0.11	0.02	2.074	2.819	-5.0	"	"
			NG=47	"	0.65	0.10	0.01	1.96	2.57	-10.0	"	"
		C	G=11	"	0.65	0.17	0.05	2.28	3.16	-2.0	Accept Ho; Reject Ha	Accept Ho Reject Ha
			NG=45	"	1.29	17.35	2.59	1.96	2.57	0.21	"	"
		N	G=43	"	0.68	0.12	0.02	"	"	-3.5	Reject Ha Accept Ha	Reject Ho Accept Ha
			NG=37	"	0.68	0.08	0.01	"	"	-7.0	"	"
9	Concrete Mix (1:2:4) materials: cement bags M³	A	G=23	6.40	5.41	1.26	0.26	2.074	2.819	-3.81	"	"
			NG=47	"	5.63	0.86	0.13	1.96	2.57	-5.92	"	"
		C	G=11	"	5.67	0.56	0.17	2.28	3.16	-4.29	"	"
			NG=45	"	5.77	0.83	0.12	1.96	2.57	-5.25	"	"
		N	G=43	"	5.41	1.69	0.26	"	"	-3.81	"	"
			NG=37	"	5.72	0.95	0.16	"	"	-4.25	"	"
10	Concrete Mix (1:2:4) materials: sand in M³	A	G=23	0.64	0.62	0.08	0.02	2.074	2.819	-1.0	Accept Ho; Reject Ha	Accept Ho Reject Ha
			NG=47	"	0.64	0.11	0.02	1.96	2.57	0	"	"
		C	G=11	"	0.66	0.04	0.01	2.28	3.16	2.0	"	"
			NG=45	"	0.66	0.07	0.01	1.96	2.57	2.0	Reject Ho; Accept Ha	"
		N	G=43	"	0.68	0.08	0.01	"	"	4.0	"	Reject Ho Accept Ha'
			NG=37	"	0.67	0.08	0.01	"	"	3.0	"	"
11	Concrete mix (1:2:4) Materials: Ballast in Tonnes/M³	A	G=23	1.28	1.19	0.12	0.03	2.074	2.819	-3.0	Reject Ho; Accept Ha at 95%	Reject Ho; Accept Ha at 99%
			NG=47	"	1.21	0.13	0.02	1.96	2.57	-3.50	"	"
		C	G=11	"	1.2	0.19	0.06	2.28	3.16	-1.33	Accept Ho; Reject Ha	Accept Ho; Reject Ha
			NG=45	"	1.28	0.13	0.02	1.96	2.57	0	"	"
		N	G=43	"	1.26	0.13	0.02	1.96	2.57	-1.00	"	"
			NG=37	"	1.25	0.10	0.02	1.96	2.57	-1.50	"	"

All μ_o-values Source: (1-20) Spence Geddes: (1976) Source: Field Survey 2005

Table 8.6: The effect of education levels on resource mix in Site Mixed Insitu Concreting and its related construction activities by construction firms in Kenya
[where A = African Firms, C = Citizen Firms, N = Non-citizen Firms; G= Graduate; NG= Nongraduates]

$$s = \sqrt{\frac{\sum (X - \bar{X})^2}{n-1}}$$ = sample standard deviation.

Main activity: Insitu Concrete Work (Mixing on Site)

	Activity	Sample Size (n)		μ_0	$\bar{X}$	S	$\delta_{\bar{x}} = \frac{s}{\sqrt{n}}$	Critical (e)		Actual Z_a	DECISION : TWO TAILED TEST	
								$Z_{0.025}$ t0.025	$Z_{0.005}$ t0.005	t	$Z_e > Z_a$: Accept H_0; Reject H_a $Z_e < Z_a$:	
											Confidence 95%	Confidence 99%
12	Water cement Ratio: Litres/bag of cement	A	G=23	0.55	0.59	0.06	0.01	2.074	2.819	4.0	Reject Ho; Accept Ha	Reject Ho; Accept Ha
			NG=47	"	0.60	0.08	0.01	1.96	2.57	5.0	"	"
		C	G=11	"	0.57	0.15	0.05	2.28	3.16	0.40	Accept Ho; Reject Ha	Accept Ho; Reject Ha
			NG=45	"	1.25	4.17	0.62	1.96	2.57	1.13	"	"
		N	G=43	"	0.63	0.10	0.02	1.96	2.57	4.0	Reject Ho; Accept Ha	Reject Ho; Accept Ha
			NG=37	"	0.63	0.05	0.01	1.96	2.57	8.0	"	"
13	Concrete mix (1:1 ½ :3) materials: Cement in Tonnes/m³	A	G=23	8.08	6.70	1.42	0.30	2.074	2.819	-4.60	"	"
			NG=47	"	7.07	1.15	0.17	1.96	2.57	-5.94	"	"
		C	G=11	"	7.21	0.57	0.17	2.28	3.16	-5.12	"	"
			NG=45	"	7.43	0.87	0.13	1.96	2.57	-5.0	"	"
		N	G=43	"	6.72	2.00	0.3	1.96	2.57	-4.53	"	"
			NG=37	"	7.00	0.77	0.13	1.96	2.57	-8.31	"	"
14	Concrete (1: 1 1/2 :3) materials: Sand in Tonnes/ M³	A	G=23	0.60	0.59	0.06	0.01	2.074	2.819	-1.0	Accept Ho; Reject Ha	Accept Ho; Reject Ha
			NG=47	"	0.63	0.13	0.02	1.96	2.57	1.50	"	"
		C	G=11	"	0.61	0.04	0.01	2.28	3.16	1.0	"	"
			NG=45	"	0.65	0.08	0.01	1.96	2.57	5.0	Reject Ho; Accept Ha	Reject Ho; Accept Ha
		N	G=43	"	0.62	0.06	0.01	1.96	2.57	2.0	"	Accept Ho; Reject Ha
			NG=37	"	0.65	0.07	0.01	1.96	2.57	5.0	"	Reject Ho; Accept Ha
15	Concrete (1: 1 ½ :3) materials: Ballast in Tonnes/ M³	A	G=23	1.21	1.12	0.15	0.03	2.074	2.819	-3.0	"	"
			NG=47	"	1.20	0.16	0.02	1.96	2.57	-0.50	Accept Ho; Reject Ha	Accept Ho; Reject Ha
		C	G=11	"	1.15	0.21	0.06	2.28	3.16	-1.0	"	"
			NG=45	"	1.24	0.20	0.03	1.96	2.57	1.0	"	"
		N	G=43	"	1.24	0.18	0.03	1.96	2.57	1.0	"	"
			NG=37	"	1.25	0.17	0.23	1.96	2.57	1.33	"	"
16	Water cement Ratio: Litres/bag of cement	A	G=23	0.45	0.54	0.06	0.01	2.074	2.819	9.00	Reject Ho Accept Ha	Reject Ho Accept Ha
			NG=47	"	0.57	0.08	0.01	1.96	2.57	12.00	"	"
		C	G=11	"	0.55	0.14	0.04	2.28	3.16	2.50	"	Accept Ho; Reject Ha
			NG=45	"	1.24	4.33	0.65	1.96	2.57	1.06	Accept Ho; Reject Ha	"
		N	G=43	"	0.58	0.08	0.01	1.96	2.57	13.0	Reject Ho; Accept Ha	Reject Ho; Accept Ha
17	Concrete mix (1:1:3) Materials cement in Tonnes/M³	A	G=23	9.86	7.76	1.79	0.37	2.074	2.819	-5.68	Reject Ho; Accept Ha	Reject Ho; Accept Ha
			NG=47	"	8.36	1.42	0.21	1.96	2.57	-7.14	"	"
		C	G=11	"	8.42	1.08	0.33	2.28	3.16	-4.36	"	"
			NG=45	"	8.33	1.49	0.22	1.96	2.57	-6.95	"	"
		N	G=43	"	7.85	2.25	0.34	1.96	2.57	-5.91	"	"
			NG=37	"	8.26	0.89	0.15	1.96	2.57	-10.67	"	"

All μ_0-values Source: (1-20) Spence Geddes: (1976) Source: Field Survey 2005

Table 6.5: The effect of education levels on resource mix in Site Mixed Insitu Concreting and its related construction activities by construction firms in Kenya [Where A = African Firms, C = Citizen Firms, N = Non-citizen Firms; G= Graduate; NG= Nongraduates]

$$s = \sqrt{\frac{\sum (X - \bar{X})^2}{n-1}}$$ = sample standard deviation.

Main activity: Insitu Concrete Work (Mixing on Site)

	Activity	Sample Size (n)		μ₀	$\bar{X}$	S	$\delta_{\bar{x}} = \frac{s}{\sqrt{n}}$	Critical (e) $Z_{0.025}$ to 0.025	Critical (e) $Z_{0.005}$ to 0.005	Actual Z_a	Decision: TWo Tailed Test $Z_e > Z_a$: Accept H_0; Reject H_a $Z_a < Z_e$: Confidence 95%	Confidence 99%
18	Concrete (1:1:3) materials: sand in Bags/M³	A	G=23	0.75	0.56	0.18	0.04	2.074	2.819	-4.75	"	"
			NG=47	"	0.58	0.18	0.03	1.96	2.57	-5.67	"	"
		C	G=11	"	0.56	0.07	0.02	2.28	3.16	-9.50	"	"
			NG=45	"	0.56	0.17	0.03	1.96	2.57	-6.33	"	"
		N	G=43	"	0.60	0.19	0.03	1.96	2.57	-5.00	"	"
			NG=37	"	0.58	0.15	0.02	1.96	2.57	-8.50	"	"
19	Concrete (1:1:3) materials: Ballast in Bags/M³	A	G=23	0.99	1.12	0.15	0.03	2.074	2.819	4.33	"	"
			NG=47	"	1.25	0.30	0.04	1.96	2.57	6.50	"	"
		C	G=11	"	1.14	0.20	0.06	2.28	3.16	2.50	"	"
			NG=45	"	1.21	0.26	0.04	1.96	2.57	5.50	"	"
		N	G=43	"	1.22	0.17	0.03	1.96	2.57	7.67	"	"
			NG=37	"	1.22	0.13	0.02	1.96	2.57	11.50	"	"
20	Water cement ratio litres/Bag of cement	A	G=23	0.40	0.53	0.08	0.02	2.074	2.819	6.50	"	"
			NG=47	"	0.54	0.08	0.01	1.96	2.57	14.0	"	"
		C	G=11	"	0.55	0.14	0.04	2.28	3.16	3.75	"	"
			NG=45	"	1.23	4.38	0.65	1.96	2.57	1.28	"	"
		N	G=43	"	0.58	0.07	0.01	1.96	2.57	18.00	"	"
			NG=37	"	0.56	0.05	0.01	1.96	2.57	16.00	"	"
21	Machine time: Mixer 7/5 (0.20/0.14) output/hr in (M³)	A	G=23	1.40	2.9	1.31	0.27	2.074	2.819	5.56	Reject Ho; Accept Ha;	Reject Ho; Accept Ha
			NG=47	"	3.13	1.71	0.25	1.96	2.57	6.95	"	"
		C	G=11	"	2.64	1.22	0.37	2.28	3.16	3.35	"	"
			NG=45	"	3.27	2.07	0.31	1.96	2.57	6.03	"	"
		N	G=43	"	3.5	1.54	0.23	1.96	2.57	9.13	"	"
			NG=37	"	3.14	1.25	0.21	1.96	2.57	8.29	"	"
22	Mixer 7/5 (0.20/0.14). Time off for starting (hrs)	A	G=23	0.25	0.26	0.11	0.02	2.074	2.819	0.50	"	"
			NG=47	"	0.29	0.11	0.02	1.96	2.57	2.0	"	Accept Ho; Reject Ha
		C	G=11	"	0.24	0.10	0.03	2.28	3.16	-0.33	Accept Ho; Reject Ha;	"
			NG=45	"	0.26	0.17	0.03	1.96	2.57	0.33	"	"
		N	G=43	"	0.27	0.12	0.02	1.96	2.57	1.00	"	"
			NG=37	"	0.24	0.10	0.02	1.96	2.57	-0.50	"	"
23	Mixer 7/50: (0.20/0.14) Cleaning time/day. (hrs)	A	G=23	0.50	0.36	0.17	0.04	2.074	2.819	-3.50	Reject Ho; Accept Ha	Reject Ho; Accept Ha
			NG=47	"	0.38	0.15	0.02	1.96	2.57	-6.0	"	"
		C	G=11	"	0.39	0.16	0.05	2.28	3.16	-2.20	Accept Ho; Reject Ha	Accept Ho; Reject Ha
			NG=45	"	0.32	0.15	0.02	1.96	2.57	-9.0	Reject Ho; Accept Ha	Reject Ho; Accept Ha
		N	G=43	"	0.39	0.10	0.02	1.96	2.57	-5.50	"	"
			NG=37	"	0.35	0.17	0.03	1.96	2.57	-0.30	Accept Ho; Reject Ha	Accept Ho; Reject Ha
24	Mix 7/50.20/0.14) site idle time/day (hrs)	A	G=23	0.33	0.61	0.48	0.10	2.074	2.819	2.80	Reject Ho; Accept Ha	"
			NG=47	"	0.42	0.33	0.05	1.96	2.57	1.80	Accept Ho; Reject Ha	"
		C	G=11	"	0.83	0.95	0.29	2.28	33.16	1.72	"	"
			NG=45	"	0.69	0.27	0.04	1.96	2.57	9.00	Reject Ho; Accept Ha	Reject Ho; Accept Ha
		N	G=43	"	0.49	0.32	0.05	1.96	2.57	3.20	"	"
			NG=37	"	0.45	0.26	0.04	1.96	2.57	3.00	"	"

All μ_0 values 21-32. Source Enterkin and Reynolds (1978)   Source: Own Field Survey 2005

Table 6.6: The effect of education levels on resource mix in Site Mixed Insitu Concreting and its related construction activities by construction firms in Kenya

[where A = African Firms, C = Citizen Firms, N = Non-citizen Firms; G= Graduate; NG= Nongraduates]

$$s = \sqrt{\frac{\sum (X - \bar{X})^2}{n-1}}$$ = sample standard deviation.

Main activity: Insitu Concrete Work (Mixing on Site)

	Activity	Sample Size (n)		μo	$\bar{X}$	S	$\delta_{\bar{x}} = \frac{s}{\sqrt{n}}$	Critical (e) $Z_{0.025}$	Critical (e) $Z_{0.005}$	Actual Z_e	DECISION : TWO TAILED TEST ($Z_e > Z_c$: Accept H_0; Reject H_a $Z_e < Z_c$:) Confidence 95%	Confidence 99%
25	Mixer 10/7 (0.28/0.20) Output/hr in (M³)	A	G=23	2.0	3.69	1.43	0.30	2.074	2.819	5.63	"	"
			NG=47	"	3.99	2.08	0.30	1.96	2.57	6.63	"	"
		C	G=11	"	3.58	1.57	0.47	2.28	3.16	3.36	"	"
			NG=45	"	3.90	1.98	0.30	1.96	2.57	6.33	"	"
		N	G=43	"	4.41	1.55	0.24	1.96	2.57	10.04	"	"
			NG=37	"	4.13	1.28	0.21	"	"	10.14	"	"
26	Mixer 10/7 (0.28/0.20) Time off for starting (Hrs)	A	G=23	0.25	0.26	0.13	0.03	2.074	2.819	0.33	Accept Ho; Reject Ha	Accept Ho; Reject Ha;
			NG=47	"	0.29	0.11	0.02	1.96	2.57	2.00	Reject Ho; Accept Ha	"
		C	G=11	"	2.24	0.10	0.03	2.28	3.16	-0.33	Accept Ho; Reject Ha	"
			NG=45	"	0.30	0.16	0.02	1.96	2.57	2.50	Reject Ho; Accept Ha	"
		N	G=43	"	0.26	0.12	0.02	1.96	2.57	0.50	Accept Ho; Reject Ha	"
			NG=37	"	0.24	0.10	0.02	1.96	2.57	-0.50	"	"
27	Mixer 10/7 (0.28/0.20) cleaning time/day (hrs)	A	G=23	0.50	0.39	0.15	0.03	2.074	2.819	-3.67	Reject Ho; Accept Ha	Reject Ho; Accept Ha
			NG=47	"	0.38	0.15	0.02	1.96	2.57	-6.0	"	"
		C	G=11	"	0.39	0.15	0.05	2.28	3.16	-2.20	Accept Ho; Reject Ha	Accept Ho; Reject Ha
			NG=45	"	0.28	0.15	0.02	1.96	2.57	-11.00	Reject Ho; Accept Ha	Reject Ho; Accept Ha
		N	G=43	"	0.38	0.11	0.02	1.96	2.57	-6.0	"	"
			NG=37	"	0.35	0.13	0.02	1.96	2.57	-7.50	"	"
28	Mixer 10/7 (0.28/0.20) idle time/day (hrs)	A	G=23	0.33	0.59	0.47	0.10	2.074	2.819	2.60	"	Accept Ho; Reject Ha
			NG=47	"	0.42	0.33	0.05	1.96	2.57	1.80	Accept Ho; Reject Ha	Accept Ho; Reject Ha
		C	G=11	"	0.83	0.95	0.29	2.28	3.16	1.72	"	"
			NG=45	"	0.68	0.30	0.04	1.96	2.57	8.75	Reject Ho; Accept Ha	Reject Ho; Accept Ha
		N	G=43	"	0.49	0.32	0.05	1.96	2.57	3.20	"	"
			NG=37	"	0.46	0.25	0.04	1.96	2.57	3.25	"	"
29	Mixer 14/10 (0.40/0.28) output/hr in (m³)	A	G=23	2.8	4.85	1.67	0.35	2.074	2.819	5.86	"	"
			NG=47	"	5.22	2.77	0.40	1.96	2.57	6.05	"	"
		C	G=11	"	4.5	1.96	0.59	2.28	3.16	2.88	"	Accept Ho; Reject Ha
			NG=45	"	5.29	5.68	0.85	1.96	2.57	2.93	"	Reject Ho; Accept Ha
		N	G=43	"	5.49	1.52	0.23	1.96	2.57	11.70	"	"
			NG=37	"	5.10	1.22	0.2	1.96	2.57	11.50	"	"
30	Mixer 14/10 (0.40/0.28) time off starting (hrs)	A	G=23	0.25	0.32	0.22	0.05	2.074	2.819	1.40	Accept Ho; Reject Ha	Accept Ho; Reject Ha
			NG=47	"	0.32	0.13	0.02	1.96	2.57	3.50	Reject Ho; Accept Ha	Reject Ho; Accept Ha
		C	G=11	"	0.25	0.10	0.03	2.28	3.16	0	Accept Ho; Reject Ha	Accept Ho; Reject Ha
			NG=45	"	0.30	0.17	0.03	1.96	2.57	1.67	"	"
		N	G=43	"	0.29	0.17	0.03	1.96	2.57	1.33	"	"
			NG=37	"	0.25	0.11	0.02	1.96	2.57	0	"	"

μo-values Source: 21-32 : Hugh Enterkin and Gerald Reynolds (1978)

Source: Field Survey 2005

Table 6.6: The effect of education levels on resource mix Site Mixed Insitu Concreting and its related construction activities by construction firms in Kenya [Where A = African Firms, C = Citizen Firms, N = Non-citizen Firms; G= Graduate; NG= Nongraduates]

$$s = \sqrt{\frac{\sum (X - \bar{X})^2}{n-1}}$$ = sample standard deviation.

Site activity: Insitu Concrete Work (Mixing on Site)

	Activity	Sample Size (n)		μ_o	$\bar{X}$	S	$\delta_{\bar{x}} = \frac{s}{\sqrt{n}}$	Critical (e)		Actual Z_a	Decision : TWo Tailed Test	
								$Z_{0.025}$ $t_{0.025}$	$Z_{0.005}$ $t_{0.005}$	t_a	$Z_e > Z_a$: Accept H_0; Reject H_a $Z_e < Z_a$:	
											Confidence 95%	Confidence 99%
31	Mixer 14/10 (0.40/0.28) cleaning time/ day (Hrs)	A	G=23	0.50	0.41	0.15	0.03	2.074	2.819	-3.0	Reject Ho; at 95% Accept Ha	Reject Ho; Accept Ha; 99%
			NG=47	"	0.42	0.16	0.02	1.96	2.57	-4.0	"	"
		C	G=11	"	0.40	0.15	0.05	2.28	3.16	-2.0	Accept Ho; Reject Ha;	Accept Ho; Reject Ha;
			NG=45	"	0.29	0.16	0.02	1.96	2.57	-10.50	Reject Ho; Accept Ha;	Reject Ho; Accept Ha;
		N	G=43	"	0.40	0.11	0.02	1.96	2.57	-5.0	"	"
			NG=37	"	0.38	0.15	0.02	1.96	2.57	-6.0	"	"
32	Mixer 14/10 (0.40/0.28) site idle time/ day (Hrs)	A	G=23	0.33	0.67	0.58	0.12	2.074	2.819	2.83	"	"
			NG=47	"	0.43	0.35	0.05	1.96	2.57	2.00	"	Accept Ho; Reject Ha;
		C	G=11	"	0.86	0.96	0.29	2.28	3.16	1.83	Accept Ho; Reject Ha;	Accept Ho; Reject Ha;
			NG=45	"	0.69	0.27	0.04	1.96	2.57	9.00	Reject Ho; Accept Ha;	Reject Ho; Accept Ha;
		N	G=43	"	0.49	0.32	0.05	1.96	2.57	3.20	"	"
			NG=37	"	0.45	0.25	0.04	1.96	2.57	3.00	"	"
33	Mixer 18/12 (0.51/0.34) output/hour (m^3)	A	G=23	3.4	5.68	2.21	0.46	2.074	2.819	4.96	"	"
			NG=47	"	6.21	3.29	0.48	1.96	2.57	5.85	"	"
		C	G=11	"	5.55	2.39	0.72	2.28	3.16	2.97	"	Accept Ho; Reject Ha;
			NG=45	"	6.35	2.68	0.40	1.96	2.57	7.38	"	Reject Ho; Accept Ha;
		N	G=43	"	6.24	1.67	0.25	1.96	2.57	11.36	"	"
			NG=37	"	5.40	1.54	0.25	1.96	2.57	8.00	"	"
34	Mixer 18/12 (0.51/0.34) time off for starting (hrs)	A	G=23	0.25	0.30	0.17	0.04	2.074	2.819	1.25	Accept Ho; Reject Ha;	Accept Ho; Reject Ha;
			NG=47	"	0.36	0.17	0.03	1.96	2.57	3.67	Reject Ho; Accept Ha;	Reject Ho; Accept Ha;
		C	G=11	"	0.26	0.11	0.03	2.28	3.16	0.33	Accept Ho; Reject Ha;	Accept Ho; Reject Ha;
			NG=45	"	0.29	0.18	0.03	1.96	2.57	1.33	"	"
		N	G=43	"	0.29	0.18	0.03	1.96	2.57	1.33	"	"
			NG=37	"	0.26	0.13	0.02	1.96	2.57	0.50	"	"
35	Mixer 18/12 (0.51/0.34) cleaning time/day (hrs)	A	G=23	0.50	0.47	0.18	0.04	2.074	2.819	-0.75	"	"
			NG=47	"	0.44	0.14	0.02	1.96	2.57	-3.00	Reject Ho; Accept Ha;	Reject Ho; Accept Ha;
		C	G=11	"	0.41	0.15	0.05	2.28	3.16	-1.80	Accept Ho; Reject Ha;	Accept Ho; Reject Ha;
			NG=45	"	0.29	0.16	0.02	1.96	2.57	-10.50	Reject Ho; Accept Ha;	Reject Ho; Accept Ha;
		N	G=43	"	0.40	0.14	0.02	1.96	2.57	-10.50	"	"
			NG=37	"	0.40	0.15	0.02	1.96	2.57	-5.00	"	"

All μ_o-values Source: 33-36 Smith R.C (1986)

Source: Field survey 2005

Table 6.6: The effect of education levels on resource mix site mixed insitu concreting and its related construction activities by construction firms in Kenya [Where A = African Firms, C = Citizen Firms, N = Non-citizen Firms; G= Graduate; NG= Nongraduates]

$$s = \sqrt{\frac{\sum (X - \bar{X})^2}{n-1}}$$ = sample standard deviation.

Main activity: Insitu Concrete Work (Mixing on Site)

	Activity	Sample Size (n)		μ_o	$\bar{X}$	S	$\delta_{\bar{x}} = \frac{s}{\sqrt{n}}$	Critical (e)		Actual Z_a	DECISION : TWO TAILED TEST	
								$Z_{0.025}$	$Z_{0.005}$		$Z_e > Z_a$: Accept H_0; Reject H_a $Z_a < Z_e$	
											Confidence 95%	Confidence 99%
36	Mixed 18/12 (0.51/0.34) site idle time/day (hrs)	A	G=23	0.33	0.63	0.56	0.12	2.074	2.819	2.50	Reject Ho; Accept Ha at 95%	Accept Ho; Reject Ha; at 99%
			NG=47	"	0.44	0.37	0.05	1.96	2.57	2.20	"	"
		C	G=11	"	0.86	0.96	0.29	2.28	3.16	1.83	Accept Ho; Reject Ha;	Accept Ho; Reject Ha;
			NG=45	"	0.69	0.28	0.04	1.96	2.57	1.29	"	"
		N	G=43	"	0.53	0.39	0.06	1.96	2.57	3.33	Reject Ho; Accept Ha	Reject Ho; Accept Ha
			NG=37	"	0.45	0.24	0.04	1.96	2.57	3.00	"	Reject Ho; Accept Ha
37	Gang size: Mixers 7/5 (0.20/0.14): Operators (No)	A	G=23	1	1.30	0.48	0.10	2.074	2.819	3.0	"	"
			NG=47	"	1.13	0.34	0.05	1.96	2.57	2.60	"	"
		C	G=11	"	1.09	0.32	0.10	2.28	3.16	0.90	Accept Ho; Reject Ha;	Accept Ho; Reject Ha;
			NG=45	"	1.23	0.43	0.06	1.96	2.57	3.83	Reject Ho; Accept Ha	Reject Ho; Accept Ha
		N	G=43	"	1.19	0.40	0.06	1.96	2.57	3.16	"	"
			NG=37	"	1.08	0.28	0.05	1.96	2.57	1.6	Accept Ho; Reject Ha;	Accept Ho; Reject Ha;
38	Gang size 7/5 /0.20.14) Labourers (No)	A	G=23	1	4	3.66	0.76	2.074	2.819	3.95	Reject Ho; Accept Ha	Reject Ho; Accept Ha
			NG=47	"	3.19	1.72	0.25	1.96	2.57	8.76	"	"
		C	G=11	"	3.45	1.43	0.43	2.28	3.16	5.70	"	"
			NG=45	"	2.93	1.48	0.22	1.96	2.57	8.77	"	"
		N	G=43	"	3.62	1.30	0.20	1.96	2.57	1.31	Accept Ho; Reject Ha;	Accept Ho; Reject Ha;
			NG=37	"	3.00	1.45	0.24	1.96	2.57	8.33	Reject Ho; Accept Ha	Reject Ho; Accept Ha
39	Gang size: Mix Mix 7/5 (0.20/0.14): Wheelers (No)	A	G=23	0	3.17	1.26	0.26	2.074	2.819	12.19	"	"
			NG=47	"	3.21	0.96	0.14	1.96	2.57	22.93	"	"
		C	G=11	"	2.82	1.03	0.31	2.28	3.16	9.09	"	"
			NG=45	"	3.16	1.38	0.21	1.96	2.57	15.05	"	"
		N	G=43	"	2.67	1.02	0.16	1.96	2.57	16.69	"	"
			NG=37	"	2.89	1.14	0.19	1.96	2.57	15.21	"	"
40	Gang idle time mixer 7/5 (0.20/0.14) (%)	A	G=23	0	9.39	5.76	1.20	2.074	2.819	7.85	"	"
			NG=47	"	8.49	4.66	0.68	1.96	2.57	12.49	"	"
		C	G=11	"	10.0	5.53	1.67	2.28	3.16	5.99	"	"
			NG=45	"	9.14	7.47	1.11	1.96	2.57	8.23	"	"
		N	G=43	"	9.20	3.90	0.59	1.96	2.57	15.59	"	"
			NG=37	"	7.49	3.61	0.59	1.96	2.57	12.70	"	"
41	Gang size mixer 10/7 (0.28/0.20) operators (No)	A	G=23	1	1.39	0.60	0.13	2.074	2.819	3.00	Reject Ho: at 95% Accept Ha;	Reject Ho; Accept Ha at 99%
			NG=47	"	1.21	0.42	0.06	1.96	2.57	3.50	"	"
		C	G=11	"	1.09	0.32	0.10	2.28	3.16	0.90	Accept Ho: Reject Ha	Accept Ho: Reject Ha
			NG=45	"	1.29	0.46	0.07	1.96	2.57	4.14	Reject Ho; Accept Ha	Reject Ho; Accept Ha
		N	G=43	"	1.21	0.42	0.06	1.96	2.57	3.50	"	"
			NG=37	"	1.14	0.35	0.06	1.96	2.57	2.33	"	Accept Ho; Reject Ha

All μ_o-values Source: 37-48 Hugh Enterkin and Gerald Reynolds (1978): Source: Own Field Survey 2005

Table 6.6: The effect of education levels on resource mix site mixed insitu concreting and its related construction activities by construction firms in Kenya

where A = African Firms, C = Citizen Firms, N = Non-citizen Firms; G= Graduate; NG= Nongraduates]

$$s = \sqrt{\frac{\sum (X - \bar{X})^2}{n-1}}$$ = sample standard deviation.

Main activity: Insitu Concrete Work (Mixing on Site)

	Activity	Sample Size (n)		μ_o	$\bar{X}$	S	$\delta_{\bar{X}} = \frac{s}{\sqrt{n}}$	Critical (e)		Actual Z_a	DECISION : TWO TAILED TEST	
								$Z_{0.025}$ ID.025	$Z_{0.005}$ to.005		$Z_e > Z_a$: Accept H_o; Reject H_a $Z_e < Z_a$:	
											Confidence 95%	Confidence 99%
42	Gang size 10/7 (0.28/0.20) Labourers (No)	A	G=23	1	4.60	3.81	0.79	2.074	2.819	4.56	Reject Ho; Accept Ha	Reject Ho; Accept Ha
			NG=47	"	3.40	1.82	0.27	1.96	2.57	8.89	"	"
		C	G=11	"	3.90	1.78	0.54	2.28	3.16	5.37	"	"
			NG=45	"	3.44	1.71	0.25	1.96	2.57	9.76	"	"
		N	G=43	"	4.67	1.96	0.30	1.96	2.57	12.23	"	"
			NG=37	"	3.27	1.60	0.26	1.96	2.57	8.73	"	"
43	Gang size: Mixer 10/7 (0.28/0.20): Wheelers (No)	A	G=23	1	3.43	1.77	0.37	2.074	2.819	6.57	"	"
			NG=47	"	3.60	1.00	0.15	1.96	2.57	17.33	"	"
		C	G=11	"	3.27	1.41	0.43	2.28	3.16	5.28	"	"
			NG=45	"	3.44	1.15	0.17	1.96	2.57	14.35	"	"
		N	G=43	"	3.23	1.16	0.18	1.96	2.57	12.39	"	"
			NG=37	"	3.03	1.11	0.18	1.96	2.57	11.28	"	"
44	Gang idle time Mix 10/7 (0.28/0.20) (%)	A	G=23	0	9.26	5.04	1.05	2.074	2.819	8.82	"	"
			NG=47	"	8.48	4.04	0.59	1.96	2.57	14.37	"	"
		C	G=11	"	9.70	4.92	1.48	2.28	3.16	6.55	"	"
			NG=45	"	9.02	7.41	1.10	1.96	2.57	8.20	"	"
		N	G=43	"	9.20	3.72	0.57	1.96	2.57	16.14	"	"
			NG=37	"	7.62	3.80	0.62	1.96	2.57	12.29	"	"
45	Gang size: Mix 14/10 (0.40/0.28) Operators (No)	A	G=23	1	1.65	5.32	1.11	2.074	2.819	0.59	Accept Ho; Reject Ha	Accept Ho; Reject Ha
			NG=47	"	1.34	0.61	0.09	1.96	2.57	3.78	Reject Ho; Accept Ha	Reject Ho; Accept Ha
		C	G=11	"	1.36	0.53	0.16	2.28	3.16	2.25	Accept Ho; Reject Ha	Accept Ho; Reject Ha
			NG=45	"	1.33	0.48	0.07	1.96	2.57	4.71	Reject Ho; Accept Ha	Reject Ho; Accept Ha
		N	G=43	"	1.17	0.38	0.06	1.96	2.57	2.83	"	"
			NG=37	"	1.54	1.63	0.27	1.96	2.57	2.00	"	Accept Ho; Reject Ha
46	Gang size: Mixer 14/10 (0.40/0.28) Labourers (No)	A	G=23	1	5.22	4.14	0.86	2.074	2.819	4.91	Reject Ho; Accept Ha	Reject Ho, Accept Ha;
			NG=47	"	4.81	2.37	0.35	1.96	2.57	10.89	"	"
		C	G=11	"	5.10	2.37	0.71	2.28	3.16	5.77	"	"
			NG=45	"	4.53	2.57	0.38	1.96	2.57	9.29	"	"
		N	G=43	"	5.98	2.40	0.37	1.96	2.57	13.46	"	"
			NG=37	"	4.62	2.72	0.45	1.96	2.57	8.04	"	"
47	Gang size: Mixer 14/10 (0.40/0.28). Wheelers (No)	A	G=23	2	4.26	2.56	0.53	2.074	2.819	4.26	"	"
			NG=47	"	4.91	1.55	0.23	1.96	2.57	12.65	"	"
		C	G=11	"	4.45	2.17	0.65	2.28	3.16	3.77	"	"
			NG=45	"	4.42	1.47	0.22	1.96	2.57	11.00	"	"
		N	G=43	"	4.38	1.83	0.28	1.96	2.57	4.93	"	"
			NG=37	"	4.03	1.84	0.30	1.96	2.57	6.77	"	"

All μ_o-values Source: 37-48 Hugh Enterkin and Gerald Reynolds (1978): Source: Own Field Survey 2005

Table 6.6: The effect of education levels on resource mix site mixed insitu concreting and its related construction activities by construction firms in Kenya [Where A = African Firms, C = Citizen Firms, N = Non-citizen Firms; G= Graduate; NG= Nongraduates]

$$s = \sqrt{\frac{\sum (X - \bar{X})^2}{n-1}}$$ = sample standard deviation.

Main activity: Insitu Concrete Work (Mixing on Site)

No.	Activity	Sample Size (n)		μ_o	$\bar{X}$	S	$\delta_{\bar{x}} = \frac{s}{\sqrt{n}}$	Critical (e)		Actual Z_o	DECISION : TWO TAILED TEST	
								$Z_{0.025}$ $t_{0.025}$	$Z_{0.005}$ $t_{0.005}$		$Z_o > Z_e$: Accept H_0; Reject H_a $Z_o < Z_e$: Confidence 95%	Confidence 99%
	Gang idle time. Mixer 14/10 (0.40/0.28) (%)	A	G=23	0	9.35	4.93	1.03	2.074	2.819	9.08	"	"
			NG=47	"	8.37	3.69	0.54	1.96	2.57	15.50	"	"
		C	G=11	"	9.50	4.59	1.38	2.28	3.16	6.88	"	"
			NG=45	"	8.79	7.46	1.11	1.96	2.57	7.92	"	"
		N	G=43	"	9.20	3.72	0.57	1.96	2.57	16.14	"	"
			NG=37	"	7.62	3.98	0.65	1.96	2.57	11.72	"	"
	Gang size: Mixer 18/12 (0.51/0.34) Operators (No)	A	G=23	1	1.48	0.61	0.13	2.074	2.819	3.69	"	"
			NG=47	"	1.38	0.58	0.08	1.96	2.57	4.75	"	"
		C	G=11	"	1.36	0.53	0.16	2.28	3.16	2.25	Accept Ho; Reject Ha	Accept Ho; Reject Ha
			NG=45	"	1.38	0.5	0.07	1.96	2.57	5.42	Reject Ho; Accept Ha	Reject Ho; Accept Ha
		N	G=43	"	1.35	1.12	0.17	1.96	2.57	2.06	"	Accept Ho; Reject Ha
			NG=37	"	1.30	0.75	0.12	1.96	2.57	2.50	"	"
50	Gang size: Mixer 18/12 (0.51/0.34) : Labourer (No)	A	G=23	1	5.74	4.91	1.02	2.074	2.819	4.65	"	Reject Ho; Accept Ha
			NG=47		5.15	2.8	0.41	1.96	2.57	10.12	"	
		C	G=11		5.82	2.56	0.77	2.28	3.16	6.26	"	"
			NG=45		5.02	3.14	0.47	1.96	2.57	8.55	"	"
		N	G=43		6.56	3.23	0.49	1.96	2.57	11.35	"	"
			NG=37		4.65	2.97	0.49	1.96	2.57	7.45	"	"
51	Gang size: Mixer 18/12 (0.51/0.34): Wheelers (No)	A	G=23	2	4.91	3.07	0.64	2.074	2.819	4.55	Reject Ho; Accept Ha	Reject Ho/ Accept Ha
			NG=47	"	5.49	1.58	0.23	1.96	2.57	15.17	"	"
		C	G=11	"	5.55	2.83	0.85	2.28	3.16	4.18	"	"
			NG=45	"	5.11	1.91	0.28	1.96	2.57	11.11	"	"
		N	G=43	"	5.40	2.26	0.34	1.96	2.57	10.0	"	"
			NG=37	"	4.59	2.09	0.34	1.96	2.57	7.62	"	"
52	Gang idle time: Mixer 18/12 (0.51/0.34) (%)	A	G=23	0	9.33	5.44	1.13	2.074	2.819	8.26	"	"
			NG=47	"	8.44	3.84	0.56	1.96	2.57	15.07	"	"
		C	G=11	"	9.50	3.87	1.17	2.28	3.16	8.12	"	"
			NG=45	"	8.72	7.51	1.12	1.96	2.57	7.79	"	"
		N	G=43	"	9.83	4.46	0.68	1.96	2.57	14.46	"	"
			NG=37	"	7.76	4.64	0.76	1.96	2.57	10.21	"	"
53	Fixing formwork to soffits <3..50 high. Output per hour in (M^2)	A	G=23	1.8	6.46	1.99	0.41	2.074	2.819	11.37	"	"
			NG=47	"	7.71	4.02	0.59	1.96	2.57	10.02	"	"
		C	G=11	"	6.82	1.41	0.43	2.28	3.16	11.67	"	"
			NG=45	"	10.71	12.54	1.87	1.96	2.57	4.76	"	"
		N	G=43	"	7.01	2.26	0.34	1.96	2.57	15.32	"	"
			NG=37	"	6.95	1.93	0.32	1.96	2.57	16.09	"	"
54	Stripping formwork to soffits < 3.50m high output/hr in (m^2)	A	G=23	0.90	7.83	2.97	0.62	2.074	2.819	11.26	"	"
			NG=47	"	10.03	11.07	1.61	1.96	2.57	5.67	"	"
		C	G=11	"	10.77	11.96	3.61	2.28	3.16	2.73	"	"
			NG=45	"	11.97	11.42	1.70	1.96	2.57	6.51	"	"
		N	G=43	"	10.05	8.29	1.26	1.96	2.57	7.26	"	"
			NG=37	"	7.40	1.75	0.29	1.96	2.57	22.41	"	"

All μ_o – **values source** : 49-93 Smith R.C. (1986) ;Source: Field survey 2005

Table 6.6: The effect of education levels on resource mix site mixed insitu concreting and its related construction activities by construction firms in Kenya [Where A = African Firms, C = Citizen Firms, N = Non-citizen Firms; G= Graduate; NG= Nongraduates]

$$s = \sqrt{\frac{\sum (X - \bar{X})^2}{n-1}}$$ = sample standard deviation.

Main activity: Insitu Concrete Work (Mixing on Site)

Activity	Sample Size (n)		μ_o	$\bar{X}$	S	$\delta_{\bar{x}} = \frac{s}{\sqrt{n}}$	Critical (e)		Actual Z_e	DECISION : TWO TAILED TEST	
							$Z_{0.025}$ t0.025	$Z_{0.005}$ to 0.05	tc	$Z_e > Z_a$: Accept H_0; Reject H_a $Z_e < Z_a$:	
										Confidence 95%	Confidence 99%
Gangsize: Stripping; fixing formwork carpenters (No)	A	G=23	1	1.0	0.46	0.10	2.074	2.819	0	Accept Ho; Reject Ha	Accept Ho; Reject Ha
		NG=47	"	1.13	0.34	0.05	1.96	2.57	2.60	Reject Ho; Accept Ha	Reject Ho; Accept Ha
	C	G=11	"	1.0	0.00	0	2.28	3.16	0	Accept Ho; Reject Ha	Accept Ho; Reject Ha
		NG=45	"	1.09	0.29	0.04	1.96	2.57	2.25	Reject Ho; Accept Ha	"
	N	G=43	"	1.0	0.50	0.08	1.96	2.57	0	"	"
		NG=37	"	1.0	0.00	0	1.96	2.57	0	"	"
Gang size: Fixing form work: Labourers (No)	A	G=23	1	3.0	1.47	0.31	2.074	2.819	6.45	Reject Ho; Accept Ha	Reject Ho; Accept Ha
		NG=47	"	1.91	0.75	0.11	1.96	2.57	8.27	"	"
	C	G=11	"	2.0	0.0	0	2.28	3.16	α	"	"
		NG=45	"	1.82	0.50	0.07	1.96	2.57	11.71	"	"
	N	G=43	"	2.0	0.27	0.04	1.96	2.57	25.0	"	"
		NG=37	"	1.89	0.52	0.09	1.96	2.57	9.89	"	"
57 Fixing formwork to sides and soffits <3.50m high output/hr in (M²)	A	G=23	1.8	3.75	1.51	0.31	2.074	2.819	6.29	"	"
		NG=47	"	4.54	3.05	0.44	1.96	2.57	6.23	"	"
	C	G=11	"	4.0	1.88	0.57	2.28	3.16	3.86	"	"
		NG=45	"	6.40	7.38	1.10	1.96	2.57	4.18	"	"
	N	G=43	"	4.57	4.48	0.68	1.96	2.57	4.07	"	"
		NG=37	"	3.85	1.73	0.28	1.96	2.57	7.32	"	"
Stripping form work to sides and soffits <3.50 m high Output/hr in (m²)	A	G=23	0.9	4.72	4.15	0.87	2.074	2.819	4.39	"	"
		NG=47	"	6.28	10.4	1.52	1.96	2.57	3.54	"	"
	C	G=11	"	6.70	8.37	2.52	2.28	3.16	2.30	"	"
		NG=45	"	8.75	12.76	1.90	1.96	2.57	4.13	"	"
	N	G=43	"	6.70	8.23	1.26	1.96	2.57	4.60	"	"
		NG=37	"	3.49	1.29	0.21	1.96	2.57	12.33	"	"
Gangsize: Fixing and stripping; <3.50m high carpenters (No)	A	G=23	1	2	0.46	0.10	2.074	2.819	10.0	"	"
		NG=47	"	1.19	0.45	0.07	1.96	2.57	2.71	"	"
	C	G=11	"	1	0.0	0	2.28	3.16	0.0	Accept Ho; Reject Ha	Accept Ho; Reject Ha
		NG=45	"	1.13	0.35	0.05	1.96	2.57	2.60	Reject Ho; Accept Ha	"
	N	G=43	"	1	0.50	0.08	1.96	2.57	0	Accept Ho; Reject Ha	"
		NG=37	"	1.08	0.28	0.05	1.96	2.57	1.60	"	"
Gangsize: fixing and stripping <3.50m high labourers (No)	A	G=23	1	3	1.74	0.36	2.074	2.819	5.56	Reject Ho; Accept Ha	Reject Ho; Accept Ha
		NG=47	"	1.89	0.74	0.11	1.96	2.57	8.09	"	"
	C	G=11	"	2	0.0	0	2.28	3.16	α	"	"
		NG=45	"	1.89	0.44	0.07	1.96	2.57	12.71	"	"
	N	G=43	"	2	0.22	0.03	1.96	2.57	33.33	"	"
		NG=37	"	1.95	0.47	0.08	1.96	2.57	11.88	"	"
Fixing sides of columns formwork output/hr (M²)	A	G=23	1.60	3.92	3.73	0.78	2.074	2.819	2.96	Reject Ho; Accept Ha	Reject Ho; Accept Ha
		NG=47	"	5.94	8.69	1.27	1.96	2.57	3.42	"	"
	C	G=11	"	3.73	1.76	0.53	2.28	3.16	4.02	"	"
		NG=45	"	10.24	13.56	2.02	1.96	2.57	4.28	"	"
	N	G=43	"	4.35	4.98	0.76	1.96	2.57	3.62	"	"
		NG=37	"	3.27	1.46	0.24	1.96	2.57	6.96	"	"

All μ_o – values source : 49-93 Smith R.C. (1986) ; Source: Field survey 2005

Table 6.6:. The effect of education levels on resource mix site mixed insitu concreting and its related construction activities by construction firms in Kenya

[Where A = African Firms, C = Citizen Firms, N = Non-citizen Firms; G= Graduate; NG= Nongraduates]

$$s = \sqrt{\frac{\sum (X - \bar{X})^2}{n-1}}$$ = sample standard deviation.

Main activity: Insitu Concrete Work (Mixing on Site)

	Activity	Sample Size (n)		μ_o	$\bar{X}$	S	$\delta_{\bar{x}} = \frac{s}{\sqrt{n}}$	Critical (e) $Z_{0.025}$	Critical (e) $Z_{0.005}$	Actual Z_a	DECISION : TWO TAILED TEST $Z_a > Z_e$: Accept H_0; Reject H_a $Z_e < Z_a$: Confidence 95%	Confidence 99%
52	Stripping sides of columns form work output/hr (M²)	A	G=23	0.8	6.78	10.10	2.11	2.074	2.819	2.83	"	"
			NG=47	"	9.33	17.30	2.52	1.96	2.57	3.38	"	"
		C	G=11	"	6.14	5.14	1.55	2.28	3.16	3.46	"	"
			NG=45	"	14.85	21.24	3.17	1.96	2.57	4.43	"	"
		N	G=43	"	11.23	31.22	4.76	1.96	2.57	2.19	Accept Ho; Reject Ha	Accept Ho; Reject Ha
			NG=37	"	3.80	1.58	0.26	1.96	2.57	11.54	Reject Ho; Accept Ha	Reject Ho; Accept Ha
53	Column form work gang size: carpenters (No)	A	G=23	1	2	0.43	0.09	2.074	2.819	11.11	"	"
			NG=47	"	1.17	0.44	0.06	1.96	2.57	2.83	"	"
		C	G=11	"	1	0	0	2.28	3.16	0	Accept Ho; Reject Ha	Accept Ho; Reject Ha
			NG=45	"	1.13	0.35	0.11	1.96	2.57	1.18	"	"
		N	G=43	"	1	0.52	0.08	1.96	2.57	0	"	"
			NG=37	"	1.05	0.23	0.04	1.96	2.57	1.25	"	"
54	Column form work gang size. Labourers (No)	A	G=23	1	3	1.19	0.25	2.074	2.819	8.0	Reject Ho; Accept Ha	Reject Ho; Accept Ha
			NG=47	"	1.79	0.63	0.09	1.96	2.57	8.78	"	"
		C	G=11	"	2	0	0	2.28	3.16	0	Accept Ho; Reject Ha	Accept Ho; Reject Ha
			NG=45	"	1.87	0.41	0.06	1.96	2.57	14.5	Reject Ho; Accept Ha	Reject Ho; Accept Ha
		N	G=43	"	2	0.22	0.03	1.96	2.57	33.33	"	"
			NG=37	"	2.03	0.56	0.09	1.96	2.57	11.44	"	"
55	Fixing sides of foundations: form work output per hour (M²)	A	G=23	1.5	5.39	3.05	0.64	2.074	2.819	6.08	"	"
			NG=47	"	8.81	12.44	1.81	1.96	2.57	4.04	"	"
		C	G=11	"	4.61	2.63	0.79	2.28	3.16	3.94	"	"
			NG=45	"	17.74	26.14	3.90	1.96	2.57	4.16	"	"
		N	G=43	"	5.41	5.58	0.85	1.96	2.57	4.60	"	"
			NG=37	"	5.16	3.18	0.52	1.96	2.57	7.04	"	"
56	Stripping sides of foundations. Form work output per hour (M²)	A	G=23	0.75	10.04	20.28	4.23	2.074	2.819	2.20	Reject Ho; Accept Ha	Reject Ho; Accept Ha
			NG=47	"	13.71	26.91	3.93	1.96	2.57	3.30	Reject Ho; Accept Ha	Reject Ho; Accept Ha
		C	G=11	"	8.55	12.88	3.88	2.28	3.16	2.01	Accept Ho; Reject Ha	Accept Ho; Reject Ha
			NG=45	"	28.19	47.14	7.03	1.96	2.57	3.90	Reject Ho; Accept Ha	Reject Ho; Accept Ha
		N	G=43	"	7.45	9.28	1.42	1.96	2.57	4.72	"	"
			NG=37	"	5.21	2.46	0.40	1.96	2.57	11.15	"	"
57	Gang size: Fixing and stripping foundation form work: Carpenters (No)	A	G=23	"1	2	0.43	0.09	2.074	2.819	11.11	"	"
			NG=47	"	1.17	0.44	0.06	1.96	2.57	2.83	"	"
		C	G=11	"	1	0	0	2.28	3.16	0	Accept Ho; Reject Ha	Accept Ho; Reject Ha
			NG=45	"	1.09	0.29	0.04	1.96	2.57	2.25	Reject Ho; Accept Ha	"
		N	G=43	"	1	0.52	0.08	1.96	2.57	0	Accept Ho; Reject Ha	Accept Ho; Reject Ha
			NG=37	"	1.05	0.23	0.04	1.96	2.57	1.25	"	"

All μ_o – values source : 49-93 Smith R.C. (1986) ; Source: Field survey 2005

[illegible] 6.4: The effect of education levels on resource mix site mixed insitu concreting and its related construction activities by construction firms [illegible] Kenya

[Where A = African Firms, C = Citizen Firms, N = Non-citizen Firms; G= Graduate; NG= Nongraduates]

$$s = \sqrt{\frac{\sum (X - \bar{X})^2}{n-1}}$$ = sample standard deviation.

[illegible] activity: Insitu Concrete Work (Mixing on Site)

No.	Activity	Sample Size (n)		μ_o	$\bar{X}$	S	$\delta_{\bar{x}} = \frac{s}{\sqrt{n}}$	Critical (e)		Actual Z_e	DECISION : TWO TAILED TEST	
								$Z_{0.025}$ $t_{0.025}$	$Z_{0.005}$ $t_{0.005}$	t_e	$Z_e > Z_a$: Accept H_0: Reject H_a $Z_e < Z_e$:	
											Confidence 95%	Confidence 99%
[illegible]	Gang size: Fixing and stripping foundation form work: Labourers (No)	A	G=23	1	3	1.25	0.26	2.074	2.819	7.69	Reject Ho; Accept Ha	Reject Ho; Accept Ha
			NG=47	"	1.74	0.65	0.09	1.96	2.57	8.22	"	"
		C	G=11	"	1	0	0	2.28	3.16	0	Accept Ho; Reject Ha	Accept Ho; Reject Ha
			NG=45	"	1.80	0.46	0.07	1.96	2.57	11.43	Reject Ho; Accept Ha	Reject Ho; Accept Ha
		N	G=43	"	1	0.35	0.05	1.96	2.57	0	Accept Ho; Reject Ha	Accept Ho; Reject Ha
			NG=37	"	1.97	0.45	0.07	1.96	2.57	13.86	Reject Ho; Accept Ha	Reject Ho; Accept Ha
[illegible]	Fixing form work to soffits of slabs ≥ 3.50m high in (m^2)	A	G=23	2.04	4.04	1.59	0.33	2.074	2.819	6.06	"	"
			NG=47	"	5.11	2.92	0.43	1.96	2.57	7.14	"	"
		C	G=11	"	4.86	1.94	0.58	2.28	3.16	4.86	"	"
			NG=45	"	8.34	9.35	1.39	1.96	2.57	4.53	"	"
		N	G=43	"	5.74	5.24	0.80	1.96	2.57	4.63	"	"
			NG=37	"	4.35	1.32	0.22	1.96	2.57	10.50	"	"
70	Stripping form work to soffits of slabs ≥ 3.50m high output/hr (m^2)	A	G=23	1.02	5.30	2.54	0.53	2.074	2.819	8.08	"	"
			NG=47	"	6.84	7.22	1.05	1.96	2.57	5.54	"	"
		C	G=11	"	6.55	6.45	1.94	2.28	3.16	2.85	"	"
			NG=45	"	10.27	11.98	1.79	1.96	2.57	5.17	"	"
		N	G=43	"	7.95	10.14	1.55	1.96	2.57	4.47	"	"
			NG=37	"	4.81	1.34	0.22	1.96	2.57	17.23	"	"
71	Gangsize: fixing and stripping soffits of slabs ≥ 3.50m high: Carpenters (No)	A	G=23	1	2	0.74	0.15	2.074	2.819	6.67	"	"
			NG=47	"	1.28	0.59	0.09	1.96	2.57	3.11	"	"
		C	G=11	"	1	0.32	0.10	2.28	3.16	0	Accept Ho Reject Ho	Accept Ho Reject Ho
			NG=45	"	1.11	0.39	0.06	1.96	2.57	1.83	"	"
		N	G=43	"	1	0.52	0.08	1.96	2.57	0	"	"
			NG=37	"	1.30	1.26	0.21	1.96	2.57	1.43	"	"
72	Gang size: Fixing and stripping soffits slabs ≥ 3.50m high Labourers (No)	A	G=23	1	3	2.51	0.52	2.074	2.819	3.85	Reject Ho Accept Ha	Reject Ho Accept Ha
			NG=47	"	2.06	1.04	0.15	1.96	2.57	7.07	"	"
		C	G=11	"	2.0	0.63	0.19	2.28	3.16	5.26	"	"
			NG=45	"	1.91	0.64	0.10	1.96	2.57	9.10	"	"
		N	G=43	"	2.0	0.64	0.10	1.96	2.57	10.0	"	"
			NG=37	"	1.92	0.69	0.11	1.96	2.57	8.36	"	"
73	Fixing form work to sides and soffits of beams ≥ 3.50 m high output/hr (M^2)	A	G=23	2.04	3.07	1.73	0.36	2.074	2.819	2.86	"	"
			NG=47	"	4.27	3.24	0.47	1.96	2.57	4.74	"	"
		C	G=11	"	3.0	2.63	0.79	2.28	3.16	1.22	Accept Ho Reject Ho	Accept Ho Reject Ho
			NG=45	"	5.20	6.08	0.91	1.96	2.57	3.47	Reject Ho Accept Ha	Reject Ho Accept Ha
		N	G=43	"	2.72	1.41	0.22	1.96	2.57	3.09	"	
			NG=37	"	3.43	1.93	0.32	1.96	2.57	4.34	"	

All μ_o – values source : 49-93 Smith R.C. (1986) ; Source: Field survey 2005

Table 6.6: The effect of education levels on resource mix site mixed insitu concreting and its related construction activities by construction firms in Kenya

[where A = African Firms, C = Citizen Firms, N = Non-citizen Firms; G= Graduate; NG= Nongraduates]

$$s = \sqrt{\frac{\sum (X - \bar{X})^2}{n-1}}$$ = sample standard deviation.

Main activity: Insitu Concrete Work (Mixing on Site)

	Activity	Sample Size (n)		μ_o	$\bar{X}$	S	$\delta_{\bar{x}} = \frac{s}{\sqrt{n}}$	Critical (e)		Actual Z_a	DECISION : TWO TAILED TEST	
								$Z_{0.025}$ $t_{0.025}$	$Z_{0.005}$ $t_{0.005}$	t_a	$Z_e > Z_a$: Accept H_0; Reject H_a $Z_e < Z_a$:	
											Confidence 95%	Confidence 99%
74	Stripping form work to sides & beams ≥3.50m high: output/hr (M²)	A	G=23	1.02	4.06	3.82	0.80	2.074	2.819	3.80	"	"
			NG=47	"	5.40	7.01	1.02	1.96	2.57	4.29	"	"
		C	G=11	"	2.72	1.02	0.31	2.28	3.16	5.48	"	"
			NG=45	"	7.01	9.26	1.38	1.96	2.57	4.34	"	"
		N	G=43	"	5.23	6.80	1.04	1.96	2.57	4.05	"	"
			NG=37	"	3.68	1.98	0.33	1.96	2.57	8.06	"	"
75	Gangsize: fixing and stripping form work to sides & soffits of beams≥ 3.5m high carpenters (No)	A	G=23	1	2.0	0.86	0.18	2.074	2.819	5.56	"	"
			NG=47	"	1.32	0.67	0.10	1.96	2.57	3.20	"	"
		C	G=11	"	1.0	0.32	0.10	2.28	3.16	0	Accept Ho Reject Ho	Accept Ho Reject Ho
			NG=45	"	1.13	0.41	0.06	1.96	2.57	2.17	"	"
		N	G=43	"	2.0	0.62	0.10	1.96	2.57	10.0	Reject Ho Accept Ha	Reject Ho Accept Ha
			NG=37	"	1.24	0.44	0.07	1.96	2.57	3.43	"	"
76	Gang size fixing and stripping form work to sides and soffits of beams ≥ 3.5m high labourers (No)	A	G=23	1	3.0	1.79	0.37	2.074	2.819	5.41	"	"
			NG=47	"	2.06	0.95	0.14	1.96	2.57	7.57	"	"
		C	G=11	"	2.0	0.63	0.19	2.28	3.16	5.26	"	"
			NG=45	"	1.93	0.62	0.09	1.96	2.57	10.33	"	"
		N	G=43	"	2.0	0.52	0.08	1.96	2.57	12.50	"	"
			NG=37	"	1.97	0.62	0.10	1.96	2.57	9.70	"	"
77	Waste factor (%) for timber size 50mm x 50mm (%)	A	G=23	5	11.39	6.00	1.25	2.074	2.819	5.11	"	"
			NG=47	"	4.11	0.63	0.09	1.96	2.57	-9.89	"	"
		C	G=11	"	13	3.67	1.11	2.28	3.16	7.21	"	"
			NG=45	"	10.87	5.24	0.78	1.96	2.57	7.53	"	"
		N	G=43	"	11.21	5.63	0.86	1.96	2.57	7.22	"	"
			NG=37	"	11.19	6.12	1.00	1.96	2.57	6.19	"	"
78	Waste factor for 50mm x 75mm timber (%)	A	G=23	5	10.57	4.46	0.93	2.074	2.819	5.99	"	"
			NG=47	"	0.68	0.10	0.01	1.96	2.57	-432.0	"	"
		C	G=11	"	13	3.67	1.11	2.28	3.16	7.21	"	"
			NG=45	"	11.11	5.67	0.86	1.96	2.57	7.11	"	"
		N	G=43	"	11.21	5.63	0.86	1.96	2.57	7.22	"	"
			NG=37	"	11.35	6.84	1.12	1.96	2.57	5.67	"	"
79	Waste factor for 50x100mm timber (%)	A	G=23	5	10.91	5.56	1.16	2.074	2.819	5.09	"	"
			NG=47	"	1.28	0.12	0.02	1.96	2.57	-186.0	"	"
		C	G=11	"	12.27	4.30	1.30	2.28	3.16	5.59	"	"
			NG=45	"	10.93	5.45	0.81	1.96	2.57	7.32	"	"
		N	G=43	"	10.98	5.46	0.83	1.96	2.57	7.21	"	"
			NG=37	"	11.49	6.84	1.12	1.96	2.57	5.79	"	"
80	Waste factor for 50mm x 150mm timber (%)	A	G=23	5	10.52	5.03	1.05	2.074	2.819	5.26	"	"
			NG=47	"	0.65	0.10	0.01	1.96	2.57	-435.0	"	"
		C	G=11	"	13	3.67	1.11	2.28	3.16	7.21	"	"
			NG=45	"	11.25	6.02	0.90	1.96	2.57	6.94	"	"
		N	G=43	"	11.21	5.84	0.89	1.96	2.57	6.98	"	"
			NG=37	"	11.05	6.51	1.07	1.96	2.57	5.65	"	"

All μ_o – values source : 49-93 Smith R.C. (1986) ; Source: Field survey 2005

Table 5.5: The effect of education levels on resource mix site mixed insitu concreting and its related construction activities by construction firms in Kenya

[where A = African Firms, C = Citizen Firms, N = Non-citizen Firms; G= Graduate; NG= Nongraduates]

$$s = \sqrt{\frac{\sum (X - \bar{X})^2}{n-1}}$$ = sample standard deviation.

Main activity: Insitu Concrete Work (Mixing on Site)

	Activity	Sample Size (n)		μ_o	$\bar{X}$	S	$\delta_{\bar{X}} = \frac{s}{\sqrt{n}}$	Critical (e) $Z_{0.025}$ $t_{0.025}$	Critical (e) $Z_{0.005}$ $t_{0.005}$	Actual Z_a t_a	DECISION : TWO TAILED TEST $Z_e > Z_a$: Accept H_0; Reject H_a $Z_e < Z_a$: Confidence 95%	Confidence 99%
11	Reinforcement bars: Waste (%) / kg: 6mm-10mm bars	A	G=23	2	5.65	2.07	0.43	2.074	2.819	8.49	"	"
			NG=47	"	5.63	0.86	0.13	1.96	2.57	27.92	"	"
		C	G=11	"	9.09	3.94	1.19	2.28	3.16	5.96	"	"
			NG=45	"	8.33	4.13	0.62	1.96	2.57	10.21	"	"
		N	G=43	"	7.42	3.22	0.49	1.96	2.57	11.06	"	"
			NG=37	"	7.43	3.07	0.50	1.96	2.57	10.86	"	"
12	Reinforcement bars waste (%) /kg 12-16 mm bars	A	G=23	2	5.52	2.07	0.43	2.074	2.819	8.19	"	"
			NG=47	"	0.64	0.11	0.02	1.96	2.57	-68.0	"	"
		C	G=11	"	8.86	4.29	1.29	2.28	3.16	5.32	"	"
			NG=45	"	8.38	4.10	0.61	1.96	2.57	10.46	"	"
		N	G=43	"	7.42	3.22	0.49	1.96	2.57	10.06	"	"
			NG=37	"	7.16	3.06	0.50	1.96	2.57	10.32	"	"
13	Reinforcement bars waste (%) 20mm-32mm bars	A	G=23	2	5.5	3.02	0.63	2.074	2.819	5.56	"	"
			NG=47	"	1.21	0.13	0.02	1.96	2.57	-39.50	"	"
		C	G=11	"	8.86	4.29	1.29	2.28	3.16	5.32	"	"
			NG=45	"	8.44	4.11	0.61	1.96	2.57	10.56	"	"
		N	G=43	"	7.42	3.22	0.49	1.96	2.57	11.06	"	"
			NG=37	"	7.03	3.04	0.50	1.96	2.57	10.06	"	"
14	Black tying wire: 50kg rolls/tonne of reinforcement	A	G=23	0.16	0.34	0.46	0.10	2.074	2.819	1.80	"	"
			NG=47	"	0.60	0.08	0.11	1.96	2.57	4.0	"	"
		C	G=11	"	0.14	3.01	0.91	2.28	3.16	-0.02	Accept Ho Reject Ha	Accept Ho Reject Ha
			NG=45	"	8.24	3.26	0.49	1.96	2.57	16.49	Reject Ho Accept Ha	Reject Ho Accept Ha
		N	G=43	"	0.19	0.15	0.02	1.96	2.57	1.50	Accept Ho Reject Ha	Accept Ho Reject Ha
			NG=37	"	0.16	0.05	0.01	1.96	2.57	0	"	"
15	Black tying wre: 25kg rolls/tonne of reinforcement.	A	G=23	0.32	0.51	0.54	0.11	2.074	2.819	1.73	"	"
			NG=47	"	7.07	1.15	0.17	1.96	2.57	39.71	Reject Ho Accept Ha	Reject Ho Accept Ha
		C	G=11	"	0.13	2.67	0.81	2.28	3.16	-0.23	Accept Ho Reject Ha	Accept Ho Reject Ha
			NG=45	"	7.29	2.16	0.32	1.96	2.57	21.78	Reject Ho Accept Ha	Reject Ho Accept Ha
		N	G=43	"	0.31	0.32	0.05	1.96	2.57	-0.20	Accept Ho Reject Ha	Accept Ho Reject Ha
			NG=37	"	0.27	0.10	0.02	1.96	2.57	-2.50	"	"
16	Steel fixers Gang size/ tonne of reinforcement (No)	A	G=23	1	3	1.74	0.36	2.074	2.819	5.56	Reject Ho Accept Ha	Reject Ho Accept Ha
			NG=47	"	0.63	0.13	0.02	1.96	2.57	-18.50	"	"
		C	G=11	"	3	1.14	0.34	2.28	3.16	5.88	"	"
			NG=45	"	1.96	0.81	0.12	1.96	2.57	8.0	"	"
		N	G=43	"	2	1.13	0.17	1.96	2.57	5.88	"	"
			NG=37	"	2.08	0.97	0.16	1.96	2.57	6.75	"	"

All μ_o – values source : 49-93 Smith R.C. (1986) ; Source: Field survey 2005

Table 6.6: The effect of education levels on resource mix site mixed insitu concreting and its related construction activities by construction firms in Kenya

Where A = African Firms, C = Citizen Firms, N = Non-citizen Firms; G= Graduate; NG= Nongraduates]

$$s = \sqrt{\frac{\sum (X - \bar{X})^2}{n-1}}$$ = sample standard deviation.

Main activity: Insitu Concrete Work (Mixing on Site)

Activity	Sample Size (n)		μ₀	$\bar{X}$	S	$\delta_{\bar{x}} = \frac{s}{\sqrt{n}}$	Critical (e)		Actual Z_e	DECISION : TWO TAILED TEST	
							$Z_{0.025}$ $t_{0.025}$	$Z_{0.005}$ $t_{0.005}$	te	$Z_e > Z_a$: Accept H_0; Reject H_a $Z_e < Z_a$:	
										Confidence 95%	Confidence 99%
Labour/ Tonne of Reinforcement: Gang size labourers (No)	A	G=23	1	4	2.12	0.44	2.074	2.819	6.82	"	"
		NG=47	"	1.2	0.16	0.02	1.96	2.57	10.0	"	"
	C	G=11	"	6	2.06	0.62	2.28	3.16	8.07	"	"
		NG=45	"	3.31	1.75	0.26	1.96	2.57	8.89	"	"
	N	G=43	"	4	1.99	0.30	1.96	2.57	10.0	"	"
		NG=37	"	3.38	1.34	0.22	1.96	2.57	10.82	"	"
Time taken/ Gang for 1 tonne of Reinforcement (hrs)	A	G=23	20	7.38	5.08	1.06	2.074	2.819	-11.91	"	"
		NG=47	"	0.57	0.08	0.01	1.96	2.57	1943.0	"	"
	C	G=11	"	7.36	3.93	1.18	2.28	3.16	-10.71	"	"
		NG=45	"	5.65	1.68	0.25	1.96	2.57	-57.40	"	"
	N	G=43	"	6.61	2.31	0.35	1.96	2.57	-38.26	"	"
		NG=37	"	6.25	2.14	0.35	1.96	2.57	-39.29	"	"
Idle time/Tonne of reinforcement (hrs)	A	G=23	0	1.03	0.92	0.19	2.074	2.819	5.42	"	"
		NG=47	"	8.36	1.42	0.21	1.96	2.57	39.81	"	"
	C	G=11	"	0.96	0.64	0.19	2.28	3.16	5.05	"	"
		NG=45	"	1.15	1.16	0.17	1.96	2.57	6.76	"	"
	N	G=43	"	1.00	1.07	0.16	1.96	2.57	6.25	"	"
		NG=37	"	1.10	1.14	0.19	1.96	2.57	5.79	"	"
Machine time for cutting of bending 1 tonne of Reinforcement: Gang size: steel fixers (No)	A	G=23	1	2	0.97	0.20	2.074	2.819	5.0	"	"
		NG=47	"	0.58	0.18	0.03	1.96	2.57	-14.0	"	"
	C	G=11	"	2	0.71	0.21	2.28	3.16	4.76	"	"
		NG=45	"	1.6	0.66	0.10	1.96	2.57	6.0	"	"
	N	G=43	"	2	0.68	0.10	1.96	2.57	10.0	"	"
		NG=37	"	1.62	0.87	0.14	1.96	2.57	4.43	"	"
Machine cutting and bending 1 tonne of Reift. Gangsize: Labourers (No)	A	G=23	1	4	2.03	0.42	2.074	2.819	7.14	"	"
		NG=47	"	1.25	0.3	0.04	1.96	2.57	6.25	"	"
	C	G=11	"	3	1.41	0.43	2.28	3.16	4.65	"	"
		NG=45	"	2.75	1.22	0.18	1.96	2.57	9.72	"	"
	N	G=43	"	3	1.92	0.29	1.96	2.57	6.90	"	"
		NG=37	"	3.73	2.02	0.33	1.96	2.57	8.27	"	"
Time taken by gang for cutting and bending 1 tonne of Reinforcement (Hrs)	A	G=23	35	4.60	6.44	1.34	2.074	2.819	-22.69	"	"
		NG=47	"	0.53	0.08	0.01	1.96	2.57	-3447.0	"	"
	C	G=11	"	3.41	2.69	0.81	2.28	3.16	-39.00	"	"
		NG=45	"	2.56	1.14	0.17	1.96	2.57	-190.82	"	"
	N	G=43	"	3.25	2.19	0.33	1.96	2.57	-96.21	"	"
		NG=37	"	3.36	2.4	0.39	1.96	2.57	-81.13	"	"
Idle time/time of reinforcement cut and bend (hrs)	A	G=23	0	0.93	0.78	0.16	2.074	2.819	5.81	"	"
		NG=47	"	0.90	0.78	0.11	1.96	2.57	8.18	"	"
	C	G=11	"	0.65	0.48	0.14	2.28	3.16	4.64	"	"
		NG=45	"	0.73	0.88	0.13	1.96	2.57	5.62	"	"
	N	G=43	"	0.57	0.48	0.07	1.96	2.57	8.14	"	"
		NG=37	"	0.73	1.12	0.18	1.96	2.57	4.06	"	"

[1] μ₀ – values source : 49-93 Smith R.C. (1986) ; Source: Field survey 2005

Table 6.8:. The effect of education levels on resource mix Walling and its related construction activities by construction firms in Kenya

[where A = African Firms, C = Citizen Firms, N = Non-citizen Firms; G= Graduate; NG= Nongraduates]

$$s = \sqrt{\frac{\sum (X - \bar{X})^2}{n-1}}$$ = sample standard deviation. $$Z = \frac{\bar{X} - \mu o}{s/\sqrt{n}} \text{ or } t = \frac{\bar{X} - \mu o}{s/\sqrt{n}} \quad ; n < 30$$

	Activity	Sample Size (n)		μ_o	$\bar{X}$	S	$\delta_{\bar{X}} = \frac{s}{\sqrt{n}}$	Critical (e)		Actual Z_o	DECISION : TWO TAILED TEST	
								$Z_{0.025}$ t0.025	$Z_{0.005}$ to 0.005	t/z	$Z_e > Z_o$: Accept H_o; Reject $H_a Z_e < Z_o$:	
											Confidence 95%	Confidence 99%
1	200x200x 390mm p.c blocks (No/M^2)	A	G=23	12.5	13.46	1.76	0.37	2.074	2.819	2.59	Reject Ho; 95% Accept Ha	Accept Ho: Reject Ha 99%
			NG=47	"	13.73	1.13	0.16	1.96	2.57	7.69	"	Reject Ho; Accept Ha
		C	G=11	"	13.76	1.08	0.33	2.28	3.16	3.82	"	"
			NG=45	"	13.77	2.52	0.38	1.96	2.57	3.34	"	"
		N	G=43	"	13.93	1.48	0.22	1.96	2.57	6.5	"	"
			NG=37	"	14.06	1.61	0.26	1.96	2.57	6.0	"	"
2	Waste on 200x200x 390mm p.c blocks per m^2	A	G=23	5	7.27	4.38	0.91	2.074	2.819	2.49	"	Accept Ho: Reject Ha
			NG=47	"	6.98	3.59	0.52	1.96	2.57	3.81	"	Reject Ho; Accept Ha
		C	G=11	"	8.33	2.56	0.77	2.28	3.16	4.32	"	"
			NG=45	"	7.66	3.32	0.49	1.96	2.57	5.43	"	"
		N	G=43	"	7.57	2.97	0.45	1.96	2.57	5.71	"	"
			NG=37	"	6.68	2.39	0.39	1.96	2.57	4.31	"	"
3	150mmx2 00mmx39 0mm p.c Blocks/m^2	A	G=23	12.5	13.44	1.64	0.34	2.074	2.819	2.76	"	Accept Ho: Reject Ha
			NG=47	"	13.87	1.64	0.24	1.96	2.57	5.71	"	"
		C	G=11	"	13.24	1.15	0.35	2.28	3.16	2.11	Accept Ho: Reject Ha	Accept Ho: Reject Ha
			NG=45	"	14.10	2.28	0.34	1.96	2.57	4.71	Reject Ho; Accept Ha	Reject Ho; Accept Ha
		N	G=43	"	13.74	1.45	0.22	1.96	2.57	5.64	"	"
			NG=37	"	13.94	1.75	0.29	1.96	2.57	4.97	"	"
4	Waste on 150mmx 200mm 390m^2 Blocks per M^2	A	G=23	5	7.38	4.07	0.85	2.074	2.819	2.80	"	Accept Ho: Reject Ha
			NG=47	"	7.83	4.95	0.72	1.96	2.57	3.93	"	Reject Ho; Accept Ha
		C	G=11	"	8.33	2.56	0.77	2.28	3.16	4.32	"	"
			NG=45	"	7.66	3.32	0.49	1.96	2.57	5.43	"	"
		N	G=43	"	7.57	2.97	0.45	1.96	2.57	5.71	"	"
			NG=37	"	7.01	2.98	0.49	1.96	2.57	4.10	"	"
5	100x200x 390mm p.c blocks (No/M^2)	A	G=23	12.5	13.35	1.32	0.28	2.074	2.819	3.04	"	"
			NG=47	"	13.75	1.62	0.24	1.96	2.57	5.20	"	"
		C	G=11	"	13.18	1.40	0.42	2.28	3.16	1.62	Accept Ho: Reject Ha	Accept Ho: Reject Ha
			NG=45	"	14.01	2.21	0.33	1.96	2.57	4.58	Reject Ho; Accept Ha	Reject Ho; Accept Ha
		N	G=43	"	13.81	1.56	0.24	1.96	2.57	5.42	"	"
			NG=37	"	14.15	2.33	0.38	1.96	2.57	4.34	"	"
6	Waste in 100mm thick p.c Blocks per M^2 (%)	A	G=23	5	6.92	3.79	0.79	2.074	2.819	2.43	"	Accept Ho; Reject Ha
			NG=47	"	7.53	3.36	0.49	1.96	2.57	5.16	"	Reject Ho Ho;Accept Ha
		C	G=11	"	10	3.56	1.07	2.28	3.16	4.67	"	"
			NG=45	"	7.39	3.25	0.48	1.96	2.57	4.98	"	"
		N	G=43	"	7.69	2.75	0.42	1.96	2.57	6.41	"	"
			NG=37	"	7.73	3.07	0.50	1.96	2.57	5.46	"	"

μo-values source (1-6): Smith R-C (1986)
Source: Field Survey 2005

Table 6.6: The effect of education levels on resource mix in Walling and its related construction activities by construction firms in Kenya

[Where A = African Firms, C = Citizen Firms, N = Non-citizen Firms; G= Graduate; NG= Nongraduates]

$$s = \sqrt{\frac{\sum(X - \bar{X})^2}{n-1}}$$ = sample standard deviation.

	Activity	Sample Size (n)		μ_o	$\bar{X}$	S	$\delta_{\bar{x}} = \frac{s}{\sqrt{n}}$	Critical (e)		Actual Z_a	DECISION : TWO TAILED TEST	
								$Z_{0.025}$ $t_{0.025}$	$Z_{0.005}$ $t_{0.005}$	ta	$Z_e > Z_a$: Accept H_0; Reject H_a $Z_e < Z_a$: Confidence 95%	Confidence 99%
7	200mm thick stone walls (Ft.m²)	A	G=23	14.6	15.8	1.58	0.33	2.074	2.819	3.64	"	"
			NG=47	"	16.30	1.26	0.18	1.96	2.57	9.44	"	"
		C	G=11	"	16.61	0.90	0.27	2.28	3.16	7.44	"	"
			NG=45	"	16.61	1.83	0.27	1.96	2.57	7.44	"	"
		N	G=43	"	16.58	1.67	0.25	1.96	2.57	7.92	"	"
			NG=37	"	16.45	1.18	0.19	1.96	2.57	9.74	"	"
8	Waste on 200mm thick stone walls/m² (%)	A	G=23	12.5	7.39	7.73	1.61	2.074	2.819	-3.17	"	"
			NG=47	"	8.07	5.84	0.85	1.96	2.57	-5.21	"	"
		C	G=11	"	9.67	4.19	1.26	2.28	3.16	-2.25	"	"
			NG=45	"	7.68	3.51	0.52	1.96	2.57	-9.27	"	"
		N	G=43	"	7.85	4.13	0.63	1.96	2.57	-7.38	"	"
			NG=37	"	6.49	2.89	0.48	1.96	2.57	-12.52	"	"
9	150mm thick stone walls (Feet/M²)	A	G=23	14.6	16.28	1.93	0.40	2.074	2.819	4.20	"	"
			NG=47	"	16.16	1.35	0.20	1.96	2.57	7.80	"	"
		C	G=11	"	16.38	0.97	0.29	2.28	3.16	6.14	"	"
			NG=45	"	16.66	1.95	0.29	1.96	2.57	7.10	"	"
		N	G=43	"	16.56	1.55	0.24	1.96	2.57	8.16	"	"
			NG=37	"	15.66	2.59	0.43	1.96	2.57	2.47	"	Accept Ho; Reject Ha
10	Waste on 150mm stone walls/M² (%)	A	G=23	12.5	7.04	5.46	1.14	2.074	2.819	-4.09	"	Reject Ho; Accept Ha
			NG=47	"	7.95	5.39	0.79	1.96	2.57	-5.76	"	"
		C	G=11	"	9.67	4.19	1.26	2.28	3.16	-2.25	Accept Ho; Reject Ha	Accept Ho; Reject Ha
			NG=45	"	7.86	8.65	1.29	1.96	2.57	-3.60	Reject Ho; Accept Ha	Reject Ho; Accept Ha
		N	G=43	"	7.97	4.54	0.69	1.96	2.57	-6.57	"	"
			NG=37	"	6.62	2.94	0.48	1.96	2.57	-12.25	"	"
11	10mm stone walls (Ft/ m²)	A	G=23	14.6	16.26	3.24	0.68	2.074	2.819	2.44	"	Accept Ho; 99% Reject Ha
			NG=47	"	16.14	1.92	0.28	1.96	2.57	6.16	"	Reject Ho; Accept Ha
		C	G=11	"	16.08	1.20	0.36	2.28	3.16	4.11	"	"
			NG=45	"	16.10	2.52	0.38	1.96	2.57	3.95	"	"
		N	G=43	"	16.44	1.57	0.24	1.96	2.57	7.67	"	"
			NG=37	"	16.58	1.20	0.20	1.96	2.57	9.90	"	"
12	Waste on 100mm stone walls/M² (%)	A	G=23	12.5	6.94	4.64	0.97	2.074	2.819	-5.73	"	"
			NG=47	"	7.74	4.82	0.70	1.96	2.57	-6.80	"	"
		C	G=11	"	12	11.69	3.52	2.28	3.16	-0.14	Accept Ho; Reject Ha	Accept Ho; Reject Ha
			NG=45	"	7.52	3.54	0.53	1.96	2.57	-9.40	Reject Ho; Accept Ha	Reject Ho; Accept Ha
		N	G=43	"	8.08	5.04	0.77	1.96	2.57	-5.74	"	"
			NG=37	"	6.76	2.98	0.79	1.96	2.57	-11.71	"	"

μ_o-values (7-12): Hugh Enterkin & Reynolds (1978)
Source: Field Survey 2005

Table 6.6: The effect of education levels on resource mix in Walling and its related construction activities by construction firms in Kenya

[where A = African Firms, C = Citizen Firms, N = Non-citizen Firms; G= Graduate; NG= Nongraduates]

$$s = \sqrt{\frac{\sum (X - \bar{X})^2}{n-1}}$$ = sample standard deviation.

	Activity	Sample Size (n)		μ_o	$\bar{X}$	S	$\delta_{\bar{x}} = \frac{s}{\sqrt{n}}$	Critical (e)		Actual Z_a	DECISION : TWO TAILED TEST	
								$Z_{0.025}$ $t_{0.025}$	$Z_{0.005}$ $t_{0.005}$	=	$Z_c > Z_a$: Accept H_0: Reject H_a $Z_a < Z_c$:	
											Confidence 95%	Confidence 99%
13	Gang size: For walls: Mason (No)	A	G=23	2	1	0.44	0.09	2.074	2.819	-11.11	"	"
			NG=47	"	1	0.17	0.02	1.96	2.57	-50.0	"	"
		C	G=11	"	1	0.00	0	2.28	3.16	-α	"	"
			NG=45	"	1	0.30	0.04	1.96	2.57	-25.0	"	"
		N	G=43	"	1	0.26	0.04	1.96	2.57	-25.0	"	"
			NG=37	"	1	0.17	0.03	1.96	2.57	-33.33	"	"
14	Gang size for walls labourers (No)	A	G=23	1	2	1.11	0.23	2.074	2.819	4.35	"	"
			NG=47	"	2	0.35	0.05	1.96	2.57	20.0	"	"
		C	G=11	"	2	0.32	0.10	2.28	3.16	10.0	"	"
			NG=45	"	2	0.45	0.07	1.96	2.57	14.29	"	"
		N	G=43	"	2	0.45	0.07	1.96	2.57	14.29	"	"
			NG=37	"	2	0.35	0.06	1.96	2.57	16.67	"	"
15	Output/ Gang for 200mm walls/day (m^2)	A	G=23	8.9	8.12	2.06	0.43	2.074	2.819	-1.81	Accept Ho; Reject Ha	Accept Ho; Reject Ha
			NG=47	"	8.03	1.97	0.29	1.96	2.57	-3.0	Reject Ho; Accept Ha	Reject Ho; Accept Ha
		C	G=11	"	8.23	2.50	0.75	2.28	3.16	-0.89	Accept Ho; Reject Ha	Accept Ho; Reject Ha
			NG=45	"	9.24	5.71	0.85	1.96	2.57	0.40	"	"
		N	G=43	"	7.44	1.76	0.27	1.96	2.57	-5.41	Reject Ho; Accept Ha	Reject Ho; Accept Ha
			NG=37	"	8.03	1.95	0.32	1.96	2.57	-2.72	"	"
16	Idle time on 200mm walls/ M^2	A	G=23	0	0.13	0.81	0.17	2.074	2.819	0.76	Accept Ho; at Reject Ha	Accept Ho; at Reject Ha
			NG=47	"	0.18	0.14	0.02	1.96	2.57	9.0	Reject Ho. Accept Ha	Reject Ho. Accept Ha
		C	G=11	"	1.50	3.36	1.01	2.28	3.16	1.49	Accept Ho; Reject Ha	Accept Ho; Reject Ha
			NG=45	"	0.30	0.36	0.05	1.96	2.57	6.0	Reject Ho. Accept Ha	Reject Ho. Accept Ha
		N	G=43	"	0.15	0.09	0.01	1.96	2.57	15.0	"	"
			NG=37	"	0.18	0.14	0.02	1.96	2.57	9.00	"	"
17	Idle time on 200mm stone walls per day (hrs)	A	G=23	0	0.58	0.43	0.09	2.074	2.819	6.44	"	"
			NG=47	"	0.48	0.27	0.04	1.96	2.57	12.0	"	"
		C	G=11	"	1.06	0.75	0.23	2.28	3.16	4.61	"	"
			NG=45	"	0.64	0.47	0.07	1.96	2.57	9.14	"	"
		N	G=43	"	0.58	0.33	0.05	1.96	2.57	11.60	"	"
			NG=37	"	0.48	0.27	0.04	1.96	2.57	12.00	"	"
18	Output/ gang on 150mm walls/day (M^2)	A	G=23	12.1	8.38	2.28	0.48	2.074	2.819	-7.75	"	"
			NG=47	"	8.51	2.33	0.34	1.96	2.57	-10.56	"	"
		C	G=11	"	8.58	2.81	0.85	2.28	3.16	-4.14	"	"
			NG=45	"	9.56	5.76	0.86	1.96	2.57	-2.95	"	"
		N	G=43	"	8.72	2.51	0.38	1.96	2.57	-8.89	"	"
			NG=37	"	8.51	2.31	0.38	1.96	2.57	-9.45	"	"

μ_o-values: Sources (13-23) Smith R-C (1986)
Source: Field survey 2005

Table 6.6: The effect of education levels on resource mix Walling and its related construction activities by construction firms in Kenya

[where A = African Firms, C = Citizen Firms, N = Non-citizen Firms; G= Graduate; NG= Nongraduates]

$$s = \sqrt{\frac{\sum (X - \bar{X})^2}{n-1}}$$ = sample standard deviation.

	Activity	Sample Size (n)		μo	$\bar{X}$	S	$\delta_{\bar{x}} = \frac{s}{\sqrt{n}}$	Critical (e) $Z_{0.025}$ t0.025	Critical (e) $Z_{0.005}$ to.005	Actual Z_a tc	Decision : Two Tailed Test $Z_e > Z_a$: Accept H_0; Reject H_a $Z_e < Z_a$: Confidence 95%	Confidence 99%
19	Idle time on 150mm walls/M² (hrs)	A	G=23	0	0.13	0.08	0.02	2.074	2.819	6.50	"	"
			NG=47	"	0.18	0.14	0.02	1.96	2.57	9.0	"	"
		C	G=11	"	1.5	3.36	1.01	2.28	3.16	1.49	Accept Ho; Reject Ha	Accept Ho; Reject Ha
			NG=45	"	0.32	0.39	0.06	1.96	2.57	5.3	Reject Ho. Accept Ha	Reject Ho. Accept Ha
		N	G=43	"	0.15	0.09	0.01	1.96	2.57	15.0	"	"
			NG=37	"	0.18	0.14	0.02	1.96	2.57	9.0	"	"
20	Idle time on 150mm walls/day (hrs)	A	G=23	0	0.58	0.43	0.09	2.074	2.819	6.44	"	"
			NG=47	"	0.47	0.25	0.04	1.96	2.57	11.75	"	"
		C	G=11	"	1.04	0.73	0.22	2.28	3.16	4.73	"	"
			NG=45	"	0.64	0.47	0.07	1.96	2.57	9.14	"	"
		N	G=43	"	0.58	0.3	0.05	1.96	2.57	11.60	"	"
			NG=37	"	0.47	0.25	0.04	1.96	2.57	11.75	"	"
21	Output/ gang for 100mm walls/ day (m²)	A	G=23	16	9.35	2.94	0.61	2.074	2.819	-10.90	"	"
			NG=47	"	8.54	2.82	0.41	1.96	2.57	-18.20	"	"
		C	G=11	"	8.99	3.12	0.94	2.28	3.16	-7.46	"	"
			NG=45	"	9.33	4.7	0.70	1.96	2.57	-9.53	"	"
		N	G=43	"	9.47	3.36	0.51	1.96	2.57	-12.80	"	"
			NG=37	"	8.54	2.79	0.46	1.96	2.57	-16.22	"	"
22	Idle time on 100m walls/ m² (Hrs)	A	G=23	0	0.18	0.16	0.03	2.074	2.819	6.0	"	"
			NG=47	"	0.16	0.13	0.02	1.96	2.57	1.23	Accept Ho; Reject Ha	Accept Ho; Reject Ha
		C	G=11	"	1.49	3.37	1.02	2.28	3.16	1.46	"	"
			NG=45	"	0.34	0.43	0.06	1.96	2.57	5.67	Reject Ho; Accept Ha	Reject Ho; Accept Ha
		N	G=43	"	0.14	0.09	0.01	1.96	2.57	14.0	"	"
			NG=37	"	0.16	0.13	0.02	1.96	2.57	8.0	"	"
23	Idle time for 100mm walls/ day (hrs)	A	G=23	0	0.56	0.4	0.08	2.074	2.819	7.0	"	"
			NG=47	"	0.53	0.36	0.05	1.96	2.57	10.60	"	"
		C	G=11	"	1.02	0.72	0.22	2.28	3.16	4.64	"	"
			NG=45	"	0.65	0.47	0.07	1.96	2.57	9.29	"	"
		N	G=43	"	0.56	0.28	0.04	1.96	2.57	14.0	"	"
			NG=37	"	0.53	0.35	0.06	1.96	2.57	8.83	"	"
24	Output/gang on 200mm stone walls per day (m²)	A	G=23	6.77	7.92	1.92	0.40	2.074	2.819	2.88	"	"
			NG=47	"	7.68	2.06	0.30	1.96	2.57	3.03	"	"
		C	G=11	"	8.18	1.92	0.57	2.28	3.16	2.47	"	Accept Ho; Reject Ha
			NG=45	"	9.42	5.54	0.83	1.96	2.57	3.19	"	Reject Ho; Accept Ha
		N	G=43	"	7.81	1.88	0.29	1.96	2.57	3.59	"	Reject Ho; Accept Ha
			NG=37	"	7.68	2.04	0.34	1.96	2.57	2.68	"	"
25	Idle time on 200mm stone walls/ m² (hrs)	A	G=23	0	0.18	0.18	0.04	2.074	2.819	4.50	"	"
			NG=47	"	0.16	0.14	0.02	1.96	2.57	8.0	"	"
		C	G=11	"	1.51	3.36	1.01	2.28	3.16	1.50	Accept Ho; Reject Ha	Accept Ho; Reject Ha
			NG=45	"	0.31	0.35	0.05	1.96	2.57	6.20	Reject Ho; Accept Ha	Reject Ho; Accept Ha
		N	G=43	"	0.16	0.10	0.02	1.96	2.57	8.0	"	"
			NG=37	"	0.16	0.14	0.02	1.96	2.57	8.0	"	"

μo - values ; Source (24-32). Enterkin Hugh & Reynolds (1978) ; Source: Field survey 2005

Table 6.8: The effect of education levels on resource mix Walling and its related construction activities by construction firms in Kenya

[where A = African Firms, C = Citizen Firms, N = Non-citizen Firms; G= Graduate; NG= Nongraduates]

$$s = \sqrt{\frac{\sum (X - \bar{X})^2}{n-1}}$$ = sample standard deviation.

No.	Activity	Sample Size (n)		μ_o	$\bar{X}$	S	$\delta_{\bar{x}} = \frac{s}{\sqrt{n}}$	Critical (e)		Actual Z_e	DECISION : TWO TAILED TEST	
								$Z_{0.025}$ $t_{0.025}$	$Z_{0.005}$ $t_{0.005}$		$Z_e > Z_e$: Accept H_0: Reject H_a $Z_e < Z_e$:	
											Confidence 95%	Confidence 99%
26	Idle time on 200mm stone walls/ m^2	A	G=23	0	0.64	0.41	0.09	2.074	2.819	7.11	"	"
			NG=47	"	0.49	0.27	0.04	1.96	2.57	12.25	"	"
		C	G=11	"	1.12	0.81	0.24	2.28	3.16	4.67	"	"
			NG=45	"	0.64	0.47	0.07	1.96	2.57	9.14	"	"
		N	G=43	"	0.58	0.29	0.04	1.96	2.57	14.50	"	"
			NG=37	"	0.49	0.27	0.04	1.96	2.57	12.25	"	"
27	Output/gang on 150mm stone walls mm per day (m^2)	A	G=23	6.77	9.18	2.91	0.61	2.074	2.819	3.95	"	"
			NG=47	"	8.70	2.49	0.36	1.96	2.57	5.36	"	"
		C	G=11	"	8.45	2.27	0.68	2.28	3.16	2.47	"	Accept Ho; Reject Ha
			NG=45	"	9.58	5.73	0.85	1.96	2.57	3.31	"	Reject Ho; Accept Ha
		N	G=43	"	8.63	2.67	0.41	1.96	2.57	4.54	"	"
			NG=37	"	8.70	2.47	0.41	1.96	2.57	4.71	"	"
28	Idle time on 150mm stone walls/ m^2 (hrs)	A	G=23	0	0.18	0.16	0.03	2.074	2.819	6.0	"	"
			NG=47	"	0.17	0.14	0.02	1.96	2.57	8.50	"	"
		C	G=11	"	1.51	3.36	1.01	2.28	3.16	1.50	Accept Ho; Reject Ha	Accept Ho; Reject Ha
			NG=45	"	0.31	0.35	0.05	1.96	2.57	6.20	Reject Ho; Accept Ha	Reject Ho; Accept Ha
		N	G=43	"	0.15	0.09	0.01	1.96	2.57	15.0		
			NG=37	"	0.17	0.14	0.02	1.96	2.57	8.50	"	"
29	Idle time on 150mm stone walls/ m^2 (hrs)	A	G=23	0	0.58	0.42	0.09	2.074	2.819	6.44	"	"
			NG=47	"	0.46	0.25	0.04	1.96	2.57	11.50	"	"
		C	G=11	"	1.02	0.72	0.22	2.28	3.16	4.64	"	"
			NG=45	"	0.65	0.47	0.07	1.96	2.57	9.29	"	"
		N	G=43	"	0.56	0.28	0.04	1.96	2.57	14.0	"	"
			NG=37	"	0.46	0.25	0.04	1.96	2.57	11.50	"	"
30	Output/ gang on 100mm stone walls per day (m^2)	A	G=23	13	9.03	3.33	0.69	2.074	2.819	-5.76	"	"
			NG=47	"	8.78	3.24	0.47	1.96	2.57	-8.98	"	"
		C	G=11	"	9.0	3.04	0.92	2.28	3.16	-4.35	"	"
			NG=45	"	9.60	4.62	0.69	1.96	2.57	-4.93	"	"
		N	G=43	"	9.55	3.33	0.51	1.96	2.57	-6.76	"	"
			NG=37	"	8.78	3.20	0.53	1.96	2.57	-7.96	"	"
31	Idle time on 100mm stone walls/ m^2 (hrs)	A	G=23	0	0.18	0.15	0.03	2.074	2.819	6.0	"	"
			NG=47	"	0.17	0.14	0.02	1.96	2.57	8.50	"	"
		C	G=11	"	1.51	3.36	1.01	2.28	3.16	1.50	Accept Ho Reject Ho	Accept Ho Reject Ho
			NG=45	"	0.32	0.35	0.05	1.96	2.57	6.40	Reject Ho Accept Ha	Reject Ho Accept Ha
		N	G=43	"	0.15	0.09	0.01	1.96	2.57	15.0	"	"
			NG=37	"	0.17	0.14	0.02	1.96	2.57	8.50	"	"
32	Idle time on 100mm stone walls/ m^2 (hrs)	A	G=23	0	0.61	0.42	0.09	2.074	2.819	6.78	"	"
			NG=47	"	0.51	0.32	0.05	1.96	2.57	10.20	"	"
		C	G=11	"	1.14	0.85	0.26	2.28	3.16	4.38	"	"
			NG=45	"	0.65	0.47	0.07	1.96	2.57	9.29	"	"
		N	G=43	"	0.58	0.28	0.04	1.96	2.57	14.50	"	"
			NG=37	"	0.51	0.32	0.05	1.96	2.57	10.20	"	"

μ_o - values ; Source (24-32). Enterkin Hugh & Reynolds (1978) ; Source: Field survey 2005

Table 6.6: The effect of education levels on resource mix Walling and its related construction activities by construction firms in Kenya

[where A = African Firms, C = Citizen Firms, N = Non-citizen Firms; G= Graduate; NG= Nongraduates]

$$s = \sqrt{\frac{\sum (X - \bar{X})^2}{n-1}}$$ = sample standard deviation.

$$Z = \frac{\bar{X} - \mu o}{s/\sqrt{n}} \quad \text{or} \quad t = \frac{\bar{X} - \mu o}{s/\sqrt{n}}$$

	Activity	Sample Size (n)		μ_o	$\bar{X}$	S	$\delta_{\bar{x}} = \frac{s}{\sqrt{n}}$	Critical (e)		Actual Z_e	DECISION : TWO TAILED TEST	
								$Z_{0.025}$ $t_{0.025}$	$Z_{0.005}$ $t_{0.005}$	t_e	$Z_e > Z_a$: Accept H_0: Reject H_a $Z_e < Z_a$:	
											Confidence 95%	Confidence 99%
33	Mortal (1:3) Materials per m^3 Cement (bags)	A	G=23	10.4	8.27	3.22	0.67	2.074	2.819	-3.18	"	"
			NG=47	"	8.91	2.02	0.29	1.96	2.57	-5.14	"	"
		C	G=11	"	9.41	1.92	0.39	2.28	3.16	-2.54	"	"
			NG=45	"	9.05	1.77	0.26	1.96	2.57	-5.19	"	"
		N	G=43	"	8.53	2.37	0.36	1.96	2.57	-5.19	"	"
			NG=37	"	9.24	1.67	0.27	1.96	2.57	-4.30	"	"
34	Mortal (1:3) Materials per m^3Sand (Tonnes)	A	G=23	0.72	1.48	0.65	0.14	2.074	2.819	5.43	"	"
			NG=47	"	1.71	0.45	0.07	1.96	2.57	14.29	"	"
		C	G=11	"	1.48	0.07	0.02	2.28	3.16	38.0	"	"
			NG=45	"	1.68	0.40	0.06	1.96	2.57	16.0	"	"
		N	G=43	"	1.57	0.29	0.04	1.96	2.57	21.25	"	"
			NG=37	"	1.47	0.37	0.06	1.96	2.57	12.50	"	"
35	on (1:3) Mortar/ m^3 (%)	A	G=23	5	8.57	5.59	1.17	2.074	2.819	3.05	"	"
			NG=47	"	8.76	4.25	0.62	1.96	2.57	6.06	"	"
		C	G=11	"	9.09	3.94	1.19	2.28	3.16	3.44	"	"
			NG=45	"	9.22	4.17	0.62	1.96	2.57	6.81	"	"
		N	G=43	"	9.53	4.53	0.69	1.96	2.57	6.57	"	"
			NG=37	"	7.64	4.31	0.71	1.96	2.57	3.72	"	"
36	Water cement ratio mortar (1:3) Litres/Bag of cement	A	G=23	0.3	0.50	0.17	0.04	2.074	2.819	5.0	"	"
			NG=47	"	0.57	0.13	0.02	1.96	2.57	13.50	"	"
		C	G=11	"	0.64	0.12	0.04	2.28	3.16	8.50	"	"
			NG=45	"	071	0.83	0.12	1.96	2.57	3.42	"	"
		N	G=43	"	0.62	0.12	0.02	1.96	2.57	16.0	"	"
			NG=37	"	0.57	0.10	0.02	1.96	2.57	13.50	"	"
37	Mortar (1:4) materials per m^3 cement in bags	A	G=23	7.8	7.4	2.91	0.61	2.074	2.819	-0.66	Accept Ho Reject Ho	Accept Ho Reject Ho
			NG=47	"	7.94	1.6	0.23	1.96	2.57	0.61	"	"
		C	G=11	"	7.38	2.08	0.63	2.28	3.16	-0.67	"	"
			NG=45	"	8.15	1.21	0.18	1.96	2.57	1.94	"	"
		N	G=43	"	7.64	2.13	0.32	1.96	2.57	-0.50	"	"
			NG=37	"	7.84	1.39	0.23	1.96	2.57	0.17	"	"
38	Mortar (1:4) materials/m^3 Sand in tonnes	A	G=23	0.79	1.53	0.5	0.10	2.074	2.819	7.40	Reject Ho Accept Ha	Reject Ho Accept Ha
			NG=47	"	1.65	0.31	0.05	1.96	2.57	17.20	"	"
		C	G=11	"	1.52	0.1	0.03	2.28	3.16	24.33	"	"
			NG=45	"	1.74	0.45	0.07	1.96	2.57	13.57	"	"
		N	G=43	"	1.72	0.42	0.06	1.96	2.57	15.50	"	"
			NG=37	"	1.63	0.56	0.09	1.96	2.57	9.33	"	"
39	Waste factor on (1:4) mortar/M3 (%)	A	G=23	5	8.13	5.66	1.18	2.074	2.819	1.95	"	"
			NG=47	"	9.07	5.00	0.73	1.96	2.57	5.58	"	"
		C	G=11	"	9.36	3.70	1.12	2.28	3.16	3.89	"	"
			NG=45	"	9.40	4.07	0.61	1.96	2.57	7.21	"	"
		N	G=43	"	9.42	4.58	0.70	1.96	2.57	6.31	"	"
			NG=37	"	7.77	3.95	0.65	1.96	2.57	4.26	"	"
40	Water cement ratio on (1:4) Mortar Litres/Bag	A	G=23	0.3	0.53	0.27	0.06	2.074	2.819	3.83	"	"
			NG=47	"	0.57	0.14	0.02	1.96	2.57	13.50	"	"
		C	G=11	"	0.61	0.13	0.04	2.28	3.16	7.75	"	"
			NG=45	"	0.70	0.68	0.10	1.96	2.57	4.0	"	"
		N	G=43	"	0.60	0.14	0.02	1.96	2.57	15.0	"	"
			NG=37	"	0.58	0.11	0.02	1.96	2.57	14.0	"	"

μ_o – values: Source (33-40) Smith R.C. (1986); Spence Geddes (1978)
Source: Field Survey 2005

Table 6.8: The effect of education levels on resource mix Walling and its related construction activities by construction firms in Kenya

[Where A = African Firms, C = Citizen Firms, N = Non-citizen Firms; G= Graduate; NG= Nongraduates]

$s = \sqrt{\frac{\sum (X - \bar{X})^2}{n-1}}$ = sample standard deviation. $Z = \frac{\bar{X} - \mu o}{s/\sqrt{n}}$ or $t = \frac{\bar{X} - \mu o}{s/\sqrt{n}}$

	Activity	Sample Size (n)		μ_o	$\bar{X}$	S	$\delta_{\bar{x}} = \frac{s}{\sqrt{n}}$	Critical (e)		Actual Z_e	DECISION : TWO TAILED TEST	
								$Z_{0.025}$ $t_{0.025}$	$Z_{0.005}$ $t_{0.005}$	t_e	$Z_e > Z_a$: Accept H_0; Reject H_a $Z_e < Z_a$:	
											Confidence 95%	Confidence 99%
41	Mortar (1:4) materials /m^3 Sand in tonnes	A	G=23	1.4	5.42	2.79	0.58	2.074	2.819	6.93	"	"
			NG=47	"	5.78	2.60	0.38	1.96	2.57	11.52	"	"
		C	G=11	"	4.46	2.31	0.70	2.28	3.16	4.37	Accept Ho Reject Ha	Accept Ho Reject Ha
			NG=45	"	5.91	2.04	0.30	1.96	2.57	15.03	Reject Ho Accept Ha	Reject Ho Accept Ha
		N	G=43	"	5.44	1.98	0.30	1.96	2.57	13.47	"	"
			NG=37	"	6.04	2.31	0.38	1.96	2.57	12.21	"	"
42	Time off for starting mixer 7/5 (hrs)	A	G=23	0.25	0.25	0.12	0.03	2.074	2.819	0	Accept Ho Reject Ha	Accept Ho Reject Ha
			NG=47	"	0.32	0.28	0.04	1.96	2.57	1.75	"	"
		C	G=11	"	0.21	0.04	0.01	2.28	3.16	-4.0	Reject Ho Accept Ha	Accept Ho Reject Ha
			NG=45	"	0.30	0.14	0.02	1.96	2.57	2.50	"	Reject Ho Accept Ha
		N	G=43	"	0.25	0.09	0.01	1.96	2.57	0	"	"
			NG=37	"	0.25	0.10	0.02	1.96	2.57	0	"	"
43	Cleaning time mixer 7/5 (hrs)	A	G=23	0.50	0.43	0.22	0.05	2.074	2.819	-1.40	"	"
			NG=47	"	0.38	0.17	0.02	1.96	2.57	-6.0	Reject Ho Accept Ha	Reject Ho Accept Ha
		C	G=11	"	0.33	0.12	0.04	2.28	3.16	-4.25	"	"
			NG=45	"	0.38	0.13	0.02	1.96	2.57	-6.0	"	"
		N	G=43	"	0.37	0.10	0.02	1.96	2.57	-6.50	"	"
			NG=37	"	0.35	0.13	0.02	1.96	2.57	-7.50	"	"
44	Site idle time per day. Mixer 7/10 (hrs)	A	G=23	0.33	0.52	0.94	0.20	2.074	2.819	0.95	Accept Ho Reject Ha	Accept Ho Reject Ha
			NG=47	"	0.39	0.48	0.07	1.96	2.57	0.86	"	"
		C	G=11	"	0.36	0.54	0.16	2.28	3.16	0.19	"	"
			NG=45	"	0.49	0.52	0.08	1.96	2.57	2.00	Reject Ho Accept Ha	"
		N	G=43	"	0.54	0.10	0.02	1.96	2.57	10.50	"	Reject Ho Accept Ha
			NG=37	"	0.50	051	0.08	1.96	2.57	2.13	"	Accept Ho Reject Ha
45	Mortar: Mixer 10/7 (0.28/0.20) Output/hr (M^3)	A	G=23	2.0	5.74	0.48	0.10	2.074	2.819	37.40	"	Reject Ho Accept Ha
			NG=47	"	7.05	0.43	0.06	1.96	2.57	84.17	"	"
		C	G=11	"	5.52	0.43	0.13	2.28	3.16	27.08	"	"
			NG=45	"	7.04	0.52	0.08	1.96	2.57	63.0	"	"
		N	G=43	"	6.40	0.37	0.06	1.96	2.57	73.33	"	"
			NG=37	"	7.49	0.50	0.08	1.96	2.57	68.63	"	"
46	Time off for starting mixer 10/7	A	G=23	0.25	0.26	3.22	0.67	2.074	2.819	0.01	Accept Ho Reject Ha	Accept Ho Reject Ha
			NG=47	"	0.33	2.70	0.39	1.96	2.57	0.21	"	"
		C	G=11	"	0.21	2.33	0.70	2.28	3.16	-0.06	"	"
			NG=45	"	0.31	1.94	0.29	1.96	2.57	0.21	"	"
		N	G=43	"	0.25	1.94	0.30	1.96	2.57	0	"	"
			NG=37	"	0.26	2.80	0.46	1.96	2.57	0.02	"	"

All μo values ; Source (41-52). Enterkin Hugh & Reynolds (1978) ; Source: Field survey 2005

Table 6.6: The effect of education levels on resource mix Walling and its related construction activities by construction firms in Kenya

[Where A = African Firms, C = Citizen Firms, N = Non-citizen Firms; G= Graduate; NG= Nongraduates]

$$s = \sqrt{\frac{\sum (X - \bar{X})^2}{n - 1}}$$ = sample standard deviation. $$Z = \frac{\bar{X} - \mu o}{s / \sqrt{n}}$$ or $$t = \frac{\bar{X} - \mu o}{s / \sqrt{n}}$$

No.	Activity	Sample Size (n)		μ_o	$\bar{X}$	S	$\delta_{\bar{x}} = \frac{s}{\sqrt{n}}$	Critical (e)		Actual Z_a	DECISION : TWO TAILED TEST	
								$Z_{0.025}$ $t_{0.025}$	$Z_{0.005}$ $t_{0.005}$		$Z_e > Z_a$: Accept H_0: Reject H_a $Z_e < Z_a$:	
											Confidence 95%	Confidence 99%
	Cleaning time (Mix) 10/71 (hrs)	A	G=23	0.5	0.47	0.13	0.67	2.074	2.819	-1.0	Accept Ho Reject Ha	Accept Ho Reject Ha
			NG=47	"	0.41	0.28	0.39	1.96	2.57	-2.25	"	"
		C	G=11	"	0.33	0.04	0.70	2.28	3.16	-17.0	"	"
			NG=45	"	0.40	0.14	0.29	1.96	2.57	-5.0	"	"
		N	G=43	"	0.38	0.11	0.30	1.96	2.57	-6.0	"	"
			NG=37	"	0.38	0.20	0.46	1.96	2.57	-6.0	"	"
48	Site Idle time mixer 10/7 (hrs)	A	G=23	0.33	0.76	0.20	0.04	2.074	2.819	1.08	Accept Ho Reject Ha	Accept Ho Reject Ha
			NG=47	"	0.43	0.17	0.02	1.96	2.57	5.0	Reject Ho Accept Ha	Reject Ho Accept Ha
		C	G=11	"	0.41	0.12	0.04	2.28	3.16	2.0	"	"
			NG=45	"	0.49	0.14	0.02	1.96	2.57	8.0	Accept Ho Reject Ha	Accept Ho Reject Ha
		N	G=43	"	0.67	0.12	0.02	1.96	2.57	17.0	Reject Ho Accept Ha	Reject Ho Accept Ha
			NG=37	"	0.56	0.13	0.02	1.96	2.57	11.50	"	"
49	Mortar mixer 14/10 (0.40/0.28) output per hour (M^3)	A	G=23	2.8	8.46	5.9	1.23	2.074	2.819	4.60	Reject Ho Accept Ha	Reject Ho Accept Ha
			NG=47	-	9.90	4.82	0.70	1.96	2.57	10.14	"	"
		C	G=11	"	7.24	4.82	1.45	2.28	3.16	3.06	Accept Ho Reject Ha	"
			NG=45	"	9.48	4.43	0.66	1.96	2.57	10.12		"
		N	G=43	"	8.18	3.97	0.61	1.96	2.57	8.82	"	"
			NG=37	"	10.80	6.19	1.02	1.96	2.57	7.84	"	"
50	Time off for starting (hrs)	A	G=23	0.25	0.31	0.22	0.05	2.074	2.819	1.20	Accept Ho Reject Ha	Accept Ho Reject Ha
			NG=47	"	0.37	0.28	0.04	1.96	2.57	3.0	Reject Ho Accept Ha	Reject Ho Accept Ha
		C	G=11	"	0.24	0.11	0.03	2.28	3.16	-0.33	Accept Ho Reject Ha	Accept Ho Reject Ha
			NG=45	"	0.31	0.14	0.02	1.96	2.57	3.00	Reject Ho Accept Ha	Reject Ho Accept Ha
		N	G=43	"	0.27	0.13	0.02	1.96	2.57	1.00	Accept Ho Reject Ha	Accept Ho Reject Ha
			NG=37	"	0.25	0.11	0.02	1.96	2.57	0	"	"
51	Cleaning time mixer 7/5 (hrs)	A	G=23	0.50	0.48	0.17	0.04	2.074	2.819	-0.12	Reject Ho Accept Ha	Accept Ho Reject Ha
			NG=47	"	0.45	0.16	0.02	1.96	2.57	-2.50	Reject Ho Accept Ha	Reject Ho Accept Ha
		C	G=11	"	0.33	0.12	0.04	2.28	3.16	-4.25	"	"
			NG=45	"	0.39	0.12	0.02	1.96	2.57	-5.50	"	"
		N	G=43	"	0.38	0.12	0.02	1.96	2.57	-6.0	"	"
			NG=37	"	0.37	0.13	0.02	1.96	2.57	-6.50	"	"
52	Site idle time per day. Mixer 7/10 (hrs)	A	G=23	0.33	0.67	0.64	0.13	2.074	2.819	2.62	"	Accept Ho Reject Ha
			NG=47	"	0.44	0.52	0.08	1.96	2.57	1.38	Accept Ho Reject Ha	"
		C	G=11	"	0.46	0.67	0.20	2.28	3.16	0.65	"	"
			NG=45	"	0.48	0.51	0.08	1.96	2.57	1.88	"	"
		N	G=43	"	0.53	0.36	0.05	1.96	2.57	4.0	Reject Ho Accept Ha	Reject Ho Accept Ha
			NG=37	"	0.55	0.53	0.09	1.96	2.57	2.44	"	Accept Ho Reject Ha

All µo values ; Source (41-52). Enterkin Hugh & Reynolds (1978) ; Source: Field survey 2005

Table 6.6: The effect of education levels on resource mix Walling and its related construction activities by construction firms in Kenya

[Where A = African Firms, C = Citizen Firms, N = Non-citizen Firms; G= Graduate; NG= Nongraduates]

$s = \sqrt{\frac{\sum (X - \bar{X})^2}{n-1}}$ = sample standard deviation. $Z = \frac{\bar{X} - \mu o}{s/\sqrt{n}}$ or $t = \frac{\bar{X} - \mu o}{s/\sqrt{n}}$

Activity	Sample Size (n)		μ_o	$\bar{X}$	S	$\delta_{\bar{x}} = \frac{s}{\sqrt{n}}$	Critical (e)		Actual Z_a	DECISION : TWO TAILED TEST $Z_e > Z_a$: Accept H_0; Reject H_a $Z_e < Z_a$:	
							$Z_{0.025}$ $t_{0.025}$	$Z_{0.005}$ $t_{0.005}$	t_a	Confidence 95%	Confidence 99%
Mortar: Mixer 10/7 (0.28/0.20) Output/hr (M^3)	A	G=23	3.4	10.85	6.24	1.30	2.074	2.819	5.73	"	Reject Ho Accept Ha
		NG=47	"	12.84	5.88	0.86	1.96	2.57	10.98	"	"
	C	G=11	"	8.64	4.67	1.41	2.28	3.16	3.72	"	"
		NG=45	"	11.22	4.98	0.74	1.96	2.57	10.57	"	"
	N	G=43	"	10.56	5.37	0.82	1.96	2.57	8.73	"	"
		NG=37	"	12.55	5.96	0.98	1.96	2.57	9.37	"	"
Time off for starting mixer 18/12 (hrs)	A	G=23	0.25	0.28	0.12	0.03	2.074	2.819	1.0	Accept Ho Reject Ha	Accept Ho Reject Ha
		NG=47	"	0.40	0.29	0.04	1.96	2.57	3.75	Reject Ho Accept Ha	Reject Ho Accept Ha
	C	G=11	"	0.25	0.17	0.05	2.28	3.16	0	Accept Ho Reject Ha	Accept Ho Reject Ha
		NG=45	"	0.33	0.14	0.02	1.96	2.57	4.0	Reject Ho Accept Ha	Reject Ho Accept Ha
	N	G=43	"	0.27	0.13	0.02	1.96	2.57	1.0	Accept Ho Reject Ha	Accept Ho Reject Ha
		NG=37	"	0.26	0.12	0.02	1.96	2.57	0.50	"	"
Cleaning time mixer 18/12 (hrs)	A	G=23	0.50	0.49	0.17	0.04	2.074	2.819	0.25	"	"
		NG=47	"	0.48	0.12	0.02	1.96	2.57	-1.0	"	"
	C	G=11	"	0.33	0.12	0.04	2.28	3.16	-4.25	Reject Ho Accept Ha	Reject Ho Accept Ha
		NG=45	"	0.41	0.12	0.02	1.96	2.57	-4.50	"	"
	N	G=43	"	0.38	0.14	0.02	1.96	2.57	-6.0	"	"
		NG=37	"	0.40	0.76	0.12	1.96	2.57	-0.83	Accept Ho Reject Ha	Accept Ho Reject Ha
Site idle time/day mixer 18/12 (hrs)	A	G=23	0.33	0.77	0.76	0.16	2.074	2.819	2.75	"	"
		NG=47	"	0.47	0.63	0.09	1.96	2.57	1.56	Reject Ho Accept Ha	Reject Ho Accept Ha
	C	G=11	"	0.46	0.67	0.20	2.28	3.16	0.65	"	"
		NG=45	"	0.47	0.52	0.08	1.96	2.57	1.75	"	"
	N	G=43	"	0.53	0.36	0.05	1.96	2.57	4.0	Reject Ho Accept Ha	Reject Ho Accept Ha
		NG=37	"	0.55	0.51	0.08	1.96	2.57	2.75	"	"
Gangsize: Mixer 7/5 (0.2/0.14) Operators (No)	A	G=23	1	1	0.4	0.08	2.074	2.819	0	Accept Ho Reject Ha	Accept Ho Reject Ha
		NG=47	"	1	0.29	0.04	1.96	2.57	0	"	"
	C	G=11	"	1	0.42	0.13	2.28	3.16	0	"	"
		NG=45	"	1	0.37	0.06	1.96	2.57	0	"	"
	N	G=43	"	1	0.33	0.05	1.96	2.57	0	"	"
		NG=37	"	1	0.56	0.09	1.96	2.57	0	"	"
Gangsize: Mixer 7/5 (0.20/0.14) Labourers (No)	A	G=23	1	4	2.24	0.47	2.074	2.819	6.38	Reject Ho Accept Ha	Reject Ho Accept Ha
		NG=47	"	3	2.21	0.32	1.96	2.57	6.25	"	"
	C	G=11	"	4	2.10	0.63	2.28	3.16	4.76	"	"
		NG=45	"	4	2.38	0.35	1.96	2.57	8.57	"	"
	N	G=43	"	4	1.96	0.30	1.96	2.57	10.0	"	"
		NG=37	"	4	2.12	0.35	1.96	2.57	8.57	"	"
Gangsize: Mixer 7/5 (0.20/0.14) Wheelers (No)	A	G=23	0	3	1.04	0.22	2.074	2.819	13.64	Reject Ho Accept Ha	Reject Ho Accept Ha
		NG=47	"	3	0.	0.13	1.96	2.57	23.08	"	"
	C	G=11	"	4	0.86	0.26	2.28	3.16	15.38	"	"
		NG=45	"	3	1.12	0.17	1.96	2.57	17.65	"	"
	N	G=43	"	3	1.09	0.17	1.96	2.57	17.65	"	"
		NG=37	"	3	1.11	0.18	1.96	2.57	16.67	"	"

Table 6.6: The effect of education levels on resource mix Walling and its related construction activities by construction firms in Kenya

[where A = African Firms, C = Citizen Firms, N = Non-citizen Firms; G= Graduate; NG= Nongraduates]

$$s = \sqrt{\frac{\sum (X - \bar{X})^2}{n-1}}$$ = sample standard deviation. $$Z = \frac{\bar{X} - \mu o}{s/\sqrt{n}}$$ or $$t = \frac{\bar{X} - \mu o}{s/\sqrt{n}}$$

No.	Activity	Sample Size (n)		μ_o	$\bar{X}$	S	$\delta_{\bar{x}} = \frac{s}{\sqrt{n}}$	Critical (e)		Actual Z_e	DECISION : TWO TAILED TEST	
								$Z_{0.025}$ $t_{0.025}$	$Z_{0.005}$ $t_{0.005}$	t_e	$Z_c > Z_e$: Accept H_0; Reject H_a $Z_c < Z_e$	
											Confidence 95%	Confidence 99%
[illegible]	Idle time: Mixer 7/5 (%)	A	G=23	0	8.95	5.25	1.09	2.074	2.819	8.21	"	"
			NG=47	"	8.25	4.2	0.61	1.96	2.57	13.53	"	"
		C	G=11	"	9.11	2.54	0.77	2.28	3.16	11.83	"	"
			NG=45	"	7.53	3.17	0.47	1.96	2.57	16.02	"	"
		N	G=43	"	8.54	3.96	0.60	1.96	2.57	14.23	"	"
			NG=37	"	7.11	3.54	0.58	1.96	2.57	12.26	"	"
51	Gang size:Mixer 10/7 (0.28/0.20) Operators (No)	A	G=23	1	1	0.4	0.08	2.074	2.819	0	Accept Ho Reject Ha	Accept Ho Reject Ha
			NG=47	"	1	0.32	0.05	1.96	2.57	0	"	"
		C	G=11	"	1	0.42	0.13	2.28	3.16	0	"	"
			NG=45	"	2	0.48	0.07	1.96	2.57	14.29	Reject Ho Accept Ha	Reject Ho Accept Ha
		N	G=43	"	1	0.26	0.04	1.96	2.57	0	"	"
			NG=37	"	1	0.47	0.08	1.96	2.57	0	"	"
52	Gang size:Mixer 10/7 (0.28/0.20) Labourers (No)	A	G=23	1	4	2.22	0.46	2.074	2.819	6.52	Reject Ho Accept Ha	Reject Ho Accept Ha
			NG=47	"	4	2.21	0.32	1.96	2.57	9.38	"	"
		C	G=11	"	5	2.24	0.68	2.28	3.16	5.88	Reject Ho Accept Ha	Accept Ho Reject Ha
			NG=45	"	5	2.30	0.34	1.96	2.57	11.77	"	Reject Ho Accept Ha
		N	G=43	"	5	2.23	0.34	1.96	2.57	11.77	"	"
			NG=37	"	4	2.30	0.38	1.96	2.57	7.89	"	"
53	Gang size:Mixer 10/7 (0.28/0.20) Wheelers (No)	A	G=23	1	3	0.97	0.20	2.074	2.819	10.0	"	"
			NG=47	"	3	0.9	0.13	1.96	2.57	2.22	Reject Ho Accept Ha	Accept Ho Reject Ha
		C	G=11	"	4	1.19	0.36	2.28	3.16	8.33	"	Reject Ho Accept Ha
			NG=45	"	3	1.10	0.16	1.96	2.57	12.5	"	"
		N	G=43	"	4	1.14	0.17	1.96	2.57	17.65	"	"
			NG=37	"	3	1.27	0.21	1.96	2.57	9.52	"	"
54	Idle time: Mixer 10/7 (%)	A	G=23	0	8.60	4.51	0.94	2.074	2.819	9.15	"	"
			NG=47	"	8.70	5.33	0.78	1.96	2.57	11.15	"	"
		C	G=11	"	8.67	2.29	0.69	2.28	3.16	12.56	"	"
			NG=45	"	7.55	3.16	0.47	1.96	2.57	16.02	"	"
		N	G=43	"	8.54	3.96	0.60	1.96	2.57	14.23	"	"
			NG=37	"	7.32	3.65	0.60	1.96	2.57	12.20	"	"
55	Gang size:Mixer 10/7 (0.28/0.20) Wheelers (No)	A	G=23	1	2	0.52	0.11	2.074	2.819	9.09	"	"
			NG=47	"	2	0.46	0.67	1.96	2.57	14.29	"	"
		C	G=11	"	1	0.49	0.15	2.28	3.16	0	Accept Ho Reject Ha	Accept Ho Reject Ha
			NG=45	"	2	0.61	0.09	1.96	2.57	11.11	Reject Ho Accept Ha	Reject Ho Accept Ha
		N	G=43	"	1	0.42	0.06	1.96	2.57	0	Accept Ho Reject Ha	Accept Ho Reject Ha
			NG=37	"	1	0.35	0.06	1.96	2.57	0	"	"

All μ_o values ; Source (53-56). Smith R. C. (1986). 57-68 Enterkin Hugh & Reynolds (1978) ; Source: Own Field survey 2005

Table 6.6: The effect of education levels on resource mix Walling and its related construction activities by construction firms in Kenya

[where A = African Firms, C = Citizen Firms, N = Non-citizen Firms; G= Graduate; NG= Nongraduates]

$$s = \sqrt{\frac{\sum (X - \bar{X})^2}{n-1}}$$ = sample standard deviation. $$Z = \frac{\bar{X} - \mu o}{s/\sqrt{n}}$$ or $$t = \frac{\bar{X} - \mu o}{s/\sqrt{n}}$$

	Activity	Sample Size (n)		μo	$\bar{X}$	S	$\delta_{\bar{x}} = \frac{s}{\sqrt{n}}$	Critical (e)		Actual Z_e	DECISION : TWO TAILED TEST	
								$Z_{0.025}$ $t_{0.025}$	$Z_{0.005}$ $t_{0.005}$	t_e	$Z_e > Z_a$: Accept H_0; Reject H_a $Z_e < Z_a$:	
											Confidence 95%	Confidence 99%
66	Gangsize: Mixer 14/10 (0.40/0.28) Labourers (No)	A	G=23	1	5	2.17	0.45	2.074	2.819	8.89	Reject Ho Accept Ha	Reject Ho Accept Ha
			NG=47	"	5	2.38	0.35	1.96	2.57	11.43	"	"
		C	G=11	"	7	2.63	0.79	2.28	3.16	7.60	"	"
			NG=45	"	5	2.94	0.44	1.96	2.57	9.09	"	"
		N	G=43	"	6	2.71	0.41	1.96	2.57	12.20	"	"
			NG=37	"	5	2.79	0.46	1.96	2.57	8.70	"	"
67	Gangsize: Mixer 14/10 (0.40/0.28) Wheelers (No)	A	G=23	2	4	1.40	0.29	2.074	2.819	6.90	"	"
			NG=47	"	4	1.50	0.22	1.96	2.57	9.09	"	"
		C	G=11	"	5	1.96	0.59	2.28	3.16	5.08	"	"
			NG=45	"	4	1.71	0.25	1.96	2.57	8.0	"	"
		N	G=43	"	5	1.73	0.26	1.96	2.57	11.54	"	"
			NG=37	"	4	1.86	0.31	1.96	2.57	6.45	"	"
68	Idle time : Mixer 14/10 (%)	A	G=23	0	8.52	4.5	0.94	2.074	2.819	9.06	"	"
			NG=47	"	9.50	7.02	1.02	1.96	2.57	9.31	"	"
		C	G=11	"	8.44	2.47	0.74	2.28	3.16	11.41	"	"
			NG=45	"	7.63	3.41	0.51	1.96	2.57	15.06	"	"
		N	G=43	"	8.54	3.96	0.60	1.96	2.57	14.23	"	"
			NG=37	"	7.51	3.76	0.62	1.96	2.57	12.11	"	"
69	Gangsize: Mixer 18/12 (0.51/0.34) operators (No)	A	G=23	1	2	0.51	0.11	2.074	2.819	9.09	"	"
			NG=47	"	2	0.51	0.07	1.96	2.57	14.29	"	"
		C	G=11	"	2	0.55	0.17	2.28	3.16	5.88	"	"
			NG=45	"	2	0.59	0.09	1.96	2.57	11.11	"	"
		N	G=43	"	2	0.47	0.09	1.96	2.57	14.29	"	"
			NG=37	"	2	0.49	0.08	1.96	2.57	12.5	"	"
70	Gangsize: Mixer 18/12 (0.51/0.34) Labourers (No)	A	G=23	1	5	2.53	0.53	2.074	2.819	7.54	"	"
			NG=47	"	5	2.47	0.36	1.96	2.57	11.11	"	"
		C	G=11	"	88	3.80	1.15	2.28	3.16	6.09	"	"
			NG=45	"	6	3.52	0.52	1.96	2.57	9.62	"	"
		N	G=43	"	7	3.18	0.48	1.96	2.57	12.50	"	"
			NG=37	"	5	3.14	0.52	1.96	2.57	7.69	"	"
71	Gangsize: Mixer 18/12 (0.51/0.34) wheelers (No)	A	G=23	2	5	1.61	0.34	2.074	2.819	8.82	"	"
			NG=47	"	5	1.38	0.20	1.96	2.57	15.0	"	"
		C	G=11	"	6	2.5	0.75	2.28	3.16	5.33	"	"
			NG=45	"	5	1.96	0.29	1.96	2.57	10.35	"	"
		N	G=43	"	6	2.39	0.36	1.96	2.57	11.11	"	"
			NG=37	"	5	2.15	0.35	1.96	2.57	8.57	"	"
72	Idle time: Mixer 18/12 (%)	A	G=23	1	9.22	4.56	0.95	2.074	2.819	9.71	"	"
			NG=47	"	9.63	8.26	1.20	1.96	2.57	8.03	"	"
		C	G=11	"	10	3.31	1.00	2.28	3.16	10.0	"	"
			NG=45	"	8.15	3.26	0.49	1.96	2.57	16.63	"	"
		N	G=43	"	9.07	4.62	0.70	1.96	2.57	12.96	"	"
			NG=37	"	8.32	3.85	0.63	1.96	2.57	13.21	"	"

All μo values ; Source (69-82). R.C. Smith (1986) ; Source: Field survey 2005

Table 6.8: The effect of education levels on resource mix Walling and its related construction activities by construction firms in Kenya

[where A = African Firms, C = Citizen Firms, N = Non-citizen Firms; G= Graduate; NG= Nongraduates]

$s = \sqrt{\frac{\sum (X - \bar{X})^2}{n-1}}$ = sample standard deviation. $Z = \frac{\bar{X} - \mu o}{s/\sqrt{n}}$ or $t = \frac{\bar{X} - \mu o}{s/\sqrt{n}}$

	Activity	Sample Size (n)		μ_o	$\bar{X}$	S	$\delta_{\bar{x}} = \frac{s}{\sqrt{n}}$	Critical (e)		Actual Z_e	DECISION : TWO TAILED TEST	
								$Z_{0.025}$ $t_{0.025}$	$Z_{0.005}$ $t_{0.005}$	t_e	$Z_e > Z_e$: Accept H_0, Reject H_a $Z_e < Z_e$:	
											Confidence 95%	Confidence 99%
[illegible]	Damp proof course 100mm wide (m)	A	G=23	1	1	0.0	0	2.074	2.819	0	Accept Ho Reject Ha	Accept Ho Reject Ha
			NG=47	"	1.09	0.29	0.04	1.96	2.57	2.25	Reject Ho Accept Ha	"
		C	G=11	"	1	0.0	0	2.28	3.16	0	Accept Ho Reject Ha	"
			NG=45	"	1	0.0	0	1.96	2.57	0		"
		N	G=43	"	1	0.0	0	1.96	2.57	0	"	"
			NG=37	"	1.16	0.56	0.09	1.96	2.57	1.78	"	"
74	Waste on 100mm DPC (%)	A	G=23	3	7.87	3.85	0.80	2.074	2.819	6.09	Reject Ho Accept Ha	Reject Ho Accept Ha
			NG=47	"	3.15	2.21	0.32	1.96	2.57	0.47	Accept Ho Reject Ha	Accept Ho Reject Ha
		C	G=11	"	10.91	6.12	1.85	2.28	3.16	4.28	Reject Ho Accept Ha	Reject Ho Accept Ha
			NG=45	"	8.19	3.61	0.54	1.96	2.57	9.61	"	"
		N	G=43	"	7.87	4.27	0.65	1.96	2.57	7.50	"	"
			NG=37	"	3.81	2.21	0.35	1.96	2.57	2.31	"	Accept Ho Reject Ha
[illegible]	Damp proof course: 150mm wide (m)	A	G=23	1	1	0.0	0	2.074	2.819	0	Accept Ho Reject Ha	"
			NG=47	"	2.79	0.9	0.13	1.96	2.57	13.77	Reject Ho Accept Ha	Reject Ho Accept Ha
		C	G=11	"	1	0	0	2.28	3.16	1.0	Accept Ho Reject Ha	Accept Ho Reject Ha
			NG=45	"	1	0	0	1.96	2.57	1.0	"	"
		N	G=43	"	1	0	0	1.96	2.57	1.0	"	"
			NG=37	"	2.76	1.11	0.18	1.96	2.57	9.78	Reject Ho Accept Ha	Reject Ho Accept Ha
76		A	G=23	3	8.78	4.7	0.98	2.074	2.819	5.90	"	"
			NG=47	"	8.24	4.2	0.61	1.96	2.57	8.59	"	"
		C	G=11	"	10.91	6.12	1.85	2.28	3.16	4.28	"	"
			NG=45	"	8.53	4.14	0.62	1.96	2.57	8.92	"	"
		N	G=43	"	8.34	4.75	0.72	1.96	2.57	7.42	"	"
			NG=37	"	7.10	3.54	0.58	1.96	2.57	7.07	"	"
77		A	G=23	1	1	0	0	2.074	2.819	1.0	"	"
			NG=47	"	1.10	0.32	0.05	1.96	2.57	2.0	Reject Ho Accept Ha	"
		C	G=11	"	1	0	0	2.28	3.16	1.0	Accept Ho Reject Ha	"
			NG=45	"	1	0	0	1.96	2.57	1.0	"	"
		N	G=43	"	1	0	0	1.96	2.57	1.0	"	"
			NG=37	"	1.19	0.47	0.08	1.96	2.57	2.38	Reject Ho Accept Ha	"

All μ_o values ; Source (69-82). R.C. Smith (1986) ; Source: Field survey 2005

Table 6.6: The effect of education levels on resource mix Walling and its related construction activities by construction firms in Kenya

[where A = African Firms, C = Citizen Firms, N = Non-citizen Firms; G= Graduate; NG= Nongraduates]

$$s = \sqrt{\frac{\sum (X - \bar{X})^2}{n-1}}$$ = sample standard deviation. $$Z = \frac{\bar{X} - \mu o}{s/\sqrt{n}}$$ or $$t = \frac{\bar{X} - \mu o}{s/\sqrt{n}}$$

	Activity	Sample Size (n)		μ_o	$\bar{X}$	S	$\delta_{\bar{x}} = \frac{s}{\sqrt{n}}$	Critical (e)		Actual Z_e	DECISION : TWO TAILED TEST	
								$Z_{0.025}$ $t_{0.025}$	$Z_{0.005}$ $t_{0.005}$	t_e	$Z_e > Z_a$: Accept H_0; Reject H_a $Z_e < Z_a$:	
											Confidence 95%	Confidence 99%
78	Waste on 200mm DPC (%)	A	G=23	3	9.72	9.74	2.03	2.074	2.819	3.31	"	Reject Ho Accept Ha
			NG=47	"	3.47	2.21	0.32	1.96	2.57	1.47	Accept Ho Reject Ha	Accept Ho Reject Ha
		C	G=11	"	10.91	6.12	1.85	2.28	3.16	4.28	Reject Ho Accept Ha	Reject Ho Accept Ha
			NG=45	"	8.61	4.44	0.66	1.96	2.57	8.50		"
		N	G=43	"	7.76	4.28	0.65	1.96	2.57	7.32	"	"
			NG=37	"	4.16	2.30	0.38	1.96	2.57	3.05	"	"
79	Waste on 100mm DPC (%)	A	G=23	2	1	0.21	0.04	2.074	2.819	-25.0	"	"
			NG=47	"	3	0.9	0.13	1.96	2.57	15.38	"	"
		C	G=11	"	1	0.0	0	2.28	3.16	-α	"	"
			NG=45	"	1	0.27	0.04	1.96	2.57	-25.0	"	"
		N	G=43	"	1	0	0	1.96	2.57	-α	"	"
			NG=37	"	3	1.27	0.21	1.96	2.57	4.76	"	"
80	Damp proof course: 150mm wide (m)	A	G=23	1	2	0.66	0.14	2.074	2.819	7.14	"	"
			NG=47	"	9	5.33	0.78	1.96	2.57	10.26	"	"
		C	G=11	"	2	0.0	0	2.28	3.16	+α	"	"
			NG=45	"	2	0.42	0.06	1.96	2.57	16.67	"	"
		N	G=43	"	2	0.47	0.07	1.96	2.57	14.29	"	"
			NG=37	"	8	3.65	0.60	1.96	2.57	11.67	"	"
81	Gang size/ DPC roll (hrs)	A	G=23	0.12	1.0	1.89	0.39	2.074	2.819	2.26	Reject Ho Accept Ha	Accept Ho Reject Ha
			NG=47	"	1.28	0.46	0.07	1.96	2.57	16.57	"	Reject Ho Accept Ha
		C	G=11	"	1.94	2.79	0.84	2.28	3.16	2.17	Accept Ho Reject Ha	Accept Ho Reject Ha
			NG=45	"	1.49	2.29	0.34	1.96	2.57	4.03	Reject Ho Accept Ha	Reject Ho Accept Ha
		N	G=43	"	2.12	1.59	0.24	1.96	2.57	8.33	"	"
			NG=37	"	1.14	0.35	0.06	1.96	2.57	17.0	"	"
82	Gang output /hr (m)	A	G=23	250	13.94	8.44	1.76	2.074	2.819	-134.13	"	"
			NG=47	"	4.26	2.38	0.35	1.96	2.57	-702.11		"
		C	G=11	"	16.88	12.05	3.63	2.28	3.16	-64.22		"
			NG=45	"	11.18	13.52	2.02	1.96	2.57	-117.92	"	"
		N	G=43	"	37.85	34.76	5.30	1.96	2.57	-40.03	"	"
			NG=37	"	5.05	2.79	0.46	1.96	2.57	-532.50	"	"

All μ_o values ; Source (69-82). R.C. Smith (1986) ; Source: Field survey 2005

Table 6.7:. The effect of education levels on resource mix on plasterwork and its related construction activities by construction firms in Kenya

[where A = African Firms, C = Citizen Firms, N = Non-citizen Firms; G= Graduate; NG= Nongraduates]

$$s=\sqrt{\frac{\sum(X-\bar{X})^2}{n-1}}$$ = sample standard deviation. $$Z=\frac{\bar{X}-\mu o}{s/\sqrt{n}} \text{ or } t=\frac{\bar{X}-\mu o}{s/\sqrt{n}}$$

No.	Activity	Sample Size (n)		μ_o	$\bar{X}$	S	$\delta_{\bar{x}} = \frac{s}{\sqrt{n}}$	Critical (e)		Actual Z_e	DECISION : TWO TAILED TEST	
								$Z_{0.025}$ $t_{0.025}$	$Z_{0.005}$ $t_{0.005}$	te	$Z_e > Z_a$: Accept H_0: Reject H_a $Z_e < Z_a$:	
											Confidence 95%	Confidence 99%
1	Materials: Gang size/Day Plasterer s (No)	A	G=23	2	1	0.43	0.09	2.074	2.819	-11.11	Reject Ho; at 95% Accept Ha	Reject Ho at 99% Accept Ha
			NG=47	"	1	0.36	0.05	1.96	2.57	-2.76	"	"
		C	G=11	"	1	0.95	0.29	2.28	3.16	-1.05	Accept Ho; Reject Ha	Accept Ho; Reject Ha
			NG=45	"	1	0.39	0.06	1.96	2.57	-2.56	Reject Ho; Accept Ha	"
		N	G=43	"	1	0.37	0.06	1.96	2.57	-2.70	"	Reject Ho; Accept Ha
			NG=37	"	1	1.19	0.20	1.96	2.57	-0.84	Accept Ho; Reject Ha	Accept Ho; Reject Ha
2	Gang size/Day Labourers (No)	A	G=23	1	2	0.57	0.12	2.074	2.819	1.75	"	"
			NG=47	"	2	0.95	0.14	1.96	2.57	1.05	"	"
		C	G=11	"	2	1.26	0.38	2.28	3.16	0.79	"	"
			NG=45	"	2	0.68	0.10	1.96	2.57	1.47	"	"
		N	G=43	"	2	0.48	0.07	1.96	2.57	2.08	"	"
			NG=37	"	2	0.51	0.08	1.96	2.57	1.96	"	"
3	15mm plaster Output/day (M2)	A	G=23	9	13.74	7.86	1.64	2.074	2.819	-0.70	"	"
			NG=47	"	11.98	6.22	0.91	1.96	2.57	3.27	Reject Ho; Accept Ha	Reject Ho; Accept Ha
		C	G=11	"	10.73	4.60	1.39	2.28	3.16	1.25	Accept Ho; Reject Ha	Accept Ho; Reject Ha
			NG=45	"	12.62	9.55	1.42	1.96	2.57	2.55	Reject Ho; Accept Ha	"
		N	G=43	"	10	2.74	0.42	1.96	2.57	2.38	"	"
			NG=37	"	11.05	2.48	0.41	1.96	2.57	5.0	"	Reject Ho; Accept Ha
4	15mm Plaster: Idle time (%)	A	G=23	5	9.2	4.68	0.98	2.074	2.819	4.29	"	"
			NG=47	"	8.4	3.36	0.49	1.96	2.57	6.94	"	"
		C	G=11	"	9.7	3.33	1.00	2.28	3.16	4.70	"	"
			NG=45	"	8.4	3.04	0.45	1.96	2.57	7.56	"	"
		N	G=43	"	8.8	4.09	0.62	1.96	2.57	6.13	"	"
			NG=37	"	7.4	3.88	0.64	1.96	2.57	3.75	"	"
5	Materials: 20-25 Plaster output/day (M^2)	A	G=23	6	11.5	5.96	1.24	2.074	2.819	4.44	"	"
			NG=47	"	10.2	5.62	0.82	1.96	2.57	5.12	"	"
		C	G=11	"	9.6	3.76	1.13	2.28	3.16	3.19	"	"
			NG=45	"	12	12.36	1.84	1.96	2.57	3.26	"	"
		N	G=43	"	8.7	2.31	0.35	1.96	2.57	7.71	"	"
			NG=37	"	9.4	2.31	0.38	1.96	2.57	8.95	"	"
6	20-25 Plaster Idle time (%)/Day	A	G=23	5	9.75	4.77	0.99	2.074	2.819	4.80	"	"
			NG=47	"	9.0	3.84	0.56	1.96	2.57	7.14	"	"
		C	G=11	"	9.4	3.36	1.01	2.28	3.16	4.36	"	"
			NG=45	"	8.3	3.07	0.46	1.96	2.57	7.17	"	"
		N	G=43	"	8.9	4.05	0.62	1.96	2.57	6.29	"	"
			NG=37	"	6.9	3.48	0.57	1.96	2.57	3.33	"	"

All μ_o-values: Sources (1-21) R-C Smith (1986) Source: Field survey 2005

Table 6.7:. The effect of education levels on resource mix on plasterwork and its related construction activities by construction firms in Kenya

[where A = African Firms, C = Citizen Firms, N = Non-citizen Firms; G= Graduate; NG= Nongraduates]

$$s = \sqrt{\frac{\sum (X - \bar{X})^2}{n-1}}$$ = sample standard deviation $$Z = \frac{\bar{X} - \mu o}{s/\sqrt{n}}$$ or $$t = \frac{\bar{X} - \mu o}{s/\sqrt{n}}$$

	Activity	Sample Size (n)		μ_o	$\bar{X}$	S	$\delta_{\bar{x}} = \frac{s}{\sqrt{n}}$	Critical (e)		Actual Z_a	DECISION : TWO TAILED TEST	
								$Z_{0.025}$ $t_{0.025}$	$Z_{0.005}$ $t_{0.005}$	=	$Z_e > Z_a$: Accept H_0: Reject H_a $Z_e < Z_a$:	
											Confidence 95%	Confidence 99%
	15mm Render output/day (M^2)	A	G=23	9	12.8	5.12	1.07	2.074	2.819	3.55	"	"
			NG=47	"	11.3	4.93	0.72	1.96	2.57	2.96	"	"
		C	G=11	"	10.3	4.29	1.29	2.28	3.16	1.01	Accept Ho Reject Ha	Accept Ho Reject Ha
			NG=45	"	12.4	8.95	1.33	1.96	2.57	2.56	Reject Ho. Accept Ha	"
		N	G=43	"	9.8	3.86	0.59	1.96	2.57	1.36	Accept Ho Reject Ha	"
			NG=37	"	10.8	2.06	0.34	1.96	2.57	5.29	Reject Ho. Accept Ha	Reject Ho. Accept Ha
8	15mm Render Idle time (%) /Day	A	G=23	5	10	5.75	1.20	2.074	2.819	4.17	"	"
			NG=47	"	9.0	4.41	0.64	1.96	2.57	6.25	"	"
		C	G=11	"	9.4	3.60	1.08	2.28	3.16	4.07	"	"
			NG=45	"	8.4	3.42	0.51	1.96	2.57	6.67	"	"
		N	G=43	"	8.8	4.09	0.62	1.96	2.57	6.13	"	"
			NG=37	"	7.2	4.06	0.67	1.96	2.57	3.28	"	"
9	Materials: 20-25mm Render output/day (M^2)	A	G=23	6	11.0	4.11	0.86	2.074	2.819	5.81	"	"
			NG=47	"	9.9	4.82	0.70	1.96	2.57	5.57	"	"
		C	G=11	"	9	2.97	0.90	2.28	3.16	3.33	"	"
			NG=45	"	11.6	12.71	1.90	1.96	2.57	2.95	"	"
		N	G=43	"	8.7	4.11	0.63	1.96	2.57	4.29	"	
			NG=37	"	8.7	2.26	0.37	1.96	2.57	7.30	"	
10	20-25mm Render Iddle time (%)/ Day	A	G=23	5	10.2	5.60	1.17	2.074	2.819	4.44	"	
			NG=47	"	9.5	4.87	0.71	1.96	2.57	6.34	"	
		C	G=11	"	9.4	3.36	1.01	2.28	3.16	4.36	"	
			NG=45	"	8.6	3.39	0.51	1.96	2.57	7.06	"	
		N	G=43	"	8.9	4.05	0.62	1.96	2.57	6.29	"	
			NG=37	"	7.4	3.71	0.61	1.96	2.57	3.93	"	
11	15mm Plaster to soft its/slabs output/day (M^2)	A	G=23	6.96	9.9	5.84	1.22	2.074	[illegible]	[illegible]	"	
			NG=47	"	8.1	3.46	0.50	1.96	[illegible]	[illegible]		
		C	G=11	"	6.5	2.63	0.79	2.28	[illegible]	[illegible]		
			NG=45	"	9.1	8.67	1.29	1.96	[illegible]	[illegible]		
		N	G=43	"	7.3	2.95	0.45	1.96	[illegible]	[illegible]		
			NG=37	"	7.4	2.53	0.42	1.96	[illegible]	[illegible]		
12	15mm Plaster to soft its/slabs Idle time (%)/ Day	A	G=23	5	10.6	5.90	1.23	2.074	[illegible]	[illegible]		
			NG=47	"	9.8	5.61	0.82	1.96	2.57	5.8[illegible]		
		C	G=11	"	9.4	3.36	1.01	2.28	3.16	4.36	"	"
			NG=45	"	8.5	4.03	0.60	1.96	2.57	5.83	"	"
		N	G=43	"	8.9	4.12	0.63	1.96	2.57	6.19	"	"
			NG=37	"	7.4	3.69	0.61	1.96	2.57	3.93	"	"
13	Materials: waste during plaster (%)	A	G=23	7.5	17.8	6.01	1.25	2.074	2.819	1.71	Accept Ho; Reject Ha	Accept Ho. Reject Ha
			NG=47	"	14.6	7.29	1.06	1.96	2.57	6.76	Reject Ho; Accept Ha	Reject Ha. Accept Ha.
		C	G=11	"	14.8	6.83	2.06	2.28	3.16	3.54	"	"
			NG=45	"	13.5	6.81	1.02	1.96	2.57	5.88	"	"
		N	G=43	"	14.3	6.38	0.97	1.96	2.57	7.01	"	"
			NG=37	"	14.5	7.71	1.27	1.96	2.57	5.51	"	"

All μ_o-values: Sources (1-21) R-C Smith (1986)   Source: Field survey 2005

Table 6.8:. The effect of education levels on resource mix floor paving and its related construction activities by construction firms in Kenya

[Where A = African Firms, C = Citizen Firms, N = Non-citizen Firms; G= Graduate; NG= Nongraduates]

$$s = \sqrt{\frac{\sum (X - \bar{X})^2}{n-1}}$$ = sample standard deviation.

	Activity	Sample Size (n)		μ_o	$\bar{X}$	S	$\delta_{\bar{x}} = \frac{s}{\sqrt{n}}$	Critical (e) $Z_{0.025}$	Critical (e) $Z_{0.005}$	Actual Z_e	DECISION : TWO TAILED TEST $Z_e > Z_e$: Accept H_0; Reject H_a $Z_e < Z_e$: Confidence 95%	Confidence 99%
14	25mm paving gang size/day spreaders (No)	A	G=23	1	2	1.24	0.26	2.074	2.819	3.85	Reject Ho at 95% Accept Ha	Reject Ho at 99% Accept Ha
			NG=47	"	2	0.88	0.13	1.96	2.57	7.69	"	"
		C	G=11	"	2	1.02	0.31	2.28	3.16	3.23	"	"
			NG=45	"	2	0.76	0.11	1.96	2.57	9.09	"	"
		N	G=43	"	1	0.61	0.09	1.96	2.57	0	Accept Ho. Reject Ha	Accept Ho. Reject Ha
			NG=37	"	1	0.76	0.13	1.96	2.57	0	"	"
15	25mm paving gang size/day spreaders (No)	A	G=23	1	3	1.68	0.35	2.074	2.819	5.71	Reject Ho. Accept Ha	Reject Ho. Accept Ha
			NG=47	"	4	2.41	0.35	1.96	2.57	8.57	"	"
		C	G=11	"	3	2.01	0.61	2.28	3.16	3.28	"	"
			NG=45	"	3	1.90	0.28	1.96	2.57	7.14	"	"
		N	G=43	"	2	1.56	0.24	1.96	2.57	4.17	"	"
			NG=37	"	3	1.86	0.31	1.96	2.57	6.45	"	"
16	25mm paving output/day (M^2)	A	G=23	27	29.56	22.82	4.76	2.074	2.819	0.54	Accept Ho. Reject Ha	Accep [illegible]
			NG=47	"	36.45	24.83	3.63	1.96	2.57	2.60	Reject Ho. Accept Ha	
		C	G=11	"	21.1	19.03	5.74	2.28	3.16	-1.03	Accept Ho. Reject Ha	
			NG=45	"	28.5	22.48	3.35	1.96	2.57	0.45	"	
		N	G=43	"	19.86	14.90	2.27	1.96	2.57	-3.15	Reject Ho. Accept Ha	Reject Ho. Accept Ha
			NG=37	"	26.32	20.93	3.44	1.96	2.57	-0.20	Accept Ho. Reject Ha	Accept Ho. Reject Ha
17	25mm paving paying waste (%)	A	G=23	7.5	7.20	3.75	0.78	2.074	2.819	-0.38	"	"
			NG=47	"	8.07	6.17	0.90	1.96	2.57	0.63	"	"
		C	G=11	"	8.64	3.39	1.02	2.28	3.16	1.12	"	"
			NG=45	"	8.38	4.57	0.68	1.96	2.57	1.29	"	"
		N	G=43	"	8.86	3.52	0.54	1.96	2.57	2.52	Reject Ho. Accept H	"
			NG=37	"	7.72	3.97	0.65	1.96	2.57	0.34	Accept Reject H	
18	40mm paving gang size/Day spreaders (No)	A	G=23	1	2	0.96	0.20	2.074	2.819	5.00	Reject Ho. At Accept Ha	Accept Ha
			NG=47	"	2	1.05	0.15	1.96	2.57	6.67	"	"
		C	G=11	"	2	1.02	0.31	2.28	3.16	3.23	"	"
			NG=45	"	2	0.86	0.13	1.96	2.57	7.69	"	"
		N	G=43	"	1	0.61	0.09	1.96	2.57	11.11	"	"
			NG=37	"	2	0.88	0.15	1.96	2.57	6.67	"	"
19	40mm paving gang size/labourers (No)	A	G=23	1	3	2.07	0.43	2.074	2.819	4.65	"	"
			NG=47	"	4	2.34	0.34	1.96	2.57	8.82	"	"
		C	G=11	"	3	2.01	0.61	2.28	3.16	3.28	"	"
			NG=45	"	3	2.02	0.30	1.96	2.57	6.67	"	"
		N	G=43	"	2	1.35	0.21	1.96	2.57	4.76	"	"
			NG=37	"	4	4.89	0.80	1.96	2.57	3.75	"	"

All μ_o-values: Sources (1-21) R-C Smith (1986) Source: Field survey 2005

Table 6.8: The effect of education levels on resource mix floor paving and its related construction activities by construction firms in Kenya

[Where A = African Firms, C = Citizen Firms, N = Non-citizen Firms; G= Graduate; NG= Nongraduates]

$$s = \sqrt{\frac{\sum (X - \bar{X})^2}{n-1}}$$ = sample standard deviation. $$Z = \frac{\bar{X} - \mu o}{s/\sqrt{n}} \text{ or } t = \frac{\bar{X} - \mu o}{s/\sqrt{n}}$$

	Activity	Sample Size (n)		μ_o	$\bar{X}$	S	$\delta_{\bar{x}} = \frac{s}{\sqrt{n}}$	Critical (e)		Actual Z_e	DECISION : TWO TAILED TEST	
								$Z_{0.025}$ $t_{0.025}$	$Z_{0.005}$ $t_{0.005}$	te	$Z_e > Z_e$: Accept H_o: Reject H_a $Z_e < Z_e$:	
											Confidence 95%	Confidence 99%
20	40mm paving output/Day (M^2)	A	G=23	18	30.87	20.74	4.32	2.074	2.819	2.98	"	"
			NG=47	"	39.70	26.26	3.83	1.96	2.57	5.67	"	"
		C	G=11	"	21.10	19.03	5.74	2.28	3.16	0.54	Accept Ho. Reject Ha	Accept Ho. Reject Ha
			NG=45	"	32.37	27.79	4.14	1.96	2.57	3.47	Reject Ho Accept Ha	Reject Ho Accept Ha
		N	G=43	"	21.10	17.41	2.66	1.96	2.57	1.17	Accept Ho. Reject Ha	Accept Ho. Reject Ha
			NG=37	"	28.76	24.79	4.08	1.96	2.57	2.64	Reject Ho Accept Ha	Reject Ho Accept Ha
21	40mm paving laying waste (%)	A	G=23	7.5	7.74	5.31	1.11	2.074	2.819	0.22	Accept Ho. Reject Ha	Accept Ho. Reject Ha
			NG=47	"	7.95	5.94	0.87	1.96	2.57	0.52	"	"
		C	G=11	"	9.09	3.94	1.19	2.28	3.16	1.34	"	"
			NG=45	"	8.34	4.12	0.61	1.96	2.57	1.38	"	"
		N	G=43	"	8.87	3.76	0.57	1.96	2.57	2.40	Reject Ho Accept Ha	"
			NG=37	"	7.77	4.39	0.72	1.96	2.57	0.38	Accept Ho. Reject Ha	"
22	2mm pvc 300x300mm material pieces/m^2 (No)	A	G=23	11.11	14.17	8.17	1.70	2.074	2.819	1.80	Reject Ho. Accept Ha	Reject Ho. Accept Ha
			NG=47	"	12	1.26	0.18	1.96	2.57	4.94	"	"
		C	G=11	"	13.4	2.22	0.67	2.28	3.16	3.42	"	"
			NG=45	"	13.74	3.14	0.46	1.96	2.57	5.72	"	"
		N	G=43	"	13.47	2.4	0.36	1.96	2.57	6.39	"	"
			NG=37	"	12.74	1.68	0.28	1.96	2.57	5.82	"	"
23	2mm pvc 300x300mm output/day m^2	A	G=23	20	8.70	10.26	2.14	2.074	2.819	-5.528	"	"
			NG=47	"	8.29	8.14	1.19	1.96	2.57	-9.84	"	"
		C	G=11	"	7.67	8.87	2.67	2.28	3.16	-4.62	"	"
			NG=45	"	6.91	4.97	0.74	1.96	2.57	-17.69	"	"
		N	G=43	"	6.54	5.22	0.80	1.96	2.57	-16.83	"	"
			NG=37	"	6	3.50	0.57	1.96	2.57	-24.56	"	"
24	2mm pvc 300x300mm tiles laying waste (%)	A	G=23	5	6.16	3.17	0.66	2.074	2.819	1.76	Accept Ho. Reject Ha	Accep Reject
			NG=47	"	7.39	4.55	0.66	1.96	2.57	3.62	Reject Ho. Accept Ha	Reject Accept Ha
		C	G=11	"	8.56	4.84	1.46	2.28	3.16	2.44	"	Accept Ho. Reject Ha
			NG=45	"	7.94	2.82	0.42	1.96	2.57	7.00	"	Reject Ho. Accept Ha
		N	G=43	"	7.57	2.88	0.44	1.96	2.57	5.84	"	"
			NG=37	"	6.72	3.10	0.51	1.96	2.57	3.37	"	"
25	2mm pvc tiles layers gang size (No)	A	G=23	2	1	0.35	0.07	2.074	2.819	-14.29	"	"
			NG=47	"	1	0.21	0.03	1.96	2.57	-33.33	"	"
		C	G=11	"	1	0.32	0.10	2.28	3.16	-10.0	"	"
			NG=45	"	1	0.35	0.05	1.96	2.57	-20.0	"	"
		N	G=43	"	1	0.22	0.03	1.96	2.57	-33.33	"	"
			NG=37	"	1	0	0	1.96	2.57	α	"	"

All μ_o-values(22-30): Source: Spence Geddes (1976) and Manufacturers catalogues for these materials Source: Field survey 2005

Table 6.8: The effect of education levels on resource mix floor paving and its related construction activities by construction firms in Kenya

[Where A = African Firms, C = Citizen Firms, N = Non-citizen Firms; G= Graduate; NG= Nongraduates]

$$s = \sqrt{\frac{\sum (X - \bar{X})^2}{n-1}}$$ = sample standard deviation. $$Z = \frac{\bar{X} - \mu o}{s/\sqrt{n}}$$ or $$t = \frac{\bar{X} - \mu o}{s/\sqrt{n}}$$

	Activity	Sample Size (n)		μ_o	$\bar{X}$	S	$\delta_{\bar{x}} = \frac{s}{\sqrt{n}}$	Critical (e)		Actual Z_a	DECISION : TWO TAILED TEST	
								$Z_{0.025}$ $t_{0.025}$	$Z_{0.005}$ $t_{0.005}$	t_a	$Z_e > Z_a$: Accept H_0; Reject H_a $Z_e < Z_a$:	
											Confidence 95%	Confidence 99%
26	2mm pvc gange size labourers (No)	A	G=23	1	2	0.47	0.10	2.074	2.819	10.0	"	"
			NG=47	"	2	0.49	0.07	1.96	2.57	14.29	"	"
		C	G=11	"	2	0	0	2.28	3.16	α	"	"
			NG=45	"	2	0.41	0.06	1.96	2.57	16.67	"	"
		N	G=43	"	2	0.4	0.06	1.96	2.57	16.67	"	"
			NG=37	"	2	0.42	0.07	1.96	2.57	14.29	"	"
27	4kg tires of stronghold adhesive /gange size layers (No.)	A	G=23	2	1	0.29	0.06	2.074	2.819	-16.67	"	"
			NG=47	"	1	0.21	0.03	1.96	2.57	-33.33	"	"
		C	G=11	"	1	0	0	2.28	3.16	- α	"	"
			NG=45	"	1	0.35	0.05	1.96	2.57	-20.0	"	"
		N	G=43	"	1	0.22	0.34	1.96	2.57	-2.94	"	"
			NG=37	"	1	0.17	0.03	1.96	2.57	-33.33	"	"
28	4kg tins of stronghold gange size labourers (No.)	A	G=23	1	2	0.53	0.11	2.074	2.819	9.09	"	"
			NG=47	"	2	0.50	0.07	1.96	2.57	14.29	"	"
		C	G=11	"	2	0.33	0.10	2.28	3.16	10.0	"	"
			NG=45	"	2	0.39	0.06	1.96	2.57	16.67	"	"
		N	G=43	"	2	0.49	0.07	1.96	2.57	14.29	"	"
			NG=37	"	2	0.91	0.15	1.96	2.57	6.67	"	"
29	4kg tins of stronghold adhesive M2/Tin coverage (M^2)	A	G=23	4	15.87	5.75	1.20	2.074	2.819	9.89	"	"
			NG=47	"	16.16	6.01	0.88	1.96	2.57	13.82	"	"
		C	G=11	"	16.6	1.58	0.48	2.28	3.16	25.33	"	"
			NG=45	"	17	4.43	0.66	1.96	2.57	19070	"	"
		N	G=43	"	15.76	4.35	0.66	1.96	2.57	17.82	"	"
			NG=37	"	16.82	1.88	0.31	1.96	2.57	41.35	"	"
30	Strong adhesive waste (%)	A	G=23	5	7.55	3.88	0.81	2.074	2.819	3.15	"	"
			NG=47	"	8.85	5.15	0.75	1.96	2.57	5.13	"	"
		C	G=11	"	6.67	4.60	1.39	2.28	3.16	1.92	"	"
			NG=45	"	10.46	5.43	0.81	1.96	2.57	6.74	"	"
		N	G=43	"	7.88	3.38	0.52	1.96	2.57	5.54	"	"
			NG=37	"	7.57	3.30	0.54	1.96	2.57	4.76	"	"

All μ_o-values(22-30): Source: Spence Geddes (1976) and Manufacturers catalogues for these materials Source: Field survey 2005

Table 6.9: The effect of education levels on resource mix in wood block floor finishes and its related construction activities by construction firms in Kenya

[Where A = African Firms, C = Citizen Firms, N = Non-citizen Firms; G= Graduate; NG= Nongraduates]

$$s = \sqrt{\frac{\sum(X-\bar{X})^2}{n-1}}$$ = sample standard deviation. $$Z = \frac{\bar{X}-\mu o}{s/\sqrt{n}}$$ or $$t = \frac{\bar{X}-\mu o}{s/\sqrt{n}}$$

	Activity	Sample Size (n)		μ_o	$\bar{X}$	S	$\delta_{\bar{X}} = \frac{s}{\sqrt{n}}$	Critical (e) $Z_{0.025}$ $t_{0.025}$	Critical (e) $Z_{0.005}$ $t_{0.005}$	Actual Z_a t_a	Decision : TWo Tailed Test $Z_e > Z_a$: Accept H_0; Reject H_a $Z_e < Z_a$: Confidence 95%	Confidence 99%
1	Stronghold adhesive kg/m^2 of tiling	A	G=23	1.9	6.2	8.03	1.67	2.074	2.819	2.57	Reject Ho a 95% Accept Ha	Accept Ho. Reject Ha at 99%
			NG=47	"	5.5	9.43	1.38	1.96	2.57	2.61	"	"
		C	G=11	"	14.4	6.55	1.97	2.28	3.16	6.35	"	"
			NG=45	"	9.9	8.81	1.31	1.96	2.57	6.11	"	"
		N	G=43	"	8.9	8.99	1.37	1.96	2.57	5.11	"	"
			NG=37	"	10.2	8.39	1.38	1.96	2.57	6.01	"	"
2	Stronghold adhesive waste factor (%)	A	G=23	5	11.00	7.38	1.54	2.074	2.819	3.90	"	"
			NG=47	"	10.3	0.05	0.01	1.96	2.57	530.0	"	"
		C	G=11	"	12.5	7.94	2.39	2.28	3.16	5.11	"	"
			NG=45	"	10.7	7.25	1.08	1.96	2.57	5.28	"	"
		N	G=43	"	11.0	7.85	1.20	1.96	2.57	5.0	"	"
			NG=37	"	9.0	5.99	0.98	1.96	2.57	4.08	"	"
3	Stronghold adhesive output/day (M^2)	A	G=23	16.67	23.6	20.4	4.25	2.074	2.819	1.63	Accept Ho Reject Ha	Accept Ho Reject Ha
			NG=47	"	28	20.8	3.03	1.96	2.57	3.74	Reject Ho Accept Ha	Reject Ho Accept Ha
		C	G=11	"	10.0	5.4	1.63	2.28	3.16	-4.09	"	"
			NG=45	"	21.5	19.66	2.63	1.96	2.57	1.84	Accept Ho Reject Ha	Accept Ho Reject Ha
		N	G=43	"	13.0	11.54	1.76	1.96	2.57	-2.09	"	"
			NG=37	"	20.5	17.78	2.92	1.96	2.57	1.31	Accept Ho Reject Ha	"
4	Gang size skilled craftsmen (No)	A	G=23	1	1	0.22	0.05	2.074	2.819	0	"	"
			NG=47	"	1	0.22	0.03	1.96	2.57	0	"	"
		C	G=11	"	1	0.32	0.10	2.28	3.16	0	"	"
			NG=45	"	1	0.42	0.06	1.96	2.57	0	"	"
		N	G=43	"	1	0	0	1.96	2.57	0	"	"
			NG=37	"	1	0	0	1.96	2.57	0	"	"
5	Gang size labourers (No)	A	G=23	1	2	0.88	0.18	2.074	2.819	5.6	Reject Ho Accept Ho	Reject Ho Accept Ho
			NG=47	"	1	1.01	0.15	1.96	2.57	0	Accept Ho. Reject Ho	Accept Ho. Reject Ho
		C	G=11	"	2	0.32	0.10	2.28	3.16	10.0	Reject Ho Accept Ho	Reject Ho Accept Ho
			NG=45	"	2	0.65	0.10	1.96	2.57	10.0	"	"
		N	G=43	"	2	0.33	0.05	1.96	2.57	20.0	"	"
			NG=37	"	2	0.33	0.05	1.96	2.57	20.0	"	"
6	Idle time/Day (%)	A	G=23	5	6.7	3.02	0.63	2.074	2.819	2.70	"	Accept Ho. Reject Ho
			NG=47	"	7.6	2.92	0.43	1.96	2.57	6.05	"	Reject Ho Accept Ho
		C	G=11	"	8.3	3.80	1.15	2.28	3.16	2.86	"	Accept Ho. Reject Ho
			NG=45	"	7.8	2.87	0.43	1.96	2.57	6.51	"	Reject Ho Accept Ho
		N	G=43	"	8.4	3.64	0.56	1.96	2.57	6.07	"	"
			NG=37	"	7.6	3.71	0.61	1.96	2.57	4.26	"	"

All μ_o-values((1-19)): Source: Spence Geddes (1976)   Source: Field survey 2005

Table 6.9: The effect of education levels on resource in wood block floor finishes and its related construction activities by construction firms in [illegible]

[Where A = African Firms, C = Citizen Firms, N = Non-citizen Firms; G= Graduate; NG= Nongraduates]

$$s = \sqrt{\frac{\sum (X - \bar{X})^2}{n-1}}$$ = sample standard deviation. $$Z = \frac{\bar{X} - \mu o}{s / \sqrt{n}} \text{ or } t = \frac{\bar{X} - \mu o}{s / \sqrt{n}}$$

Activity	Sample Size (n)		μ_o	$\bar{X}$	S	$\delta_{\bar{x}} = \frac{s}{\sqrt{n}}$	Critical (e)		Actual Z_a	DECISION : TWO TAILED TEST	
							$Z_{0.025}$ $t_{0.025}$	$Z_{0.005}$ $t_{0.005}$	ta	$Z_e > Z_a$: Accept H_0; Reject H_a $Z_e < Z_a$:	
										Confidence 95%	Confidence 99%
8mm thick paraquet flooring material (m²)	A	G=23	1	1	0	0	2.074	2.819	0	Accept Ho. Reject Ho	Accept Ho. Reject Ho
		NG=47	"	1	0	0	1.96	2.57	0	"	"
	C	G=11	"	3.4	6.47	1.95	2.28	3.16	1.23	"	"
		NG=45	"	1.8	5.20	0.78	1.96	2.57	1.03	"	"
	N	G=43	"	1.7	2.73	0.42	1.96	2.57	1.67	"	"
		NG=37	"	0.8	0.42	0.07	1.96	2.57	-2.86	Reject Ho Accept Ho	Reject Ho Accept Ho
8mm thick paraquet waste factor (%)	A	G=23	5	8.7	8.4	1.75	2.074	2.819	2.11	"	Accept Ho. Reject Ho
		NG=47	"	8.2	5.29	0.77	1.96	2.57	4.16	"	Reject Ho Accept Ho
	C	G=11	"	7	3.73	1.12	2.28	3.16	0.88	Accept Ho. Reject Ho	Accept Ho. Reject Ho
		NG=45	"	7.5	5.60	0.83	1.96	2.57	3.01	Reject Ho Accept Ho	Reject Ho Accept Ho
	N	G=43	"	7.9	4.33	0.66	1.96	2.57	4.39	"	"
		NG=37	"	5.8	3.0	0.49	1.96	2.57	1.63	Accept Ho. Reject Ho	Accept Ho. Reject Ho
8mm thick paraquet output/ Day (m²)	A	G=23	16.67	23.3	20.46	4.27	2.074	2.819	1.55	"	"
		NG=47	"	21.5	16.97	2.48	1.96	2.57	1.95	"	"
	C	G=11	"	9.5	4.28	1.29	2.28	3.16	-5.56	Reject Ho Accept Ha	Reject Ho Accept Ha
		NG=45	"	18.3	16.35	2.44	1.96	2.57	0.67	Accept Ho Reject Ha	Accept Ho Reject Ha
	N	G=43	"	12.4	12.26	1.87	1.96	2.57	-2.28	Reject Ho Accept Ha	"
		NG=37	"	17.8	15.49	2.55	1.96	2.57	0.44	Accept Ho Reject Ha	"
Gang size for paraquet skilled craftmen (No)	A	G=23	1	1	0.22	0.05	2.074	2.819	0	"	"
		NG=47	"	1	0.22	0.03	1.96	2.57	0	"	"
	C	G=11	"	1	0.32	0.10	2.28	3.16	0	"	"
		NG=45	"	1	0.32	0.05	1.96	2.57	0	"	"
	N	G=43	"	1	0	0	1.96	2.57	0	"	"
		NG=37	"	1	0	0	1.96	2.57	0	"	"
Gang size Paraquet labourers (No)	A	G=23	1	2	0.44	0.99	2.074	2.819	11.11	Reject Ho Accept Ha	Reject Ho Accept Ha
		NG=47	"	2	2.95	0.43	1.96	2.57	2.33	"	Accept Ho Reject Ha
	C	G=11	"	2	0.32	0.10	2.28	3.16	10.0	"	Reject Ho Accept Ha
		NG=45	"	2	2.90	0.43	1.96	2.57	2.33	"	Accept Ho Reject Ha
	N	G=43	"	2	0.33	0.05	1.96	2.57	20.0	"	Reject Ho Accept Ha
		NG=37	"	2	3.75	0.62	1.96	2.57	1.61	Reject Ho Accept Ha	Accept Ho Reject Ha

All μ_o-values((1-19)): Source: Spence Geddes (1976) Source: Field survey 2005

Table 6.9: The effect of education levels on resource mix in wood block floor finishes and its related construction activities by construction firms in Kenya

[Where A = African Firms, C = Citizen Firms, N = Non-citizen Firms; G= Graduate; NG= Nongraduates]

$$s = \sqrt{\frac{\sum (X - \bar{X})^2}{n-1}}$$ = sample standard deviation. $$Z = \frac{\bar{X} - \mu o}{s/\sqrt{n}} \text{ or } t = \frac{\bar{X} - \mu o}{s/\sqrt{n}}$$

	Activity	Sample Size (n)		μ_o	$\bar{X}$	S	$\delta_{\bar{x}} = \frac{s}{\sqrt{n}}$	Critical (e)		Actual Z_a t_a	DECISION : TWO TAILED TEST $Z_e > Z_a$: Accept H_0: Reject H_a $Z_e < Z_a$:	
								$Z_{0.025}$ $t_{0.025}$	$Z_{0.005}$ $t_{0.005}$		Confidence 95%	Confidence 99%
12	Laying parquet idle time/day (%)	A	G=23	5	7	3.12	0.65	2.074	2.819	3.08	Accept Ho Reject Ha	Reject Ho Accept Ha
			NG=47	"	7.7	5.17	0.75	1.96	2.57	3.60	"	"
		C	G=11	"	9	3.88	1.17	2.28	3.16	3.42	"	"
			NG=45	"	7.8	3.43	0.51	1.96	2.57	5.49	"	"
		N	G=43	"	8.6	4.08	0.62	1.96	2.57	5.81	"	"
			NG=37	"	7.2	2.21	0.36	1.96	2.57	6.11	"	"
13	Machine sanding time (Hrs/M²)	A	G=23		6.4	18.13	3.78	2.074	2.819		"	"
			NG=47		3.3	4.29	0.63	1.96	2.57		"	"
		C	G=11		1.5	2.73	0.82	2.28	3.16		"	"
			NG=45		1.7	4.59	0.68	1.96	2.57		"	"
		N	G=43		1.1	2.76	0.42	1.96	2.57		"	"
			NG=37		0.7	4.41	0.72	1.96	2.57		"	"
14	Idle machine time/day (%)	A	G=23		8.5	6.3	1.31	2.074	2.819		"	"
			NG=47		6.8	0.30	0.04	1.96	2.57		"	"
		C	G=11		10.1	7.3	2.20	2.28	3.16		"	"
			NG=45		7.0	4.87	0.73	1.96	2.57		"	"
		N	G=43		5.6	4.45	0.68	1.96	2.57		"	"
			NG=37		7.8	4.98	0.82	1.96	2.57		"	"
15	Two pack polish (litres/M²)	A	G=23		0.9	2.56	0.53	2.074	2.819		"	"
			NG=47		0.4	7.29	1.06	1.96	2.57		"	"
		C	G=11		2.6	5.62	1.69	2.28	3.16		"	"
			NG=45		1.5	9.12	1.36	1.96	2.57		"	"
		N	G=43		1.0	2.52	0.38	1.96	2.57		"	"
			NG=37		1.4	6.90	1.13	1.96	2.57		"	"
16	Two pack polish waste factor (%)	A	G=23		11.7	9.48	1.98	2.074	2.819		"	"
			NG=47		10.5	7.29	1.06	1.96	2.57		"	"
		C	G=11		13.6	9.34	2.82	2.28	3.16		"	"
			NG=45		12.2	9.12	1.36	1.96	2.57		"	"
		N	G=43		11.3	8.30	1.27	1.96	2.57		"	"
			NG=37		9.3	6.90	1.13	1.96	2.57		"	"
17	Two pack polish Output/Day (M²)	A	G=23		31.8	49.17	10.25	2.074	2.819		"	"
			NG=47		32.4	22.60	3.30	1.96	2.57		"	"
		C	G=11		11.5	3.85	1.16	2.28	3.16		"	"
			NG=45		23.8	21.11	3.15	1.96	2.57		"	"
		N	G=43		15.4	14.98	2.28	1.96	2.57		"	"
			NG=37		24.0	22.3	3.66	1.96	2.57		"	"
18	Two pack polish Gang size. Skilled craftsmen (No)	A	G=23		1	0.22	0.05	2.074	2.819		"	"
			NG=47		1	0.16	0.02	1.96	2.57		"	"
		C	G=11		1	0.32	0.10	2.28	3.16		"	"
			NG=45		1	0.41	0.06	1.96	2.57		"	"
		N	G=43		1	0	0	1.96	2.57		"	"
			NG=37		1	0	0	1.96	2.57		"	"
19	Gang size idle time/day (%)	A	G=23		6.1	3.42	0.71	2.074	2.819		"	"
			NG=47		7.6	3.38	0.49	1.96	2.57		"	"
		C	G=11		9	3.88	1.17	2.28	3.16		"	"
			NG=45		7.8	2.67	0.40	1.96	2.57		"	"
		N	G=43		8.6	408	0.62	1.96	2.57		"	"
			NG=37		7.3	3.58	0.59	1.96	2.57		"	"

All μ_o-values((1-19)): Source: Spence Geddes (1976) Source: Field survey 2005

Table 8.10 The effect of education levels on resource mix in ceramic floor/wall tiles construction activities by construction firms in Kenya

Where A = African Firms, C = Citizen Firms, N = Non-citizen Firms; G= Graduate; NG= Nongraduales]

$$s=\sqrt{\frac{\sum(X-\bar{X})^2}{n-1}}$$ = sample standard deviation. $$Z=\frac{\bar{X}-\mu o}{s/\sqrt{n}} \text{ or } t=\frac{\bar{X}-\mu o}{s/\sqrt{n}}$$

Activity	Sample Size (n)		μ_o	$\bar{X}$	S	$\delta_{\bar{X}} = \frac{S}{\sqrt{n}}$	Critical (e)		Actual Z_a	Decision : TWo Tailed Test	
							$Z_{0.025}$ $t_{0.025}$	$Z_{0.005}$ $t_{0.005}$	t_a	$Z_e > Z_a$: Accept H_0: Reject H_a $Z_e < Z_a$:	
										Confidence 95%	Confidence 99%
Materials: 150x150x6mm white wall tiles (No/M²)	A	G=23	44	45.13	1.58	0.33	2.074	2.819	3.42	Reject Ho Accept Ha	Reject Ho Accept Ha
		NG=47	"	45.11	1.88	0.27	1.96	2.57	4.11	"	"
	C	G=11	"	42.9	10.17	3.07	2.28	3.16	-0.36	Accept Ho Reject Ha	Accept Ho Reject Ha
		NG=45	"	45.93	6.79	1.01	1.96	2.57	1.91	"	"
	N	G=43	"	45.21	4.88	0.74	1.96	2.57	1.64	"	"
		NG=37	"	44.27	4.85	0.80	1.96	2.57	0.34	"	"
Waste (%) on wall tiles: 150x150x6mm thick	A	G=23	5	9.21	6.18	1.29	2.074	2.819	3.26	Reject Ho Accept Ha	Reject Ho Accept Ha
		NG=47	"	7.44	3.30	0.48	1.96	2.57	5.08	"	"
	C	G=11	"	8.9	3.48	1.05	2.28	3.16	3.71	"	"
		NG=45	"	6.75	3.67	0.55	1.96	2.57	3.18	"	"
	N	G=43	"	7.84	3.08	0.47	1.96	2.57	6.04	"	"
		NG=37	"	7.5	3.09	0.51	1.96	2.57	4.90	"	"
Output on 150 x 150x 6mm tiles/day (M²)	A	G=23	7.6	11.72	11.8	2.46	2.074	2.819	1.67	Accept Ho Reject Ha	Accept Ho Reject Ha
		NG=47	"	12.19	10.79	1.57	1.96	2.57	2.92	Reject Ho Accept Ha	Reject Ho Accept Ha
	C	G=11	"	9.5	4.77	1.44	2.28	3.16	1.32	Accept Ho Reject Ha	Accept Ho Reject Ha
		NG=45	"	11.24	8.47	1.26	1.96	2.57	2.89	Reject Ho Accept Ha	Reject Ho Accept Ha
	N	G=43	"	10.81	11.46	1.75	1.96	2.57	1.83	Accept Ho Reject Ha	Accept Ho Reject Ha
		NG=37	"	9.62	10.08	1.66	1.96	2.57	1.22	"	"
Gang size: Craftsmen. (No)	A	G=23	2	2	0.53	0.11	2.074	2.819	0		
		NG=47	"	1	0.29	0.04	1.96	2.57	-25.0	Reject Ho Accept Ha	Reject Ho Accept Ha
	C	G=11	"	1	0.0	0	2.28	3.16	0	Accept Ho Reject Ha	Accept Ho Reject Ha
		NG=45	"	1	1.01	0.15	1.96	2.57	-6.67	Reject Ho Accept Ha	Reject Ho Accept Ha
	N	G=43	"	1	0.22	0.03	1.96	2.57	-33.33	"	"
		NG=37	"	1	0.0	0	1.96	2.57	0	Accept Ho Reject Ha	Accept Ho Reject Ha
Gangsize: Labourers (No)	A	G=23	1	2	0.83	0.17	2.074	2.819	5.88	Reject Ho Accept Ha	Reject Ho Accept Ha
		NG=47	"	2	0.76	0.11	1.96	2.57	9.09	"	"
	C	G=11	"	2	0.0	0	2.28	3.16	α	"	"
		NG=45	"	2	0.52	0.08	1.96	2.57	12.50	"	"
	N	G=43	"	2	0.52	0.08	1.96	2.57	12.50	"	"
		NG=37	"	2	0.32	0.05	1.96	2.57	20.0	"	"
Idle time (%)	A	G=23	5	8.28	4.20	0.88	2.074	2.819	3.73	"	"
		NG=47	"	7.97	3.35	0.49	1.96	2.57	6.06	"	"
	C	G=11	"	8.95	3.57	1.08	2.28	3.16	3.66	"	"
		NG=45	"	7.33	3.67	0.55	1.96	2.57	4.24	"	"
	N	G=43	"	8.93	3.60	0.55	1.96	2.57	7.15	"	"
		NG=37	"	6.89	3.30	0.54	1.96	2.57	3.50	"	"

All μ_o-values(1-36): Sources; Manufacturer specifications; Smith R.C.(1986) Enterkin Hugh & Gerald Reynolds (1978) Source: Field survey 2005

6.10 The effect of education levels on resource mix in ceramic floor/wall tiles construction activities by construction firms in Kenya

A = African Firms, C = Citizen Firms, N = Non-citizen Firms; G= Graduate; NG= Nongraduates]

$$s = \sqrt{\frac{\sum(X - \bar{X})^2}{n-1}}$$ = sample standard deviation.

Activity	Sample Size (n)		μ_0	$\bar{X}$	S	$\delta_{\bar{x}} = \frac{s}{\sqrt{n}}$	Critical (e) $Z_{0.025}$ $t_{0.025}$	Critical (e) $Z_{0.005}$ $t_{0.005}$	Actual Z_a	DECISION : TWO TAILED TEST $Z_e > Z_a$: Accept H_0. Reject $H_a Z_e < Z_a$ Confidence 95%	DECISION : TWO TAILED TEST Confidence 99%
Materials 200x200x6mm wall tiles (No/m²)	A	G=23	25	26.78	2.47	0.52	2.074	2.819	3.42	"	"
		NG=47	"	26.74	2.85	0.42	1.96	2.57	4.14	"	"
	C	G=11	"	28.54	4.84	1.46	2.28	3.16	2.42	"	Accept Ho. Reject Ha
		NG=45	"	26.82	2.82	0.42	1.96	2.57	4.33	"	Reject Ho Accept Ho
	N	G=43	"	28.91	4.43	0.68	1.96	2.57	5.75	"	"
		NG=37	"	26.92	3.88	0.64	1.96	2.57	3.0	"	"
Waste (%) on 200x200x6mm wall tiles	A	G=23	5	9.21	5.55	1.16	2.074	2.819	3.63	"	"
		NG=47	"	7.93	4.61	0.67	1.96	2.57	4.37	"	"
	C	G=11	"	8.9	3.48	1.05	2.28	3.16	3.71	"	"
		NG=45	"	6.64	3.12	0.47	1.96	2.57	3.49	"	"
	N	G=43	"	7.84	3.08	0.47	1.96	2.57	6.04	"	"
		NG=37	"	8.19	3.86	0.63	1.96	2.57	5.06	"	"
Output on 200x200x 6mm wall tiles/day (M²)	A	G=23	7.6	10.65	5.81	1.21	2.074	2.819	2.52	"	Accept Ho. Reject Ha
		NG=47	"	11.60	6.06	0.88	1.96	2.57	4.55	"	Reject Ho Accept Ho
	C	G=11	"	10.09	4.23	1.28	2.28	3.16	1.95	Accept Ho. Reject Ha	Accept Ho. Reject Ha
		NG=45	"	12.29	7.20	1.07	1.96	2.57	4.38	Reject Ho Accept Ho	Reject Ho Accept Ho
	N	G=43	"	10.35	4.81	0.73	1.96	2.57	3.77	"	"
		NG=37	"	10.59	6.36	1.05	1.96	2.57	2.85	"	"
Gang size Craftsmen (No)	A	G=23	2	2	0.53	0.11	2.074	2.819	0	Accept Ho. Reject Ha	Accept Ho. Reject Ha
		NG=47	"	1	0.29	0.04	1.96	2.57	-25.0	Reject Ho Accept Ho	Reject Ho Accept Ho
	C	G=11	"	1	0	0	2.28	3.16	α	"	"
		NG=45	"	2	1.01	0.15	1.96	2.57	0	Accept Ho. Reject Ha	Accept Ho. Reject Ha
	N	G=43	"	1	0.22	0.03	1.96	2.57	-33.33	Reject Ho Accept Ho	Reject Ho Accept Ho
		NG=37	"	1	0	0	1.96	2.57	0	Accept Ho. Reject Ha	Accept Ho. Reject Ha
Gang size: Labourers (No)	A	G=23	1	2	0.83	0.17	2.074	2.819	5.88	Reject Ho Accept Ho	Reject Ho Accept Ho
		NG=47	"	2	0.76	0.11	1.96	2.57	9.09	Reject Ho Accept Ho	Reject Ho Accept Ho
	C	G=11	"	2	0	0	2.28	3.16	0	Reject Ho Accept Ho	Reject Ho Accept Ho
		NG=45	"	2	0.52	0.08	1.96	2.57	12.50	Accept Ho. Reject Ha	Accept Ho. Reject Ha
	N	G=43	"	2	0.52	0.08	1.96	2.57	12.50	"	"
		NG=37	"	2	0.32	0.05	1.96	2.57	20.0	"	"
Idle time (%)	A	G=23	5	8.46	4.35	0.91	2.074	2.819	3.80	"	"
		NG=47	"	7.98	3.35	0.49	1.96	2.57	6.08	"	"
	C	G=11	"	8.95	3.57	1.08	2.28	3.16	3.66	"	"
		NG=45	"	7.39	3.70	0.55	1.96	2.57	4.35	"	"
	N	G=43	"	8.93	3.60	0.55	1.96	2.57	7.15	"	"
		NG=37	"	7.56	3.43	0.56	1.96	2.57	4.57	"	"

μ_0-values(1-36): Sources; Manufacturer specifications; Smith R.C.(1986) Enterkin Hugh & Gerald Reynolds (1978) Source: Field survey 2005

Table 6.10 The effect of education levels on resource mix in ceramic floor/wall tiles construction activities by construction firms in Kenya

A = African Firms, C = Citizen Firms, N = Non-citizen Firms; G= Graduate; NG= Nongraduates]

$$s = \sqrt{\frac{\sum (X - \bar{X})^2}{n-1}}$$ = sample standard deviation.

Activity	Sample Size (n)		μ_o	$\bar{X}$	S	$\delta_{\bar{x}} = \frac{s}{\sqrt{n}}$	Critical (e)		Actual Z_e	DECISION : TWO TAILED TEST	
							$Z_{0.025}$ $t_{0.025}$	$Z_{0.005}$ $t_{0.005}$		$Z_e > Z_e$: Accept H_0. Reject H_a $Z_e < Z_e$:	
										Confidence 95%	Confidence 99%
Materials: 300x300x 6mm wall tiles (No/M²)	A	G=23	11.11	12.83	4.62	0.96	2.074	2.819	1.79	Accept Ho. Reject Ha	Accept Ho. Reject Ha
		NG=47	"	12.83	3.57	0.52	1.96	2.57	3.31	Reject Ho Accept Ho	Reject Ho Accept Ho
	C	G=11	"	18.27	13.69	4.13	2.28	3.16	1.73	Accept Ho. Reject Ha	Accept Ho. Reject Ha
		NG=45	"	13.29	5.43	0.81	1.96	2.57	2.69	Reject Ho Accept Ho	Reject Ho Accept Ho
	N	G=43	"	16.53	9.39	1.43	1.96	2.57	3.79	"	"
		NG=37	"	12.70	2.87	0.47	1.96	2.57	3.38	"	"
Waste (%) on 300x300x 6mm tiles	A	G=23	10	8.91	5.49	1.14	2.074	2.819	3.43	"	"
		NG=47	"	7.82	3.8	0.55	1.96	2.57	5.13	"	"
	C	G=11	"	8.9	3.48	1.05	2.28	3.16	3.71	"	"
		NG=45	"	6.48	3.11	0.46	1.96	2.57	3.22	"	"
	N	G=43	"	7.61	3.09	0.47	1.96	2.57	5.55	"	"
		NG=37	"	8.28	4.84	0.80	1.96	2.57	4.10	"	"
Output on 300x300x 6mm tiles/day (M²)	A	G=23	5	10.49	4.67	0.97	2.074	2.819	0.51	Accept Ho. Reject Ha	Accept Ho. Reject Ha
		NG=47	"	12.46	10.65	1.55	1.96	2.57	1.59	"	"
	C	G=11	"	13	5.16	1.56	2.28	3.16	1.92	"	"
		NG=45	"	14	8.75	1.30	1.96	2.57	3.08	"	"
	N	G=43	"	10.22	3.15	0.48	1.96	2.57	0.46	"	"
		NG=37	"	11.65	8.43	1.39	1.96	2.57	1.19	"	"
Gang size craftsmen (No)	A	G=23	2	2	0.53	0.11	2.074	2.819	0	"	"
		NG=47	"	1	0.29	0.04	1.96	2.57	-25.0	Reject Ho Accept Ha	Reject Ho Accept Ho
	C	G=11	"	1	0	0	2.28	3.16	α	"	"
		NG=45	"	2	1.01	0.15	1.96	2.57	0	Accept Ho. Reject Ha	Accept Ho. Reject Ha
	N	G=43	"	1	0.22	0.03	1.96	2.57	-33.33	Reject Ho Accept Ha	Reject Ho Accept Ha
		NG=37	"	1	0	0	1.96	2.57	α	"	"
Gang size: Labourers (No)	A	G=23	1	3	0.83	0.17	2.074	2.819	11.76	"	"
		NG=47	"	2	0.76	0.11	1.96	2.57	9.09	"	"
	C	G=11	"	2	0	0	2.28	3.16	α	"	"
		NG=45	"	2	0.52	0.08	1.96	2.57	12.50	"	"
	N	G=43	"	2	0.52	0.08	1.96	2.57	12.50	"	"
		NG=37	"	2	0.32	0.05	1.96	2.57	20.0	"	"
Idle time (%)	A	G=23	5	8.91	4.62	0.96	2.074	2.819	4.07	"	"
		NG=47	"	8.39	3.61	0.53	1.96	2.57	6.40	"	"
	C	G=11	"	8.95	3.57	1.08	2.28	3.16	3.66	"	"
		NG=45	"	7.39	3.70	0.55	1.96	2.57	4.35	"	"
	N	G=43	"	9.16	3.67	0.56	1.96	2.57	7.43	"	"
		NG=37	"	7.83	3.81	0.63	1.96	2.57	4.49	"	"

μ_o-values(1-36): Sources; Manufacturer specifications; Smith R.C.(1986) Enterkin Hugh & Gerald Reynolds (1978) Source: Field Survey 2005

6.10 The effect of education levels on resource mix in ceramic floor/wall tiles construction activities by construction firms in Kenya

A = African Firms, C = Citizen Firms, N = Non-citizen Firms; G= Graduate; NG= Nongraduates]

$$s = \sqrt{\frac{\sum (X-\bar{X})^2}{n-1}} = \text{sample standard deviation.}$$

Activity	Sample Size (n)		μ_o	$\bar{X}$	S	$\delta_{\bar{x}} = \frac{S}{\sqrt{n}}$	Critical (e)		Actual Z_e	DECISION : TWO TAILED TEST	
							$Z_{0.025}$ $t_{0.025}$	$Z_{0.005}$ $t_{0.005}$	t_e	$Z_e > Z_e$: Accept H_0; Reject H_a $Z_e < Z_e$	
										Confidence 95%	Confidence 99%
Materials: 150x150x8mm Floor tiles (No/m²)	A	G=23	44	44.78	2.09	0.44	2.074	2.819	1.77	Accept Ho. Reject Ha	Accept Ho. Reject Ha
		NG=47	"	44.96	2.29	0.33	1.96	2.57	2.91	Reject Ho Accept Ha	Reject Ho Accept Ha
	C	G=11	"	43.45	9.01	2.72	2.28	3.16	-0.20	Accept Ho. Reject Ha	Accept Ho. Reject Ha
		NG=45	"	45.33	7.4	1.10	1.96	2.57	1.21	"	"
	N	G=43	"	44.51	4.73	0.72	1.96	2.57	0.71	"	"
		NG=37	"	48.43	11.34	1.86	1.96	2.57	2.38	Reject Ho Accept Ha	"
Waste on floor tiles: 150x150x8mm (%)	A	G=23	5	10.21	7.71	1.61	2.074	2.819	3.24	"	Reject Ho Accept Ha
		NG=47	"	7.71	3.80	0.55	1.96	2.57	4.93	"	"
	C	G=11	"	8.9	3.48	1.05	2.28	3.16	3.71	"	"
		NG=45	"	6.77	3.64	0.54	1.96	2.57	3.28	"	"
	N	G=43	"	7.21	3.08	0.47	1.96	2.57	4.70	"	"
		NG=37	"	8.06	4.25	0.70	1.96	2.57	4.37	"	"
Output on 150x150x8mm floor tiles/day (M²)	A	G=23	8	14.57	11.2	2.34	2.074	2.819	2.81	Reject Ho Accept Ha	Accept Ho. Reject Ha
		NG=47	"	17.21	15.98	2.33	1.96	2.57	3.95	"	"
	C	G=11	"	9.36	3.99	1.20	2.28	3.16	1.33	Accept Ho. Reject Ha	Accept Ho. Reject Ha
		NG=45	"	11.83	7.71	1.15	1.96	2.57	3.33	Reject Ho Accept Ha	Reject Ho Accept Ha
	N	G=43	"	13.2	8.65	1.32	1.96	2.57	3.94	"	"
		NG=37	"	12.43	10.8	1.78	1.96	2.57	2.49	"	Accept Ho. Reject Ha
Gang size: Craftsmen (No)	A	G=23	2	2	0.37	0.08	2.074	2.819	0	"	Accept Ho. Reject Ha
		NG=47	"	2	0.49	0.07	1.96	2.57	0	"	"
	C	G=11	"	1	0	0	2.28	3.16	α	Reject Ho Accept Ha	Reject Ho Accept Ha
		NG=45	"	2	1.01	0.15	1.96	2.57	0	Accept Ho. Reject Ha	Accept Ho. Reject Ha
	N	G=43	"	1	0.22	0.03	1.96	2.57	-33.33	Reject Ho Accept Ha	Reject Ho Accept Ha
		NG=37	"	1	0.0	0	1.96	2.57	A	"	"
Gang size labourers (No)	A	G=23	1	2	0.73	0.15	2.074	2.819	6.67	"	"
		NG=47	"	2	0.86	0.13	1.96	2.57	7.69	"	"
	C	G=11	"	2	0	0	2.28	3.16	α	"	"
		NG=45	"	2	0.52	0.08	1.96	2.57	12.5	"	"
	N	G=43	"	2	0.49	0.07	1.96	2.57	14.29	"	"
		NG=37	"	2	0.28	0.05	1.96	2.57	20.0	"	"
Idle time (%)	A	G=23	5	8.26	2.92	0.61	2.074	2.819	5.34	"	"
		NG=47	"	8.17	3.16	0.46	1.96	2.57	6.89	"	"
	C	G=11	"	9.15	3.36	1.01	2.28	3.16	4.11	"	"
		NG=45	"	7.33	3.67	0.55	1.96	2.57	4.24	"	"
	N	G=43	"	8.81	3.48	0.53	1.96	2.57	7.19	"	"
		NG=37	"	7.63	3.40	0.56	1.96	2.57	4.70	"	"

Source: Field survey 2005 All μ_o-values(1-36): Sources; Manufacturer specifications; Smith R.C.(1986) Enterkin Hugh & Gerald Reynolds (1978) Source: Field survey 2005

Table 6.10 The effect of education levels on resource mix in ceramic floor/wall tiles construction activities by construction firms in Kenya

[Where A = African Firms, C = Citizen Firms, N = Non-citizen Firms; G= Graduate; NG= Nongraduates]

$$s = \sqrt{\frac{\sum (X - \bar{X})^2}{n-1}}$$ = sample standard deviation.

	Activity	Sample Size (n)		μ_o	$\bar{X}$	S	$\delta_{\bar{x}} = \frac{s}{\sqrt{n}}$	Critical (e)		Actual Z_a	DECISION : TWO TAILED TEST	
								$Z_{0.025}$ $t_{0.025}$	$Z_{0.005}$ $t_{0.005}$	t_a	$Z_e > Z_a$: Accept H_0; Reject H_a $Z_a < Z_e$:	
											Confidence 95%	Confidence 99%
25	Materials: 200x200x 8mm floor tiles (No/m²)	A	G=23	25	28.52	7.8	1.63	2.074	2.819	2.16	"	Accept Ho. Reject Ha
			NG=47	"	27.27	5.55	0.81	1.96	2.57	2.80	"	"
		C	G=11	"	30.45	7.27	2.19	2.28	3.16	2.49	"	"
			NG=45	"	26.89	2.87	0.43	1.96	2.57	2.50	"	"
		N	G=43	"	29.79	5.82	0.89	1.96	2.57	5.38	"	Reject Ho Accept Ha
			NG=37	"	26.73	2.89	0.48	1.96	2.57	3.60	"	"
26	Materials: Waste (%) on 200x200x8 mm floor tile	A	G=23	5	9.62	7.71	1.61	2.074	2.819	2.87	"	"
			NG=47	"	7.82	4.62	0.67	1.96	2.57	4.21	"	"
		C	G=11	"	8.9	3.48	1.05	2.28	3.16	3.71	"	"
			NG=45	"	6.66	3.08	0.46	1.96	2.57	3.61	"	"
		N	G=43	"	7.72	3.09	0.47	1.96	2.57	5.79	"	"
			NG=37	"	7.64	3.09	0.51	1.96	2.57	5.18	"	"
27	Output/day on 200x200x8 mm floor tiles (M²)	A	G=23	8	14.78	7.46	1.56	2.074	2.819	4.35	"	"
			NG=47	"	18.53	15.55	2.27	1.96	2.57	4.64	"	"
		C	G=11	"	12.55	3.79	1.14	2.28	3.16	3.99	"	"
			NG=45	"	12.80	5.70	0.85	1.96	2.57	5.65	"	"
		N	G=43	"	14.28	5.56	0.85	1.96	2.57	7.39	"	"
			NG=37	"	14.73	7.63	1.25	1.96	2.57	5.38	"	"
28	Gang size: Craftsmen (No)	A	G=23	2	2	0.37	0.08	2.074	2.819	0	Accept Ho Reject Ha	Accept Ho Reject Ha
			NG=47	"	2	0.49	0.07	1.96	2.57	0	"	"
		C	G=11	"	1	0	0	2.28	3.16	α	Reject Ho Accept Ha	Reject Ho Accept Ha
			NG=45	"	2	1.01	0.15	1.96	2.57	0	Accept Ho Reject Ha	Accept Ho Reject Ha
		N	G=43	"	1	0.22	0.03	1.96	2.57	-33.33	Reject Ho Accept Ha	Reject Ho Accept Ha
			NG=37	"	1	0	0	1.96	2.57	α	"	"
29	Gang size: Labourers (No)	A	G=23	1	2	0.73	0.15	2.074	2.819	6.67	"	"
			NG=47	"	2	0.86	0.13	1.96	2.57	7.69	"	"
		C	G=11	"	2	0	0	2.28	3.16	α	"	"
			NG=45	"	2	0.52	0.08	1.96	2.57	-12.50	"	"
		N	G=43	"	2	0.49	0.07	1.96	2.57	14.29	"	"
			NG=37	"	2	0.28	0.05	1.96	2.57	20.0	"	"
30.	Idle time (%)	A	G=23	5	8.17	3.28	0.68	2.074	2.819	4.66	"	"
			NG=47	"	8.28	3.32	0.48	1.96	2.57	6.83	"	"
		C	G=11	"	9.15	3.36	1.01	2.28	3.16	4.11	"	"
			NG=45	"	7.39	3.70	0.55	1.96	2.57	4.35	"	"
		N	G=43	"	8.81	3.48	0.53	1.96	2.57	7.19	"	"
			NG=37	"	7.69	3.82	0.63	1.96	2.57	4.27	"	"

All μ_o-values(1-36): Sources; Manufacturer specifications; Smith R.C.(1986) Enterkin Hugh & Gerald Reynolds (1978) Source: Field survey 2005

6.10 The effect of education levels on resource mix in ceramic floor/wall tiles construction activities by construction firms in Kenya

where A = African Firms, C = Citizen Firms, N = Non-citizen Firms; G= Graduate; NG= Nongraduates]

$$S = \sqrt{\frac{\sum(X-\bar{X})^2}{n-1}}$$ = sample standard deviation.

	Activity		Sample Size (n)	μ_o	$\bar{X}$	S	$\delta_{\bar{x}} = \frac{s}{\sqrt{n}}$	Critical (e)		Actual Z_e	DECISION : TWO TAILED TEST	
								$Z_{0.025}$ $t_{0.025}$	$Z_{0.005}$ $t_{0.005}$		$Z_e > Z_a$: Accept H_0: Reject H_a $Z_e < Z_a$:	
											Confidence 95%	Confidence 99%
31	Materials: 300x300x 8mm floor tiles (No/M²)	A	G=23	11.11	14.87	10.04	2.09	2.074	2.819	1.80	Accept Ho Reject Ha	Accept Ho Reject Ha
			NG=47	"	13.21	4.28	0.62	1.96	2.57	3.39	Reject Ho Accept Ha	Reject Ho Accept Ha
		C	G=11	"	13.55	3.09	0.93	2.28	3.16	2.62	"	Accept Ho Reject Ha
			NG=45	"	13.71	7.90	1.18	1.96	2.57	2.20	"	"
		N	G=43	"	16.48	10.51	1.60	1.96	2.57	3.36	"	Reject Ho Accept Ha
			NG=37	"	12.84	3.3	0.54	1.96	2.57	3.20	"	"
32	Material waste (%) on 300x300x 8mm floor tiles	A	G=23	5	8.64	6.24	1.30	2.074	2.819	2.80	"	Accept Ho Reject Ha
			NG=47	"	7.71	3.65	0.53	1.96	2.57	5.11	"	Reject Ho Accept Ha
		C	G=11	"	8.9	3.48	1.05	2.28	3.16	3.71	"	"
			NG=45	"	6.5	3.08	0.46	1.96	2.57	3.26	"	"
		N	G=43	"	7.49	3.09	0.47	1.96	2.57	5.30	"	"
			NG=37	"	7.64	3.09	0.51	1.96	2.57	5.18	"	"
33	Output/day on 300x300x 8mm floor tiles (M²)	A	G=23	10	15.96	11.01	2.30	2.074	2.819	2.59	"	Accept Ho Reject Ha
			NG=47	"	18.45	16.93	2.47	1.96	2.57	3.42	"	Reject Ho Accept Ha
		C	G=11	"	13.3	4.02	1.21	2.28	3.16	2.73	"	Accept Ho Reject Ha
			NG=45	"	14.47	7.21	1.07	1.96	2.57	4.18	"	Reject Ho Accept Ha
		N	G=43	"	13.85	4.78	0.73	1.96	2.57	5.27	"	"
			NG=37	"	15.11	9.22	1.52	1.96	2.57	3.36	"	"
34	Gang size craftsmen (No)	A	G=23	2	2	0.37	0.08	2.074	2.819	0	Accept Ho Reject Ha	Accept Ho Reject Ha
			NG=47	"	2	0.49	0.07	1.96	2.57	0	"	"
		C	G=11	"	1	0	0	2.28	3.16	α	Reject Ho Accept Ha	Reject Ho Accept Ha
			NG=45	"	2	1.01	0.15	1.96	2.57	0	Accept Ho Reject Ha	Accept Ho Reject Ha
		N	G=43	"	1	0.22	0.03	1.96	2.57	-33.33	Reject Ho Accept Ha	Reject Ho Accept Ha
			NG=37	"	1	0	0	1.96	2.57	α	"	"
35	Gang size labourers (No)	A	G=23	1	2	0.73	0.15	2.074	2.819	6.67	"	"
			NG=47	"	2	0.86	0.13	1.96	2.57	7.69	"	"
		C	G=11	"	2	0	0	2.28	3.16	α	"	"
			NG=45	"	2	0.52	0.08	1.96	2.57	12.50	"	"
		N	G=43	"	2	0.49	0.07	1.96	2.57	14.29	"	"
			NG=37	"	2	0.32	0.05	1.96	2.57	20.0	"	"
36	Idle time (%)	A	G=23	5	7.86	3.02	0.63	2.074	2.819	4.54	"	"
			NG=47	"	8.07	3.19	0.47	1.96	2.57	6.53	"	"
		C	G=11	"	9.15	3.35	1.01	2.28	3.16	4.11	"	"
			NG=45	"	7.39	3.70	0.55	1.96	2.57	4.35	"	"
		N	G=43	"	8.91	3.47	0.53	1.96	2.57	7.38	"	"
			NG=37	"	7.56	3.63	0.60	1.96	2.57	4.27	"	"

μ_o-values(1-36): Sources; Manufacturer specifications; Smith R.C.(1986) Enterkin Hugh & Gerald Reynolds (1978) Source: Field survey 2005

Table 6.11 The effect of education levels on resource mix in brick facing and its related construction activities by construction firms in Kenya

[Where A = African Firms, C = Citizen Firms, N = Non-citizen Firms; G= Graduate; NG= Nongraduates]

$$s = \sqrt{\frac{\sum (X-\bar{X})^2}{n-1}}$$ = sample standard deviation. $$Z = \frac{\bar{X}-\mu o}{s/\sqrt{n}}$$ or $$t = \frac{\bar{X}-\mu o}{s/\sqrt{n}}$$

Activity	Sample Size (n)		μ_o	$\bar{X}$	S	$\delta_{\bar{x}} = \frac{s}{\sqrt{n}}$	Critical (e)		Actual Z_c	DECISION : TWO TAILED TEST	
							$Z_{0.025}$ $t_{0.025}$	$Z_{0.005}$ $t_{0.005}$	t_c	$Z_c > Z_e$: Accept H_0: Reject H_a $Z_c < Z_e$:	
										Confidence 95%	Confidence 99%
230x75x5 mm bricks (No/m²)	A	G=23	50	52.6	9.88	2.06	2.074	2.819	1.26	Accept Ho. Reject Ha	Accept Ho Reject Ha
		NG=47	"	48.8	15.32	2.23	1.96	2.57	-0.54	"	"
	C	G=11	"	51.8	9.97	3.00	2.28	3.16	0.60	"	"
		NG=45	"	4	19.72	2.94	1.96	2.57	-2.04	Reject Ho Accept Ha	"
	N	G=43	"	52.3	13.89	2.12	1.96	2.57	1.08	Accept Ho Reject Ha	"
		NG=37	"	51.7	8.90	1.46	1.96	2.57	1.16	"	"
Waste on bricks (%)	A	G=23	5	10.0	4.94	1.03	2.074	2.819	4.85	Reject Ho Accept Ha	Reject Ho Accept Ha
		NG=47	"	9.3	5.81	0.85	1.96	2.57	5.06	"	"
	C	G=11	"	8.8	4.5	1.36	2.28	3.16	2.79	"	Accept Ho Reject Ha
		NG=45	"	7.7	3.3	0.50	1.96	2.57	5.40	"	Reject Ho Accept Ha
	N	G=43	"	7.9	3.35	0.51	1.96	2.57	5.67	"	"
		NG=37	"	7.9	4.07	0.67	1.96	2.57	4.33	Accept Ho Reject Ha	Accept Ho Reject Ha
230x75mmx25mm bricks. Output/day (M²)	A	G=23	8	8.7	8.5	1.77	2.074	2.819	0.40	"	"
		NG=47	"	11	11.70	1.71	1.96	2.57	1.75	"	"
	C	G=11	"	7.8	1.81	0.55	2.28	3.16	-0.36	"	"
		NG=45	"	9.9	7.69	1.15	1.96	2.57	1.65	"	"
	N	G=43	"	7.8	2.02	0.31	1.96	2.57	-0.65	"	"
		NG=37	"	8.8	2.35	0.39	1.96	2.57	2.05	Reject Ho Accept Ha	"
Gang size craftsmen (No)	A	G=23	2	1	0.29	0.06	2.074	2.819	-16.67	"	Reject Ho Accept Ha
		NG=47	"	1	0.25	0.04	1.96	2.57	-25.0	"	"
	C	G=11	"	1	0.32	0.10	2.28	3.16	-10.0	"	"
		NG=45	"	1	0.21	0.03	1.96	2.57	-33.33	"	"
	N	G=43	"	1	0.15	0.02	1.96	2.57	-50.0	"	"
		NG=37	"	1	0	0	1.96	2.57	- α	"	"
Gang size Labourers (No)	A	G=23	1	2	0.43	0.09	2.074	2.819	+11.11	"	"
		NG=47	"	2	0.55	0.08	1.96	2.57	12.5	"	"
	C	G=11	"	2	0	0	2.28	3.16	α	"	"
		NG=45	"	2	0.55	0.08	1.96	2.57	12.5	"	"
	N	G=43	"	2	0.48	0.07	1.96	2.57	14.29	"	"
		NG=37	"	2	0.33	0.05	1.96	2.57	20.0	"	"
Idle time/day (%)	A	G=23	5	7.5	4.04	0.84	2.074	2.819	2.98	"	"
		NG=47	"	8.5	3.44	0.50	1.96	2.57	7.0	"	"
	C	G=11	"	9.6	4.58	1.38	2.28	3.16	3.33	"	"
		NG=45	"	7.7	3.15	0.47	1.96	2.57	5.74	"	"
	N	G=43	"	8.7	3.46	0.53	1.96	2.57	6.98	"	"
		NG=37	"	7.8	4.62	0.76	1.96	2.57	3.68	"	"
230x75x50mm bricks (No/m²)	A	G=23	50	53.1	9.89	2.06	2.074	2.819	1.50	Accept Ho Reject Ha	Accept Ho Reject Ha
		NG=47	"	49.8	14.27	2.08	1.96	2.57	-0.10	"	"
	C	G=11	"	54.4	4.31	1.30	2.28	3.16	3.38	Reject Ho Accept Ha	Reject Ho Accept Ha
		NG=45	"	44.5	19.27	2.87	1.96	2.57	1.55	Accept Ho Reject Ha	Accept Ho Reject Ha
	N	G=43	"	53.2	13.19	2.01	1.96	2.57	1.59	"	"
		NG=37	"	52.3	11.80	1.94	1.96	2.57	1.19	"	"

μo-values: Source: Hugh Enterkin & Gerald Reynolds (1978) and manufacturers catalogues (Clayworks Ltd)
Source: Field survey 2005

6.11 The effect of education levels on resource mix in brick facing and its related construction activities by construction firms in Kenya

[Where A = African Firms, C = Citizen Firms, N = Non-citizen Firms; G= Graduate; NG= Nongraduates]

$$s = \sqrt{\frac{\sum (X - \bar{X})^2}{n-1}}$$ = sample standard deviation.

	Activity	Sample Size (n)		μ_o	$\bar{X}$	S	$\delta_{\bar{x}} = \frac{s}{\sqrt{n}}$	Critical (e)		Actual Z_a	Decision : TWo Tailed Test	
								$Z_{0.025}$ $t_{0.025}$	$Z_{0.005}$ $t_{0.005}$	t_a	$Z_a > Z_e$: Accept H_0; Reject H_a $Z_a < Z_e$:	
											Confidence 95%	Confidence 99%
[illegible]	Waste factor on bricks (%)	A	G=23	5	11.3	6.88	1.43	2.074	2.819	4.41	Reject Ho Accept Ha	Reject Ho Accept Ha
			NG=47	"	10.1	6.87	1.00	1.96	2.57	5.1	"	"
		C	G=11	"	8.8	4.50	1.36	2.28	3.16	2.79	"	Accept Ho Reject Ha
			NG=45	"	8.1	4.78	0.71	1.96	2.57	4.37	"	Reject Ho Accept Ha
		N	G=43	"	7.9	3.35	0.51	1.96	2.57	5.69	"	"
			NG=37	"	7.8	4.73	0.78	1.96	2.57	3.59	"	"
[illegible]	230x75x 50mm bricks output/ day (M^2)	A	G=23	8	8.5	8.56	1.78	2.074	2.819	0.28	Accept Ho Reject Ha	Accept Ho Reject Ha
			NG=47	"	10.5	11.56	1.69	1.96	2.57	1.48	"	"
		C	G=11	"	8.4	1.89	0.57	2.28	3.16	0.70	"	"
			NG=45	"	10.1	7.84	1.17	1.96	2.57	1.79	"	"
		N	G=43	"	7.8	2.25	0.34	1.96	2.57	-0.59	"	"
			NG=37	"	9	2.50	0.41	1.96	2.57	2.44	Reject Ho Accept Ha	"
10.	Gang size skilled craftsmen (No)	A	G=23	2	1	0.29	0.06	2.074	2.819	-16.67	"	Reject Ho Accept Ha
			NG=47	"	1	0.25	0.04	1.96	2.57	-25.0	"	"
		C	G=11	"	1	0.32	0.10	2.28	3.16	-10.0	"	"
			NG=45	"	1	0.21	0.03	1.96	2.57	-33.33	"	"
		N	G=43	"	1	0.5	0.02	1.96	2.57	-50.0	"	"
			NG=37	"	1	0	0	1.96	2.57	α	"	"
11.	Gang size labourers (No)	A	G=23	1	2	0.43	0.09	2.074	2.819	11.11	"	"
			NG=47	"	2	0.55	0.08	1.96	2.57	12.5	"	"
		C	G=11	"	2	0	0	2.28	3.16	α	"	"
			NG=45	"	2	0.55	0.08	1.96	2.57	12.5	"	"
		N	G=43	"	2	0.48	0.07	1.96	2.57	14.29	"	"
			NG=37	"	2	0.33	0.05	1.96	2.57	20.0	"	"
12.	Idle time/day (%)	A	G=23	5	7.3	3.74	0.78	2.074	2.819	2.95	"	"
			NG=47	"	8.1	3.34	0.49	1.96	2.57	6.33	"	"
		C	G=11	"	9.6	4.58	1.38	2.28	3.16	3.33	"	"
			NG=45	"	7.5	3.14	0.47	1.96	2.57	5.32	"	"
		N	G=43	"	8.8	3.45	0.53	1.96	2.57	7.17	"	"
			NG=37	"	7.3	3.66	0.60	1.96	2.57	3.83	"	"
13	230x65x65 mm bricks (No/M^2)	A	G=23	55	57.3	12.26	2.56	2.074	2.819	0.90	Accept Ho Reject Ha	Accept Ho Reject Ha
			NG=47	"	52.7	17.14	2.50	1.96	2.57	-0.92	"	"
		C	G=11	"	56.2	6.08	1.83	2.28	3.16	0.66	"	"
			NG=45	"	45.8	20.04	2.99	1.96	2.57	-3.08	Reject Ho Accept Ha	Reject Ho Accept Ha
		N	G=43	"	55.8	14.56	2.22	1.96	2.57	0.36	Accept Ho Reject Ha	Accept Ho Reject Ha
			NG=37	"	55.6	9.37	1.54	1.96	2.57	0.39	"	"

μ_o-values: Source: Hugh Enterkin & Gerald Reynolds (1978) and manufacturers catalogues (Clayworks Ltd)
Source: Field survey 2005

Table 6.11 The effect of education levels on resource mix in brick facing and its related construction activities by construction firms in Kenya

[Where A = African Firms, C = Citizen Firms, N = Non-citizen Firms; G= Graduate; NG= Nongraduates]

$$S = \sqrt{\frac{\sum (X - \bar{X})^2}{n-1}}$$ = sample standard deviation..

No.	Activity	Sample Size (n)		μ_o	$\bar{X}$	S	$\delta_{\bar{x}} = \frac{s}{\sqrt{n}}$	Critical (e)		Actual Z_a	DECISION : TWO TAILED TEST	
								$Z_{0.025}$ $t_{0.025}$	$Z_{0.005}$ $t_{0.005}$	t_a	$Z_a > Z_e$: Accept H_o: Reject H_o $Z_a < Z_e$:	
											Confidence 95%	Confidence 99%
[illegible]	230x65x65mm bricks waste factor (%)	A	G=23	5	11.7	7.85	1.64	2.074	2.819	4.08	Reject Ho Accept Ha	Reject Ho Accept Ha
			NG=47	"	9.9	6.17	0.90	1.96	2.57	5.44	"	"
		C	G=11	"	8.8	4.50	1.36	2.28	3.16	2.79	"	Accept Ho Reject Ha
			NG=45	"	8.0	4.79	0.71	1.96	2.57	4.22	"	Reject Ho Accept Ha
		N	G=43	"	8	3.36	0.51	1.96	2.57	5.88	"	"
			NG=37	"	7.7	4.79	0.79	1.96	2.57	3.42	"	"
5	230x65x65mm bricks output/day (M^2)	A	G=23	8	8.5	8.59	1.79	2.074	2.819	0.28	Accept Ho Reject Ha	Accept Ho Reject Ha
			NG=47	"	10.3	9.9	1.44	1.96	2.57	1.60	"	"
		C	G=11	"	8.5	2.36	0.71	2.28	3.16	0.70	"	"
			NG=45	"	9.8	7.73	1.15	1.96	2.57	1.56	"	"
		N	G=43	"	7.9	2.60	0.40	1.96	2.57	-0.25	"	"
			NG=37	"	8.4	2.51	0.41	1.96	2.57	0.98	"	"
6	Gang size: skilled craftsmen (No)	A	G=23	2	1	0.30	0.06	2.074	2.819	-16.67	Reject Ho Accept Ha	Reject Ho Accept Ha
			NG=47	"	1	0.25	0.04	1.96	2.57	-25.0	"	"
		C	G=11	"	1	0.32	0.10	2.28	3.16	-10.0	"	"
			NG=45	"	1	0.21	0.03	1.96	2.57	-33.33	"	"
		N	G=43	"	1	0.15	0.02	1.96	2.57	-50.0	"	"
			NG=37	"	1	0	0	1.96	2.57	α	"	"
7	Gang size labourers (No)	A	G=23	1	2	0.43	0.09	2.074	2.819	11.11	"	"
			NG=47	"	2	0.55	0.08	1.96	2.57	12.50	"	"
		C	G=11	"	2	0	0	2.28	3.16	α	"	"
			NG=45	"	2	0.55	0.08	1.96	2.57	12.50	"	"
		N	G=43	"	2	0.48	0.07	1.96	2.57	14.29	"	"
			NG=37	"	2	0.33	0.05	1.96	2.57	20.0	"	"
8	Gang size idle time/day (%)	A	G=23	5	7.6	3.97	0.83	2.074	2.819	3.13	"	"
			NG=47	"	8.3	3.51	0.51	1.96	2.57	6.47	"	"
		C	G=11	"	9.6	4.59	1.38	2.28	3.16	3.33	"	"
			NG=45	"	7.5	3.13	0.47	1.96	2.57	5.32	"	"
		N	G=43	"	8.9	3.41	0.52	1.96	2.57	7.50	"	"
			NG=37	"	7.3	3.43	0.56	1.96	2.57	4.11	"	"

μ_o-values: Source: Hugh Enterkin & Gerald Reynolds (1978) and manufacturers catalogues (Clayworks Ltd)
Source: Field survey 2005

Table 6.12 The effect of Resource mix on construction performance by construction firms in Kenya according to citizenship status:
where A = African Firms, C = Citizen Firms, N = Non-citizen Firms:

$$Z = \frac{\bar{X} - \mu_o}{S/\sqrt{n}}$$ when n ≥ 30: $$S = \sqrt{\frac{\sum (x - \bar{x})^2}{n-1}}$$ = sample standard deviation.

Item activity: Excavations and Earthworks

	Sub activity	Sample Size (n)	μ_o	$\bar{X}$	S	$\delta_{\bar{x}} = \frac{S}{\sqrt{n}}$	Critical (e)		Actual Z_a	DECISION : TWO TAILED TEST $Z_e > Z_a$: Accept H_0. Reject H_a $Z_e < Z_a$:	
							$Z_{0.025}$	$Z_{0.005}$		Confidence 95%	Confidence 99%
1	Excavate to reduce levels (Hrs/M³)	A=70	2.50	2.76	1.46	0.17	±1.96	±2.57	1.53	A(Cho); R(HA)	A(Cho); R(HA)
		C=56	2.50	2.69	1.28	0.17	±1.96	±2.57	1.12	" "	" "
		N=80	2.50	2.79	1.16	0.13	±1.96	±2.57	2.23	R(Ho); A(AHA)	" "
2	Ditto Bsment ≤ 1.50m (Hrs/M³)	A=70	2.75	3.91	1.74	0.21	±1.96	±2.57	5.52	" "	
		C=56	2.75	3.83	1.59	0.21	±1.96	±2.57	5.14	" "	R(Ho); A(HA)
		N=80	2.75	3.84	1.32	0.15	±1.96	±2.57	7.26	" "	" "
3	Ditto 1.50m-3.0m (Hrs/M³)	A=70	3.0	5.37	1.86	0.22	±1.96	±2.57	10.77	" "	" "
		C=56	3.0	5.26	1.82	0.24	±1.96	±2.57	9.42	" "	" "
		N=80	3.0	5.43	1.35	0.15	±1.96	±2.57	16.20	" "	" "
4	Ditto 3.0m-4.50m (Hrs/M³)	A=70	4.50	6.37	2.17	0.26	±1.96	±2.57	7.19	" "	" "
		C=56	4.50	6.51	1.69	0.23	±1.96	±2.57	8.74	" "	" "
		N=80	4.50	6.35	1.60	0.18	±1.96	±2.57	10.28	" "	" "
5	Ditto 4.5m-6.0m (Hrs/M³)	A=70	6.0	7.89	3.10	0.37	±1.96	±2.57	5.11	" "	" "
		C=56	6.0	8.13	2.09	0.28	±1.96	±2.57	7.61	" "	" "
		N=80	6.0	7.53	2.14	0.24	±1.96	±2.57	6.38	" "	" "
6	Exc. Top soil 150mm thick wheeled dpst	A=70	2.0	2.23	1.49	0.18	±1.96	±2.57	1.28	A(Ho); R(HA)	A(Ho); R(HA)
		C=56	2.0	2.15	1.14	0.15	±1.96	±2.57	1.0	" "	" "
		N=80	2.0	2.17	1.50	0.17	±1.96	±2.57	1.0	" "	" "
7	Cart away 100/Lab (Hrs/M³)	A=70	1.0	1.60	0.80	0.10	±1.96	±2.57	6.0	R(Ho); A(HA)	R(Ho); A(HA)
		C=56	1.0	1.71	0.95	0.13	±1.96	±2.57	5.46	" "	" "
		N=80	1.0	1.49	0.66	0.07	±1.96	±2.57	47.0	" "	" "
8	Bulkage of Esc. Soil per M³ (%)	A=70	25	24.91	9.80	1.17	±1.96	±2.57	-0.08	A(Ho); R(HA)	
		C=56	25	23.91	7.52	10.05	±1.96	±2.57	-0.11	" "	
		N=80	25	22.50	6.52	0.73	±1.96	±2.57	-3.42	R(Ho); A(HA)	R(Ho); A(HA)
9	Trenc. Exc. 150m deep (Hrs/M³)	A=70	2.50	3.13	1.56	0.19	±1.96	±2.57	3.32	" "	" "
		C=56	2.50	3.26	1.46	0.20	±1.96	±2.57	3.80	" "	" "
		N=80	2.50	2.95	1.26	0.14	±1.96	±2.57	3.21	" "	" "
10	Ditto 1.50m-mm (Hrs/M³)	A=70	3.25	3.97	1.88	0.22	±1.96	±2.57	3.27	" "	" "
		C=56	3.25	3.85	1.31	0.18	±1.96	±2.57	3.33	" "	" "
		N=80	3.25	3.71	1.35	0.15	±1.96	±2.57	3.07	" "	" "
11	Backfull in fdns. 1 lab. (Hrs/M³)	A=70	1.50	1.87	1.41	0.17	±1.96	±2.57	2.18	" "	A(Ho) ; R(HA)
		C=56	1.50	1.92	1.68	0.22	±1.96	±2.57	1.91	A(Ho) ; R(Ha)	" "
		N=80	1.50	1.58	0.63	0.07	±1.96	±2.57	1.14	" "	" "
12	Disposal No.. Men/ 5m³ Lorry (No)	A=70	2.0	3	1.88	0.22	±1.96	±2.57	4.55	R(Ho); A(Ha)	R(Ho); A(Ha)
		C=56	2.0	2	0.72	0.10	±1.96	±2.57	0	R(Ho); A(Ha)	R(Ho); R(Ha)
		N=80	2.0	2	0.94	0.11	±1.96	±2.57	0	" "	" "
13	Timetaken to load 5m³ lorry (Hrs)	A=70	2.0	2.59	1.63	0.19	±1.96	±2.57	3.11	R(Ho); A(Ha)	R(Ho); A(Ha)
		C=56	2.0	2.78	2.24	0.30	±1.96	±2.57	2.60	" "	" "
		N=80	2.0	2.05	1.08	0.12	±1.96	±2.57	0.42	A(Ho) ; R(Ha)	A(Ho) ; R(Ha)

All μo values *: 1-47: Source: R-C Smith (1986)
Source: Field Survey 2005

Table 6.12 The effect of Resource mix on construction performance by construction firms in Kenya according to citizenship status:
Where A = African Firms, C = Citizen Firms, N = Non-citizen Firms:

$$Z = \frac{\bar{X}-\mu_o}{S/\sqrt{n}}$$ when n ≥ 30: $$S = \sqrt{\frac{\sum(x-\bar{x})^2}{n-1}}$$ = sample standard deviation.

Main activity: Excavations and Earthworks

Sub activity	Sample Size (n)	μ_o	$\bar{X}$	S	$\delta_{\bar{x}} = \frac{s}{\sqrt{n}}$	Critical (e) $Z_{0.025}$	Critical (e) $Z_{0.005}$	Actual Z_e	DECISION : TWO TAILED TEST ($Z_e > Z_e$: Accept H_0: Reject H_a $Z_e < Z_e$:) Confidence 95%	Confidence 99%
Black cotton soil bulkage M³ (%)	A=70	35	30.31	8.25	0.99	±1.96	±2.57	-4.74	R(Ho); A(Ha)	R(Ho); A(Ha)
	C=56	35	28.70	7.89	1.05	"	"	-6.0	" "	" "
	N=80	35	27.22	7.67	0.86	"	"	-9.05	" "	" "
Ditto Red loam soil/M³ (%)	A=70	25	23.64	9.03	1.08	"	"	-1.26	A(Ho) ; R(Ha)	A(Ho); A(Ha)
	C=56	25	25.72	6.52	0.87	"	"	0.83	" "	" "
	N=80	25	25.84	5.74	0.64	"	"	1.31	" "	" "
Ditto Gravel per M³ (%)	A=70	10.0	15.87	7.20	0.86	"	"	6.83	R(Ho); A(Ha)	R(Ho); A(Ha)
	C=56	10.0	16.64	6.60	0.88	"	"	7.55	" "	" "
	N=80	10.0	15.89	6.07	0.68	"	"	8.66	" "	" "
Ditto Sand/M³ (%)	A=70	12.50	15.69	7.81	0.93	"	"	3.43	" "	" "
	C=56	12.50	15.02	6.31	0.84	"	"	3.00	" "	" "
	N=80	12.50	14.87	7.37	0.82	"	"	2.89	" "	" "
Ditto clay /M³ (%)	A=70	33.33	26.50	8.25	0.99	"	"	-6.90	" "	" "
	C=56	33.33	26.10	8.69	1.16	"	"	-6.23	" "	" "
	N=80	33.33	23.50	9.03	10.10	"	"	-0.97	A(Ho); R(Ha)	A(Ho); R(Ha)
Ditto murram/ M³ (%)	A=70	33.33	25.63	9.18	1.10	"	"	-7.0	R(Ho); A(Ha)	R(Ho); A(Ha)
	C=56	33.33	26.79	8.04	1.07	"	"	-6.11	" "	" "
	N=80	33.33	25.89	7.86	0.88	"	"	-8.46	" "	" "
Machine site strip output / hr in (M³)	A=70	14.0	12.41	11.41	1.36	"	"	-1.17	A(Ho); R(Ha)	A(Ho); R(Ha)
	C=56	14.0	11.35	8.61	1.15	"	"	-2.30	R(Ho); A(Ha)	" "
	N=80	14.0	8.82	3.84	0.43	"	"	-12.05	" "	R(Ho) ; A(Ha)
Reduce levels ¼ M³ bckt (M³ /hr)	A=70	15.0	11.26	8.73	1.04	"	"	-3.60	" "	" "
	C=56	15.0	9.49	5.82	0.78	"	"	-7.06	" "	" "
	N=80	15.0	8.56	3.72	0.42	"	"	-15.33	" "	" "
Ditto Basmit ≤ 1.50m (M³/hr)	A=70	15.0	9.66	7.65	0.91	"	"	-5.87	" "	" "
	C=56	15.0	8.28	5.71	0.76	"	"	-8.84	" "	" "
	N=80	15.0	7.55	3.07	0.34	"	"	-21.91	" "	" "
Ditto Bsment 1.50-3.0m (M³/hr)	A=70	15.0	8.38	7.19	0.86	"	"	-7.70	" "	" "
	C=56	15.0	7.36	5.00	0.67	"	"	-11.40	" "	" "
	N=80	15.0	6.40	2.66	0.30	"	"	-28.67	" "	" "
Ditto 3.0-4.50m (M³/hr)	A=70	15.0	7.05	5.08	0.61	"	"	-13.03	" "	" "
	C=56	15.0	6.72	4.65	0.62	"	"	-13.35	" "	" "
	N=80	15.0	5.70	3.11	0.35	"	"	-26.57	" "	" "
Ditto 4.50-6.0m (M³/hr)	A=70	15.0	5.78	4.99	0.60	"	"	-15.37	" "	" "
	C=56	15.0	6.08	4.58	0.61	"	"	-14.62	" "	" "
	N=80	15.0	4.93	3.06	0.34	"	"	-29.62	" "	" "
Reduce trench ¼ ≤1.50m (M³ /hr)	A=70	11.00	7.25	7.12	0.85	"	"	-4.41	" "	" "
	C=56	11.00	6.17	3.96	0.53	"	"	-9.11	" "	" "
	N=80	11.00	5.32	2.15	0.24	"	"	-23.67	" "	" "

All μo values : 1-47. Source: R.C. Smith (1986)
Source: Field Survey

Table 6.12 The effect of Resource mix on construction performance by construction firms in Kenya according to citizenship status:

where A = African Firms, C = Citizen Firms, N = Non-citizen Firms:

$$Z = \frac{\bar{X} - \mu_o}{S/\sqrt{n}} \text{ when } n \geq 30: \qquad S = \sqrt{\frac{\sum (x - \bar{x})^2}{n-1}} = \text{sample standard deviation.}$$

Main activity: Excavations and Earthworks

Sub activity	Sample Size (n)	μ_o	$\bar{X}$	S	$\delta_{\bar{x}} = \frac{S}{\sqrt{n}}$	Critical (e) $Z_{0.025}$	Critical (e) $Z_{0.005}$	Actual Z_e	DECISION : TWO TAILED TEST — $Z_e > Z_c$: Accept H_0. Reject H_0 $Z_e < Z_c$: Confidence 95%	Confidence 99%
Ditto 1.50-3.0m (M^3/hr)	A=70	11.00	6.06	7.19	0.86	±1.96	±2.57	-5.74	R(Ho); A(Ha)	R(Ho) ; A(Ha)
	C=56	11.00	4.95	3.94	0.53	"	"	-11.42	" "	" "
	N=80	11.00	3.84	1.80	0.20	"	"	-35.8	" "	" "
Ditto pits ≤ 1.50m (M^3/hr)	A=70	8.00	5.69	4.95	0.59	"	"	-3.92	" "	" "
	C=56	8.00	5.76	5.73	0.77	"	"	-2.91	" "	" "
	N=80	8.00	5.11	4.64	0.52	"	"	-5.56	" "	" "
Ditto 1.50-3.0m (M^3/hr)	A=70	8.00	5.02	4.73	0.57	"	"	-5.23	" "	" "
	C=56	8.00	4.98	3.64	0.49	"	"	-6.16	" "	" "
	N=80	8.00	4.19	2.57	0.29	"	"	-13.14	" "	" "
Exc. Plain conc. Compressor (hrs/M^3)	A=70	1.50	3.51	1.42	0.17	"	"	11.82	" "	" "
	C=56	1.50	3.79	1.26	0.17	"	"	13.47	" "	" "
	N=80	1.50	3.87	1.53	0.17	"	"	13.94	" "	" "
Ditto R.C. Conc (hrs/M^3)	A=70	3.60	5.34	1.85	0.22	"	"	7.91	" "	" "
	C=56	3.60	5.71	1.54	0.21	"	"	10.05	" "	" "
	N=80	3.60	5.51	1.54	0.17	"	"	11.24	" "	" "
Ditto Hard rock compressor (hrs/M^3)	A=70	2.90	6.52	2.47	0.30	"	"	12.07	" "	" "
	C=56	2.90	6.72	1.70	0.23	"	"	16.61	" "	" "
	N=80	2.90	6.75	1.96	0.22	"	"	17.50	" "	" "
Compressor outlets (No)	A=70	1.0	2	0.38	0.05	"	"	20.0	" "	" "
	C=56	1.0	2	0.29	0.04	"	"	25.0	" "	" "
	N=80	1.0	2	0.16	0.02	"	"	50.0	" "	" "
Operators/ compressor. (Men) (No)	A=70	1.0	2	0.68	0.08	"	"	12.50	" "	" "
	C=56	1.0	2	0.53	0.07	"	"	14.29	" "	" "
	N=80	1.0	2	0.38	0.04	"	"	25.0	" "	" "
Lab. With operators men No.	A=70	1.0	3	1.09	0.13	"	"	15.38	" "	" "
	C=56	1.0	3	1.29	0.17	"	"	11.76	" "	" "
	N=80	1.0	2	0.68	0.08	"	"	12.50	" "	" "
Exc plain conc.in trenches (hrs/M^3)	A=70	2.90	4.91	1.96	0.23	"	"	8.74	" "	" "
	C=56	2.90	5.02	1.64	0.22	"	"	9.64	" "	" "
	N=80	2.90	5.12	1.79	0.20	"	"	11.10	" "	" "
Ditto R.C. in trench (hrs/M^3)	A=70	7.20	6.25	2.31	0.28	"	"	-3.39	" "	" "
	C=56	7.20	6.59	1.85	0.25	"	"	-2.44	" "	A(Ho) R(Ha)
	N=80	7.20	6.36	1.87	0.21	"	"	-4.0	" "	" "
Ditto rock in trench (hrs/M^3)	A=70	5.90	7.51	3.17	0.38	"	"	4.24	" "	" "
	C=56	5.90	7.71	2.52	0.34	"	"	5.32	" "	" "
	N=80	5.90	7.64	2.36	0.26	"	"	6.69	" "	" "
Compressor outlets in trench (No)	A=70	1.0	2.0	0.42	0.05	"	"	20.0	" "	" "
	C=56	1.0	2.0	0.31	0.04	"	"	25.0	" "	" "
	N=80	1.0	2.0	0.11	0.01	"	"	100.00	" "	" "

All μo values : 1-47: Source: R.C. Smith (1986)

Source: Field Survey

Table 6.12. The effect of Resource mix on construction performance by construction firms in Kenya according to citizenship status:

Where A = African Firms, C = Citizen Firms, N = Non-citizen Firms:

$$Z = \frac{\bar{X} - \mu_o}{S/\sqrt{n}} \text{ when } n \geq 30; \quad S = \sqrt{\frac{\sum (x - \bar{x})^2}{n-1}} = \text{sample standard deviation.}$$

Main activity: Excavations and Earthworks

	Sub activity	Sample Size (n)	μ_o	$\bar{X}$	S	$\delta_{\bar{x}} = \frac{S}{\sqrt{n}}$	Critical (e)		Actual Z_e	DECISION : TWO TAILED TEST	
							$Z_{0.025}$	$Z_{0.005}$		$Z_c > Z_e$: Accept H_0; Reject H_0 $Z_e < Z_c$:	
										Confidence 95%	Confidence 99%
[illegible]	Operators/ compressor in trench (No)	A=70	1.0	2	0.99	0.12	±1.96	±2.57	8.33	R(Ho) ; A(Ha)	R(Ho) ; A(Ha)
		C=56	1.0	2	0.42	0.06	"	"	16.67	"	"
		N=80	1.0	2	0.66	0.07	"	"	14.29	"	"
[illegible]	Lab with Operators/ trenches (No)	A=70	1.0	3	1.08	0.13	"	"	15.38	"	"
		C=56	1.0	3	1.33	0.18	"	"	11.11	"	"
		N=80	1.0	2	0.59	0.07	"	"	14.29	"	"
[illegible]	Hardcore fill ≤ 300mm (hrs/M^3)	A=70	1.20	2.48	1.37	0.16	"	"	8.0	"	"
		C=56	1.20	3.15	2.04	0.27	"	"	7.22	"	"
		N=80	1.20	2.72	1.58	0.18	"	"	8.44	"	"
[illegible]	Exc plain conc.in trenches (hrs/M^3)	A=70	1.20	3.07	1.45	0.17	"	"	11.0	"	"
		C=56	1.20	3.68	1.88	0.25	"	"	9.92	"	"
		N=80	1.20	3.26	1.48	0.17	"	"	12.12	"	"
[illegible]	Hardcore roller ≤ 5 tonnes (hrs/M^3)	A=70	1.60	0.85	1.08	0.13	"	"	-5.77	"	"
		C=56	1.60	0.67	0.67	0.09	"	"	-10.33	"	"
		N=80	1.60	0.84	0.66	0.07	"	"	-10.86	"	"
[illegible]	Ditto roller > 10 tons (hrs/M^3)	A=70	0.08	0.86	1.65	0.20	"	"	3.90	"	"
		C=56	0.08	0.51	0.39	0.05	"	"	8.60	"	"
		N=80	0.08	0.81	0.71	0.08	"	"	9.13	"	"
[illegible]	Hardcore consoldtion factor (%)	A=70	25	19.51	10.24	1.22	"	"	-4.50	"	"
		C=56	25	20.22	10.63	1.42	"	"	-3.37	"	"
		N=80	25	19.94	7.29	0.82	"	"	-6.74	"	"
47	Hardcore Density (Tons/M^3)	A=70	1.60	1.58	0.35	0.04	"	"	-0.5	A(Ho) ; R(Ha)	A(Ho) ; R(Ha)
		C=56	1.60	1.73	0.43	0.06	"	"	2.17	R(Ho) ; A(Ha)	A(Ho) ; R(Ha)
		N=80	1.60	1.74	0.47	0.05	"	"	2.80	R(Ho) ; A(Ha)	R(Ho) ; A(Ha)

All μ_o values : 1-47: Source: R.C. Smith (1986)

Source: Field Survey

Table 613 The effect of Resource mix on construction performance by construction firms in Kenya according to citizenship status:
Where A = African Firms, C = Citizen Firms, N = Non-citizen Firms:

$$Z = \frac{\bar{X} - \mu_o}{S/\sqrt{n}} \text{ when } n \geq 30: \quad S = \sqrt{\frac{\sum (x - \bar{x})^2}{n-1}} = \text{sample standard deviation.}$$

Main activity: Insitu Concrete Work (Site Mixed)

	Sub activity	Sample Size (n)	μ_o	$\bar{X}$	S	$\delta_{\bar{x}} = \frac{S}{\sqrt{n}}$	Critical (e)		Actual Z_e	DECISION : TWO TAILED TEST	
							$Z_{0.025}$	$Z_{0.005}$		$Z_e > Z_a$: Accept H_0. Reject H_a $Z_e < Z_a$:	
										Confidence 95%	Confidence 99%
1	1:4:8 cement/ M^3 (Bags)	A=70	3.60	3.18	0.68	0.08	±1.96	±2.57	-5.25	R(Ho) : A(Ha)	R(Ho) : A(Ha)
		C=56	3.60	3.30	1.00	0.13	"	"	-2.31	" "	" "
		N=80	3.60	3.09	0.89	0.10	"	"	-5.1	" "	" "
2	1:4:8 Sand/ M^3 Tonnes/M^3	A=70	0.73	0.70	0.11	0.01	"	"	-3.0	" "	" "
		C=56	0.73	0.74	0.09	0.01	"	"	1.0	A(Ho) ; R(Ha)	A(Ho) ; R(Ha)
		N=80	0.73	0.75	0.12	0.01	"	"	+2.0	R(Ho) : A(Ha)	" "
3	1:4:8 Sand Ballast/M^3 tonnes/ M^3	A=70	1.43	1.28	0.19	0.02	"	"	-7.50	R(Ho) : A(Ha)	R(Ho) : A(Ha)
		C=56	1.43	1.35	0.14	0.02	"	"	-4.0	" "	" "
		N=80	1.43	1.37	0.15	0.02	"	"	-3.0	" "	" "
4	Water cement Ratio Litres/Bag	A=70	0.80	0.68	0.30	0.04	"	"	-3.0	" "	" "
		C=56	0.80	0.73	0.12	0.02	"	"	-3.50	" "	" "
		N=80	0.80	1.09	0.10	0.01	"	"	29.0	" "	" "
5	1:3:6 cement/ M^3 (Bags)	A=70	4.54	4.01	0.71	0.08	"	"	-6.63	" "	" "
		C=56	4.54	4.15	0.70	0.09	"	"	-4.33	" "	" "
		N=80	4.54	3.97	1.06	0.12	"	"	-4.75	" "	" "
6	1:3:6 sand Tonnes/ M^3	A=70	0.68	0.68	0.09	0.01	"	"	0	A(Ho) ; R(Ha)	A(Ho) ; R(Ha)
		C=56	0.68	0.69	0.10	0.03	"	"	0.33	" "	" "
		N=80	0.68	0.70	0.08	0.01	"	"	2.0	R(Ho) : A(Ha)	" "
7	1:3:6 Ballast/ M^3 Tonnes/ M^3	A=70	1.36	1.26	0.14	0.02	"	"	-5.0	" "	R(Ho) : A(Ha)
		C=56	1.36	1.32	0.13	0.02	"	"	-2.0	" "	A(Ho) ; R(Ha)
		N=80	1.36	1.32	0.12	0.01	"	"	-4.0	" "	R(Ho) : A(Ha)
8	Water/ Cement ratio litres/ Bag	A=70	0.75	0.65	0.10	0.01	"	"	-10.0	" "	" "
		C=56	0.75	0.67	0.11	0.02	"	"	-4.0	" "	" "
		N=80	0.75	0.68	0.10	0.01	"	"	-7.0	" "	" "
9	1:2:4 cement/ M^3 (Bags)	A=70	6.40	5.56	1.0	0.12	"	"	-7.00	" "	" "
		C=56	6.40	5.75	0.78	0.10	"	"	-6.50	" "	" "
		N=80	6.40	5.55	1.39	0.16	"	"	-5.31	A(Ho);R(Ha)	A(Ho);R(Ha)
10	1:2:4 sand tonnes/M^3	A=70	0.64	0.63	0.10	0.01	"	"	-1.0	R(Ho);A(Ha)	" "
		C=56	0.64	0.66	0.06	0.01	"	"	2.0	" "	" "
		N=80	0.64	0.67	0.08	0.01	"	"	3.00	" "	R(Ho);A(Ha)
11	1:2:4 Ballast tonnes/M^3	A=70	1.28	1.21	0.12	0.01	"	"	-7.0	" "	" "
		C=56	1.28	1.26	0.14	0.02	"	"	-1.0	A(Ho);R(Ha)	A(Ho);R(Ha)
		N=80	1.28	1.25	0.12	0.01	"	"	-3.0	R(Ho);A(Ha)	R(Ho);A(Ha)
12	Water/cemt ratio litres/bag	A=70	0.55	0.60	0.08	0.01	"	"	5.00	" "	" "
		C=56	0.55	0.62	0.10	0.01	"	"	7.00	" "	" "
		N=80	0.55	0.63	0.08	0.01	"	"	8.0	" "	" "
13	1:1 ½ :3 cement/ M^3 (bags)	A=70	8.08	6.95	1.24	0.15	"	"	-7.53	" "	" "
		C=56	8.08	7.38	0.82	0.11	"	"	-6.36	" "	" "
		N=80	8.08	6.85	1.55	0.17	"	"	-7.24	A(Ho);R(Ha)	A(Ho);R(Ha)

All μ_o values ((1-20)) Source: Spence Geddes (1976) Source: Field survey 2005

Table 6.13 The effect of Resource mix on construction performance by construction firms in Kenya according to citizenship status:
where A = African Firms, C = Citizen Firms, N = Non-citizen Firms:

$$Z = \frac{\bar{X}-\mu_o}{S/\sqrt{n}} \text{ when } n \geq 30: \qquad S = \sqrt{\frac{\sum(x-\bar{x})^2}{n-1}} = \text{sample standard deviation.}$$

Main activity: Insitu Concrete Work (Site Mixed)

	Sub activity	Sample Size (n)	μ_o	$\bar{X}$	S	$\delta_{\bar{x}} = \frac{s}{\sqrt{n}}$	Critical (e)		Actual Z_a	DECISION : TWO TAILED TEST	
							$Z_{0.025}$	$Z_{0.005}$		$Z_a > Z_e$: Accept H_o: Reject H_a $Z_a < Z_e$:	
										Confidence 95%	Confidence 99%
14	1:1½ :3 sand Tonnes/ M^3	A=70	0.60	0.62	0.11	0.01	±1.96	±2.57	2.00	R(Ho) : A(Ha)	A(Ho);R(Ha)
		C=56	0.60	0.65	0.07	0.01	"	"	5.00	" "	R(Ho) ; A(Ha)
		N=80	0.60	0.64	0.07	0.01	"	"	4.00	" "	" "
15.	1:1½ :3 Ballast Tonnes/ M^3	A=70	1.21	1.18	0.16	0.02	"	"	-1..50	A(Ho) : R(Ha)	A(Ho);R(Ha)
		C=56	1.21	1.22	0.20	0.03	"	"	0.33	" "	" "
		N=80	1.21	1.25	0.17	0.02	"	"	2.00	" "	" "
16.	Water/cemt ratio litres/bag	A=70	0.45	0.56	0.07	0.01	"	"	11.00	" "	R(Ho) ; A(Ha)
		C=56	0.45	0.59	0.10	0.01	"	"	14.01	" "	" "
		N=80	0.45	0.58	0.07	0.01	"	"	13.0	" "	" "
17.	1:1½ :3 cement/M^3 Bags	A=70	9.86	8.17	1.55	0.19	"	"	-8.89	" "	" "
		C=56	9.86	8.35	1.40	0.19	"	"	-7.95	" "	" "
		N=80	9.86	8.04	1.74	0.20	"	"	-9.10	" "	" "
18.	1:1 :3 sand Tonnes/ M^3	A=70	0.75	0.57	0.18	0.02	"	"	-9.0	" "	" "
		C=56	0.75	0.56	0.15	0.02	"	"	-9.50	" "	" "
		N=80	0.75	0.59	0.17	0.02	"	"	-8.0	" "	" "
19.	1:1 :3 ballast Tonnes/ M^3	A=70	0.99	1.22	0.27	0.03	"	"	7.67	" "	" "
		C=56	0.99	1.20	0.25	0.03	"	"	7.00	" "	" "
		N=80	0.99	1.22	0.15	0.02	"	"	11.50	" "	" "
20.	Water/cemt ratio litres/bag	A=70	0.40	0.53	0.08	0.01	"	"	13.0	" "	" "
		C=56	0.40	0.57	0.11	0.01	"	"	17.0	" "	" "
		N=80	0.40	0.57	0.06	0.01	"	"	17.0	" "	" "
21.	7/5 mixer output/ Hr (m^3)	A=70	1.40	3.06	1.58	0.19	"	"	8.74	" "	" "
		C=56	1.40	3.50	1.96	0.26	"	"	8.08	" "	" "
		N=80	1.40	3.33	1.40	0.16	"	"	12.06	" "	" "
22.	7/5 mixer start time (hrs)	A=70	0.25	0.27	0.11	0.01	"	"	2.0	" "	A(Ho);R(Ha)
		C=56	0.25	0.30	0.16	0.02	"	"	2.50	" "	" "
		N=80	0.25	0.25	0.11	0.01	"	"	0	A(Ho);R(Ha)	A(Ho);R(Ha)
23	7/5 mixer cleaning (hrs)/day	A=70	0.50	0.37	0.16	0.02	"	"	-6.50	R(Ho);A(Ha)	R(Ho);A(Ha)
		C=56	0.50	0.37	0.15	0.02	"	"	-6.50	" "	" "
		N=80	0.50	0.37	0.14	0.02	"	"	-6.50	" "	" "
24	7/5 idle time/day(hrs)	A=70	0.33	0.51	0.42	0.05	"	"	3.60	" "	" "
		C=56	0.33	0.63	0.45	0.06	"	"	5.0	" "	" "
		N=80	0.33	0.47	0.29	0.03	"	"	4.67	" "	" "
25	10/7 mixer output/ hr (M^3)	A=70	2.0	3.91	1.89	0.23	"	"	8.30	" "	" "
		C=56	2.0	4.30	1.92	0.26	"	"	8.85	" "	" "
		N=80	2.0	4.28	1.42	0.16	"	"	14.25	" "	" "
26.	10/7 mixer start time (hrs)	A=70	0.25	0.28	0.12	0.01	"	"	3.00	" "	" "
		C=56	0.25	0.33	0.16	0.02	"	"	4.00	" "	" "
		N=80	0.25	0.25	0.11	0.01	"	"	0	A(Ho);R(Ha)	A(Ho);R(Ha)

All μ_o values (21-32): Source: Enterkin and Reynolds (1978)
Source: Field survey 2005

Table 6.13. The effect of Resource mix on construction performance by construction firms in Kenya according to citizenship status:
Where A = African Firms, C = Citizen Firms, N = Non-citizen Firms:

$$Z = \frac{\bar{X} - \mu_o}{S / \sqrt{n}} \text{ when } n \geq 30: \qquad S = \sqrt{\frac{\sum (x - \bar{x})^2}{n - 1}} = \text{sample standard deviation.}$$

Main activity: Insitu concrete work

	Sub activity	Sample Size (n)	μo	$\bar{X}$	S	$\delta_{\bar{x}} = \frac{s}{\sqrt{n}}$	Critical (e)		Actual Z_o	DECISION : TWO TAILED TEST $Z_e > Z_o$: Accept H_o: Reject H_a $Z_o < Z_e$:	
							$Z_{0.025}$	$Z_{0.005}$		Confidence 95%	Confidence 99%
27	10/7 mixer cleaning (hrs/day)	A=70	0.50	0.39	0.15	0.02	±1.96	±2.57	-5.50	R(Ho) A(Ha)	R(Ho) A(Ha)
		C=56	"	0.37	0.15	0.02	"	"	-6.50	" "	" "
		N=80	"	0.37	0.12	0.01	"	"	-13.0	" "	" "
28	10/7 mixer idle time (hrs/day)	A=70	0.33	0.50	0.42	0.05	"	"	3.40	" "	" "
		C=56	"	0.63	0.47	0.06	"	"	5.00	" "	" "
		N=80	"	0.47	0.28	0.03	"	"	4.67	" "	" "
29	14/10 mixer output/ hr (M^3)	A=70	2.80	5.13	2.45	0.29	"	"	8.03	" "	" "
		C=56	"	6.16	5.19	0.69	"	"	4.87	" "	" "
		N=80	"	5.31	1.39	0.16	"	"	15.69	" "	" "
30	14/10 mixer start time (hrs)	A=70	0.25	0.32	0.17	0.02	"	"	3.50	" "	" "
		C=56	"	0.33	0.16	0.02	"	"	4.0	" "	" "
		N=80	"	0.27	0.14	0.02	"	"	1.00	A(Ho);R(Ha)	A(Ho);R(Ha)
31	14/10 mixer clean time (hrs/day	A=70	0.50	0.42	0.15	0.02	"	"	-4.0	R(Ho);A(Ha)	R(Ho);A(Ha)
		C=56	"	0.39	0.15	0.02	"	"	-5.50	" "	R(Ho);A(Ha)
		N=80	"	0.39	0.13	0.01	"	"	-11.00	" "	" "
32	14/10 mixer idle time (hrs/day	A=70	0.33	0.53	0.47	0.06	"	"	3.33	" "	" "
		C=56	"	0.63	0.46	0.07	"	"	4.29	" "	" "
		N=80	"	0.47	0.28	0.03	"	"	4.67	" "	" "
33	18/12 mixer output/hr (m^3)	A=70	3.40	6.07	2.98	0.36	"	"	7.42	" "	" "
		C=56	"	6.52	2.63	0.35	"	"	8.91	" "	" "
		N=80	"	5.87	1.65	0.18	"	"	13.72	" "	" "
34	18/12 mixer start time (hrs)	A=70	0.25	0.33	0.17	0.02	"	"	4.0	" "	" "
		C=56	"	0.33	0.17	0.03	"	"	2.67	" "	" "
		N=80	"	0.28	0.16	0.02	"	"	1.50	A(Ho);R(Ha)	A(Ho);R(Ha)
35	18/12 mixer cleaning time (hrs)	A=70	0.50	0.45	0.15	0.02	"	"	-2.50	R(Ho);A(Ha)	" "
		C=56	"	0.39	0.15	0.02	"	"	-5.50	" "	R(Ho);A(Ha)
		N=80	"	0.40	0.14	0.02	"	"	-5.0	" "	" "
36	18/12 mixer idle time (hrs/day)	A=70	0.33	0.53	0.47	0.06	"	"	3.33	" "	" "
		C=56	"	0.63	0.46	0.06	"	"	5.0	" "	" "
		N=80	"	0.49	0.33	0.04	"	"	4.0	" "	" "
37	7/5 gang operators (No)	A=70	1.0	1	0.39	0.05	"	"	0	A(Ho);R(Ha)	A(Ho);R(Ha)
		C=56	"	1	0.41	0.05	"	"	0	" "	" "
		N=80	"	1	0.35	0.04	"	"	0	" "	" "
38	7/5 gang labour (No)	A=70	1.0	4	2.50	0.30	"	"	10.0	R(Ho);A(Ha)	R(Ho);A(Ha)
		C=56	"	3	1.46	0.20	"	"	10.0	" "	" "
		N=80	"	4	1.39	0.16	"	"	18.76	" "	" "
39	7/5 Gang wheelers (No)	A=70	0	3	1.05	0.13	"	"	23.08	" "	" "
		C=56	"	3	1.31	0.18	"	"	16.67	" "	" "
		N=80	"	3	1.07	0.12	"	"	25.0	" "	" "

All μo values (33-36); Source: R.. Smith (1986)
(37-48); Source: Hugh Enterkin and Gerald Reynolds (1978)

Source: Field Survey, 2005

Table 6.13. The effect of Resource mix on construction performance by construction firms in Kenya according to citizenship status:
Where A = African Firms, C = Citizen Firms, N = Non-citizen Firms:

$$Z = \frac{\bar{X} - \mu_o}{S/\sqrt{n}} \text{ when } n \geq 30; \quad S = \sqrt{\frac{\sum (x - \bar{x})^2}{n-1}} = \text{sample standard deviation.}$$

Main activity: Insitu Concrete

	Sub activity	Sample Size (n)	μ_o	$\bar{X}$	S	$\delta_{\bar{x}} = \frac{s}{\sqrt{n}}$	Critical (e)		Actual Z_a	DECISION : TWO TAILED TEST	
							$Z_{0.025}$	$Z_{0.005}$		$Z_e > Z_a$: Accept H_0; Reject H_a $Z_e < Z_a$;	
										Confidence 95%	Confidence 99%
40	7/5 gang Idle time (%)	A=70	0	8.78	4.98	0.60	±1.96	±2.57	14.63	R(Ho) ; A(Ho)	R(Ho); A(Ha)
		C=56	0	9.30	7.06	0.94	"	"	9.89	" "	" "
		N=80	0	8.38	3.81	0.43	"	"	19.49	" "	" "
41	10/7 gang operators (No)	A=70	1.0	1.00	0.48	0.06	"	"	0	A(Ho) : R (Ha)	A(Ho) R(Ha)
		C=56	1.0	1.00	0.44	0.06	"	"	0	" "	" "
		N=80	1.0	1.00	0.39	0.04	"	"	0	" "	" "
42	10/7 gang labour (No)	A=70	1.0	4	2.65	0.32	"	"	9.38	R(Ho) ; A(Ho)	R(Ho); A(Ha)
		C=56	1.0	4	1.70	0.23	"	"	13.04	" "	" "
		N=80	1.0	4	1.91	0.21	"	"	14.29	" "	" "
43	10/7 Gang wheelers (No)	A=70	1.0	4	1.28	0.15	"	"	20.0	" "	" "
		C=56	1.0	4	1.18	0.16	"	"	18.75	" "	" "
		N=80	1.0	3	1.12	0.13	"	"	15.38	" "	" "
44	10/7 gang Idle time(%)	A=70	0	8.74	4.34	0.52	"	"	16.81	" "	" "
		C=56	0	9.15	6.94	0.92	"	"	9.95	" "	" "
		N=80	0	8.44	3.80	0.42	"	"	20.10	" "	" "
45	14/10 gang operators (No)	A=70	1.0	2	0.98	0.12	"	"	8.33	" "	" "
		C=56	1.0	2	0.48	0.06	"	"	16.67	" "	" "
		N=80	1.0	2	1.15	0.13	"	"	7.69	" "	" "
46	14/10 gang labour (No)	A=70	1.0	5	3.00	0.36	"	"	11.11	" "	" "
		C=56	1.0	5	2.51	0.33	"	"	12.12	" "	" "
		N=80	1.0	6	2.61	0.29	"	"	17.24	" "	" "
47	14/10 Gang wheelers (No)	A=70	2.0	2	1.93	0.23	"	"	0	A(Ho) : R (Ha)	A(Ho) R(Ha)
		C=56	2.0	5	1.59	0.21	"	"	14.29	R(Ho) ; A(Ha)	R(Ho); A(Ha)
		N=80	2.0	4	1.82	0.20	"	"	10.0	" "	" "
48	14/10 gang Idle time(%)	A=70	0	8.69	4.09	0.49	"	"	0	A(Ho) : R (Ha)	A(Ho) R(Ha)
		C=56	0	8.92	6.94	0.93	"	"	0	" "	" "
		N=80	0	8.44	3.88	0.43	"	"	0	R(Ho) ; A(Ha)	R(Ho); A(Ha)
49	18/12 gang operators (No)	A=70	1.0	2	0.58	0.07	"	"	14.29	" "	" "
		C=56	1.0	2	0.49	0.07	"	"	14.29	" "	" "
		N=80	1.0	2	0.96	0.11	"	"	9.09	" "	" "
50	18/12 gang labour (No)	A=70	1.0	6	3.56	0.43	"	"	11.63	" "	" "
		C=56	1.0	5	3.01	0.40	"	"	10.0	" "	" "
		N=80	1.0	6	3.22	0.36	"	"	13.89	" "	" "
51	18/12 Gang wheelers (No)	A=70	2.0	6	2.14	0.26	"	"	15.38	" "	" "
		C=56	2.0	5	2.06	0.28	"	"	10.71	" "	" "
		N=80	2.0	5	2.20	0.25	"	"	12.0	" "	" "
52	18/12 gang Idle time(%)	A=70	0	8.73	4.37	0.52	"	"	16.79	" "	" "
		C=56	0	8.87	6.92	0.92	"	"	9.64	" "	" "
		N=80	0	8.85	4.61	0.52	"	"	17.02	" "	" "

All μo values: (49-93): Source: R-C. Smith (1986) Sources: Field survey 2005

Table 6.13. The effect of Resource mix on construction performance by construction firms in Kenya according to citizenship status:
where A = African Firms, C = Citizen Firms, N = Non-citizen Firms:

$$Z = \frac{\bar{X} - \mu_o}{S/\sqrt{n}} \text{ when } n \geq 30; \quad S = \sqrt{\frac{\sum (x-\bar{x})^2}{n-1}} = \text{sample standard deviation.}$$

Main activity: Insitu concrete

	Sub activity	Sample Size (n)	μ_o	$\bar{X}$	S	$\delta_{\bar{x}} = \frac{S}{\sqrt{n}}$	Critical (e)		Actual Z_o	DECISION : TWO TAILED TEST $Z_o > Z_e$: Accept H_o; Reject H_o $Z_o < Z_e$	
							$Z_{0.025}$	$Z_{0.005}$		Confidence 95%	Confidence 99%
53	Frok to soffts M²/hr	A=70	1.80	7.31	3.51	0.42	±1.96	±2.57	13.12	R(Ho) A(Ha)	R(Ho) ; A(Ha)
		C=56	1.80	8.02	4.41	0.59	"	"	10.54	" "	" "
		N=80	1.80	6.99	2.09	0.23	"	"	22.57	" "	" "
54	Strip fwk to soffits M²/hr	A=70	0.90	9.60	9.45	1.13	"	"	7.70	" "	" "
		C=56	0.90	11.74	11.32	1.51	"	"	7.18	" "	" "
		N=80	0.90	8.82	6.27	0.70	"	"	11.31	" "	" "
55	Gang size strip fix carpenters (No)	A=70	1.0	1.19	0.39	0.05	"	"	3.80	" "	" "
		C=56	1.0	1.07	0.26	0.04	"	"	1.75	" "	" "
		N=80	1.0	1.06	0.37	0.04	"	"	1.50	" "	" "
56	Gang ditto Labourers (No)	A=70	1.0	2.13	1.07	0.13	"	"	8.69	" "	" "
		C=56	1.0	1.86	0.45	0.06	"	"	14.33	" "	" "
		N=80	1.0	1.94	0.29	0.03	"	"	31.33	" "	" "
57	Fwk sides & soffts M²/hr	A=70	1.80	4.29	2.65	0.32	"	"	7.78	" "	" "
		C=56	1.80	5.29	4.52	0.60	"	"	5.82	" "	" "
		N=80	1.80	4.24	3.46	0.39	"	"	6.26	" "	" "
58	Strip to ditto M²/hr	A=70	0.90	4.55	4.06	0.49	"	"	7.45	" "	" "
		C=56	0.90	5.96	5.41	0.72	"	"	7.03	" "	" "
		N=80	0.90	5.22	6.24	0.70	"	"	6.17	" "	" "
59	Gang size fix & strip sides & soffts carpenters (No)	A=70	1.0	1.23	1.45	0.16	"	"	1.44	A(Ho) R(Ha)	A(Ho) R(Ha)
		C=56	1.0	1.11	0.31	0.04	"	"	2.75	R(Ho) A(Ha)	R(Ho) A(Ha)
		N=80	1.0	1.10	0.41	0.05	"	"	2.0	" "	A(Ho) R(Ha)
60	Ditto Labourers (No)	A=70	1.0	2.14	1.19	0.14	"	"	8.14	" "	R(Ho) A(Ha)
		C=56	1.0	1.91	0.40	0.05	"	"	18.20	" "	" "
		N=80	1.0	1.95	0.35	0.04	"	"	23.75	" "	" "
61	Fwk to cols sides M²/hr	A=70	1.60	4.00	3.72	0.44	"	"	5.45	" "	" "
		C=56	1.60	4.51	3.60	0.48	"	"	6.06	" "	" "
		N=80	1.60	3.15	1.19	0.14	"	"	11.07	" "	" "
62	Strip cols fwk M²/hr	A=70	0.80	4.29	3.04	0.36	"	"	9.69	" "	" "
		C=56	0.80	8.23	7.96	1.06	"	"	7.01	" "	" "
		N=80	0.80	4.39	2.56	0.29	"	"	12.38	" "	" "
63	Coln. Fwk gang carp (No)	A=70	1.0	1.19	0.43	0.05	"	"	3.80	" "	" "
		C=56	1.0	1.11	0.32	0.04	"	"	2.75	" "	" "
		N=80	1.0	1.10	0.41	0.05	"	"	2.0	" "	" "
64	Ditto Labourers (No)	A=70	1.0	1.93	0.86	0.10	"	"	9.30	" "	A(Ho) R(Ha)
		C=56	1.0	1.89	0.37	0.05	"	"	17.8	" "	R(Ho) A(Ha)
		N=80	1.0	1.99	0.41	0.05	"	"	19.8	" "	" "
65	Fix fwk to fdn sides (M²/hr)	A=70	1.50	6.44	5.50	0.66	"	"	7.48	" "	" "
		C=56	1.50	5.43	3.28	0.44	"	"	8.93	" "	" "
		N=80	1.50	5.29	4.57	0.51	"	"	7.43	" "	" "

All μo values: (49-93): Source: R-C. Smith (1986) Sources: Field survey 2005

Table 6.13 The effect of Resource mix on construction performance by construction firms in Kenya according to citizenship status:
where A = African Firms, C = Citizen Firms, N = Non-citizen Firms:

$$Z = \frac{\bar{X} - \mu_o}{S/\sqrt{n}} \text{ when } n \geq 30: \qquad S = \sqrt{\frac{\sum(x-\bar{x})^2}{n-1}} = \text{sample standard deviation.}$$

Main activity: Insitu Concrete

No.	Sub activity	Sample Size (n)	μ_o	$\bar{X}$	S	$\delta_{\bar{x}} = \frac{S}{\sqrt{n}}$	Critical (e) $Z_{0.025}$	Critical (e) $Z_{0.005}$	Actual Z_a	DECISION : TWO TAILED TEST ($Z_e > Z_a$: Accept H_o: Reject H_a $Z_e < Z_a$:) Confidence 95%	Confidence 99%
[illegible]	Strip Fdn fwk. M^2/hr	A=70	0.75	6.17	3.95	0.47	±1.96	±2.57	11.53	" "	" "
		C=56	0.75	7.45	5.27	0.70	"	"	9.57	" "	" "
		N=80	0.75	5.21	2.83	0.32	"	"	13.94	" "	" "
[illegible]	Gang for strip fdn fwk.Carp. (No)	A=70	1.0	1.19	0.43	0.05	"	"	3.80	" "	" "
		C=56	1.0	1.07	.026	0.03	"	"	2.33	" "	" "
		N=80	1.0	1.10	0.41	0.05	"	"	2.0	" "	A(Ho) R(Ha)
[illegible]	Ditto Labourers (No)	A=70	1.0	1.93	0.91	0.11	"	"	8.45	" "	" "
		C=56	1.0	1.84	0.42	0.06	"	"	14.0	" "	R(Ho) A(Ha)
		N=80	1.0	1.98	0.39	0.04	"	"	24.50	" "	" "
69	Fwk soffts ≥ 3.5m high M^2/hr	A=70	2.04	4.86	2.65	0.32	"	"	8.81	" "	" "
		C=56	2.04	5.70	3.90	0.52	"	"	7.04	" "	" "
		N=80	2.04	5.10	3.97	0.44	"	"	6.96	" "	" "
70	Ditto but strip M^2/hr	A=70	1.02	6.60	6.27	0.75	"	"	7.44	" "	" "
		C=56	1.02	6.27	3.94	0.53	"	"	9.91	" "	" "
		N=80	1.02	4.88	1.44	0.16	"	"	24.12	" "	" "
[illegible]	Ditto Gang size Carp. (No)	A=70	1.0	2	0.63	0.08	"	"	12.5	" "	" "
		C=56	1.0	1	0.37	0.05	"	"	0	A(Ho) R(Ha)	A(Ho) R(Ha)
		N=80	1.0	1	0.93	0.10	"	"	0	R(Ho) A(Ha)	R(Ho) A(Ha)
[illegible]	Ditto Gang Labourers (No)	A=70	1.0	3	1.66	0.02	"	"	100.0	" "	" "
		C=56	1.0	2	0.64	0.08	"	"	12.50	" "	" "
		N=80	1.0	2	0.66	0.07	"	"	14.29	" "	" "
[illegible]	Fwk to sides & soffts beams ≥3.5m M^2/hr	A=70	2.04	3.86	2.87	0.34	"	"	5.35	" "	" "
		C=56	2.04	4.34	3.86	0.52	"	"	4.42	" "	" "
		N=80	2.04	3.05	1.69	0.19	"	"	5.32	" "	" "
[illegible]	Ditto, strip M^2/hr	A=70	1.02	3.99	3.08	0.37	"	"	8.03	" "	" "
		C=56	1.02	4.98	4.42	0.59	"	"	6.71	" "	" "
		N=80	1.02	3.41	1.47	0.16	"	"	14.94	" "	" "
[illegible]	Ditto but Gang. Carp. (No)	A=70	1.0	2.00	0.74	0.09	"	"	11.11	" "	" "
		C=56	1.0	1	0.39	0.05	"	"	0	A(Ho) R(Ha)	A(Ho) R(Ha)
		N=80	1.0	1	0.54	0.06	"	"	0	R(Ho) A(Ha)	R(Ho) A(Ha)
76	Ditto Labourer (No)	A=70	1.0	3	1.32	0.16	"	"	12.50	" "	" "
		C=56	1.0	2	0.62	0.08	"	"	6.25	" "	" "
		N=80	1.0	2	0.55	0.06	"	"	1667	" "	" "
[illegible]	50x50mm timber waste (%)	A=70	5	10.70	4.82	0.58	"	"	9.83	" "	" "
		C=56	5	11.30	4.99	0.67	"	"	9.40	" "	" "
		N=80	5	11.20	5.79	0.65	"	"	9.54	" "	" "
[illegible]	50x75mm Ditto (%)	A=70	5	10.60	4.55	0.54	"	"	10.37	" "	" "
		C=56	5	11.50	5.43	0.73	"	"	8.90	" "	" "
		N=80	5	11.30	6.14	0.69	"	"	9.13	" "	" "

μ_o values: (49-93): Source: R-C. Smith (1986)   Sources: Field survey 2005

Table 6.13. The effect of Resource mix on construction performance by construction firms in Kenya according to citizenship status:
Where A = African Firms, C = Citizen Firms, N = Non-citizen Firms:

$$Z = \frac{\bar{X} - \mu_o}{S/\sqrt{n}} \text{ when } n \geq 30: \qquad S = \sqrt{\frac{\sum (x - \bar{x})^2}{n-1}} = \text{sample standard deviation}$$

Main activity: Insitu concrete

	Sub activity	Sample Size (n)	μ_o	$\bar{X}$	S	$\delta_{\bar{x}} = \frac{s}{\sqrt{n}}$	Critical (e)		Actual Z_e	DECISION : TWO TAILED TEST	
							$Z_{0.025}$	$Z_{0.005}$		$Z_e > Z_a$: Accept H_0; Reject H_a $Z_e < Z_a$:	
										Confidence 95%	Confidence 99%
79	50x100mm ditto (%)	A=70	5	10.68	5.16	0.62	±1.96	±2.57	9.16	" "	" "
		C=56	5	11.20	5.20	0.69	"	"	8.99	" "	" "
		N=80	5	11.21	6.06	0.68	"	"	9.13	" "	" "
80	50x105mm ditto (%)	A=70	5	10.35	4.31	0.52	"	"	10.29	" "	" "
		C=56	5	11.57	5.65	0.76	"	"	8.65	" "	" "
		N=80	5	11.14	6.08	0.68	"	"	9.03	" "	" "
81	6-10mm Reift bars waste (%)	A=70	2	6.30	2.66	0.32	"	"	13.44	" "	" "
		C=56	2	8.48	4.03	0.54	"	"	12.00	" "	" "
		N=80	2	7.43	3.11	0.35	"	"	15.51	" "	" "
82	12-16mm ditto (%)	A=70	2	6.23	2.48	0.30	"	"	14.10	" "	" "
		C=56	2	8.47	4.06	0.54	"	"	11.98	" "	" "
		N=80	2	7.30	3.11	0.35	"	"	15.14	" "	" "
83	20-32mm ditto (%)	A=70	2	6.28	2.89	0.35	"	"	12.23	" "	" "
		C=56	2	8.53	4.07	0.54	"	"	12.09	" "	" "
		N=80	2	7.24	3.10	0.35	"	"	14.97	" "	" "
84	Tying wire 50kg roll/ tonne (No)	A=70	0.16	0.34	0.90	0.11	"	"	1.64	A(Ho) R(Ha)	A(Ho) R(Ha)
		C=56	0.16	8.07	3.18	0.42	"	"	18.83	R(Ho) A(Ha)	R(Ho) A(Ha)
		N=80	0.16	0.17	0.12	0.01	"	"	1.00	A(Ho) R(Ha)	A(Ho) R(Ha)
85	Ditto 25kg Ditto (No)	A=70	0.32	0.48	0.71	0.08	"	"	2.00	R(Ho) A(Ha)	" "
		C=56	0.32	7.13	2.24	0.30	"	"	22.70	" "	R(Ho) A(Ha)
		N=80	0.32	0.30	0.24	0.03	"	"	-0.67	A(Ho) R(Ha)	A(Ho) R(Ha)
86	Steel fixers Tonne of Reift (No)	A=70	1.0	2.66	1.32	0.16	"	"	10.38	R(Ho) A(Ha)	R(Ho) A(Ha)
		C=56	1.0	2.13	0.93	0.12	"	"	9.42	" "	" "
		N=80	1.0	2.10	1.05	0.12	"	"	9.17	" "	" "
87	Labourers Tonne of Reift (No)	A=70	1.0	3.86	2.36	0.28	"	"	10.21	" "	" "
		C=56	1.0	3.75	1.99	0.27	"	"	10.19	" "	" "
		N=80	1.0	3.54	1.71	0.19	"	"	13.37	" "	" "
88	Gang time per Tonne of Reift (No)	A=70	20	6.53	4.09	0.49	"	"	-27.49	" "	" "
		C=56	20	5.99	2.32	0.31	"	"	-45.19	" "	" "
		N=80	20	6.44	2.21	0.25	"	"	-54.24	" "	" "
89	Idle time per tonne of Rieft (hrs)	A=70	0	1.16	1.09	0.13	"	"	8.92	" "	" "
		C=56	0	1.11	1.07	0.14	"	"	7.93	" "	" "
		N=80	0	1.05	1.09	0.12	"	"	8.75	" "	" "
90	Machine time: Cut bent/ Tonne Steel fixers (No)	A=70	1	2.00	0.85	0.10	"	"	10.0	" "	" "
		C=56	1	2.00	0.66	0.07	"	"	14.29	" "	" "
		N=80	1	2.00	0.77	0.09	"	"	11.11	" "	" "
91	Ditto Labourers (No)	A=70	1	4	2.39	0.29	"	"	10.35	" "	" "
		C=56	1	3	1.25	0.17	"	"	11.76	" "	" "
		N=80	1	4	1.95	0.22	"	"	13.64	" "	" "
92	Ditto time by gang. (hrs)/ Tonne	A=70	35	4.11	5.21	0.62	±1.96	±2.57	-49.82	R(Ho) A(Ha)	R(Ho) A(Ha)
		C=56	35	2.73	1.54	0.21	"	"	-153.67	" "	" "
		N=80	35	3.30	2.26	0.25	"	"	-126.80	" "	" "
93	Idle time/tonne Rieft (hrs)	A=70	0	0.88	0.79	0.09	"	"	9.78	" "	" "
		C=56	0	0.63	0.50	0.07	"	"	9.00	" "	" "
		N=80	0	0.52	0.37	0.04	"	"	13.0	" "	" "

All μo values: (49-93): Source: R-C. Smith (1986) Sources: Field survey 2005

Table 8.14 The effect of Resource mix on construction performance by construction firms in Kenya according to citizenship status:
where A = African Firms, C = Citizen Firms, N = Non-citizen Firms:

$$Z = \frac{\bar{X} - \mu_o}{S/\sqrt{n}} \text{ when } n \geq 30: \qquad S = \sqrt{\frac{\sum (x - \bar{x})^2}{n-1}} = \text{sample standard deviation.}$$

Main activity: WALLING

	Sub activity	Sample Size (n)	μ_o	$\bar{X}$	S	$\delta_{\bar{x}} = \frac{S}{\sqrt{n}}$	Critical (e) $Z_{0.025}$	Critical (e) $Z_{0.005}$	Actual Z_a	DECISION : TWO TAILED TEST $Z_e > Z_a$: Accept H_o; Reject H_a $Z_e < Z_a$: Confidence 95%	Confidence 99%
1	200x200x 390mm p.c blocks No/M^2	A=70	12.5	13.64	1.34	0.16	±1.96	±2.57	7.13	R(Ho) A(Ha)	R(Ho) A(Ha)
		C=56	12.5	13.76	2.31	0.31	"	"	4.06	" "	" "
		N=80	12.5	13.99	1.52	0.16	"	"	9.32	" "	" "
2	Ditto waste %	A=70	5	6.98	3.71	0.44	"	"	4.50	" "	" "
		C=56	5	7.77	3.18	0.42	"	"	6.60	" "	" "
		N=80	5	7.16	2.72	0.30	"	"	7.20	" "	" "
3	150x200x 390mm p.c. blocks No/M^2	A=70	12.5	13.77	1.66	0.20	"	"	6.35	" "	" "
		C=56	12.5	13.89	2.14	0.29	"	"	4.79	" "	" "
		N=80	12.5	13.84	1.57	0.18	"	"	7.44	" "	" "
4	Ditto waste %	A=70	5	7.59	4.47	0.53	"	"	4.89	" "	" "
		C=56	5	7.77	3.18	0.42	"	"	6.60	" "	" "
		N=80	5	7.32	2.95	0.33	"	"	7.03	" "	" "
5	100x200x 390mm p.c blocks No/M^2	A=70	12.5	13.62	1.47	0.18	"	"	6.22	" "	" "
		C=56	12.5	13.78	2.10	0.28	"	"	4.57	" "	" "
		N=80	12.5	13.97	1.94	0.22	"	"	6.68	" "	" "
6	Ditto waste %	A=70	5	7.37	3.40	0.41	"	"	5.78	" "	" "
		C=56	5	7.88	3.47	0.46	"	"	6.26	" "	" "
		N=80	5	7.71	2.86	0.32	"	"	8.47	" "	" "
7	200mm stone walls feet/ M^2	A=70	14.6	16.13	1.46	0.17	"	"	9.0	" "	" "
		C=56	14.6	16.62	1.68	0.22	"	"	9.18	" "	" "
		N=80	14.6	16.52	1.45	0.16	"	"	12.0	" "	" "
8	Ditto waste	A=70	12.50	7.84	5.28	0.63	"	"	-7.40	" "	" "
		C=56	12.50	8.09	3.73	0.50	"	"	-8.82	" "	" "
		N=80	12.50	7.22	3.63	0.41	"	"	-12.88	" "	" "
9	150mm stone walls feet/ M^2	A=70	14.6	16.19	1.61	0.19	"	"	8.37	" "	" "
		C=56	14.6	16.59	1.80	0.24	"	"	8.29	" "	" "
		N=80	14.6	16.14	2.12	0.24	"	"	6.42	" "	" "
10	Ditto waste %	A=70	12.5	7.99	5.19	0.62	"	"	-7.27	" "	" "
		C=56	12.5	8.24	3.82	0.51	"	"	-8.35	" "	" "
		N=80	12.5	7.34	3.90	0.44	"	"	-11.73	" "	" "
11	100mm stone walls feet/ M^2	A=70	14.6	16.20	2.43	0.29	"	"	5.52	" "	" "
		C=56	14.6	16.07	2.33	0.31	"	"	4.74	" "	" "
		N=80	14.6	16.51	1.39	0.16	"	"	11.94	" "	" "
12	Ditto waste %	A=70	12.5	7.56	4.60	0.55	"	"	-8.98	" "	" "
		C=56	12.5	8.64	6.98	0.93	"	"	-4.15	" "	" "
		N=80	12.5	7.47	4.22	0.47	"	"	-10.70	" "	" "
13	Gang masons (No)	A=70	2	1	0.36	0.04	"	"	-25.0	" "	" "
		C=56	2	1	0.27	0.04	"	"	-25.0	" "	" "
		N=80	2	1	0.22	0.02	"	"	-50.0	" "	" "

All μo values 1-6; Source: R.C. Smith (1986)
7-12; Source: Hugh Enterkin & Gerald Reynolds (1978)

Source: Field Survey, 2005

Table 6.14 The effect of Resource mix on construction performance by construction firms in Kenya according to citizenship status:
where A = African Firms, C = Citizen Firms, N = Non-citizen Firms:

$$Z = \frac{\bar{X} - \mu_o}{S / \sqrt{n}} \text{ when } n \geq 30: \quad S = \sqrt{\frac{\sum (x - \bar{x})^2}{n-1}} = \text{sample standard deviation.}$$

Main activity: Walling

	Sub activity	Sample Size (n)	μ_o	$\bar{X}$	S	$\delta_{\bar{x}} = \frac{S}{\sqrt{n}}$	Critical (e) $Z_{0.025}$	Critical (e) $Z_{0.005}$	Actual Z_e	DECISION : TWO TAILED TEST ($Z_e > Z_e$: Accept H_0; Reject H_a $Z_e < Z_e$:) Confidence 95%	Confidence 99%
14	Gang labourers (No)	A=70	1	2	0.75	0.09	±1.96	±2.57	11.11	" "	" "
		C=56	1	2	0.43	0.06	"	"	16.67	" "	" "
		N=80	1	2	0.41	0.05	"	"	20.0	" "	" "
15	200mm walls gang output/ day (m^2)	A=70	8.9	7.87	2.60	0.31	"	"	-3.32	" "	" "
		C=56	8.9	9.05	5.22	0.70	"	"	0.21	A(Ho) R(Ha)	A(Ho) R(Ha)
		N=80	8.9	7.71	1.85	0.21	"	"	-5.67	R(Ho) A(Ha)	R(Ho) A(Ha)
16	Idle time/ m^2 200mm walls (Hrs)	A=70	0	0.16	0.16	0.02	"	"	8.0	" "	" "
		C=56	0	0.60	1.66	0.22	"	"	2.73	" "	" "
		N=80	0	0.16	0.11	0.01	"	"	16.0	" "	" "
17	Ditto/day 200mm walls (Hrs)	A=70	0	0.57	0.36	0.04	"	"	14.25	" "	" "
		C=56	0	0.71	0.53	0.07	"	"	10.14	" "	" "
		N=80	0	0.53	0.55	0.06	"	"	8.83	" "	" "
18	150mm wall gang output /Day m^2	A=70	12.1	7.85	2.82	0.34	"	"	-12.50	" "	" "
		C=56	12.1	9.36	5.28	0.71	"	"	-3.86	" "	" "
		N=80	12.1	8.63	2.39	0.27	"	"	-12.85	" "	" "
19	Ditto idle time/ m^2 (hrs)	A=70	0	0.14	0.11	0.01	"	"	14.0	" "	" "
		C=56	0	0.47	0.40	0.05	"	"	9.40	" "	" "
		N=80	0	0.16	0.11	0.01	"	"	16.0	" "	" "
20	Ditto idle time/day (hrs)	A=70	0	0.56	0.36	0.04	"	"	14.0	" "	" "
		C=56	0	0.71	0.52	0.01	"	"	71.0	" "	" "
		N=80	0	0.53	0.28	0.03	"	"	17.67	" "	" "
21	Gang output 100mm walls/day m^2	A=70	16	8.21	3.63	0.43	"	"	-18.12	" "	" "
		C=56	16	9.27	4.39	0.59	"	"	-11.41	" "	" "
		N=80	16	9.04	3.11	0.35	"	"	-19.89	" "	" "
22	Ditto idle time/ m^2 hrs	A=70	0	0.15	0.12	0.14	"	"	1.07	" "	" "
		C=56	0	0.52	0.41	0.05	"	"	10.40	" "	" "
		N=80	0	0.15	0.11	0.01	"	"	15.0	" "	" "
23	Ditto idle time/ day hrs	A=70	0	0.56	0.36	0.04	"	"	14.0	" "	" "
		C=56	0	0.71	0.52	0.07	"	"	10.14	" "	" "
		N=80	0	0.55	0.31	0.03	"	"	18.33	" "	" "
24	200mm stone walls output/day (M^2)	A=70	6.77	7.62	2.26	0.27	"	"	3.15	" "	" "
		C=56	6.77	9.18	5.03	0.67	"	"	3.60	" "	" "
		N=80	6.77	7.75	1.93	0.22	"	"	4.46	" "	" "
25	Ditto idle time/ M^2(Hrs)	A=70	0	0.16	0.15	0.02	"	"	8.0	" "	" "
		C=56	0	0.46	0.36	0.05	"	"	9.20	" "	" "
		N=80	0	0.16	0.12	0.01	"	"	16.0	" "	" "
26	Ditto idle time/day (Hrs)	A=70	0	0.59	0.36	0.04	"	"	14.75	" "	" "
		C=56	0	0.72	0.55	0.07	"	"	10.29	" "	" "
		N=80	0	0.54	0.28	0.03	"	"	18.0	" "	" "

All μo values 13-23; Source: R.C. Smith (1986)
24-32; Source: Hugh Enterkin & Gerald Reynolds (1978)

Source: Field Survey, 2005

Table 6.18 The effect of Resource mix on construction performance by construction firms in Kenya according to citizenship status:
Where A = African Firms, C = Citizen Firms, N = Non-citizen Firms:

$$Z = \frac{\bar{X} - \mu_o}{S/\sqrt{n}} \text{ when } n \geq 30: \quad S = \sqrt{\frac{\sum (x - \bar{x})^2}{n-1}} = \text{sample standard deviation.}$$

Main activity: Ceramic Floor/Wall Tiling

No.	Item	Sample Size (n)	μ_o	$\bar{X}$	S	$\delta_{\bar{x}} = \frac{s}{\sqrt{n}}$	Critical (e) $Z_{0.025}$	Critical (e) $Z_{0.005}$	Actual Z_e	DECISION : TWO TAILED TEST — $Z_e > Z_e$: Accept H_0. Reject H_o $Z_e < Z_e$: Confidence 95%	Confidence 99%
27	Ditto output/day (M^2)	A=70	8	17.26	13.37	1.60	± 1.96	± 2.57	5.79	" "	" "
		C=56	8	12.75	5.32	0.71	"	"	6.69	" "	" "
		N=80	8	14.49	6.55	0.73	"	"	8.89	" "	" "
28	Gangsize craftsmen (No)	A=70	2	1	0.45	0.05	"	"	-20.0	" "	" "
		C=56	2	1	0.90	0.12	"	"	-8.33	" "	" "
		N=80	2	1	0.16	0.02	"	"	-50.0	" "	" "
29	Ditto labourers (No)	A=70	1	2	0.81	0.10	"	"	10.0	" "	" "
		C=56	1	2	0.46	0.06	"	"	16.67	" "	" "
		N=80	1	2	0.40	0.04	"	"	25.0	" "	" "
30	Idle time (%)	A=70	5	8.25	3.26	0.39	"	"	8.33	" "	" "
		C=56	5	7.71	3.65	0.49	"	"	5.53	" "	" "
		N=80	5	8.30	3.64	0.41	"	"	8.05	" "	" "
31	300x300x8 mm floor tiles (No/M^2)	A=70	11.11	13.76	6.63	0.79	"	"	3.35	" "	" "
		C=56	11.11	13.68	7.17	0.96	"	"	2.68	" "	" "
		N=80	11.11	14.77	8.11	0.91	"	"	4.02	" "	" "
32	Ditto waste (%)	A=70	5	8.02	4.58	0.55	"	"	5.49	" "	" "
		C=56	5	6.94	3.24	0.43	"	"	4.51	" "	" "
		N=80	5	7.56	3.05	0.34	"	"	7.53	" "	" "
33	Ditto output/day (M^2)	A=70	10	17.62	15.09	1.80	"	"	4.23	" "	" "
		C=56	10	14.26	6.70	0.90	"	"	4.73	" "	" "
		N=80	10	14.46	7.19	0.80	"	"	5.58	" "	" "
34	Gangsize craftsmen No.	A=70	2	1	0.45	0.05	"	"	-20.0	" "	" "
		C=56	2	1	0.90	0.12	"	"	-8.33	" "	" "
		N=80	2	1	0.16	0.02	"	"	-50.0	" "	" "
35	Ditto. Labourers (No)	A=70	1	2	0.81	0.10	"	"	10.0	" "	" "
		C=56	1	2	0.46	0.06	"	"	16.67	" "	" "
		N=80	1	2	0.42	0.05	"	"	20.0	" "	" "
36	Idle time (%)	A=70	5	7.99	3.09	0.37	"	"	8.08	" "	" "
		C=56	5	7.71	3.65	0.49	"	"	5.53	" "	" "
		N=80	5	8.28	3.56	0.40	"	"	8.20	" "	" "

All μo – values: 1-36; Source: Manufacturers specifications; R.C. Smith (1986); Enterkin Hugh and Gerald Reynolds (1978).

Source: Field Survey, 2005

Table 6.14. The effect of Resource mix on construction performance by construction firms in Kenya according to citizenship status:
Where A = African Firms, C = Citizen Firms, N = Non-citizen Firms:

$$Z = \frac{\bar{X} - \mu_o}{S/\sqrt{n}} \text{ when } n \geq 30: \qquad S = \sqrt{\frac{\sum (x - \bar{x})^2}{n-1}} = \text{sample standard deviation.}$$

Main activity: Walling

No.	Sub activity	Sample Size (n)	μ_o	$\bar{X}$	S	$\delta_{\bar{x}} = \frac{S}{\sqrt{n}}$	Critical (e) $Z_{0.025}$	Critical (e) $Z_{0.005}$	Actual Z_e	DECISION : TWO TAILED TEST ($Z_e > Z_e$: Accept H_0: Reject H_a $Z_e < Z_e$:) Confidence 95%	Confidence 99%
27	150mm stone wall output/ day m²	A=70	6.77	8.07	2.94	0.35	±1.96	±2.57	3.71	" "	" "
		C=56	6.77	9.36	5.22	0.70	"	"	3.70	" "	" "
		N=80	6.77	8.66	2.57	0.29	"	"	6.52	" "	" "
28	Ditto idle time/ (M²)Hrs	A=70	0	0.16	0.13	0.02	"	"	8.0	" "	" "
		C=56	0	0.46	0.36	0.05	"	"	9.20	" "	" "
		N=80	0	0.16	0.11	0.01	"	"	16.0	" "	" "
29	Ditto/ day (Hrs)	A=70	0	0.58	0.37	0.05	"	"	11.60	" "	" "
		C=56	0	0.71	0.52	0.07	"	"	10.14	" "	" "
		N=80	0	0.51	0.27	0.03	"	"	17.00	" "	" "
30	100mm stone wall output/ day m²	A=70	13	8.08	3.38	0.40	"	"	-12.3	" "	" "
		C=56	13	9.48	4.31	0.58	"	"	-6.07	" "	" "
		N=80	13	9.19	3.26	0.36	"	"	-10.58	" "	" "
31	Ditto idle time/ m² Hrs	A=70	0	0.16	0.13	0.02	"	"	8.0	" "	" "
		C=56	0	0.46	0.36	0.05	"	"	9.20	" "	" "
		N=80	0	0.16	0.11	0.01	"	"	16.0	" "	" "
32	Ditto idle time/ day Hrs	A=70	0	0.58	0.39	0.05	"	"	11.60	" "	" "
		C=56	0	0.13	0.56	0.07	"	"	10.43	" "	" "
		N=80	0	0.54	0.30	0.03	"	"	18.0	" "	" "
33	Mortar (1:3) cement Bags/ m²	A=70	10.4	8.82	2.21	0.26	"	"	-6.08	" "	" "
		C=56	10.4	9.12	1.77	0.24	"	"	-5.33	" "	" "
		N=80	10.4	8.86	2.08	0.23	"	"	-6.70	" "	" "
34	Mortar (1:3) sand Tonnes/ m³	A=70	0.72	1.65	0.49	0.06	"	"	15.50	" "	" "
		C=56	0.72	1.64	0.36	0.05	"	"	18.40	" "	" "
		N=80	0.72	1.53	0.33	0.04	"	"	20.25	" "	" "
35	Ditto (1:3) waste (%)	A=70	5	8.65	4.52	0.54	"	"	6.76	" "	" "
		C=56	5	9.20	4.06	0.54	"	"	7.78	" "	" "
		N=80	5	8.66	4.47	0.50	"	"	7.32	" "	" "
36	Mortar (1:3) water/cemt ratio (Litres/bag)	A=70	0.3	0.55	0.13	0.02	"	"	12.50	" "	" "
		C=56	0.3	0.59	0.10	0.01	"	"	29.0	" "	" "
		N=80	0.3	0.60	0.11	0.01	"	"	30.0	" "	" "
37	Mortar (1:4) cemt (bag/ m²)	A=70	7.8	7.89	1.88	0.22	"	"	9.0	" "	" "
		C=56	7.8	8.0	1.41	0.19	"	"	1.05	A(Ho) R(Ha)	A(Ho) R(Ha)
		N=80	7.8	7.74	1.80	0.20	"	"	-0.30	" "	" "
38	Mortar (1:4) sand (Tonnes/m³)	A=70	0.79	1.63	0.32	0.04	"	"	21.0	R(Ho) A(Ha)	R(Ho) A(Ha)
		C=56	0.79	1.70	0.41	0.05	"	"	18.20	" "	" "
		N=80	0.79	1.68	0.49	0.05	"	"	17.80	" "	" "
39	Mortar (1:4) waste (%)	A=70	5	8.73	5.05	0.60	"	"	6.22	" "	" "
		C=56	5	9.39	3.94	0.53	"	"	8.28	" "	" "
		N=80	5	8.66	4.33	0.48	"	"	7.63	" "	" "

All μo values 33-40; Source: R.C. Smith (1986); Spence Geddes: (1978)

Source: Field Survey, 2005

Table 6.14. The effect of Resource mix on construction performance by construction firms in Kenya according to citizenship status:
Where A = African Firms, C = Citizen Firms, N = Non-citizen Firms:

$$Z = \frac{\overline{X} - \mu_o}{S / \sqrt{n}} \quad \text{when } n \geq 30: \qquad S = \sqrt{\frac{\sum (x - \bar{x})^2}{n-1}} \quad \text{= sample standard deviation.}$$

Main activity: Walling

	Sub activity	Sample Size (n)	μ_o	$\overline{X}$	S	$\delta_{\bar{x}} = \frac{S}{\sqrt{n}}$	Critical (e)		Actual Z_e	DECISION : TWO TAILED TEST $Z_e > Z_a$: Accept H_o: Reject $H_a Z_e < Z_a$:	
							$Z_{0.025}$	$Z_{0.005}$		Confidence 95%	Confidence 99%
40	Mortar (1:4) Water/cemt ratio (Litres/bag)	A=70	0.30	0.56	0.18	0.02	±1.96	±2.57	13.0	" "	" "
		C=56	0.30	0.59	0.10	0.01	"	"	29.0	" "	" "
		N=80	0.30	0.59	0.13	0.01	"	"	29.0	" "	" "
41	Mortar mixer 7/5 (M^3/hr)	A=70	1.40	5.59	2.51	0.30	"	"	13.97	" "	" "
		C=56	1.40	5.63	2.13	0.28	"	"	15.11	" "	" "
		N=80	1.40	5.74	2.13	0.24	"	"	18.08	" "	" "
42	Ditto start time (hrs)	A=70	0.25	0.30	0.24	0.03	"	"	1.67	A(Ho) R(Ha)	A(Ho) R(Ha)
		C=56	0.25	0.28	0.13	0.02	"	"	1.50	" "	" "
		N=80	0.25	0.25	0.10	0.01	"	"	0	" "	" "
43	Ditto cleaning time/day (hrs)	A=70	0.50	0.40	0.19	0.02	"	"	-5.0	R(Ho) A(Ha)	R(Ho) A(Ha)
		C=56	0.50	0.37	0.13	0.02	"	"	-6.50	" "	" "
		N=80	0.50	0.35	0.12	0.01	"	"	-15.0	" "	" "
44	Mortar mixer 7/5 idle time (m^3/hr)	A=70	0.33	0.44	0.44	0.05	"	"	2.20	" "	A(Ho) R(Ha)
		C=56	0.33	0.39	0.37	0.05	"	"	1.20	A(Ho) R(Ha)	" "
		N=80	0.33	0.53	0.43	0.05	"	"	4.0	R(Ho) A(Ha)	R(Ho) A(Ha)
45	Mortar mixer 10/7 (m^3/hr)	A=70	2.0	6.56	2.80	0.34	"	"	13.41	" "	" "
		C=56	2.0	6.74	2.07	0.27	"	"	17.56	" "	" "
		N=80	2.0	6.93	2.40	0.27	"	"	18.26	" "	" "
46	Ditto start time: (hrs)	A=70	0.25	0.31	0.24	0.03	"	"	2.0	" "	A(Ho) R(Ha)
		C=56	0.25	0.29	0.13	0.02	"	"	2.0	" "	" "
		N=80	0.25	0.25	0.11	0.01	"	"	0	A(Ho) R(Ha)	
47	Ditto cleaning time (hrs)	A=70	0.50	0.43	0.18	0.02	"	"	-3.50	R(Ho) A(Ha)	R(Ho) A(Ha)
		C=56	0.50	0.38	0.13	0.02	"	"	-6.0	" "	" "
		N=80	0.50	0.38	0.12	0.01	"	"	-12.0	" "	" "
48	Ditto idle time/day (hrs)	A=70	0.33	0.61	0.50	0.06	"	"	4.67	" "	" "
		C=56	0.33	0.38	0.37	0.05	"	"	1.0	A(Ho) R(Ha)	A(Ho) R(Ha)
		N=80	0.33	0.58	0.31	0.03	"	"	8.33	R(Ho) A(Ha)	R(Ho) A(Ha)
49	Mortar mixer 14/10 (m^3/hr)	A=70	2.80	9.38	4.98	0.60	"	"	10.97	" "	" "
		C=56	2.80	9.04	4.51	0.60	"	"	10.40	" "	" "
		N=80	2.80	9.41	5.21	0.58	"	"	11.40	" "	" "
50	Ditto time (start) (hrs)	A=70	0.25	0.35	0.26	0.03	"	"	3.33	" "	" "
		C=56	0.25	0.30	0.14	0.02	"	"	2.50	" "	A(Ho) R(Ha)
		N=80	0.25	0.26	0.12	0.01	"	"	1.0	A(Ho) R(Ha)	" "
51	Ditto cleaning time (hrs)	A=70	0.50	0.46	0.16	0.02	"	"	-2.0	R(Ho) A(Ha)	" "
		C=56	0.50	0.38	0.12	0.02	"	"	-6.0	" "	R(Ho) A(Ha)
		N=80	0.50	0.37	0.12	0.01	"	"	-13.0	" "	R(Ho) A(Ha)
52	Ditto idle time/day (hrs)	A=70	0.33	0.53	0.55	0.07	"	"	2.86	" "	R(Ho) A(Ha)
		C=56	0.33	0.36	0.35	0.05	"	"	0.60	A(Ho) R(Ha)	A(Ho) R(Ha)
		N=80	0.33	0.54	0.44	0.05	"	"	4.20	R(Ho) A(Ha)	R(Ho) A(Ha)

All μo values ;41-52; Source: Enterkin Hugh & Gerald Reynolds (1978)

Source: Field Survey, 2005

Table 6.14. The effect of Resource mix on construction performance by construction firms in Kenya according to citizenship status:
Where A = African Firms, C = Citizen Firms, N = Non-citizen Firms:

$$Z = \frac{\bar{X} - \mu_o}{S / \sqrt{n}}$$ when n ≥ 30: $$S = \sqrt{\frac{\sum (x - \bar{x})^2}{n - 1}}$$ = sample standard deviation.

Main activity: Walling

	Sub activity	Sample Size (n)	μ_o	$\bar{X}$	S	$\delta_{\bar{x}} = \frac{s}{\sqrt{n}}$	Critical (e) $Z_{0.025}$	Critical (e) $Z_{0.005}$	Actual Z_e	DECISION : TWO TAILED TEST ($Z_e > Z_e$: Accept H_0: Reject H_a $Z_e < Z_e$:) Confidence 95%	Confidence 99%
53	Mortar mixer 18/12: (m^3/hr)	A=70	3.40	12.17	5.97	0.71	±1.96	±2.57	12.35	" "	" "
		C=56	3.40	10.71	4.95	0.66	"	"	11.08	" "	" "
		N=80	3.40	11.54	5.65	0.63	"	"	12.92	" "	" "
54	Ditto starting time (hrs)	A=70	0.25	0.36	0.25	0.03	"	"	3.67	" "	" "
		C=56	0.25	0.31	0.14	0.02	"	"	3.0	" "	" "
		N=80	0.25	0.26	0.12	0.01	"	"	1.0	A(Ho) R(Ha)	A(Ho) R(Ha)
55	Ditto cleaning time (hrs)	A=70	0.50	0.48	0.17	0.02	"	"	-1.0	" "	" "
		C=56	0.50	0.40	0.12	0.02	"	"	-5.0	R(Ho) A(Ha)	R(Ho) A(Ha)
		N=80	0.50	0.38	0.13	0.01	"	"	-12.0	" "	" "
56	Ditto idle time/day (hrs)	A=70	0.33	0.70	0.68	0.08	"	"	4.63	" "	" "
		C=56	0.33	0.34	0.32	0.04	"	"	0.25	A(Ho) R(Ha)	A(Ho) R(Ha)
		N=80	0.33	0.53	0.43	0.05	"	"	4.0	R(Ho) A(Ha)	R(Ho) A(Ha)
57	Gang size 7/5 mixer operator (No)	A=70	1	1	0.32	0.04	"	"	0	A(Ho) R(Ha)	" "
		C=56	1	1	0.37	0.05	"	"	0	" "	" "
		N=80	1	1	0.46	0.05	"	"	0	" "	" "
58	Ditto labourer (No)	A=70	1	4	2.18	0.26	"	"	11.54	R(Ho) A(Ha)	R(Ho) A(Ha)
		C=56	1	4	2.29	0.31	"	"	9.67	" "	" "
		N=80	1	4	2.03	0.23	"	"	13.04	" "	" "
59	Ditto wheelers (No)	A=70	0	3	0.94	0.11	"	"	27.27	" "	" "
		C=56	0	3	1.09	0.15	"	"	20.0	" "	" "
		N=80	0	3	1.09	0.12	"	"	25.0	" "	" "
60	Ditto Idle time %	A=70	0	8.32	4.48	0.54	"	"	15.40	" "	" "
		C=56	0	7.82	3.08	0.41	"	"	19.07	" "	" "
		N=80	0	7.79	3.85	0.43	"	"	18.12	" "	" "
61	Gang size 10/7 operators (No)	A=70	1	1	0.34	0.04	"	"	0	A(Ho) R(Ha)	A(Ho) R(Ha)
		C=56	1	1	0.46	0.06	"	"	0	" "	" "
		N=80	1	1	0.39	0.04	"	"	0	" "	" "
62	Ditto labourers (No)	A=70	1	4	2.17	0.26	"	"	11.54	R(Ho) A(Ha)	R(Ho) A(Ha)
		C=56	1	5	2.27	0.30	"	"	13.33	" "	" "
		N=80	1	5	2.28	0.25	"	"	16.00	" "	" "
63	Ditto wheelers (no)	A=70	1	3	0.91	0.11	"	"	18.18	" "	" "
		C=56	1	4	1.16	0.16	"	"	18.75	" "	" "
		N=80	1	4	1.18	0.13	"	"	23.08	" "	" "
64	Ditto idle time (%)	A=70	0	8.41	4.65	0.56	"	"	15.02	" "	" "
		C=56	0	7.73	3.02	0.40	"	"	19.33	" "	" "
		N=80	0	7.90	3.88	0.52	"	"	15.19	" "	" "
65	Gang size 14/10 operators (No)	A=70	1	2	0.48	0.06	"	"	16.67	" "	" "
		C=56	1	2	0.58	0.08	"	"	12.50	" "	" "
		N=80	1	1	0.39	0.04	"	"	0	A(Ho) R(Ha)	A(Ho) R(Ha)

All μo values 53-56 ; Source: R.C. Smith (1986)
57-68 ; Source: Hugh Enterkin & Gerald Reynolds (1978)

Source: Field Survey, 2005

Table 6.14. The effect of Resource mix on construction performance by construction firms in Kenya according to citizenship status:
Where A = African Firms, C = Citizen Firms, N = Non-citizen Firms:

$$Z = \frac{\bar{X} - \mu_o}{S/\sqrt{n}} \text{ when } n \geq 30: \qquad S = \sqrt{\frac{\sum (x - \bar{x})^2}{n-1}} \text{ = sample standard deviation.}$$

Main activity: Walling

	Sub activity	Sample Size (n)	μ_o	$\bar{X}$	S	$\delta_{\bar{x}} = \frac{s}{\sqrt{n}}$	Critical (e)		Actual Z_e	DECISION : TWO TAILED TEST	
							$Z_{0.025}$	$Z_{0.005}$		$Z_e > Z_e$: Accept H_0: Reject H_a $Z_e < Z_e$:	
										Confidence 95%	Confidence 99%
66	Ditto labourers (No)	A=70	1	5	2.27	0.27	±1.96	±2.57	14.81	R(Ho) A(Ha)	R(Ho) A(Ha)
		C=56	1	6	2.86	0.38	"	"	13.16	" "	" "
		N=80	1	6	2.75	0.31	"	"	16.13	" "	" "
67	Ditto Wheelers (No)	A=70	2	4	1.47	0.18	"	"	11.11	" "	" "
		C=56	2	5	1.77	0.24	"	"	12.50	" "	" "
		N=80	2	5	1.77	0.20	"	"	15.0	" "	" "
68	Ditto Idle time (%)	A=70	0	8.8	5.57	0.66	"	"	13.33	" "	" "
		C=56	0	7.82	3.23	0.43	"	"	18.19	" "	" "
		N=80	0	8.0	3.92	0.44	"	"	18.18	" "	" "
69	Gangsize 18/12 operators (No)	A=70	1	2	0.50	0.06	"	"	16.67	" "	" "
		C=56	1	2	0.57	0.08	"	"	12.50	" "	" "
		N=80	1	1	0.48	0.05	"	"	0	A(Ho) R(Ha)	A(Ho) R(Ha)
70	Ditto labourers (No)	A=70	1	5	2.48	0.3	"	"	13.33	R(Ho) A(Ha)	R(Ho) A(Ha)
		C=56	1	7	3.59	0.48	"	"	12.50	" "	" "
		N=80	1	6	3.28	0.37	"	"	13.51	" "	" "
71	Ditto Wheelers (No)	A=70	2	5	1.44	0.17	"	"	17.65	" "	" "
		C=56	2	6	2.07	0.28	"	"	14.29	" "	" "
		N=80	2	5	2.27	0.25	"	"	12.0	" "	" "
72	Ditto Idle time (%)	A=70	0	8.98	6.09	0.73	"	"	12.30	" "	" "
		C=56	0	8.43	3.27	0.44	"	"	19.16	" "	" "
		N=80	0	8.68	4.29	0.48	"	"	18.08	" "	" "
73	100mm wide DPC (m)	A=70	1.0	1.0	0	0	"	"	0	A(Ho) R(Ha)	A(Ho) R(Ha)
		C=56	1.0	1.0	0	0	"	"	0	" "	" "
		N=80	1.0	1.0	0	0	"	"	0	" "	" "
74	Ditto Waste (%)	A=70	3	7.60	3.43	0.41	"	"	11.22	R(Ho) A(Ha)	R(Ho) A(Ha)
		C=56	3	8.74	4.24	0.51	"	"	10.07	" "	" "
		N=80	3	7.81	3.77	0.42	"	"	11.45	" "	" "
75	150mm wide DPC (m)	A=70	1.0	1.0	0	0	"	"	0	A(Ho) R(Ha)	A(Ho) R(Ha)
		C=56	1.0	1.0	0	0	"	"	0	" "	" "
		N=80	1.0	1.0	0	0	"	"	0	" "	" "
76	Ditto Waste (%)	A=70	3	8.11	4.13	0.49	"	"	10.43	R(Ho) A(Ha)	R(Ho) A(Ha)
		C=56	3	9.0	4.58	0.61	"	"	9.84	" "	" "
		N=80	3	8.58	4.68	0.52	"	"	10.73	" "	" "
77	200mm wide DPC (m)	A=70	1.0	1.0	0	0	"	"	0	A(Ho) R(Ha)	A(Ho) R(Ha)
		C=56	1.0	1.0	0	0	"	"	0	" "	" "
		N=80	1.0	1.0	0	0	"	"	0	" "	" "
78	Ditto Waste (%)	A=70	3	8.35	6.29	0.75	"	"	7.13	R(Ho) A(Ha)	R(Ho) A(Ha)
		C=56	3	9.08	4.79	0.64	"	"	9.50	" "	" "
		N=80	3	8.34	4.65	0.52	"	"	10.27	" "	" "

All μo values 69-82 ; Source: R.C. Smith (1986)

Source: Field Survey, 2005

Table 6.14 The effect of Resource mix on construction performance by construction firms in Kenya according to citizenship status:

Where A = African Firms, C = Citizen Firms, N = Non-citizen Firms:

$$Z = \frac{\bar{X} - \mu_o}{S / \sqrt{n}}$$ when n ≥ 30: $$S = \sqrt{\frac{\sum (x - \bar{x})^2}{n-1}}$$ = sample standard deviation.

Main activity: Walling

	Sub activity	Sample Size (n)	μo	$\bar{X}$	S	$\delta_{\bar{x}} = \frac{s}{\sqrt{n}}$	Critical (e)		Actual Z_e	DECISION : TWO TAILED TEST			
										$Z_c > Z_e$: Accept H_0: Reject H_a $Z_e < Z_c$:			
							$Z_{0.025}$	$Z_{0.005}$		Confidence 95%		Confidence 99%	
[illegible]	DPC Gang size/ Roll masons (No)	A=70	2	1	0.17	0.02	±1.96	±2.57	-50.0	"	"	"	"
		C=56	2	1	0.24	0.03	"	"	0	A(Ho)	R(Ha)	A(Ho)	R(Ha)
		N=80	2	1	0	0	"	"	0	"	"	"	"
10	Ditto labourers (No)	A=70	1	2	0.57	0.07	"	"	14.29	R(Ho)	A(Ha)	R(Ho)	A(Ha)
		C=56	1	2	0.39	0.05	"	"	20.0	"	"	"	"
		N=80	1	2	0.42	0.05	"	"	20.0	"	"	"	"
11	DPC Gang time/Roll (hrs)	A=70	0.12	0.46	0.39	0.05	"	"	6.80	"	"	"	"
		C=56	0.12	0.62	0.59	0.08	"	"	6.25	"	"	"	"
		N=80	0.12	2.35	1.87	0.21	"	"	10.62	"	"	"	"
12	Gang output /hr (m)	A=70	250	9.11	4.48	0.54	"	"	-446.09	"	"	"	"
		C=56	250	8.83	4.99	0.67	"	"	-359.96	"	"	"	"
		N=80	250	21.69	14.06	1.57	"	"	-145.42	"	"	"	"

All μo values 69-82 ; Source: R.C. Smith (1986)

Source: Field Survey, 2005

Table 6.16 The effect of Resource mix on construction performance by construction firms in Kenya according to citizenship status:
Where A = African Firms, C = Citizen Firms, N = Non-citizen Firms:

$$Z = \frac{\overline{X} - \mu_o}{S / \sqrt{n}}$$ when n ≥ 30: $$S = \sqrt{\frac{\sum (x - \bar{x})^2}{n-1}}$$ = sample standard deviation.

Main activity: Plasterwork

Sub activity	Sample Size (n)	μ_o	$\overline{X}$	S	$\delta_{\bar{x}} = \frac{s}{\sqrt{n}}$	Critical (e)		Actual Z_a	DECISION : TWO TAILED TEST	
						$Z_{0.025}$	$Z_{0.005}$		$Z_e > Z_a$: Accept H_0; Reject H_a $Z_e < Z_a$:	
									Confidence 95%	Confidence 99%
Gang Plasterers /Day (No)	A=70	2	1.13	0.38	0.05	±1.96	±2.57	-17.4	R(Ho) A(Ha)	R(Ho) A(Ha)
	C=56	2	1.14	0.52	0.07	"	"	-12.86	" "	" "
	N=80	2	1.18	0.84	0.09	"	"	-9.11	" "	" "
Gang Labourers /Day (no)	A=70	1	1.83	0.84	0.10	"	"	8.30	" "	" "
	C=56	1	1.91	0.70	0.09	"	"	10.11	" "	" "
	N=80	1	1.94	0.49	0.05	"	"	18.80	" "	" "
15mm plaster output/ day (m^2)	A=70	9	12.56	6.74	0.81	"	"	4.40	" "	" "
	C=56	9	12.25	8.76	1.17	"	"	2.78	" "	" "
	N=80	9	10.49	2.65	0.30	"	"	4.97	" "	" "
Ditto idle time %	A=70	5	8.65	3.79	0.45	"	"	8.11	" "	" "
	C=56	5	8.67	3.07	0.41	"	"	8.95	" "	" "
	N=80	5	8.15	4.01	0.45	"	"	7.0	" "	" "
20-25mm plaster (M^2/day)	A=70	6	10.65	5.68	0.68	"	"	6.83	" "	" "
	C=56	6	10.25	6.07	0.81	"	"	5.25	" "	" "
	N=80	6	9.01	2.31	0.26	"	"	11.58	" "	" "
Ditto Idle time/day (%)	A=70	5	9.23	4.12	0.49	"	"	8.63	" "	" "
	C=56	5	8.49	3.09	0.41	"	"	8.51	" "	" "
	N=80	5	7.99	3.90	0.44	"	"	6.80	" "	" "
15mm Render (M^2/day)	A=70	9	11.80	4.97	0.59	"	"	4.75	" "	" "
	C=56	9	11.98	8.22	1.10	"	"	2.71	" "	" "
	N=80	9	10.27	3.15	0.35	"	"	3.63	" "	" "
Ditto Idle time (%)	A=70	5	9.31	4.83	0.58	"	"	7.43	" "	" "
	C=56	5	8.59	3.37	0.45	"	"	7.98	" "	" "
	N=80	5	8.09	4.10	0.46	"	"	6.72	" "	" "
20-25mm Render (M^2/day)	A=70	6	10.29	4.53	0.54	"	"	7.94	" "	" "
	C=56	6	9.13	3.22	0.43	"	"	7.28	" "	" "
	N=80	6	8.72	3.35	0.37	"	"	7.35	" "	" "
Ditto Idle time/day (%)	A=70	5	9.75	5.01	0.60	"	"	7.92	" "	" "
	C=56	5	8.69	3.34	0.45	"	"	8.20	" "	" "
	N=80	5	8.23	3.93	0.44	"	"	7.34	" "	" "
15mm plaster to soffts (M^2/day)	A=70	6.96	8.67	4.37	0.52	"	"	3.29	" "	" "
	C=56	6.96	7.87	3.75	0.50	"	"	1.82	" "	" "
	N=80	6.96	7.34	2.73	0.31	"	"	1.23	" "	" "
Ditto Idle time (%)	A=70	5	10.08	5.63	0.67	"	"	7.58	" "	" "
	C=56	5	8.61	3.88	0.52	"	"	6.94	" "	" "
	N=80	5	8.18	3.95	0.44	"	"	7.23	" "	" "
Materials wastes (%) during plastering	A=70	7.5	15.66	6.98	0.83	"	"	9.83	" "	" "
	C=56	7.5	13.79	6.71	0.90	"	"	6.99	" "	" "
	N=80	7.5	14.41	6.94	0.78	"	"	8.86	" "	" "

All μo values 1-13 ; Source: R.C. Smith (1986)

Source: Field Survey, 2005

ble 6.16 The effect of Resource mix on construction performance by construction firms in Kenya according to citizenship status:
Where A = African Firms, C = Citizen Firms, N = Non-citizen Firms:

$$Z = \frac{\bar{X} - \mu_o}{S/\sqrt{n}} \text{ when } n \geq 30; \quad S = \sqrt{\frac{\sum (x - \bar{x})^2}{n-1}} = \text{sample standard deviation.}$$

Main activity: Floor Pavings

No.	Sub activity	Sample Size (n)	μ_o	$\bar{X}$	S	$\delta_{\bar{x}} = \frac{S}{\sqrt{n}}$	Critical (e)		Actual Z_e	DECISION : TWO TAILED TEST	
							$Z_{0.025}$	$Z_{0.005}$		$Z_e > Z_e$: Accept H_0; Reject H_a $Z_e < Z_e$:	
										Confidence 95%	Confidence 99%
1	25mm paving gang size/day spreaders (No)	A=70	1	1.87	0.97	0.12	±1.96	±2.57	7.25	R(Ho) A(Ha)	R(Ho) A(Ha)
		C=56	1	1.50	0.78	0.10	"	"	5.0	" "	" "
		N=80	1	1.28	0.68	0.08	"	"	3.5	" "	" "
2	Ditto labourers (No)	A=70	1	3.79	2.22	0.27	"	"	10.33	" "	" "
		C=56	1	2.96	1.83	0.25	"	"	7.84	" "	" "
		N=80	1	2.57	1.70	0.19	"	"	8.26	" "	" "
3	Ditto output/day (M^2)	A=70	27	34.19	23.89	2.86	"	"	2.51	R(Ho) A(Ha)	A(Ho) R(Ha)
		C=56	27	27.05	21.07	2.82	"	"	0.02	A(Ho) R(Ha)	" "
		N=80	27	19.41	10.83	1.21	"	"	-6.27	R(Ho) A(Ha)	" "
4	Ditto waste (%)	A=70	7.5	7.79	5.40	0.65	"	"	0.45	" "	" "
		C=56	7.5	8.43	4.17	0.56	"	"	1.66	" "	" "
		N=80	7.5	8.33	3.74	0.42	"	"	1.98	"R(Ho) A(Ha	" "
5	40mm paving gangsize/day (No) spreaders	A=70	1	2.00	1.0	0.12	"	"	8.33	" "	"R(Ho) A(Ha
		C=56	1	2.00	0.85	0.11	"	"	9.09	" "	" "
		N=80	1	2.00	0.75	0.09	"	"	11.11	" "	" "
6	Ditto labourers/ day (No)	A=70	1	4	2.24	0.27	"	"	11.11	" "	" "
		C=56	1	3	1.92	0.26	"	"	7.69	" "	" "
		N=80	1	2	0.84	0.09	"	"	11.11	" "	" "
7	Ditto output/day (m^2)	A=70	18	36.8	24.65	2.95	"	"	6.37	" "	" "
		C=56	18	30.16	26.40	3.53	"	"	3.45	" "	" "
		N=80	18	18.68	9.85	1.10	"	"	0.62	A(Ho) R(Ha)	A(Ho) R(Ha)
8	Ditto waste (%)	A=70	7.5	7.88	5.67	0.68	"	"	0.56	" "	" "
		C=56	7.5	8.49	4.02	0.54	"	"	1.83	" "	" "
		N=80	7.5	8.36	4.05	0.45	"	"	1.91	" "	" "
9	2mmpvc 300x300mm pcs/m^2	A=70	11.11	12.71	4.77	0.57	"	"	2.81	R(Ho) A(Ha)	R(Ho) A(Ha)
		C=56	11.11	13.68	2.96	0.40	"	"	6.43	" "	" "
		N=80	11.11	13.10	2.09	0.23	"	"	8.65	" "	" "
10	Ditto output/day (M^2)	A=70	20	8.42	8.73	1.04	"	"	-11.14	" "	" "
		C=56	20	7.06	5.72	0.76	"	"	-17.03	" "	" "
		N=80	20	6.30	4.47	0.50	"	"	-27.4	" "	" "
11	Ditto waste (%)	A=70	5	6.99	4.15	0.50	"	"	3.98	" "	" "
		C=56	5	8.04	3.15	0.42	"	"	7.24	" "	" "
		N=80	5	7.18	2.98	0.33	"	"	6.61	" "	" "
12	PVC laying Gang layers (No)	A=70	2	1	0.26	0.03	"	"	-33.33	" "	" "
		C=56	2	1	0.34	0.05	"	"	-20.00	" "	" "
		N=80	2	1	0.16	0.02	"	"	-50.0	" "	" "
13	Ditto labourers (No)	A=70	1	2	0.49	0.06	"	"	16.67	" "	" "
		C=56	1	2	0.38	0.07	"	"	14.29	" "	" "
		N=80	1	2	0.41	0.05	"	"	20.00	" "	" "
14	Adhesive layers 4kg tins (No)	A=70	2	1	0.24	0.03	±1.96	±2.57	-13.33	" "	" "
		C=56	2	1	0.32	0.04	"	"	-25.00	" "	" "
		N=80	2	1	0.19	0.02	"	"	-50.00	" "	" "
15	Ditto labourers (No)	A=70	1	2	0.51	0.06	"	"	16.67	" "	" "
		C=56	1	2	0.38	0.05	"	"	20.0	" "	" "
		N=80	1	2	0.71	0.08	"	"	12.50	" "	" "
16	Adhesive coverage/ 4kg tin (M^2)	A=70	4	16.07	5.84	0.70	"	"	17.24	" "	" "
		C=56	4	16.93	4.03	0.54	"	"	23.94	" "	" "
		N=80	4	16.24	3.44	0.38	"	"	32.21	" "	" "
17	Adhesive waste (%)	A=70	5	8.43	4.76	0.57	"	"	6.02	" "	" "
		C=56	5	9.98	5.33	0.71	"	"	7.01	" "	" "
		N=80	5	7.74	3.30	0.37	"	"	7.41	" "	" "

All μo values: (1-8) Source: R.C. Smith (1986), (9-17): Source: Spence Geddes (1976); and manufacturers catalogues Source: Field Survey, 2005

Table 6.17 The effect of Resource mix on construction performance by construction firms in Kenya according to citizenship status:
where A = African Firms, C = Citizen Firms, N = Non-citizen Firms:

$$Z = \frac{\bar{X} - \mu_o}{S / \sqrt{n}} \text{ when } n \geq 30: \qquad S = \sqrt{\frac{\sum (x - \bar{x})^2}{n-1}} = \text{sample standard deviation.}$$

Main activity: Wood Block Finishes

	Sub activity	Sample Size (n)	μ_o	$\bar{X}$	S	$\delta_{\bar{x}} = \frac{s}{\sqrt{n}}$	Critical (e)		Actual Z_e	DECISION : TWO TAILED TEST	
							$Z_{0.025}$	$Z_{0.005}$		$Z_e > Z_e$: Accept H_o: Reject H_a $Z_e < Z_e$:	
										Confidence 95%	Confidence 99%
1	Stronghold adhesive kg/m² of tiling	A=70	1.90	0.86	0.59	0.07	±1.96	±2.57	-14.86	R(Ho) A(Ha)	R(Ho) A(Ha)
		C=56	1.90	10.91	8.33	1.11	"	"	8.12	" "	" "
		N=80	1.90	11.47	8.68	0.97	"	"	9.87	" "	" "
2	Ditto waste (%)	A=70	5	10.49	6.39	0.76	"	"	7.22	" "	" "
		C=56	5	11.16	7.30	0.98	"	"	6.29	" "	" "
		N=80	5	9.96	6.96	0.79	"	"	6.28	" "	" "
3	Ditto ouput/day (M²)	A=70	16.67	26.77	20.31	2.42	"	"	4.17	" "	" "
		C=56	16.67	18.75	16.20	2.16	"	"	0.96	A(Ho) R(Ha)	A(Ho) R(Ha)
		N=80	16.67	16.53	15.06	1.68	"	"	-0.08	" "	" "
4	Gang Skilled craftman (No)	A=70	1	1	0.21	0.03	"	"	0	" "	" "
		C=56	1	1	0.40	0.05	"	"	0	" "	" "
		N=80	1	1	0	0	"	"	0	" "	" "
5	Ditto labourers (No)	A=70	1	1	0.98	0.12	"	"	0	" "	" "
		C=56	1	2	0.59	0.08	"	"	12.50	R(Ho) A(Ha)	R(Ho) A(Ha)
		N=80	1	2	0.32	0.04	"	"	25.0	" "	" "
6	Idle time/ day %	A=70	5	7.23	2.90	0.35	"	"	6.37	" "	" "
		C=56	5	7.83	2.98	0.40	"	"	7.08	" "	" "
		N=80	5	8.05	3.64	0.41	"	"	7.44	" "	" "
7	8mm parquet flooring per M²	A=70	1	1.0	0	0	"	"	0	A(Ho) R(Ha)	A(Ho) R(Ha)
		C=56	1	1.0	0	0	"	"	0	" "	" "
		N=80	1	1.0	0.10	0.01	"	"	0	" "	" "
8	Ditto waste (%)	A=70	5	8.32	6.18	0.74	"	"	4.49	R(Ho) A(Ha)	R(Ho) A(Ha)
		C=56	5	7.47	5.41	0.72	"	"	3.43	" "	" "
		N=80	5	6.81	3.81	0.43	"	"	4.21	" "	" "
9	8mm paraquet output/day M²	A=70	16.67	23.01	18.18	2.17	"	"	2.92	" "	" "
		C=56	16.67	16.16	14.94	2.0	"	"	-0.26	A(Ho) R(Ha)	A(Ho) R(Ha)
		N=80	16.67	13.23	10.18	1.14	"	"	-3.02	R(Ho) A(Ha)	R(Ho) A(Ha)
10	Gang skilled craftsmen (No)	A=70	1	1.0	0.21	0.03	"	"	0	A(Ho) R(Ha)	A(Ho) R(Ha)
		C=56	1	1.0	0.31	0.04	"	"	0	" "	" "
		N=80	1	1.0	0	0	"	"	0	" "	" "
11	Gang labourers (No)	A=70	1	2	0.52	0.06	"	"	16.67	R(Ho) A(Ha)	R(Ho) A(Ha)
		C=56	1	2	0.59	0.08	"	"	12.50	" "	" "
		N=80	1	2	0.32	0.04	"	"	25.0	" "	" "
12	Laying waste (%)	A=70	5	7.4	2.94	0.35	"	"	6.86	" "	" "
		C=56	5	7.92	3.06	0.41	"	"	7.12	" "	" "
		N=80	5	7.97	3.94	0.44	"	"	6.75	" "	" "

All μo values ; 1-12: Source: Spence Geddes (1976)
Source: Field Survey, 2005

Table 6.18 The effect of Resource mix on construction performance by construction firms in Kenya according to citizenship status:
Where A = African Firms, C = Citizen Firms, N = Non-citizen Firms:

$$Z = \frac{\bar{X} - \mu_o}{S / \sqrt{n}} \text{ when } n \geq 30: \qquad S = \sqrt{\frac{\sum (x - \bar{x})^2}{n - 1}} = \text{sample standard deviation.}$$

Main activity: Ceramic Floor/Wall Tiling

	Sub activity	Sample Size (n)	μ_o	$\bar{X}$	S	$\delta_{\bar{x}} = \frac{s}{\sqrt{n}}$	Critical (e) $Z_{0.025}$	Critical (e) $Z_{0.005}$	Actual Z_e	DECISION : TWO TAILED TEST $Z_e > Z_o$: Accept H_0. Reject H_0 $Z_e < Z_o$: Confidence 95%	Confidence 99%
1	150x150x6 mm tiles (wall) (No/m²)	A=70	44	45.11	1.76	0.21	±1.96	±2.57	5.29	R(Ho) A(Ha)	R(Ho) A(Ha)
		C=56	44	44.23	6.87	0.92	"	"	0.25	A(Ho) R(Ha)	A(Ho) R(Ha)
		N=80	44	44.78	4.83	0.54	"	"	1.44	" "	" "
2	Ditto waste (%)	A=70	5	8.02	4.44	0.53	"	"	5.70	R(Ho) A(Ha)	R(Ho) A(Ha)
		C=56	5	7.07	3.21	0.43	"	"	4.81	" "	" "
		N=80	5	7.68	3.05	0.34	"	"	7.88	" "	" "
3	Ditto output/day (m²)	A=70	7.6	11.98	11.00	1.3	"	"	3.37	" "	" "
		C=56	7.6	10.75	6.66	0.89	"	"	3.54	" "	" "
		N=80	7.6	7.80	4.16	0.47	"	"	0.43	A(Ho) R(Ha)	A(Ho) R(Ha)
4	Gangsize craftsmen (No)	A=70	2	1	0.37	0.05	"	"	-20.0	R(Ho) A(Ha)	R(Ho) A(Ha)
		C=56	2	1	0.90	0.12	"	"	-8.33	" "	" "
		N=80	2	1	0.16	0.02	"	"	-50.0	" "	" "
5	Ditto labourers (No)	A=70	1	2	0.78	0.09	"	"	11.11	" "	" "
		C=56	1	2	0.46	0.06	"	"	16.67	" "	" "
		N=80	1	2	0.44	0.05	"	"	20.0	" "	" "
6	Idle time (%)	A=70	5	8.07	3.60	0.48	"	"	6.40	" "	" "
		C=56	5	7.58	3.39	0.45	"	"	5.73	" "	" "
		N=80	5	8.0	3.57	0.40	"	"	7.50	" "	" "
7	200x200x6 mm tiles (No/m²)	A=70	25	26.76	2.70	0.33	"	"	5.33	" "	" "
		C=56	25	27.07	3.54	0.47	"	"	4.40	" "	" "
		N=80	25	27.99	4.25	0.48	"	"	6.23	" "	" "
8	Ditto waste (%)	A=70	5	8.35	4.90	0.59	"	"	5.68	" "	" "
		C=56	5	7.26	3.65	0.49	"	"	4.61	" "	" "
		N=80	5	8.0	3.42	0.38	"	"	7.89	" "	" "
9	Ditto output/day (m²)	A=70	7.6	11.21	5.96	0.71	"	"	5.08	" "	" "
		C=56	7.6	12.0	5.67	0.76	"	"	5.79	" "	" "
		N=80	7.6	10.47	5.54	0.62	"	"	4.63	" "	" "
10	Gangsize craftsmen (No)	A=70	2	1	0.37	0.04	"	"	-25.0	" "	" "
		C=56	2	1	0.90	0.12	"	"	-8.33	" "	" "
		N=80	2	1	0.16	0.02	"	"	-50.0	" "	" "
11	Ditto Labourers (No)	A=70	1	2	0.78	0.09	"	"	11.11	" "	" "
		C=56	1	2	0.46	0.06	"	"	16.67	" "	" "
		N=80	1	2	0.43	0.05	"	"	20.0	" "	" "
12	Idle time (%)	A=70	5	8.13	3.66	0.44	"	"	7.11	" "	" "
		C=56	5	7.58	3.39	0.45	"	"	5.73	" "	" "
		N=80	5	8.30	3.54	0.40	"	"	8.25	" "	" "
13	300x300x6 mm wall tiles (No/m²)	A=70	11.11	12.83	3.88	0.46	"	"	3.74	" "	" "
		C=56	11.11	14.04	7.64	1.02	"	"	2.87	" "	" "
		N=80	11.11	14.77	7.33	0.82	"	"	4.46	" "	" "

All μo – values: 1-36; Source: Manufacturers specifications; R.C. Smith (1986); Enterkin Hugh and Gerald Reynolds (1978).

Source: Field Survey, 2005.

Table 6.18. The effect of Resource mix on construction performance by construction firms in Kenya according to citizenship status.
Where A = African Firms, C = Citizen Firms, N = Non-citizen Firms:

$$Z = \frac{\bar{X} - \mu_o}{S/\sqrt{n}}$$ when n ≥ 30: $$S = \sqrt{\frac{\sum (x - \bar{x})^2}{n-1}}$$ = sample standard deviation.

Main activity: Ceramic Floor/wall Tiling

	Sub activity	Sample Size (n)	μ_o	$\bar{X}$	S	$\delta_{\bar{x}} = \frac{S}{\sqrt{n}}$	Critical (e)		Actual Z_a	DECISION : TWO TAILED TEST $Z_e > Z_a$: Accept H_0; Reject H_a $Z_e < Z_a$:	
							$Z_{0.025}$	$Z_{0.005}$		Confidence 95%	Confidence 99%
14	Ditto waste (%)	A=70	5	8.18	4.37	0.52	±1.96	±2.57	6.12	" "	" "
		C=56	5	7.44	4.49	0.60	"	"	4.07	A(Ho) R(Ha)	A(Ho) R(Ha)
		N=80	5	7.91	3.94	0.44	"	"	6.61	" "	" "
15	Ditto output/day (M^2)	A=70	10	11.71	9.10	1.09	"	"	1.57	A(Ho) R(Ha)	A(Ho) R(Ha)
		C=56	10	16.63	15.51	2.07	"	"	3.20	R(Ho) A(Ha)	R(Ho) A(Ha)
		N=80	10	10.91	6.22	0.70	"	"	1.30	A(Ho) R(Ha)	A(Ho) R(Ha)
16	Gangsize craftmen (No)	A=70	2	1	0.37	0.05	"	"	-20.0	R(Ho) A(Ha)	R(Ho) A(Ha)
		C=56	2	1	0.91	0.12	"	"	-8.33	" "	" "
		N=80	2	1	0.16	0.02	"	"	-50.0	" "	" "
17	Ditto labourers (No)	A=70	1	2	0.78	0.09	"	"	11.11	" "	" "
		C=56	1	2	0.46	0.06	"	"	16.67	" "	" "
		N=80	1	2	0.43	0.05	"	"	20.0	" "	" "
18	Idle time (%)	A=70	5	8.57	3.91	0.47	"	"	7.60	" "	" "
		C=56	5	7.77	3.52	0.47	"	"	5.89	" "	" "
		N=80	5	8.56	3.75	0.42	"	"	8.48	" "	" "
19	150x150x 8mm floor tiles (No/m^2)	A=70	44	44.90	2.20	0.26	"	"	3.46	" "	" "
		C=56	44	44.96	7.61	1.02	"	"	0.94	A(Ho) R(Ha)	A(Ho) R(Ha)
		N=80	44	46.33	8.57	0.96	"	"	2.74	R(Ho) A(Ha)	R(Ho) A(Ha)
20	Ditto waste (%)	A=70	5	8.53	5.42	0.65	"	"	5.43	" "	" "
		C=56	5	7.17	3.65	0.49	"	"	4.43	" "	" "
		N=80	5	7.87	3.62	0.41	"	"	7.0	" "	" "
21	Ditto output/day (M^2)	A=70	8	16.32	14.43	1.72	"	"	4.84	" "	" "
		C=56	8	11.34	7.14	0.95	"	"	3.52	" "	" "
		N=80	8	12.83	9.62	1.08	"	"	4.47	" "	" "
22	Gangsize craftsmen (No)	A=70	2	1	0.45	0.05	"	"	-20.0	" "	" "
		C=56	2	1	0.90	0.12	"	"	-8.33	" "	" "
		N=80	2	1	0.16	0.02	"	"	-50.0	" "	" "
23	Ditto labourers (No)	A=70	1	2	0.81	0.10	"	"	10.0	" "	" "
		C=56	1	2	0.46	0.06	"	"	16.67	" "	" "
		N=80	1	2	0.40	0.05	"	"	20.0	" "	" "
24	Idle time (%)	A=70	5	8.20	3.04	0.36	"	"	8.89	" "	" "
		C=56	5	7.66	3.62	0.48	"	"	5.54	" "	" "
		N=80	5	8.27	3.44	0.39	"	"	8.38	" "	" "
25	200x200x8 mm floor tiles No/m^2	A=70	25	27.69	5.42	0.65	"	"	4.14	" "	" "
		C=56	25	27.59	4.19	0.56	"	"	4.63	" "	" "
		N=80	25	28.38	4.89	0.55	"	"	6.15	" "	" "
26	Ditto waste (%)	A=70	5	8.41	5.76	0.69	"	"	4.94	" "	" "
		C=56	5	7.07	3.22	0.43	"	"	4.81	" "	" "
		N=80	5	7.68	3.05	0.34	"	"	7.88	" "	" "

All μo – values: 1-36; Source: Manufacturers specifications; R.C. Smith (1986); Enterkin Hugh and Gerald Reynolds (1978).

Source: Field Survey, 2005

Table 6.19 The effect of Resource mix on construction performance by construction firms in Kenya according to citizenship status:
where A = African Firms, C = Citizen Firms, N = Non-citizen Firms:

$$Z=\frac{\bar{X}-\mu_o}{S/\sqrt{n}} \text{ when } n \geq 30: \qquad S=\sqrt{\frac{\sum(x-\bar{x})^2}{n-1}} = \text{sample standard deviation.}$$

Main activity: **Brick Facing**

	Sub activity	Sample Size (n)	μ_o	$\bar{X}$	S	$\delta_{\bar{x}} = \frac{S}{\sqrt{n}}$	Critical (e)		Actual Z_a	DECISION : TWO TAILED TEST	
							$Z_{0.025}$	$Z_{0.005}$		$Z_a > Z_e$: Accept H_o: Reject H_a $Z_a < Z_e$:	
										Confidence 95%	Confidence 99%
1	230x75x25 mm bricks (No/M²)	A=70	50	49.56	14.0	1.67	±1.96	±2.57	-0.26	A(Ho) R(Ha)	A(Ho) R(Ha)
		C=56	50	45.52	18.34	2.45	"	"	-1.83	" "	" "
		N=80	50	51.55	12.39	1.39	"	"	1.12	" "	" "
2	Ditto waste (%)	A=70	5	9.42	5.51	0.66	"	"	6.70	R(Ho) A(Ha)	R(Ho) A(Ha)
		C=56	5	7.87	3.51	0.47	"	"	6.11	" "	" "
		N=80	5	7.82	3.65	0.41	"	"	6.88	" "	" "
3	Ditto output/day (m²)	A=70	8	10.35	10.68	1.28	"	"	1.84	A(Ho) R(Ha)	A(Ho) R(Ha)
		C=56	8	9.50	6.95	0.93	"	"	1.61	" "	" "
		N=80	8	8.23	2.24	0.25	"	"	0.92	" "	" "
4	Gangsize craftsmen (No)	A=70	2	1	0.26	0.03	"	"	-33.33	R(Ho) A(Ha)	R(Ho) A(Ha)
		C=56	2	1	0.23	0.03	"	"	-33.33	" "	" "
		N=80	2	1	0.11	0.12	"	"	-8.33	" "	" "
5	Ditto labourers (No)	A=70	1	2	0.51	0.06	"	"	16.67	" "	" "
		C=56	1	2	0.50	0.07	"	"	14.29	" "	" "
		N=80	1	2	0.42	0.05	"	"	20.00	" "	" "
6	Idle time/day (%)	A=70	5	8.16	3.63	0.43	"	"	7.35	" "	" "
		C=56	5	8.03	3.42	0.46	"	"	6.59	" "	" "
		N=80	5	8.30	3.97	0.44	"	"	7.50	" "	" "
7	230x75x 50mm bricks (No/M²)	A=70	50	50.52	13.30	1.59	"	"	0.33	A(Ho) R(Ha)	A(Ho) R(Ha)
		C=56	50	46.46	17.74	2.37	"	"	-1.49	" "	" "
		N=80	50	52.30	13.12	1.47	"	"	1.56	" "	" "
8	Ditto waste (%)	A=70	5	10.43	6.83	0.82	"	"	6.62	R(Ho) A(Ha)	R(Ho) A(Ha)
		C=56	5	8.19	4.66	0.62	"	"	5.15	" "	" "
		N=80	5	7.78	3.98	0.44	"	"	6.32	" "	" "
9	Ditto output/day (M²)	A=70	8	7.66	3.68	0.44	"	"	-0.77	A(Ho) R(Ha)	A(Ho) R(Ha)
		C=56	8	9.79	7.07	0.95	"	"	1.88	" "	" "
		N=80	8	8.30	2.42	0.27	"	"	1.11	" "	" "
10	Gangsize craftsmen (No)	A=70	2	1	0.26	0.03	"	"	-33.33	R(Ho) A(Ha)	R(Ho) A(Ha)
		C=56	2	1	0.23	0.03	"	"	-33.33	" "	" "
		N=80	2	1	0.11	0.12	"	"	-8.33	" "	" "
11	Ditto labourers (No)	A=70	1	2	0.51	0.06	"	"	16.67	" "	" "
		C=56	1	2	0.50	0.07	"	"	14.29	" "	" "
		N=80	1	2	0.42	0.05	"	"	20.00	" "	" "
12	Idle time/day (%)	A=70	5	7.91	3.45	0.41	"	"	7.10	" "	" "
		C=56	5	7.89	3.42	0.46	"	"	6.28	" "	" "
		N=80	5	8.15	3.57	0.40	"	"	7.88	" "	" "
13	230x65x 65 mm bricks (No/M²)	A=70	55	53.93	15.73	1.88	"	"	-0.57	A(Ho) R(Ha)	A(Ho) R(Ha)
		C=56	55	47.88	18.54	2.48	"	"	-2.87	R(Ho) A(Ha)	R(Ho) A(Ha)
		N=80	55	55.03	12.88	1.44	"	"	0.02	A(Ho) R(Ha)	A(Ho) R(Ha)

All μo – values: 1-18; Source: Enterkin & Gerald Reynolds (1978) and Clayworks Ltd. catalogue

Source: Field Survey, 2005.

Table 6.19 The effect of Resource mix on construction performance by construction firms in Kenya according to citizenship status:
Where A = African Firms, C = Citizen Firms, N = Non-citizen Firms:

$$Z = \frac{\bar{X} - \mu_o}{S/\sqrt{n}}$$ when n ≥ 30: $$S = \sqrt{\frac{\sum (x - \bar{x})^2}{n-1}}$$ = sample standard deviation.

Main activity: Brick Facing

	Sub activity	Sample Size (n)	μ_o	$\bar{X}$	S	$\delta_{\bar{x}} = \frac{s}{\sqrt{n}}$	Critical (e)		Actual Z_a	DECISION : TWO TAILED TEST	
							$Z_{0.025}$	$Z_{0.005}$		$Z_e > Z_a$: Accept H_0: Reject H_a $Z_e < Z_a$:	
										Confidence 95%	Confidence 99%
14	Ditto Waste (%)	A=70	5	10.41	6.73	0.80	±1.96	±2.57	6.76	R(Ho) A(Ha)	R(Ho) A(Ha)
		C=56	5	8.19	4.66	0.63	"	"	5.06	" "	" "
		N=80	5	7.79	4.01	0.45	"	"	6.20	" "	" "
15	Ditto Output/ Day (M²)	A=70	8	9.79	9.43	1.13	"	"	1.58	A(Ho) R(Ha)	A(Ho) R(Ha)
		C=56	8	9.50	6.99	0.93	"	"	1.61	" "	" "
		N=80	8	8.12	2.53	0.28	"	"	0.43	" "	" "
16	Gang size skilled craftsmen (No)	A=70	2	1	0.26	0.03	"	"	-33.33	R(Ho) A(Ha)	R(Ho) A(Ha)
		C=56	2	1	0.23	0.03	"	"	-33.33	" "	" "
		N=80	2	1	0.11	0.01	"	"	-100.00	" "	" "
17	Ditto Labourers (No.)	A=70	1	2	0.51	0.06	"	"	16.67	" "	" "
		C=56	1	2	0.50	0.07	"	"	14.29	" "	" "
		N=80	1	2	0.42	0.05	"	"	20.00	" "	" "
18	Ditto Idle Time/Day (%)	A=70	5	8.12	3.62	0.43	"	"	7.26	" "	" "
		C=56	5	7.89	3.43	0.46	"	"	6.28	" "	" "
		N=80	5	8.17	3.46	0.39	"	"	8.13	" "	" "

All μo – values: 1-18; Source: Enterkin & Gerald Reynolds (1978) and Clayworks Ltd. catalogue
Source: Field Survey, 2005

APPENDIX D:

MULTIPLE REGRESSION ANALYSIS FOR PROJECTS PERFORMANCE ON RESOURCES.

Africans-Stepwise method
Regression

Descriptive Statistics

	Mean	Std. Deviation	N
pf	148.36	53.17	70
Incorect labour mix	21.79	10.11	70
Incorect material mix	24.97	11.77	70
Incorect macchine time mix combination	22.00	8.74	70
Information technology	22.74	11.08	70
Technology Advancement	25.86	13.78	70
Finance resource credit worthiness	31.00	15.12	70

Correlations

		pf	Incorect labour mix	Incorect material mix	Incorect macchine time mix combination	Information technology	Technology Advancement	Finance resource credit worthiness
Pearson Correlati	pf	1.000	.651	.705	.814	.723	.751	.847
	Incorect labour mix	.651	1.000	.672	.595	.303	.176	.370
	Incorect material mix	.705	.672	1.000	.699	.205	.268	.455
	Incorect macchine tir mix combination	.814	.595	.699	1.000	.413	.476	.607
	Information technolog	.723	.303	.205	.413	1.000	.663	.603
	Technology Advance	.751	.176	.268	.476	.663	1.000	.643
	Finance resource cre worthiness	.847	.370	.455	.607	.603	.643	1.000
Sig. (1-tailed)	pf	.	.000	.000	.000	.000	.000	.000
	Incorect labour mix	.000	.	.000	.000	.005	.072	.001
	Incorect material mix	.000	.000	.	.000	.044	.013	.000
	Incorect macchine tir mix combination	.000	.000	.000	.	.000	.000	.000
	Information technolog	.000	.005	.044	.000	.	.000	.000
	Technology Advance	.000	.072	.013	.000	.000	.	.000
	Finance resource cre worthiness	.000	.001	.000	.000	.000	.000	.
N	pf	70	70	70	70	70	70	70
	Incorect labour mix	70	70	70	70	70	70	70
	Incorect material mix	70	70	70	70	70	70	70
	Incorect macchine tir mix combination	70	70	70	70	70	70	70
	Information technolog	70	70	70	70	70	70	70
	Technology Advance	70	70	70	70	70	70	70
	Finance resource cre worthiness	70	70	70	70	70	70	70

Variables Entered/Removed[a]

Model	Variables Entered	Variables Removed	Method
1	Finance resource credit worthiness	.	Stepwise (Criteria: Probability-of-F-to-enter <= .050, Probability-of-F-to-remove >= .100).
2	Incorect macchine time mix combination	.	Stepwise (Criteria: Probability-of-F-to-enter <= .050, Probability-of-F-to-remove >= .100).
3	Information technology	.	Stepwise (Criteria: Probability-of-F-to-enter <= .050, Probability-of-F-to-remove >= .100).
4	Incorect material mix	.	Stepwise (Criteria: Probability-of-F-to-enter <= .050, Probability-of-F-to-remove >= .100).
5	Technology Advancement	.	Stepwise (Criteria: Probability-of-F-to-enter <= .050, Probability-of-F-to-remove >= .100).
6	Incorect labour mix	.	Stepwise (Criteria: Probability-of-F-to-enter <= .050, Probability-of-F-to-remove >= .100).

a. Dependent Variable: pf

Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Change Statistics				
					R Square Change	F Change	df1	df2	Sig. F Change
1	.847[a]	.718	.714	28.44	.718	173.156	1	68	.000
2	.928[b]	.860	.856	20.16	.142	68.298	1	67	.000
3	.958[c]	.917	.913	15.66	.057	45.130	1	66	.000
4	.981[d]	.962	.960	10.63	.045	78.174	1	65	.000
5	.991[e]	.983	.982	7.22	.021	77.093	1	64	.000
6	1.000[f]	1.000	1.000	5.86E-07	.017	.	1	63	.

a. Predictors: (Constant), Finance resource credit worthiness

b. Predictors: (Constant), Finance resource credit worthiness, Incorect macchine time mix combination

c. Predictors: (Constant), Finance resource credit worthiness, Incorect macchine time mix combination, Inform

d. Predictors: (Constant), Finance resource credit worthiness, Incorect macchine time mix combination, Inform Incorect material mix

e. Predictors: (Constant), Finance resource credit worthiness, Incorect macchine time mix combination, Inform Incorect material mix, Technology Advancement

f. Predictors: (Constant), Finance resource credit worthiness, Incorect macchine time mix combination, Informa Incorect material mix, Technology Advancement, Incorect labour mix

ANOVA[g]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	140076.7	1	140076.694	173.156	.000[a]
	Residual	55009.378	68	808.961		
	Total	195086.1	69			
2	Regression	167845.3	2	83922.650	206.412	.000[b]
	Residual	27240.772	67	406.579		
	Total	195086.1	69			
3	Regression	178907.7	3	59635.911	243.286	.000[c]
	Residual	16178.338	66	245.126		
	Total	195086.1	69			
4	Regression	187741.2	4	46935.309	415.366	.000[d]
	Residual	7344.836	65	112.997		
	Total	195086.1	69			
5	Regression	191754.4	5	38350.889	736.714	.000[e]
	Residual	3331.627	64	52.057		
	Total	195086.1	69			
6	Regression	195086.1	6	32514.345	7.7E+16	.000[f]
	Residual	2.166E-11	63	3.438E-13		
	Total	195086.1	69			

a. Predictors: (Constant), Finance resource credit worthiness

b. Predictors: (Constant), Finance resource credit worthiness, Incorect macchine time mix combination

c. Predictors: (Constant), Finance resource credit worthiness, Incorect macchine time mix combination, Information technology

d. Predictors: (Constant), Finance resource credit worthiness, Incorect macchine time mix combination, Information technology, Incorect material mix

e. Predictors: (Constant), Finance resource credit worthiness, Incorect macchine time mix combination, Information technology, Incorect material mix, Technology Advancement

f. Predictors: (Constant), Finance resource credit worthiness, Incorect macchine time mix combination, Information technology, Incorect material mix, Technology Advancement, Incorect labour mix

g. Dependent Variable: pf

Coefficients[a]

Mode		Unstandardized Coefficients		tandardized Coefficients	t	Sig.	Confidence Interval		Correlations			llinearity Statisti	
		B	td. Erro	Beta			ower Boun	pper Boun	ero-orde	Partial	Part	oleranc	VIF
1	(Constant)	55.896	7.799		7.180	.000	40.433	71.558					
	Finance resource worthiness	2.979	.226	.847	13.159	.000	2.528	3.431	.847	.847	.847	1.000	1.000
2	(Constant)	23.859	6.759		3.530	.001	10.367	37.351					
	Finance resource worthiness	1.966	.202	.559	9.735	.000	1.563	2.369	.847	.765	.444	.632	1.583
	Incorect macchin mix combination	2.888	.349	.475	8.264	.000	2.191	3.586	.814	.710	.377	.632	1.583
3	(Constant)	12.385	5.519		2.244	.028	1.366	23.405					
	Finance resource worthiness	1.380	.180	.392	7.685	.000	1.021	1.738	.847	.687	.272	.482	2.074
	Incorect macchin mix combination	2.752	.272	.452	10.114	.000	2.209	3.296	.814	.780	.359	.628	1.592
	Information techn	1.436	.214	.299	6.718	.000	1.009	1.863	.723	.637	.238	.633	1.580
4	(Constant)	5.116	3.837		1.334	.187	-2.546	12.778					
	Finance resource worthiness	1.233	.123	.351	10.027	.000	.988	1.479	.847	.779	.241	.473	2.113
	Incorect macchin mix combination	1.499	.233	.246	6.438	.000	1.034	1.964	.814	.624	.155	.395	2.529
	Information techn	1.667	.147	.347	11.304	.000	1.372	1.961	.723	.814	.272	.613	1.631
	Incorect material	1.367	.155	.303	8.842	.000	1.058	1.675	.705	.739	.213	.495	2.022
5	(Constant)	3.821	2.608		1.465	.148	-1.390	9.031					
	Finance resource worthiness	.984	.088	.280	11.167	.000	.808	1.161	.847	.813	.182	.424	2.356
	Incorect macchin mix combination	1.295	.160	.213	8.106	.000	.976	1.614	.814	.712	.132	.387	2.584
	Information techn	1.246	.111	.260	11.235	.000	1.025	1.468	.723	.815	.184	.499	2.004
	Incorect material	1.442	.105	.319	13.703	.000	1.232	1.653	.705	.864	.224	.491	2.036
	Technology Adva	.818	.093	.212	8.780	.000	.632	1.005	.751	.739	.143	.457	2.186
6	(Constant)	37E-14	.000		.000	1.000	.000	.000					
	Finance resource worthiness	1.000	.000	.284	3E+08	.000	1.000	1.000	.847	1.000	.185	.424	2.357
	Incorect macchin mix combination	1.000	.000	.164	8E+07	.000	1.000	1.000	.814	1.000	.100	.367	2.722
	Information techn	1.000	.000	.208	6E+07	.000	1.000	1.000	.723	1.000	.142	.463	2.158
	Incorect material	1.000	.000	.221	3E+07	.000	1.000	1.000	.705	1.000	.137	.385	2.598
	Technology Adva	1.000	.000	.259	2E+08	.000	1.000	1.000	.751	1.000	.170	.432	2.316
	Incorect labour m	1.000	.000	.190	9E+07	.000	1.000	1.000	.651	1.000	.131	.472	2.117

a. Dependent Variable: pf

Excluded Variables[f]

Model		Beta In	t	Sig.	Partial Correlation	Collinearity Statistics Tolerance	VIF	Minimum Tolerance
1	Incorect labour mix	.391[a]	7.667	.000	.684	.863	1.158	.863
	Incorect material mix	.404[a]	7.526	.000	.677	.793	1.261	.793
	Incorect macchine time mix combination	.475[a]	8.264	.000	.710	.632	1.583	.632
	Information technology	.333[a]	4.726	.000	.500	.637	1.571	.637
	Technology Advancem	.352[a]	4.826	.000	.508	.587	1.704	.587
2	Incorect labour mix	.250[b]	5.182	.000	.538	.646	1.547	.473
	Incorect material mix	.234[b]	4.067	.000	.448	.511	1.959	.407
	Information technology	.299[b]	6.718	.000	.637	.633	1.580	.482
	Technology Advancem	.288[b]	5.860	.000	.585	.575	1.738	.470
3	Incorect labour mix	.227[c]	6.578	.000	.632	.642	1.558	.473
	Incorect material mix	.303[c]	8.842	.000	.739	.495	2.022	.395
	Technology Advancem	.185[c]	3.903	.000	.436	.461	2.171	.435
4	Incorect labour mix	.132[d]	4.371	.000	.479	.500	1.998	.381
	Technology Advancem	.212[d]	8.780	.000	.739	.457	2.186	.387
5	Incorect labour mix	.190[e]	8.9E+07	.000	1.000	.472	2.117	.367

a. Predictors in the Model: (Constant), Finance resource credit worthiness

b. Predictors in the Model: (Constant), Finance resource credit worthiness, Incorect macchine time mix combir

c. Predictors in the Model: (Constant), Finance resource credit worthiness, Incorect macchine time mix combir Information technology

d. Predictors in the Model: (Constant), Finance resource credit worthiness, Incorect macchine time mix combir Information technology, Incorect material mix

e. Predictors in the Model: (Constant), Finance resource credit worthiness, Incorect macchine time mix combir Information technology, Incorect material mix, Technology Advancement

f. Dependent Variable: pf

Coefficient Correlations[a]

Model			Finance resource credit worthiness	Incorect macchine time mix combination	Information technology	Incorect material mix	Technology Advancement	Incorect labour mix
1	Correlations	Finance resource credit worthiness	1.000					
	Covariances	Finance resource credit worthiness	5.126E-02					
2	Correlations	Finance resource credit worthiness	1.000	-.607				
		Incorect macchine time mix combination	-.607	1.000				
	Covariances	Finance resource credit worthiness	4.079E-02	-4.285E-02				
		Incorect macchine time mix combination	-4.285E-02	.122				
3	Correlations	Finance resource credit worthiness	1.000	-.493	-.487			
		Incorect macchine time mix combination	-.493	1.000	-.074			
		Information technology	-.487	-.074	1.000			
	Covariances	Finance resource credit worthiness	3.222E-02	-2.406E-02	-1.867E-02			
		Incorect macchine time mix combination	-2.406E-02	7.405E-02	-4.325E-03			
		Information technology	-1.867E-02	-4.325E-03	4.568E-02			
4	Correlations	Finance resource credit worthiness	1.000	-.305	-.498	-.134		
		Incorect macchine time mix combination	-.305	1.000	-.166	-.609		
		Information technology	-.498	-.166	1.000	.177		
		Incorect material mix	-.134	-.609	.177	1.000		
	Covariances	Finance resource credit worthiness	1.513E-02	-8.748E-03	-9.037E-03	-2.556E-03		
		Incorect macchine time mix combination	-8.748E-03	5.423E-02	-5.694E-03	-2.191E-02		
		Information technology	-9.037E-03	-5.694E-03	2.174E-02	4.035E-03		
		Incorect material mix	-2.556E-03	-2.191E-02	4.035E-03	2.389E-02		
5	Correlations	Finance resource credit worthiness	1.000	-.239	-.287	-.153	-.321	
		Incorect macchine time mix combination	-.239	1.000	-.085	-.612	-.146	
		Information technology	-.287	-.085	1.000	.124	-.432	
		Incorect material mix	-.153	-.612	.124	1.000	.082	
		Technology Advancemen	-.321	-.146	-.432	.082	1.000	
	Covariances	Finance resource credit worthiness	7.772E-03	-3.372E-03	-2.807E-03	-1.423E-03	-2.641E-03	
		Incorect macchine time mix combination	-3.372E-03	2.552E-02	-1.510E-03	-1.029E-02	-2.167E-03	
		Information technology	-2.807E-03	-1.510E-03	1.231E-02	1.445E-03	-4.462E-03	
		Incorect material mix	-1.423E-03	-1.029E-02	1.445E-03	1.108E-02	8.054E-04	
		Technology Advancemen	-2.641E-03	-2.167E-03	-4.462E-03	8.054E-04	8.888E-03	
6	Correlations	Finance resource credit worthiness	1.000	-.238	-.282	-.146	-.307	.022
		Incorect macchine time mix combination	-.238	1.000	-.020	-.423	-.191	-.225
		Information technology	-.282	-.020	1.000	.230	-.467	-.267
		Incorect material mix	-.146	-.423	.230	1.000	-.039	-.465
		Technology Advancemen	-.307	-.191	-.467	-.039	1.000	.237
		Incorect labour mix	.022	-.225	-.267	-.465	.237	1.000
	Covariances	Finance resource credit worthiness	6.339E-17	-2.807E-17	-2.337E-17	-1.247E-17	-2.117E-17	1.975E-18
		Incorect macchine time mix combination	-2.807E-17	2.192E-16	-3.055E-18	-6.729E-17	-2.449E-17	-3.758E-17
		Information technology	-2.337E-17	-3.055E-18	1.080E-16	2.566E-17	-4.207E-17	-3.137E-17
		Incorect material mix	-1.247E-17	-6.729E-17	2.566E-17	1.153E-16	-3.667E-18	-5.636E-17
		Technology Advancemen	-2.117E-17	-2.449E-17	-4.207E-17	-3.667E-18	7.503E-17	2.313E-17
		Incorect labour mix	1.975E-18	-3.758E-17	-3.137E-17	-5.636E-17	2.313E-17	1.274E-16

a. Dependent Variable: pf

Collinearity Diagnostics

				Variance Proportions						
Model	Dimensio	Eigenvalue	Condition Index	Constant)	Finance resource credit worthiness	Incorect macchine time mix combination	Information technology	Incorect naterial mix	Technology Advancemen	Incorect abour mix
1	1	1.900	1.000	.05	.05					
	2	.100	4.359	.95	.95					
2	1	2.843	1.000	.01	.01	.01				
	2	.100	5.329	.67	.56	.00				
	3	675E-02	7.078	.31	.43	.99				
3	1	3.746	1.000	.01	.01	.01	.01			
	2	.114	5.741	.41	.10	.08	.39			
	3	.828E-02	6.515	.26	.30	.20	.41			
	4	.160E-02	8.521	.32	.59	.72	.19			
4	1	4.641	1.000	.00	.00	.00	.00	.00		
	2	.161	5.363	.00	.04	.02	.34	.22		
	3	.858E-02	6.862	.74	.25	.01	.00	.04		
	4	.975E-02	8.813	.23	.63	.01	.63	.18		
	5	.910E-02	10.896	.03	.07	.96	.02	.56		
5	1	5.534	1.000	.00	.00	.00	.00	.00	.00	
	2	.199	5.268	.02	.01	.02	.11	.17	.12	
	3	.101	7.390	.69	.13	.01	.05	.07	.04	
	4	.671E-02	9.108	.04	.20	.00	.39	.00	.81	
	5	.972E-02	9.627	.22	.62	.01	.45	.18	.01	
	6	.871E-02	11.956	.03	.04	.96	.00	.58	.02	
6	1	6.424	1.000	.00	.00	.00	.00	.00	.00	.00
	2	.245	5.116	.00	.02	.01	.07	.06	.11	.07
	3	.102	7.934	.54	.14	.02	.08	.08	.04	.01
	4	.237E-02	8.831	.36	.00	.02	.35	.02	.07	.29
	5	.349E-02	10.059	.06	.71	.00	.00	.04	.52	.03
	6	.381E-02	12.109	.01	.11	.08	.49	.31	.24	.59
	7	.870E-02	12.885	.03	.03	.88	.01	.50	.01	.00

a. Dependent Variable: pf

Citizen-Stepwise method
Regression

Descriptive Statistics

	Mean	Std. Deviation	N
pf	149.20	53.80	56
Incorect labour mix	21.88	9.93	56
Incorect material mix	22.05	9.94	56
Incorect macchine time mix combination	19.82	8.84	56
Information technology	22.86	10.65	56
Technology Advancement	30.36	13.51	56
Finance resource credit worthiness	32.23	16.09	56

Correlations

		pf	Incorect labour mix	Incorect material mix	Incorect macchine time mix combination	Information technology	Technology Advancement	Finance resource credit worthiness
Pearson Correlation	pf	1.000	.708	.769	.768	.761	.861	.783
	Incorect labour mix	.708	1.000	.779	589	.545	.374	.269
	Incorect material mix	.769	.779	1.000	.532	.467	.505	.445
	Incorect macchine time mix combination	.768	.589	.532	1 000	.594	.587	.441
	Information technology	.761	.545	.467	.594	1.000	.599	.426
	Technology Advanceme	.861	.374	.505	.587	.599	1.000	.776
	Finance resource credit worthiness	.783	.269	.445	.441	.426	.776	1.000
Sig (1-tailed)	pf	.	.000	.000	.000	.000	.000	.000
	Incorect labour mix	.000	.	.000	.000	.000	.002	.022
	Incorect material mix	.000	.000	.	.000	.000	.000	.000
	Incorect macchine time mix combination	.000	.000	.000	.	.000	.000	.000
	Information technology	.000	.000	.000	.000	.	.000	.001
	Technology Advanceme	.000	.002	.000	.000	.000	.	.000
	Finance resource credit worthiness	.000	.022	.000	.000	.001	.000	.
N	pf	56	56	56	56	56	56	56
	Incorect labour mix	56	56	56	56	56	56	56
	Incorect material mix	56	56	56	56	56	56	56
	Incorect macchine time mix combination	56	56	56	56	56	56	56
	Information technology	56	56	56	56	56	56	56
	Technology Advanceme	56	56	56	56	56	56	56
	Finance resource credit worthiness	56	56	56	56	56	56	56

Variables Entered/Removed[a]

Model	Variables Entered	Variables Removed	Method
1	Technology Advancement	.	Stepwise (Criteria: Probability-of-F-to-enter <= .050, Probability-of-F-to-remove >= .100).
2	Incorect labour mix	.	Stepwise (Criteria: Probability-of-F-to-enter <= .050, Probability-of-F-to-remove >= .100).
3	Finance resource credit worthiness	.	Stepwise (Criteria: Probability-of-F-to-enter <= .050, Probability-of-F-to-remove >= .100).
4	Information technology	.	Stepwise (Criteria: Probability-of-F-to-enter <= .050, Probability-of-F-to-remove >= .100).
5	Incorect macchine time mix combination	.	Stepwise (Criteria: Probability-of-F-to-enter <= .050, Probability-of-F-to-remove >= .100).
6	Incorect material mix	.	Stepwise (Criteria: Probability-of-F-to-enter <= .050, Probability-of-F-to-remove >= .100).

a. Dependent Variable: pf

Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Change Statistics				
					R Square Change	F Change	df1	df2	Sig. F Change
1	.861[a]	.741	.736	27.64	.741	154.404	1	54	.000
2	.956[b]	.914	.911	16.07	.173	106.704	1	53	.000
3	.976[c]	.953	.950	12.00	.039	43.100	1	52	.000
4	.988[d]	.977	.975	8.56	.024	51.156	1	51	.000
5	.994[e]	.989	.988	5.93	.012	56.367	1	50	.000
6	1.000[f]	1.000	1.000	.00	.011		1	49	

a. Predictors: (Constant), Technology Advancement

b. Predictors: (Constant), Technology Advancement, Incorect labour mix

c. Predictors: (Constant), Technology Advancement, Incorect labour mix, Finance resource credit worthiness

d. Predictors: (Constant), Technology Advancement, Incorect labour mix, Finance resource credit worthiness, Information technology

e. Predictors: (Constant), Technology Advancement, Incorect labour mix, Finance resource credit worthiness, Information technology, Incorect macchine time mix combination

f. Predictors: (Constant), Technology Advancement, Incorect labour mix, Finance resource credit worthiness, Information technology, Incorect macchine time mix combination, Incorect material mix

ANOVA[g]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	117941.1	1	117941.135	154.404	.000[a]
	Residual	41247.704	54	763.846		
	Total	159188.8	55			
2	Regression	145500.2	2	72750.113	281.676	.000[b]
	Residual	13688.613	53	258.276		
	Total	159188.8	55			
3	Regression	151704.0	3	50568.000	351.315	.000[c]
	Residual	7484.838	52	143.939		
	Total	159188.8	55			
4	Regression	155452.1	4	38863.033	530.417	.000[d]
	Residual	3736.708	51	73.269		
	Total	159188.8	55			
5	Regression	157432.3	5	31486.464	896.275	.000[e]
	Residual	1756.519	50	35.130		
	Total	159188.8	55			
6	Regression	159188.8	6	26531.473	.	.[f]
	Residual	.000	49	.000		
	Total	159188.8	55			

a. Predictors: (Constant), Technology Advancement

b. Predictors: (Constant), Technology Advancement, Incorect labour mix

c. Predictors: (Constant), Technology Advancement, Incorect labour mix, Finance resource credit worthiness

d. Predictors: (Constant), Technology Advancement, Incorect labour mix, Finance resource credit worthiness, Information technology

e. Predictors: (Constant), Technology Advancement, Incorect labour mix, Finance resource credit worthiness, Information technology, Incorect macchine time mix combination

f. Predictors: (Constant), Technology Advancement, Incorect labour mix, Finance resource credit worthiness, Information technology, Incorect macchine time mix combination, Incorect material mix

g. Dependent Variable: pf

Coefficients

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.	% Confidence Interval for		Correlations			Collinearity Statistics	
		B	Std. Error	Beta			Lower Bound	Upper Bound	Zero-order	Partial	Part	Tolerance	VIF
1	(Constant)	45.165	9.151		4.936	.000	26.819	63.511					
	Technology Advanc	3.427	.276	.861	12.426	.000	2.874	3.980	.861	.861	.861	1.000	1.000
2	(Constant)	12.304	6.199		1.985	.052	-.130	24.738					
	Technology Advanc	2.759	.173	.693	15.952	.000	2.412	3.105	.861	.910	.643	.860	1.163
	Incorect labour mix	2.430	.235	.449	10.330	.000	1.958	2.901	.708	.817	.416	.860	1.163
3	(Constant)	7.361	4.689		1.570	.122	-2.047	16.770					
	Technology Advanc	1.780	.197	.447	9.025	.000	1.384	2.176	.861	.781	.271	.369	2.714
	Incorect labour mix	2.472	.176	.456	14.067	.000	2.119	2.824	.708	.890	.423	.859	1.164
	Finance resource cr worthiness	1.047	.159	.313	6.565	.000	.727	1.367	.783	.673	.197	.397	2.516
4	(Constant)	3.765	3.383		1.113	.271	-3.027	10.558					
	Technology Advanc	1.339	.154	.336	8.715	.000	1.030	1.647	.861	.773	.187	.309	3.235
	Incorect labour mix	2.043	.139	.377	14.701	.000	1.764	2.322	.708	.899	.315	.699	1.431
	Finance resource cr worthiness	1.102	.114	.330	9.664	.000	.873	1.331	.783	.804	.207	.396	2.527
	Information technolo	1.076	.150	.213	7.152	.000	.774	1.378	.761	.708	.153	.519	1.928
5	(Constant)	1.324	2.365		.560	.578	-3.426	6.074					
	Technology Advanc	1.125	.110	.283	10.221	.000	.904	1.347	.861	.822	.152	.289	3.466
	Incorect labour mix	1.733	.105	.320	16.551	.000	1.523	1.943	.708	.920	.246	.590	1.694
	Finance resource cr worthiness	1.101	.079	.329	13.942	.000	.942	1.259	.783	.892	.207	.396	2.527
	Information technolo	.911	.106	.180	8.562	.000	.697	1.125	.761	.771	.127	.497	2.013
	Incorect macchine t mix combination	.984	.131	.162	7.508	.000	.720	1.247	.768	.728	.112	.476	2.100
6	(Constant)	18E-15	.000		.	.	.000	.000					
	Technology Advanc	1.000	.000	.251	.	.	1.000	1.000	.861	1.000	.133	.281	3.556
	Incorect labour mix	1.000	.000	.185	.	.	1.000	1.000	.708	1.000	.101	.298	3.354
	Finance resource cr worthiness	1.000	.000	.299	.	.	1.000	1.000	.783	1.000	.185	.383	2.609
	Information technolo	1.000	.000	.198	.	.	1.000	1.000	.761	1.000	.139	.490	2.041
	Incorect macchine t mix combination	1.000	.000	.164	.	.	1.000	1.000	.768	1.000	.113	.476	2.100
	Incorect material mi	1.000	.000	.185	.	.	1.000	1.000	.769	1.000	.105	.323	3.096

a Dependent Variable: pf

Excluded Variables[f]

Model		Beta In	t	Sig.	Partial Correlation	Collinearity Statistics		
						Tolerance	VIF	Minimum Tolerance
1	Incorect labour mix	.449[a]	10.330	.000	.817	.860	1.163	.860
	Incorect material mix	.448[a]	8.509	.000	.760	.745	1.343	.745
	Incorect macchine time mix combination	.401[a]	6.040	.000	.639	.656	1.524	.656
	Information technology	.382[a]	5.477	.000	.601	.641	1.560	.641
	Finance resource credit worthiness	.289[a]	2.790	.007	.358	.398	2.512	.398
2	Incorect material mix	.203[b]	3.180	.002	.403	.340	2.945	.340
	Incorect macchine time mix combination	.196[b]	3.858	.000	.472	.497	2.010	497
	Information technology	.194[b]	3.909	.000	.477	.521	1.919	.521
	Finance resource credit worthiness	.313[b]	6.565	.000	.673	.397	2.516	.369
3	Incorect material mix	.146[c]	2.973	.004	.384	.328	3.048	.328
	Incorect macchine time mix combination	.200[c]	6.093	.000	.649	.497	2.011	.323
	Information technology	.213[c]	7.152	.000	.708	.519	1.928	.309
4	Incorect material mix	.181[d]	6.427	.000	.673	.323	3.095	.301
	Incorect macchine time mix combination	.162[d]	7.508	.000	.728	.476	2.100	.289
5	Incorect material mix	.185[e]	.	.	1.000	.323	3.096	.281

a. Predictors in the Model: (Constant), Technology Advancement

b. Predictors in the Model: (Constant), Technology Advancement, Incorect labour mix

c. Predictors in the Model: (Constant), Technology Advancement, Incorect labour mix, Finance resource credit worthiness

d. Predictors in the Model: (Constant), Technology Advancement, Incorect labour mix, Finance resource credit worthiness, Information technology

e. Predictors in the Model: (Constant), Technology Advancement, Incorect labour mix, Finance resource credit worthiness, Information technology, Incorect macchine time mix combination

f. Dependent Variable: pf

Coefficient Correlations[a]

Model			Technology Advancement	Incorect labour mix	Finance resource credit worthiness	Information technology	Incorect macchine time mix combination	Incorect material mix
1	Correlations	Technology Advancement	1.000					
	Covariances	Technology Advancement	7.606E-02					
2	Correlations	Technology Advancement	1.000	-.374				
		Incorect labour mix	-.374	1.000				
	Covariances	Technology Advancement	2.990E-02	-1.522E-02				
		Incorect labour mix	-1.522E-02	5.533E-02				
3	Correlations	Technology Advancement	1.000	-.272	-.756			
		Incorect labour mix	-.272	1.000	.036			
		Finance resource credit worthiness	-.756	.036	1.000			
	Covariances	Technology Advancement	3.889E-02	-9.434E-03	-2.377E-02			
		Incorect labour mix	-9.434E-03	3.087E-02	1.019E-03			
		Finance resource credit worthiness	-2.377E-02	1.019E-03	2.542E-02			
4	Correlations	Technology Advancement	1.000	-.052	-.718	-.401		
		Incorect labour mix	-.052	1.000	.004	-.431		
		Finance resource credit worthiness	-.718	.004	1.000	.068		
		Information technology	-.401	-.431	.068	1.000		
	Covariances	Technology Advancement	2.360E-02	-1.106E-03	-1.257E-02	-9.274E-03		
		Incorect labour mix	-1.106E-03	1.931E-02	5.699E-05	-9.017E-03		
		Finance resource credit worthiness	-1.257E-02	5.699E-05	1.300E-02	1.158E-03		
		Information technology	-9.274E-03	-9.017E-03	1.158E-03	2.262E-02		
5	Correlations	Technology Advancement	1.000	.056	-.693	-.326	-.258	
		Incorect labour mix	.056	1.000	.004	-.307	-.394	
		Finance resource credit worthiness	-.693	.004	1.000	.066	-.002	
		Information technology	-.326	-.307	.066	1.000	-.206	
		Incorect macchine time mix combination	-.258	-.394	-.002	-.206	1.000	
	Covariances	Technology Advancement	1.212E-02	6.433E-04	-6.025E-03	-3.823E-03	-3.724E-03	
		Incorect labour mix	6.433E-04	1.096E-02	3.338E-05	-3.419E-03	-5.408E-03	
		Finance resource credit worthiness	-6.025E-03	3.338E-05	6.232E-03	5.586E-04	-1.921E-05	
		Information technology	-3.823E-03	-3.419E-03	5.586E-04	1.133E-02	-2.871E-03	
		Incorect macchine time mix combination	-3.724E-03	-5.408E-03	-1.921E-05	-2.871E-03	1.716E-02	
6	Correlations	Technology Advancement	1.000	.151	-.645	-.339	-.258	-.159
		Incorect labour mix	.151	1.000	.128	-.299	-.293	-.704
		Finance resource credit worthiness	-.645	.128	1.000	.044	-.005	-.177
		Information technology	-.339	-.299	.044	1.000	-.202	.117
		Incorect macchine time mix combination	-.258	-.293	-.005	-.202	1.000	.018
		Incorect material mix	-.159	-.704	-.177	.117	.018	1.000
	Covariances	Technology Advancement	.000	.000	.000	.000	.000	.000
		Incorect labour mix	.000	.000	.000	.000	.000	.000
		Finance resource credit worthiness	.000	.000	.000	.000	.000	.000
		Information technology	.000	.000	.000	.000	.000	.000
		Incorect macchine time mix combination	.000	.000	.000	.000	.000	.000
		Incorect material mix	.000	.000	.000	.000	.000	.000

a. Dependent Variable: pf

Collinearity Diagnostics

Model	Dimension	Eigenvalue	Condition Index	Variance Proportions						
				(Constant)	Technology Advancement	Incorect labour mix	Finance resource credit worthiness	Information technology	Incorect macchine time mix combination	Incorect material mix
1	1	1.915	1.000	.04	.04					
	2	8.507E-02	4.745	.96	.96					
2	1	2.815	1.000	.01	.02	.02				
	2	.104	5.207	.00	.61	.76				
	3	8.072E-02	5.906	.98	.37	.23				
3	1	3.723	1.000	.01	.00	.01	.01			
	2	.156	4.889	.07	.05	.40	.17			
	3	8.355E-02	6.675	.92	.02	.53	.01			
	4	3.809E-02	9.886	.00	.93	.06	.81			
4	1	4.640	1.000	.00	.00	.00	.00	.00		
	2	.161	5.374	.03	.05	.27	.20	.03		
	3	9.500E-02	6.989	.77	.01	.01	.00	.31		
	4	7.093E-02	8.088	.20	.00	.71	.11	.45		
	5	3.351E-02	11.767	.00	.94	.00	.69	.21		
5	1	5.570	1.000	.00	.00	.00	.00	.00	.00	
	2	.166	5.798	.01	.05	.18	.21	.02	.02	
	3	9.767E-02	7.551	.83	.01	.00	.00	.17	.05	
	4	7.273E-02	8.751	.12	.00	.28	.07	.64	.12	
	5	6.215E-02	9.467	.04	.00	.50	.09	.03	.73	
	6	3.216E-02	13.160	.00	.94	.03	.64	.14	.08	
6	1	6.495	1.000	.00	.00	.00	.00	.00	.00	.00
	2	.178	6.034	.00	.05	.08	.17	.00	.00	.03
	3	.102	7.978	.02	.00	.01	.07	.41	.10	.13
	4	9.614E-02	8.220	.97	.01	.02	.02	.00	.01	.04
	5	6.674E-02	9.866	.00	.00	.00	.00	.39	.78	.01
	6	3.427E-02	13.768	.00	.59	.15	.71	.02	.01	.18
	7	2.709E-02	15.483	.00	.35	.73	.02	.17	10	61

a. Dependent Variable: pf

Non-Citizen Stepwise Method
Regression

Descriptive Statistics

	Mean	Std. Deviation	N
pf	153.1875	43.1603	80
Incorectlabour mix	23.75	10.17	80
Incorect material mix	25.00	10.16	80
Incorect macchine time mix combination	21.94	7.77	80
Information technology	25.31	9.66	80
Technology Advancement	26.19	11.78	80
Finance resource credit worthiness	31.00	15.21	80

Correlations

		pf	Incorectlabour mix	Incorect material mix	Incorect macchine time mix combination	Information technology	Technology Advancement	Finance resource credit worthiness
Pearson Correlation	pf	1.000	.417	.652	.702	.710	.771	.717
	Incorectlabour mix	.417	1.000	.637	.467	-.019	-.061	-.090
	Incorect material mix	.652	.637	1.000	.501	.255	.182	.197
	Incorect macchine time mix combination	.702	.467	.501	1.000	.426	.403	.251
	Information technology	.710	-.019	.255	.426	1.000	.687	.472
	Technology Advancement	.771	-.061	.182	.403	.687	1.000	.691
	Finance resource credit worthiness	.717	-.090	.197	.251	.472	.691	1.000
Sig. (1-tailed)	pf	.	.000	.000	.000	.000	.000	.000
	Incorectlabour mix	.000	.	.000	.000	.435	.294	.214
	Incorect material mix	.000	.000	.	.000	.011	.053	.040
	Incorect macchine time mix combination	.000	.000	.000	.	.000	.000	.012
	Information technology	.000	.435	.011	.000	.	.000	.000
	Technology Advancement	.000	.294	.053	.000	.000	.	.000
	Finance resource credit worthiness	.000	.214	.040	.012	.000	.000	.
N	pf	80	80	80	80	80	80	80
	Incorectlabour mix	80	80	80	80	80	80	80
	Incorect material mix	80	80	80	80	80	80	80
	Incorect macchine time mix combination	80	80	80	80	80	80	80
	Information technology	80	80	80	80	80	80	80
	Technology Advancement	80	80	80	80	80	80	80
	Finance resource credit worthiness	80	80	80	80	80	80	80

Variables Entered/Removed [a]

Model	Variables Entered	Variables Removed	Method
1	Technology Advancement	.	Stepwise (Criteria: Probability-of-F-to-enter <= .050, Probability-of-F-to-remove >= .100).
2	Incorect material mix	.	Stepwise (Criteria: Probability-of-F-to-enter <= .050, Probability-of-F-to-remove >= .100).
3	Incorect macchine time mix combination	.	Stepwise (Criteria: Probability-of-F-to-enter <= .050, Probability-of-F-to-remove >= .100).
4	Finance resource credit worthiness	.	Stepwise (Criteria: Probability-of-F-to-enter <= .050, Probability-of-F-to-remove >= .100).
5	Incorectlabour mix	.	Stepwise (Criteria: Probability-of-F-to-enter <= .050, Probability-of-F-to-remove >= .100).
6	Information technology	.	Stepwise (Criteria: Probability-of-F-to-enter <= .050, Probability-of-F-to-remove >= .100).

a. Dependent Variable: pf

Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Change Statistics				
					R Square Change	F Change	df1	df2	Sig. F Change
1	.771[a]	.595	.589	27.6550	.595	114.419	1	78	.000
2	.930[b]	.865	.861	16.0696	.270	154.010	1	77	.000
3	.952[c]	.907	.903	13.4248	.042	34.328	1	76	.000
4	.979[d]	.958	.956	9.0873	.051	90.866	1	75	.000
5	.988[e]	.976	.974	6.9152	.018	55.515	1	74	.000
6	1.000[f]	1.000	1.000	.0000	.024	.	1	73	.

a. Predictors: (Constant), Technology Advancement

b. Predictors: (Constant), Technology Advancement, Incorect material mix

c. Predictors: (Constant), Technology Advancement, Incorect material mix, Incorect macchine time mix combination

d. Predictors: (Constant), Technology Advancement, Incorect material mix, Incorect macchine time mix combination, Fir resource credit worthiness

e. Predictors: (Constant), Technology Advancement, Incorect material mix, Incorect macchine time mix combination, Fir resource credit worthiness, Incorectlabour mix

f. Predictors: (Constant), Technology Advancement, Incorect material mix, Incorect macchine time mix combination, Fin resource credit worthiness, Incorectlabour mix, Information technology

ANOVA[g]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	87507.753	1	87507.753	114.419	.000[a]
	Residual	59654.434	78	764.800		
	Total	147162.2	79			
2	Regression	127278.2	2	63639.124	246.441	.000[b]
	Residual	19883.940	77	258.233		
	Total	147162.2	79			
3	Regression	133465.1	3	44488.352	246.848	.000[c]
	Residual	13697.131	76	180.225		
	Total	147162.2	79			
4	Regression	140968.7	4	35242.178	426.766	.000[d]
	Residual	6193.477	75	82.580		
	Total	147162.2	79			
5	Regression	143623.5	5	28724.695	600.678	.000[e]
	Residual	3538.713	74	47.820		
	Total	147162.2	79			
6	Regression	147162.2	6	24527.031	.	.[f]
	Residual	.000	73	.000		
	Total	147162.2	79			

a. Predictors: (Constant), Technology Advancement

b. Predictors: (Constant), Technology Advancement, Incorect material mix

c. Predictors: (Constant), Technology Advancement, Incorect material mix, Incorect macchine time mix combination

d. Predictors: (Constant), Technology Advancement, Incorect material mix, Incorect macchine time mix combination, Finance resource credit worthiness

e. Predictors: (Constant), Technology Advancement, Incorect material mix, Incorect macchine time mix combination, Finance resource credit worthiness, Incorectlabour mix

f. Predictors: (Constant), Technology Advancement, Incorect material mix, Incorect macchine time mix combination, Finance resource credit worthiness, Incorectlabour mix, Information technology

g. Dependent Variable: pf

Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.	95% Confidence Interval for B		Correlations			Collinearity Statistics	
		B	Std. Error	Beta			Lower Bound	Upper Bound	Zero-order	Partial	Part	Tolerance	VIF
1	(Constant)	79.198	7.577		10.453	.000	64.114	94.282					
	Technology Advancem	2.825	.264	.771	10.697	.000	2.300	3.351	.771	.771	.771	1.000	1.000
2	(Constant)	32.288	5.803		5.564	.000	20.733	43.842					
	Technology Advancem	2.472	.156	.675	15.834	.000	2.161	2.783	.771	.875	.663	.967	1.034
	Incorect material mix	2.247	.181	.529	12.410	.000	1.886	2.607	.652	.817	.520	.967	1.034
3	(Constant)	21.113	5.209		4.053	.000	10.738	31.488					
	Technology Advancem	2.171	.140	.593	15.492	.000	1.892	2.450	.771	.871	.542	.837	1.195
	Incorect material mix	1.768	.172	.416	10.289	.000	1.426	2.111	.652	.763	.360	.749	1.336
	Incorect macchine tim mix combination	1.413	.241	.255	5.859	.000	.933	1.894	.702	.558	.205	.649	1.542
4	(Constant)	15.064	3.583		4.205	.000	7.927	22.202					
	Technology Advancem	1.354	.128	.369	10.586	.000	1.099	1.608	.771	.774	.251	.461	2.171
	Incorect material mix	1.617	.117	.381	13.770	.000	1.383	1.851	.652	.847	.326	.735	1.361
	Incorect macchine tim mix combination	1.572	.164	.283	9.576	.000	1.245	1.899	.702	.742	.227	.642	1.558
	Finance resource cre worthiness	.896	.094	.316	9.532	.000	.708	1.083	.717	.740	.226	.512	1.953
5	(Constant)	8.098	2.882		2.810	.006	2.355	13.841					
	Technology Advancem	1.481	.099	.404	14.992	.000	1.284	1.678	.771	.867	.270	.447	2.23
	Incorect material mix	1.168	.108	.275	10.843	.000	.954	1.383	.652	.783	.195	.505	1.97
	Incorect macchine tim mix combination	1.247	.132	.225	9.430	.000	.984	1.511	.702	.739	.170	.572	1.74
	Finance resource cre worthiness	.977	.072	.344	13.510	.000	.833	1.121	.717	.844	.244	.500	1.99
	Incorectlabour mix	.818	.110	.193	7.451	.000	.599	1.037	.417	.655	.134	.485	2.06
6	(Constant)	3.87E-15	.000		.	.	.000	.000					
	Technology Advancem	1.000	.000	.273	.	.	1.000	1.000	.771	1.000	.159	.338	2.95
	Incorect material mix	1.000	.000	.235	.	.	1.000	1.000	.652	1.000	.165	.489	2.04
	Incorect macchine tim mix combination	1.000	.000	.180	.	.	1.000	1.000	.702	1.000	.133	.547	1.83
	Finance resource cre worthiness	1.000	.000	.352	.	.	1.000	1.000	.717	1.000	.249	.500	2.0
	Incorectlabour mix	1.000	.000	.236	.	.	1.000	1.000	.417	1.000	.161	.468	2.1
	Information technolog	1.000	.000	.224	.	.	1.000	1.000	.710	1.000	.155	.480	2.0

a. Dependent Variable: pf

Excluded Variables[f]

Model		Beta In	t	Sig.	Partial Correlation	Collinearity Statistics		
						Tolerance	VIF	Minimum Tolerance
1	Incorectlabour mix	.466[a]	9.398	.000	.731	.996	1.004	.996
	Incorect material mix	.529[a]	12.410	.000	.817	.967	1.034	.967
	Incorect macchine time mix combination	.467[a]	7.946	.000	.671	.838	1.194	.838
	Information technology	.341[a]	3.711	.000	.390	.529	1.892	.529
	Finance resource credit worthiness	.352[a]	3.826	.000	.400	.522	1.914	.522
2	Incorectlabour mix	.217[b]	4.295	.000	.442	.562	1.781	.545
	Incorect macchine time mix combination	.255[b]	5.859	.000	.558	.649	1.542	.649
	Information technology	.219[b]	4.098	.000	.425	.511	1.956	.511
	Finance resource credit worthiness	.283[b]	5.811	.000	.555	.517	1.933	.517
3	Incorectlabour mix	.140[c]	2.957	.004	.323	.497	2.014	.497
	Information technology	.177[c]	3.898	.000	.410	.498	2.007	.498
	Finance resource credit worthiness	.316[c]	9.532	.000	.740	.512	1.953	.461
4	Incorectlabour mix	.193[d]	7.451	.000	.655	.485	2.061	.447
	Information technology	.180[d]	6.771	.000	.618	.498	2.007	.339
5	Information technology	.224[e]	.	.	1.000	.480	2.082	.338

a. Predictors in the Model: (Constant), Technology Advancement

b. Predictors in the Model: (Constant), Technology Advancement, Incorect material mix

c. Predictors in the Model: (Constant), Technology Advancement, Incorect material mix, Incorect macchine time mix combination

d. Predictors in the Model: (Constant), Technology Advancement, Incorect material mix, Incorect macchine time mix combination, Finance resource credit worthiness

e. Predictors in the Model: (Constant), Technology Advancement, Incorect material mix, Incorect macchine time mix combination, Finance resource credit worthiness, Incorectlabour mix

f. Dependent Variable: pf

Coefficient Correlations[a]

Model			Technology Advancement	Incorect material mix	Incorect macchine time mix combination	Finance resource credit worthiness	Incorectlabour mix	Information technology
1	Correlations	Technology Advancement	1.000					
	Covariances	Technology Advancement	6.977E-02					
2	Correlations	Technology Advancement	1.000	-.182				
		Incorect material mix	-.182	1.000				
	Covariances	Technology Advancement	2.437E-02	-5.158E-03				
		Incorect material mix	-5.158E-03	3.278E-02				
3	Correlations	Technology Advancement	1.000	.025	-.366			
		Incorect material mix	.025	1.000	-.475			
		Incorect macchine time mix combination	-.366	-.475	1.000			
	Covariances	Technology Advancement	1.964E-02	5.903E-04	-1.238E-02			
		Incorect material mix	5.903E-04	2.954E-02	-1.969E-02			
		Incorect macchine time mix combination	-1.238E-02	-1.969E-02	5.820E-02			
4	Correlations	Technology Advancement	1.000	.109	-.338	-.671		
		Incorect material mix	.109	1.000	-.482	-.135		
		Incorect macchine time mix combination	-.338	-.482	1.000	.101		
		Finance resource credit worthiness	-.671	-.135	.101	1.000		
	Covariances	Technology Advancement	1.635E-02	1.633E-03	-7.099E-03	-8.057E-03		
		Incorect material mix	1.633E-03	1.379E-02	-9.288E-03	-1.493E-03		
		Incorect macchine time mix combination	-7.099E-03	-9.288E-03	2.694E-02	1.562E-03		
		Finance resource credit worthiness	-8.057E-03	-1.493E-03	1.562E-03	8.829E-03		
5	Correlations	Technology Advancement	1.000	-.008	-.372	-.627	.173	
		Incorect material mix	-.008	1.000	-.193	-.196	-.559	
		Incorect macchine time mix combination	-.372	-.193	1.000	.045	-.329	
		Finance resource credit worthiness	-.627	-.196	.045	1.000	.151	
		Incorectlabour mix	.173	-.559	-.329	.151	1.000	
	Covariances	Technology Advancement	9.762E-03	-8.440E-05	-4.856E-03	-4.478E-03	1.879E-03	
		Incorect material mix	-8.440E-05	1.161E-02	-2.757E-03	-1.524E-03	-6.612E-03	
		Incorect macchine time mix combination	-4.856E-03	-2.757E-03	1.750E-02	4.276E-04	-4.782E-03	
		Finance resource credit worthiness	-4.478E-03	-1.524E-03	4.276E-04	5.232E-03	1.202E-03	
		Incorectlabour mix	1.879E-03	-6.612E-03	-4.782E-03	1.202E-03	1.206E-02	
6	Correlations	Technology Advancement	1.000	.081	-.211	-.563	.055	-.4
		Incorect material mix	.081	1.000	-.148	-.199	-.574	-.1
		Incorect macchine time mix combination	-.211	-.148	1.000	.036	-.356	-.2
		Finance resource credit worthiness	-.563	-.199	.036	1.000	.155	.0
		Incorectlabour mix	.055	-.574	-.356	.155	1.000	.1
		Information technology	-.493	-.179	-.212	.037	.189	1.0
	Covariances	Technology Advancement	.000	.000	.000	.000	.000	.0
		Incorect material mix	.000	.000	.000	.000	.000	.0
		Incorect macchine time mix combination	.000	.000	.000	.000	.000	.0
		Finance resource credit worthiness	.000	.000	.000	.000	.000	.0
		Incorectlabour mix	.000	.000	.000	.000	.000	.0
		Information technology	.000	.000	.000	.000	.000	.0

a. Dependent Variable: pf

Collinearity Diagnostics[a]

Model	Dimension	Eigenvalue	Condition Index	Variance Proportions						
				(Constant)	Technology Advancement	Incorect material mix	Incorect macchine time mix combination	Finance resource credit worthiness	Incorectlabour mix	Information technology
1	1	1.913	1.000	.04	.04					
	2	8.706E-02	4.688	.96	.96					
2	1	2.810	1.000	.01	.02	.02				
	2	.127	4.710	.01	.73	.45				
	3	6.340E-02	6.657	.98	.25	.54				
3	1	3.756	1.000	.01	.01	.01	.00			
	2	.128	5.418	.00	.68	.30	.01			
	3	6.342E-02	7.696	.87	.21	.40	.00			
	4	5.298E-02	8.419	.12	.10	.30	.99			
4	1	4.642	1.000	.00	.00	.00	.00	.00		
	2	.182	5.047	.02	.09	.16	.04	.19		
	3	7.213E-02	8.022	.12	.10	.56	.18	.29		
	4	6.152E-02	8.686	.81	.18	.06	.19	.06		
	5	4.228E-02	10.478	.05	.62	.21	.59	.45		
5	1	5.515	1.000	.00	.00	.00	.00	.00	.00	
	2	.266	4.554	.00	.07	.03	.00	.12	.09	
	3	7.280E-02	8.704	.12	.09	.28	.21	.35	.01	
	4	6.172E-02	9.453	.69	.15	.08	.18	.06	.01	
	5	4.340E-02	11.273	.18	.09	.57	.09	.35	.46	
	6	4.129E-02	11.556	.01	.61	.04	.52	.12	.43	
6	1	6.440	1.000	.00	.00	.00	.00	.00	.00	.00
	2	.282	4.776	.00	.04	.03	.00	.08	.09	.01
	3	8.846E-02	8.532	.02	.01	.07	.06	.52	.02	.20
	4	6.269E-02	10.135	.68	.04	.25	.03	.02	.01	.02
	5	5.396E-02	10.924	.06	.05	.33	.45	.01	.07	.20
	6	4.132E-02	12.484	.03	.40	.08	.46	.08	.52	.00
	7	3.171E-02	14.251	.22	.46	.25	.00	.29	.29	.56

a. Dependent Variable: pf

APPENDIX E:

(1) PROJECT INFORMATION MANAGEMENT STRATEGIES.

(2) AWARENESS OF OPTIMIZATION TECHNIQUES.

(3) APPLICATION OF JIT PHILOSOPHY IN CONSTRUCTION PRODUCTION PROCESS.

AFRICANS

Part NA1-Project Information Management strategy by construction firms

Frequency Tables

Firms with information management strategy

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	No	35	50.0	53.0	53.0
	Yes	31	44.3	47.0	100.0
	Total	66	94.3	100.0	
Missing	System	4	5.7		
Total		70	100.0		

Information managers

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	No	56	80.0	87.5	87.5
	Yes	8	11.4	12.5	100.0
	Total	64	91.4	100.0	
Missing	System	6	8.6		
Total		70	100.0		

Electronic data interchange practice by firms

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	No	20	28.6	41.7	41.7
	Yes	28	40.0	58.3	100.0
	Total	48	68.6	100.0	
Missing	System	22	31.4		
Total		70	100.0		

Application of data on construction activities

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	No	46	65.7	65.7	65.7
	Yes	24	34.3	34.3	100.0
	Total	70	100.0	100.0	

Does it make savings on production cost?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	No	26	37.1	44.1	44.1
	Yes	33	47.1	55.9	100.0
	Total	59	84.3	100.0	
Missing	System	11	15.7		
Total		70	100.0		

% in savings on production cost

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	10	4	5.7	12.1	12.1
	15	4	5.7	12.1	24.2
	20	7	10.0	21.2	45.5
	25	1	1.4	3.0	48.5
	30	4	5.7	12.1	60.6
	40	5	7.1	15.2	75.8
	50	8	11.4	24.2	100.0
	Total	33	47.1	100.0	
Missing	System	37	52.9		
Total		70	100.0		

Better services to the firm as a benefit

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	1	1	1.4	2.4	2.4
	2	1	1.4	2.4	4.9
	3	13	18.6	31.7	36.6
	4	24	34.3	58.5	95.1
	5	2	2.9	4.9	100.0
	Total	41	58.6	100.0	
Missing	System	29	41.4		
Total		70	100.0		

Cuts time in odering of materials quantities

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	1	1	1.4	2.4	2.4
	3	11	15.7	26.8	29.3
	4	28	40.0	68.3	97.6
	5	1	1.4	2.4	100.0
	Total	41	58.6	100.0	
Missing	System	29	41.4		
Total		70	100.0		

Supports just in time production relationships

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	1	1	1.4	2.4	2.4
	3	8	11.4	19.5	22.0
	4	29	41.4	70.7	92.7
	5	3	4.3	7.3	100.0
	Total	41	58.6	100.0	
Missing	System	29	41.4		
Total		70	100.0		

Part NA2-Information obtained from the internet to assist in resource optimization

Labour constant

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	No	18	25.7	34.6	34.6
	Yes	34	48.6	65.4	100.0
	Total	52	74.3	100.0	
Missing	System	18	25.7		
Total		70	100.0		

Material constant

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	No	14	20.0	26.9	26.9
	Yes	38	54.3	73.1	100.0
	Total	52	74.3	100.0	
Missing	System	18	25.7		
Total		70	100.0		

Machine time constant

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	No	15	21.4	28.8	28.8
	Yes	37	52.9	71.2	100.0
	Total	52	74.3	100.0	
Missing	System	18	25.7		
Total		70	100.0		

Activity duration

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	No	14	20.0	26.9	26.9
	Yes	38	54.3	73.1	100.0
	Total	52	74.3	100.0	
Missing	System	18	25.7		
Total		70	100.0		

Material waste factors

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	No	21	30.0	39.6	39.6
	Yes	32	45.7	60.4	100.0
	Total	53	75.7	100.0	
Missing	System	17	24.3		
Total		70	100.0		

Effect of electronic data interchange(% cost overruns performance

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	10	9	12.9	20.5	20.5
	30	16	22.9	36.4	56.8
	50	18	25.7	40.9	97.7
	70	1	1.4	2.3	100.0
	Total	44	62.9	100.0	
Missing	System	26	37.1		
Total		70	100.0		

Effect of data interchange on % of completion time performance

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	10	10	14.3	22.7	22.7
	30	15	21.4	34.1	56.8
	50	16	22.9	36.4	93.2
	70	3	4.3	6.8	100.0
	Total	44	62.9	100.0	
Missing	System	26	37.1		
Total		70	100.0		

Effect of electronic data interchange on (%quality & workmanship)

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	5	1	1.4	2.3	2.3
	10	7	10.0	15.9	18.2
	30	10	14.3	22.7	40.9
	50	20	28.6	45.5	86.4
	70	6	8.6	13.6	100.0
	Total	44	62.9	100.0	
Missing	System	26	37.1		
Total		70	100.0		

:ffect of electronic data interchange on(Environment & other related factors e.g weather, moneymarket,workers skills etc

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	5	1	1.4	2.3	2.3
	10	11	15.7	25.0	27.3
	30	7	10.0	15.9	43.2
	50	19	27.1	43.2	86.4
	70	6	8.6	13.6	100.0
	Total	44	62.9	100.0	
Missing	System	26	37.1		
Total		70	100.0		

Part PA-awareness of optimization techniques by construction firms

Are firms aware of optimization techniques?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	No	12	17.1	17.9	17.9
	Yes	55	78.6	82.1	100.0
	Total	67	95.7	100.0	
Missing	System	3	4.3		
Total		70	100.0		

Application of optimization techniques

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	No	22	31.4	39.3	39.3
	Yes	34	48.6	60.7	100.0
	Total	56	80.0	100.0	
Missing	System	14	20.0		
Total		70	100.0		

Knowledge of appying these techniques

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	No	30	42.9	46.2	46.2
	Yes	35	50.0	53.8	100.0
	Total	65	92.9	100.0	
Missing	System	5	7.1		
Total		70	100.0		

If no,do you wish to be trained to use/apply these technique

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	No	32	45.7	52.5	52.5
	Yes	29	41.4	47.5	100.0
	Total	61	87.1	100.0	
Missing	System	9	12.9		
Total		70	100.0		

art QA1-Application of jit philosophy in construction production process

Is your firm aware of JIT philosophy in production process?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	No	14	20.0	21.9	21.9
	Yes	50	71.4	78.1	100.0
	Total	64	91.4	100.0	
Missing	System	6	8.6		
Total		70	100.0		

If yes, does your firm apply it in construction process?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	No	21	30.0	44.7	44.7
	Yes	26	37.1	55.3	100.0
	Total	47	67.1	100.0	
Missing	System	23	32.9		
Total		70	100.0		

If your company is not aware of jit are you willing to learn more About it ?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	No	4	5.7	13.3	13.3
	Yes	26	37.1	86.7	100.0
	Total	30	42.9	100.0	
Missing	System	40	57.1		
Total		70	100.0		

FUNCTIONS OF INFORMATION MANAGERS

		African Contractors	Citizen Contractors	Non-Citizen Contractors
i) ii) iii) iv) v) vi)	Keep and analyse information Acquire latest information in Construction Interpret information into field situation Liase with consultants and client Finding optimal ways of construction Optimises on material and purchases	} } } 1 } } }	1	
vii) viii)	Store information on prices of materials used Keep tender results on tender opening	} } 1		
ix) x) xi)	Research on construction phenomena Analysis of completed construction project Store and dissemination information	} } 1 }		3
xii) xiii) xiv)	To look for new ideas internationally To seek for clients through the website To get to know different plans and techniques	} } 1 }		1
xv) xvi xvii) xviii)	Arranging the next project Giving project details Providing cost information Providing production information	} } 1 } }		1
xix) xx) xxi)	Keeps information data base Source and communicate information Tendering process		} } 1 }	
xxii) xxiii)	Keeps contractors records on materials, stocks; tender information Hunt for jobs		} } 1 }	
xxiv)	Construction production records keeping and dissemination		2	
xxv) xxiv)	Production information keeping for construction companies Resources management	} } }	 1 3	
		5/70	9/56	5/80

APPLICATION OF THE DATA ON CONSTRUCTION ACTIVITIES

		African Contractors	Citizen Contractors	Non-Citizen Contractors
i)	Time and cost management	2	3	1
ii)	On tendering and sites	1	2	1
iii)	Prices for speculation	1		1
iv)	Coordination and timely delivery and optimality in production	5	1	9
v)	Resource mix	13	7	15
vi)	Applied in the whole construction production	1	7	8
vii)	Applied in production techniques	2	2	1
viii)	In ordering materials and keeping in touch with supplies.	1	3	5
ix)	Research and communication		3	1
	Totals	**26/70**	**28/56**	**42/80**

Optimization Awareness

Reasons for Not Using Optimization Techniques

		African Contractors	Citizen Contractors	Non-Citizen Contractors
1	Not known	2	1	4
2	Lack of Expertise	1	2	1
3	Still in the process of implementation	1		
4	Information not accessible			
5	Lack of Resources		1	
6	It is costly		1	1
				2
	Totals	**4/70**	**5/56**	**8/80**

Benefits Derived from Optimization

		African Contractors	Citizen Contractors	Non-Citizen Contractors
1	Saves time and cost	3	2	4
2	Meet set time target	1	3	2
3	Controls resources, facilitates faster completion, quality control and planning of resources	10	13	7
4	Maximizes profits, achieves set goals and flexibility in management	4	2	7
5	Optimizes operations	8	7	2
6	Solving problems facing the firm	1		
	Totals	**27/70**	**27/56**	**22/80**

Benefits of Applying Optimization Techniques

		African Contractors	Citizen Contractors	Non-Citizen Contractors
1	Cuts time and cost	7	9	7
2	Efficiency improved	4	3	6
3	Benefits from large stocks	1		
4	Optimizes resources	18	12	12
5	Not known	3		
6	Management and control	5	6	3
7	Maximum production achieved			1
	Totals	**38/70**	**30/56**	**29/80**

)ptimization Awareness

₹easons for Not Using Optimization Techniques

		African Contractors	Citizen Contractors	Non-Citizen Contractors
1	Not known	2	1	4
2	Lack of Expertise	1	2	1
3	Still in the process of implementation	1		
4	Information not accessible		1	
5	Lack of Resources		1	
6	It is costly			1
				2
	Totals	**4/70**	**5/56**	**8/80**

Benefits Derived from Optimization

		African Contractors	Citizen Contractors	Non-Citizen Contractors
1	Saves time and cost	3	2	4
2	Meet set time target	1	3	2
3	Controls resources, facilitates faster completion, quality control and planning of resources	10	13	7
4	Maximizes profits, achieves set goals and flexibility in management	4	2	7
5	Optimizes operations	8	7	2
6	Solving problems facing the firm	1		
	Totals	**27/70**	**27/56**	**22/80**

Benefits of Applying Optimization Techniques

		African Contractors	Citizen Contractors	Non-Citizen Contractors
1	Cuts time and cost	7	9	7
2	Efficiency improved	4	3	6
3	Benefits from large stocks	1		
4	Optimizes resources	18	12	12
5	Not known	3		
6	Management and control	5	6	3
7	Maximum production achieved			1
	Totals	**38/70**	**30/56**	**29/80**

Optimization Awareness

Reasons for not wanting to be trained on how to use Optimization Techniques in Construction Activities

		African Contractors	Citizen Contractors	Non-Citizen Contractors
1	Lack of resources for training	2	2	
2	To train later (lack of time)	1	1	1
3	Because we still get better results without these techniques	1		
4	Optimization problems are not faced by construction firms	1		
5	Costly and time wasting		2	
6	Not informed			1
	Totals	**5/70**	**5/56**	**2/80**

REASONS FOR THE APPLICATION OF JIT PHILOSOPHY

		African Contractors	Citizen Contractors	Non-Citizen Contractors
1	Unreliable resources	3		
2	Unreliable transport	3	2	
3	Uncertainty of market availability	3		
4	Avoid unnecessary time wastage	6	1	2
5	Improve company cash flow	1		
6	To avoid losses	8	12	3
7	Optimize production	10	4	5
8	Counter waste, speed up construction and save cost		8	6
	Totals	**34/70**	**27/56**	**16/80**

JIT Philosophy

How JIT Philosophy is Applied by Construction Firms

		African Contractors	Citizen Contractors	Non-Citizen Contractors
1	Timely ordering of materials equipment and labour requisition	7	12	
2	Improving on management	3	2	6
3	By reducing waste in time and materials	4	3	2
4	By producing as per demand	6	8	6
	Totals	**20/70**	**25/56**	**14/80**

Reasons why Construction Firms Respondents would not be willing to learn more about JIT Philosophy

		African Contractors	Citizen Contractors	Non-Citizen Contractors
1	Need for training in seminars, government subsidy on seminars information flow from specialists sub-contractors, manufacturers and professionals is a problem	1		
2	We do not deal with production	2	1	1
3	It is expensive to buy finished products	1		
4	No reasons at all		3	
5	We do not face problems of timely ordering of materials equipment and labour requisition			1
6	It will take too long to learn			1
7	Our transportation is well planned.			1
	Totals	**4/70**	**4/56**	**4/80**

Non-citizen

Part n-Project information management strategy by construction firms

Firms with information management strategy

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	No	29	36.3	36.7	36.7
	Yes	50	62.5	63.3	100.0
	Total	79	98.8	100.0	
Missing	System	1	1.3		
Total		80	100.0		

Information managers

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	No	72	90.0	93.5	93.5
	Yes	5	6.3	6.5	100.0
	Total	77	96.3	100.0	
Missing	System	3	3.8		
Total		80	100.0		

Electronic data interchange practice by firms

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	No	29	36.3	37.2	37.2
	Yes	49	61.3	62.8	100.0
	Total	78	97.5	100.0	
Missing	System	2	2.5		
Total		80	100.0		

Does it make savings on production cost?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	No	57	71.3	85.1	85.1
	Yes	10	12.5	14.9	100.0
	Total	67	83.8	100.0	
Missing	System	13	16.3		
Total		80	100.0		

% in savings on production cost

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	10	2	2.5	3.5	3.5
	15	1	1.3	1.8	5.3
	20	9	11.3	15.8	21.1
	25	2	2.5	3.5	24.6
	30	8	10.0	14.0	38.6
	35	6	7.5	10.5	49.1
	40	6	7.5	10.5	59.6
	50	19	23.8	33.3	93.0
	60	2	2.5	3.5	96.5
	80	1	1.3	1.8	98.2
	85	1	1.3	1.8	100.0
	Total	57	71.3	100.0	
Missing	System	23	28.8		
Total		80	100.0		

Better services to the firm as a benefit

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	2	1	1.3	1.6	1.6
	3	4	5.0	6.3	7.9
	4	56	70.0	88.9	96.8
	5	2	2.5	3.2	100.0
	Total	63	78.8	100.0	
Missing	System	17	21.3		
Total		80	100.0		

Cuts time in odering of materials quantities

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	2	1	1.3	1.6	1.6
	3	5	6.3	7.9	9.5
	4	51	63.8	81.0	90.5
	5	6	7.5	9.5	100.0
	Total	63	78.8	100.0	
Missing	System	17	21.3		
Total		80	100.0		

Supports just in time production relationships

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	3	4	5.0	6.3	6.3
	4	54	67.5	85.7	92.1
	5	5	6.3	7.9	100.0
	Total	63	78.8	100.0	
Missing	System	17	21.3		
Total		80	100.0		

Partn2-Information obtained from the internet to assist in resource optimization

Labour constant

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	No	18	22.5	23.7	23.7
	Yes	58	72.5	76.3	100.0
	Total	76	95.0	100.0	
Missing	System	4	5.0		
Total		80	100.0		

Material constant

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	No	14	17.5	18.9	18.9
	Yes	60	75.0	81.1	100.0
	Total	74	92.5	100.0	
Missing	System	6	7.5		
Total		80	100.0		

Machine time constant

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	No	14	17.5	18.9	18.9
	Yes	60	75.0	81.1	100.0
	Total	74	92.5	100.0	
Missing	System	6	7.5		
Total		80	100.0		

Activity duration

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	No	14	17.5	18.9	18.9
	Yes	60	75.0	81.1	100.0
	Total	74	92.5	100.0	
Missing	System	6	7.5		
Total		80	100.0		

Material waste factors

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	No	36	45.0	50.0	50.0
	Yes	36	45.0	50.0	100.0
	Total	72	90.0	100.0	
Missing	System	8	10.0		
Total		80	100.0		

Effect of electronic data interchange(% cost overruns on performance

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	10	11	13.8	15.9	15.9
	30	19	23.8	27.5	43.5
	50	37	46.3	53.6	97.1
	70	2	2.5	2.9	100.0
	Total	69	86.3	100.0	
Missing	System	11	13.8		
Total		80	100.0		

Effect of data interchange on % of completion time on perfomance

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	10	11	13.8	16.2	16.2
	30	13	16.3	19.1	35.3
	50	40	50.0	58.8	94.1
	70	4	5.0	5.9	100.0
	Total	68	85.0	100.0	
Missing	System	12	15.0		
Total		80	100.0		

Effect of electronic data interchange on %quality performance & workmanship

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	10	5	6.3	7.2	7.2
	30	16	20.0	23.2	30.4
	50	39	48.8	56.5	87.0
	70	9	11.3	13.0	100.0
	Total	69	86.3	100.0	
Missing	System	11	13.8		
Total		80	100.0		

Effect of electronic data interchange on(environment &other factors)

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	10	7	8.8	10.1	10.1
	30	19	23.8	27.5	37.7
	50	36	45.0	52.2	89.9
	70	7	8.8	10.1	100.0
	Total	69	86.3	100.0	
Missing	System	11	13.8		
Total		80	100.0		

Are firms aware of optimization techniques?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	No	20	25.0	26.3	26.3
	Yes	56	70.0	73.7	100.0
	Total	76	95.0	100.0	
Missing	System	4	5.0		
Total		80	100.0		

Application of optimization techniques

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	No	44	55.0	59.5	59.5
	Yes	30	37.5	40.5	100.0
	Total	74	92.5	100.0	
Missing	System	6	7.5		
Total		80	100.0		

Knowledge of appying these techniques

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	No	46	57.5	61.3	61.3
	Yes	29	36.3	38.7	100.0
	Total	75	93.8	100.0	
Missing	System	5	6.3		
Total		80	100.0		

If no,do you wish to be trained to use/apply these technique

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	No	12	15.0	21.1	21.1
	Yes	45	56.3	78.9	100.0
	Total	57	71.3	100.0	
Missing	System	23	28.8		
Total		80	100.0		

Is your firm aware of JIT philosophy in production process?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	No	29	36.3	37.2	37.2
	Yes	49	61.3	62.8	100.0
	Total	78	97.5	100.0	
Missing	System	2	2.5		
Total		80	100.0		

If yes, does your firm apply it in construction process?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	No	43	53.8	66.2	66.2
	Yes	22	27.5	33.8	100.0
	Total	65	81.3	100.0	
Missing	System	15	18.8		
Total		80	100.0		

If your company is not aware of jit are you willing to learn more about it?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	No	5	6.3	10.4	10.4
	Yes	43	53.8	89.6	100.0
	Total	48	60.0	100.0	
Missing	System	32	40.0		
Total		80	100.0		

CITIZEN

PART NC1-Project information management strategy by construction firms

Firms with information management strategy

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	No	13	23.2	23.6	23.6
	Yes	42	75.0	76.4	100.0
	Total	55	98.2	100.0	
Missing	System	1	1.8		
Total		56	100.0		

Information managers

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	No	34	60.7	82.9	82.9
	Yes	7	12.5	17.1	100.0
	Total	41	73.2	100.0	
Missing	System	15	26.8		
Total		56	100.0		

Electronic data interchange practice by firms

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	No	20	35.7	39.2	39.2
	Yes	31	55.4	60.8	100.0
	Total	51	91.1	100.0	
Missing	System	5	8.9		
Total		56	100.0		

Does it make savings on production cost?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	No	5	8.9	12.5	12.5
	Yes	35	62.5	87.5	100.0
	Total	40	71.4	100.0	
Missing	System	16	28.6		
Total		56	100.0		

% in savings on production cost

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	5	1	1.8	2.9	2.9
	10	4	7.1	11.8	14.7
	15	2	3.6	5.9	20.6
	20	4	7.1	11.8	32.4
	25	2	3.6	5.9	38.2
	30	9	16.1	26.5	64.7
	35	2	3.6	5.9	70.6
	40	3	5.4	8.8	79.4
	50	4	7.1	11.8	91.2
	70	3	5.4	8.8	100.0
	Total	34	60.7	100.0	
Missing	System	22	39.3		
Total		56	100.0		

Better services to the firm as a benefit

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	2	1	1.8	2.5	2.5
	3	5	8.9	12.5	15.0
	4	31	55.4	77.5	92.5
	5	3	5.4	7.5	100.0
	Total	40	71.4	100.0	
Missing	System	16	28.6		
Total		56	100.0		

Cuts time in odering of materials quantities

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	2	1	1.8	2.5	2.5
	3	6	10.7	15.0	17.5
	4	29	51.8	72.5	90.0
	5	4	7.1	10.0	100.0
	Total	40	71.4	100.0	
Missing	System	16	28.6		
Total		56	100.0		

Supports just in time production relationships

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	2	1	1.8	2.5	2.5
	3	5	8.9	12.5	15.0
	4	32	57.1	80.0	95.0
	5	2	3.6	5.0	100.0
	Total	40	71.4	100.0	
Missing	System	16	28.6		
Total		56	100.0		

Part Nc2-Information obtained from internet to assist in resource optimization

Labour constant

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	No	13	23.2	27.7	27.7
	Yes	34	60.7	72.3	100.0
	Total	47	83.9	100.0	
Missing	System	9	16.1		
Total		56	100.0		

Material constant

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	No	9	16.1	19.1	19.1
	Yes	38	67.9	80.9	100.0
	Total	47	83.9	100.0	
Missing	System	9	16.1		
Total		56	100.0		

Machine time constant

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	No	9	16.1	19.1	19.1
	Yes	38	67.9	80.9	100.0
	Total	47	83.9	100.0	
Missing	System	9	16.1		
Total		56	100.0		

Activity duration

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	No	9	16.1	19.1	19.1
	Yes	38	67.9	80.9	100.0
	Total	47	83.9	100.0	
Missing	System	9	16.1		
Total		56	100.0		

Material waste factors

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	No	24	42.9	51.1	51.1
	Yes	23	41.1	48.9	100.0
	Total	47	83.9	100.0	
Missing	System	9	16.1		
Total		56	100.0		

Effect of electronic data interchange on(% cost overruns perfomance

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	10	11	19.6	26.8	26.8
	30	20	35.7	48.8	75.6
	50	8	14.3	19.5	95.1
	70	1	1.8	2.4	97.6
	80	1	1.8	2.4	100.0
	Total	41	73.2	100.0	
Missing	System	15	26.8		
Total		56	100.0		

Effect of data interchange on % (of completion time performance

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	10	11	19.6	26.8	26.8
	30	14	25.0	34.1	61.0
	50	14	25.0	34.1	95.1
	70	2	3.6	4.9	100.0
	Total	41	73.2	100.0	
Missing	System	15	26.8		
Total		56	100.0		

Effect of electronic data interchange on(%quality perfomance & work manship

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	10	7	12.5	17.1	17.1
	30	13	23.2	31.7	48.8
	50	17	30.4	41.5	90.2
	70	4	7.1	9.8	100.0
	Total	41	73.2	100.0	
Missing	System	15	26.8		
Total		56	100.0		

Effect of electronic data interchange on (Environment & other factors)

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	10	14	25.0	34.1	34.1
	30	9	16.1	22.0	56.1
	50	13	23.2	31.7	87.8
	70	4	7.1	9.8	97.6
	80	1	1.8	2.4	100.0
	Total	41	73.2	100.0	
Missing	System	15	26.8		
Total		56	100.0		

Part pc1-Awareness and application of optimization techniques by construction firms

Are firms aware of optimization techniques?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	No	12	21.4	22.2	22.2
	Yes	42	75.0	77.8	100.0
	Total	54	96.4	100.0	
Missing	System	2	3.6		
Total		56	100.0		

Application of optimization techniques

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	No	15	26.8	31.9	31.9
	Yes	32	57.1	68.1	100.0
	Total	47	83.9	100.0	
Missing	System	9	16.1		
Total		56	100.0		

Knowledge of appying these techniques

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	No	25	44.6	45.5	45.5
	Yes	30	53.6	54.5	100.0
	Total	55	98.2	100.0	
Missing	System	1	1.8		
Total		56	100.0		

If no,do you wish to be trained to use/apply these technique

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	No	9	16.1	25.0	25.0
	Yes	27	48.2	75.0	100.0
	Total	36	64.3	100.0	
Missing	System	20	35.7		
Total		56	100.0		

Part qc1-Application of JIT philosophy in construction production process

Is your firm aware of JIT philosophy in production process?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	No	7	12.5	13.0	13.0
	Yes	47	83.9	87.0	100.0
	Total	54	96.4	100.0	
Missing	System	2	3.6		
Total		56	100.0		

If yes, does your firm apply it in construction process?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	No	22	39.3	44.9	44.9
	Yes	27	48.2	55.1	100.0
	Total	49	87.5	100.0	
Missing	System	7	12.5		
Total		56	100.0		

If your company is not aware of jit are you willing to learn more about it?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	No	19	33.9	86.4	86.4
	Yes	3	5.4	13.6	100.0
	Total	22	39.3	100.0	
Missing	System	34	60.7		
Total		56	100.0		

APPENDIX F: - NORMAL DEVIATE

1. F Distribution

2. "t" Distribution tables

A–4 (I) F. DISTRIBUTION $\alpha = 0.05$

ν_1	1	2	3	4	5	6	7	8	9
	161.45	199.50	215.71	224.58	230.16	233.99	236.77	238.88	240.54
	18.513	19.000	19.164	19.247	19.296	19.330	19.353	19.371	19.385
	10.128	9.5521	9.2766	9.1172	9.0135	8.9406	8.8868	8.8452	8.8123
	7.7086	6.9443	6.5914	6.3883	6.2560	6.1631	6.0942	6.0410	5.9988
	6.6079	5.7861	5.4095	5.1922	5.0503	4.9503	4.8759	4.8183	4.7725
	5.9874	5.1433	4.7571	4.5337	4.3874	4.2839	4.2066	4.1468	4.0990
	5.5914	4.7374	4.3468	4.1203	3.9715	3.8660	3.7870	3.7257	3.6767
	5.3172	4.4590	4.0662	3.8378	3.6875	3.5806	3.5005	3.4381	3.3881
	5.1174	4.2565	3.8626	3.6331	3.4817	3.3738	3.2927	3.2266	3.1789
0	4.9646	4.1028	3.7083	3.4780	3.3258	3.2172	3.1355	3.0717	3.0204
1	4.8443	3.9823	3.5874	3.3567	3.2039	3.0946	3.0123	2.9480	2.8962
2	4.7472	3.8853.	3.4903	3.2592	3.1059,	2.9961	2.9134	2.8486	2.7964
3	4.6672	3.8056	3.4105	3.1791	3.0254	2.9153	2.8321	2.7669	2.7144
4	4.6001	3.7389'	3.3439	3.1122	2.9582	2.8477	2.7642	2.6987	2.6458
5	4.5431	.3.6823	3.2874	3.0556	2.9013	2.7105	2.7066	2.6408	2.5876
16	4.4940	3.6337	3.2389	3.0069	2.8524	2.7413	2.6572	2.5911	2.5377
17	4.4513	3.5915	3.1968	2.9647	2.8100	2.6987	2.6143	2.5480	2.4943
18	4.4139	3.5546	3.1599	2.9277	2.7729	2.6613	2.5767	2.5102	2.4563
19	4.3808	3.5219	3.1274	2.8951	2.7401	2.6283	2.5435	2.4768	2.4227
20	4.3513	3.4928	3.0984	2.8661	2.7109	2.5990	2.5140	2.4471	2.3928
21	4.3248	3.4668	3.0725	2.8401	2.6848	2.5757	2.4876	2.4205	2.3661
22	4.3009	3.4434	3.0491	2.8167	2.6613	2.5491	2.4638	2.3965	2.3419
23	4.2793	3.4221	3.0280	2.7955	2.6400	2.5277	2.4422	2.3748	2.3201
24	4.2597	3.4028	3.0088	2.7763	2.6207	2.5082	2.4226	2.3551	2.3002
25	4.2417	3.3852	2.9912	27587	2.6030	2.4904	2.4047	2.3371	2.2821
26	4.2252	3.3690	2.9751	2.7426	2.5868	2.4741	2.3883	2.3205	2.2655
27	4.2100	3.3541	2.9604	2.7278	2.5719	2.4591	2.3732	2.3053	2.2501
28	4.1960	3.3404	2.9467	2.7141	2.5581	2.4453	2.3593	2.2913	2.2360
29	4.1830	3.3277	2.9340	2.7014	2.5454	2.4324	2.3463	2.2782	2.2229
0	4.1709	3.3158	2.9223	2.6896	2.5336	2.4205	2.3343	2.2662	2.2107
0	4.0848	3.2317	2.8387	2.6060	2.4495	2.3359	2.2490	2.1802	2.1240
0	4.0012	3.1504	2.7581	2.5252	2.3683	2.2540	2.1665	2.0970	2.0401
20	3.9201	3.0718	2.6802	2.4472	2.2900	2.1750	2.0867	2.0164	1.9588
∞	3.8415	2.9957	2.6049	2.3719	2.2141	2.0986	2.0096	1.9384	1.8799

ABLE A–4 (II) F. DISTRIBUTION $\alpha = 0.05$ (CONTINUED)

V_2 \ V_1	10	12	15	20	24	30	40	60	120	∞
1	241.88	243.91	245.95	248.01	249.05	250.09	251.14	252.20	253.25	254.32
2	19.396	19.413	19.429	19.446	19.454	19.462	19.471	19.479	19.487	19.496
3	8.7855	8.7446	8.7029	8.6602	3.6385	8.6166	1.5944	8.5720	8.5494	8.5265
4	5.9644	5.9117	5.8578	5.8025	5.7744	5.7459	5.7170	5.6878	5.6581	5.6281
5	4.7351	4.6777	4.6188	4.5531	4.5272	4.4957.	4.6533	4.4314	4.3984	4.3650
6	4.0600	3.9999	3.9381	3.8742	3.8415	3.8032	3.7743	3.7398	3.7047	3.6688
7	3.6365	3.5747	3.5108	3.4445	3.4105	3.3758	3.3404	3.3043	3.2674	3.2298
8	3.3472	3.2840	3.2184	3.1503	3.1152	3.0794	3.0428	3.0053	2.9669	2.9276
9	3.1373	3.0729	3.0061	2.9365	2.9005	2.8637	2.3259	2.7872	2.7475	2.7067
10	2.9782	2.9130	2.8450	2.7740	2.7372	2.6996	2.6609	2.6211	2.5801	2.5379
11	2.8536	2.7876	2.7186	2.6464	2.6090	2.5705'	'2.5309	2.4901	2.4480	2.4045
12	2.7534	2.6866	2.6169	2.5436	2.5055	2.4663	2.4259	2.3842	2.3410	2.2962
13	2.6710	2.6037	2.5331	2.4589	2.4202	2.3803	2.3392	2.2966	2.2524	2.2064
14	2.6021	2.5342	2.4630	2.3879	2.3487	2.3032	2.2664	2.2230	2.1778	2.1307
15	2.5437	2.4753	2.4035	2.3275	2.2878	2.2468	2.2043	2.1601	2.1141	2.0658
16	2.4935	2.4247	2.3522	2.2756	2.2354	2.1938	2.1507	2.1058	2.0589	2.0096
17	2.4499	2.3807	2.3077	2.2304	2.1898	2.1477	2.1040	2.0584	2.0107	1.9604
18	2.4117	2.3421	2.2686	2.1906	2.1497	2.1071	2.0629	2.0166	1.9681	1.9168
19	2.3779	2.3080	2.2341	2.1555	2.1141	2.0712	2.0264	1.9796	1.9302	1.8780
20	2.3479	2.2776	2.2033	2.1242	2.0825	2.0391	1.9938	1.9464	1.8963	1.8432
21	2.3210	2.2504	2.1757	2.0960	2.0540	2.0102	1.9645	1.9165	1.8657	1.8117
22	2.2967	2.2258	2.1508	2.0707	2.0283	1.9842	1.9380	1.8895	1.8380	1.7831
23	2.2747	2.2036	2.1282	2.0476	2.0050	1.9605	1.9139	1.8649	1.8128	1.7570
24	2.2547	2.1834	2.1077	2.0267	1.9838	1.9390	1.8920	1.8424	1.7897	1.7331
25	2.2365	2.1649	2.0889	2.0075	1.9643	1.9192	1.8718	1.8217	1.7684	1.7110
26	2.2197	2.1479	2.0716	1.9898	1.9464	1.9010	1.8533	1.8027	1.7488	1.6906
27	2.2043	2.1323	2.0558	1.9736	1.9299	1.8842	1.8361	1.7851	1.7307	1.6717
28	2.1900	2.1179	2.0411	1.9586	1.9147	1.8687	1.8203	1.7689	1.7138	1.6541
29	2 1768	2.1045	2.0275	1.9446	1.9005	1.8543	1.8055	1.7537	1.6981	1.6377
30	2.1646	2.0921	2.0148	1.9317	1.8874	1.8409	1.7918	1.7396	1.6335	1.6223
40	2 0772	2.0035	1.9245	1.8389	1.7929	1.7444	1.6928	1.6373	1.5766	1.5019
60	1.9926	1.9174	1.8364	1.7480	1.7001	1.6491	1.5943	1.5343	1.4673	1.3893
120	1.9105	1.8337	1.7505	14587	1.6084	1.5543	1.4952	1.1290	1.3519	1.2539
∞	1.8307	1.7522	1.6664	1.5705	1.5173	1.4591	1.3940	1.3180	1.2214	1.0000

A–4 (III) F Distribution $\alpha = 0.025$

V_1	1	2	3	4	5	6	7	8	9
	647.79	799.50	864.16	899.58	921.85	937.11	948.22	956.66	963.28
2	38.506	39.000	39.16	539.248	39.298	39.331	39.355	39.373	39.387
3	17.443	16.044	15.439	15.101	14.885	14.735	14.624	14.540	14.473
4	12.218	10.649	9.9792	9.6045	9.3645	9.193	9.0741	8.9796	8.9047
5	10.007	8.4336	7.7636	7.3879	7.1464	6.9177	6.8531	6.7572	6.6810
6	3.8131	7.2598	6.5988	6.2272	5.9876	5.8197	5.6955	5.5996	5.5234
7	8.0727	6.5415	5.8898	5.5226	5.2852	5.1186	4.9949	4.8994	4.8232
8	7.5709	6.0595	5.4160	5.0526	4.8173	4.6517	4.5286	4.4332	4.3372
9	7.2093	5.7147	5.0781	4.7181	4.4844	4.3197	4.1971	4.1020	4.0260
10	6.9367	5.4564	4.8256	4.4683	4.2361	4.0721	3.9498	3.8549	3.7790
11	6.7241	5.2559	4.6300	4.2751	4.0440	3.8807	3.7586	3.6638	3.5879
12	6.5538	5.0959	4.4742	4.1212	3.8911	3.7283	3.6065	3.5118	3.4358
13	6.4143	4.9653	4.3472	3.9959	3.7667	3.6043	3.4827	3.3880	3.3120
14	6.2979	4.8567	4.2417	3.8919	3.6634	3.5014	3.3799	3.2853	3.2093
15	6.1995	4.7650	4.1528	3.8043	3.5764	3.4147	3.2934	3.1987	3.1227
16	6.1151	4.6867	4.0768	3.7294	3.5021	3.3406	3.2194	3.1248	3.0488
17	6.0420	4.6189	4.0112	3.6648	3.4379	3.2767	3.1556	3.0610	2.9849
18	5.9781	4.5597	3.9539	3.6083	3.3820	3.2209	3.0999	3.0053	2.9291
19	5.9216	4.5075	3.9034	3.5587	3.3327	3.1718	3.0509	2.9563	2.8800
20	3.8715	4.4613	3.3587	3.5147	3.2891	3.1283	3.0074	2.9128	2.8365
21	5.8266	4.4199	3.8188	3.4754	3.2501	3.0895	2.9686	2.8740	2.7977
22	5.7863	4.3828	3.7829	3.4401	3.2151	3.0546	2.9338	2.8392	2.7628
23	5.7498	4.3492	3.7505	3.4083	3.1835	3.0232	2.9024	2.8077	2.7313
24	5.7167	4.3187	3.7211	3.3794	3.1548	2.9946	2.8738	2.7791	2.7027
25	5.6864	4.2909	3.6943	3.3530	3.1287	2.9685	2.8478	2.7531	2.6766
26	5.6586	4.2655	3.6697	3.3289	3.1048	2.9447	2.8240	2.7293	2.6528
27	5.6331	4.2421	3.6472	3.3067	3.0828	2.9228	2.8021	2.7074	2.6309
28	5.6096	4.2205	3.6264	3.2863	3.0625	2.9027	2.7320	2.6872	2.6106
29	5.5873	4.2006	3.6072	3.2674	3.0438	2.8840	2.7633	2.6686	2.5919
30	5.3675	4.1821	3.5894	3.2499	3.0265	2.8667	2.7460	2.6313	2.5746
40	5.4239	4.0510	3.4633	3.1261	2.9037	2.7444	2.6238	2.5289	2.4519
60	5.2857	3.9253	3.3425	3.0077	2.7863	2.6274	2.5068	2.4117	2.3344
120	3.1524	3.8046	3.2270	2.8943	2.6740	2.5154	2.3948	2.2994	2.2217
∞	5.0239	3.6889	3.1161	2.7858	2.5665	2.4082	2.2875	2.1918	2.1136

ABLE A–4 (III) F. DISTRIBUTION $\alpha = 0.025$ (CONTINUED)

V_2 \ V_1	10	12	15	20	24	30	40	60	120	∞
1	968.63	976.71	984.87	993.10	997.25	1 001.4	1005.6	1009.8	1 0140	1 018.3
2	39.398	39.415	39.431	39.448	39.456	39.465	39.473	39.481	39.490	39.498
3	14.419	14.337	14.253	14.167	14.124	14.081	14.037	13.992	13.947	13.902
4	8.8439	8.7512	8.6565	8.5599	8.5109	8.4613	8.4111	8.3604	8.3092	8.2573
5	6.6192	6.5246	6.4277	6.3285	6.2780	6.2269	6.1751	6.1225	6.0693	6.0153
6	5.4613	5.3662	5.2687	5.1684	5.1172	5.0652	5.0125	4.9589	4.9045	4.8491
7	4.7611	4.6658	4.5678	4.4667	4.4150	4.3624	4.3089	4.2544	4.1989	4.1423
8	4. 2951	4.1997	4.1012	3.9995	3.9472	3.940	3.8398	3.7844	3.7279	3.6702
9	3.9639	3.8682	3.7694	3.6669	3.6142	3.5604	3.5054	3.4493	3.3918	3.3329
10	3.7168	3.6209	3.5217	3.4186	3.3654	3.3110	3.2554	3.1984	3.1399	3.0798
11	3 5257	3.4396	3.3299	3.2261	3.1725	3.1176	3.0613	3.0035	2.9441	2.8823
12	3 3736	3.2773	3.1772	3.0728	3.0187	2.4633	2.9063	2.8478	2.7874	2.7249
13	3 2497	3.1 532	3.0527	2.9477	2.8932	2.8373	2.7797	2.7204	2.6590	2.5955
14	3 1469	3.0501	2.9493	2.8437	2.7888	2.7324	2.6742	2.6142	2.5519	2.4872
15	3 0602	2.9633	2.8621	2.7559	2.7006	24437	2.5850	2.5242	2.4611	2.3953
16	2.9862	2.8890	2.7875	2.6808	2.6111	2.5678	2.5085	2.4471	2.3831	2.3163
17	2.9222	2.8249	2.7230	2.6158	2.5598	2.5021	2.4422	2.3801	2.3153	2.2474
18	2.8664	2.7689	2.6667	2.5590	2.5027	24445	2.3842	2.3214	2.2558	2.1869
19	2.8173	2.7196	2.6171	2.5089	2.4523	2.3937	2.3329	2.2695	2.2032	2.1333
20	2.7737	2.6758	2.5731	2.4645	2.4076	2.3486	2.2873	2.2134	2.1562	2.0853
21	2.7348	2.6368	2.5338	2.4247	2.3675	2.3082	2.2465	2.1819	2.1141	2.0422
22	2.6998	2.6017	2.4984	2.3890	2.3315	2.2718	2.2097	2.1446	2.0760	2.0032
23	2.6682	2.5699	2.4665	2.3567	2.2989	2.2389	2.1763	2.1107	2.0415	1.9677
24	2.6396	2.5412	2.4374	2.3273	2.2693	2.2090	2.1460	2.0799	2.0099	1.9353
25	2.6135	2.5149	2.4110	2.3005	2.2422	2.1816	2.1183	2.0517	1.9811	1.9055
26	2.5895	2.4909	2.3867	2.2759	2.2174	2.1565	2.0928	2.0257	1.9545	1.8781
27	2.5676	2.4688	2.3644	2.2533	2.1946	2.1334	2.0693	2.0018	1.9299	1.8527
28	2.3473	2.4484	2.3438	2.2324	2.1735	2.1121	2.0477	1.9796	1.9072	1.8291
29	2.5286	2.4295	2.3248	2.2131	2.1540	2.0923	2.0276	1.9591	1.8861	1.8072
30	2.5112	2.4120	2.3072	2.1952	2.1319	2.0739	2.0089	1.9400	1.8664	1.7867
40	2.3812	2.2882	2.1819	2.0677	2.0069	1.9429	1.8752	1.8023	1.7342	1.6371
60	2.2702	2.1692	2.0613	1.9445	1.8817	1.8152	1.7440	1.6668	1.5810	1.4822
120	2.1570	2.0548	1.9450	1.8249	1.7597	1.6899	1.6141	1.5299	1.4321	1.3104
∞	2.0483	1.9447	1.8326	1.7085	1.6402	1.5660	1.4835	1.3883	1.2684	1.0000

E A–4 (IV). F. DISTRIBUTION $\alpha = 0.01$

V_1 / V_2	1	2	3	4	5	6	7	8	9
1	4052.2	4999.5	5403.3	5624.6	5763.7	5859.0	5928.3	5981.1	6022.5
2	98.503	99.000	99.166	99.249	99.299	99.332	99.356	99.374	99.388
3	34.116	30.817	29.457	28.710	28.237	27.911	27.672	27.489	27.345
4	21.198	18.000	16.614	15.977	13.322	15.207	14.976	14.799	14.659
5	16.258	13.274	12.060	11.392	10.967	10.672	10.456	10.289	10.158
6	13.745	10.925	9.7795	9.1483	8.7459	3.4661	8.2600	8.1016	7.9761
7	12.246	9.5466	8.4513	7.8467	7.4604	7.1914	6.9928	6.8401	6.7188
8	11.259	8.6491	7.5910	7.0060	6.6318	6.3707	6.1776	6.0289	5.9106
9	10.561	8.0215	6.9919	6.4221	6.0569	5.8018	5.6129	5.4671	5.3511
10	10.044	7.5594	6.5523	5.9943	5.6363	5.3858	5.2001	5.0567	4.9424
11	9.6460	7.2057	6.2167	5.6683	5.3160	5.0692	4.8861	4.7445	4.6315
12	9.3302	6.9266	5.9526	5.4119	5.0643	4.8206	4.6395	4.4994	4.3875
13	9.0738	6.7010	5.7394	5.2053	4.8616	4.6204	4.4410	4.3021	4.1911
14	8.8616	6.5149	5.5639	5.0354	4.4558	4.4558	4.2779	4.1399	4.0297
15	8.6831	6.3589	3.4170	4.8931	4.5556	4.3183	4.1415	4.0045	3.8948
16	8.5310	6.2262	5.2922	4.7726	44374	4.2016	4.0259	3.8896	3.7804
17	8.3997	6.1121	5.1850	4.6690	4.3359	4.1015	3.9267	3.7910	3.6822
18	8.2854	6.0129	5.0919	4.5790	4.2479	4.0146	3.8406	3.7054	3.5971
19	8.1850	5.9259	5.0103	4.5003	4.1708	3.9386	3.7653	3.6305	3.5225
20	3.0960	5.8489	4.9382	4.4307	4.1027	3.8714	3.6987	3.5644	3.4567
21	8.0166	5.7804	4.8740	4.3688	4.0421	3.8117	3.6396	3.5056	3.3981
22	7.9454	5.9169	4.8166	4.3134	3.9880	3.7583	3.5867	3.4530	3.3458
23	7.8811	5.6637	4.7649	4.2635	3.9392	3.7102	3.5390	3.4057	3.2986
24	7.8229	5.6136	4.7181	4.2184	3.8951	3.6667	3.4959	3.3629	3.2560
25	7.7698	5.5680	4.6755	4.1774	3.8550	3.6272	3.4568	3.3239	3.2172
26	7.7213	5.5263	4.6366	4.1400	3.8183	3.5911	3.4210	3.2884	3.1818
27	7.6767	5.4881	4.6009	4.1056	3.7848	3.5580	3.3882	3.2558	3.1494
28	7.6356	5.4529	4.5681	4.0740	3.7539	3.5276	3.3581	3.2259	3.1195
29	7.5976	5.4205	4.5378	4.0449	3.7254	3.4995	3.3302	3.1982	3.0920
30	7.5625	5.3904	4.5097	4.0179	3.6990	3.4735	3.3045	3.1726	3.0665
40	7.3141	5.1785	4.3126	3.8283	3.5138	3.2910	3.1238	2.9930	2.8876
60	7.0771	4.9774	4.1259	3.6491	3.3389	3.1187	2.9530	2.8233	2.7185
120	6.8510	4.7865	3.9493	3.4796	3.1735	2.9559	2.7918	2.6629	2.5586
∞	6.6349	4.6052	3.7816	3.3129	3.0173	2.8020	2.6393	2.5113	2.4073

TABLE A–4((1V) F. DISTRIBUTION $\alpha = 0.01$ (CONTINUED)

V_2 \ V_1	10	12	15	20	24	30	40	60	120	∞
1	6055.8	6106.3	6137.3	6208.7	6234.6	6260.7	6286.8	6313.0	6339.4	6366.0
2	99.399	99.416	99.432	99.449	99.458	99.466	99.474	99.483	99.491	99.501
3	27.229	27.052	26.872	26.690	26.598	26.598	26.411	26.316	26.221	26.125
4	14.546	14.374	14.198	14.020	13.929	13.838	13.745	13.652	13.358	13.463
5	10.051	9.8883	9.7222	9.5527	9.4665	9.3793	9.2912	9.2020	9.1118	9.0204
6	7.8741	7.7183	7.5590	7.3958	7.3127	7.2285	7.1432	7.0568	6.9690	6.8801
7	6.6201	6.4691	6.3143	6.1554	6.0743	5.9921	5.9084	5.8236	5.7372	5.6495
8	5.8143	5.6668	5.3131	5.3591	3.2793	5.1981	5.1156	5.0316	4.9460	4.8518
9	3.2565	3.1114	4.9621	4.8080	4.7290	4.6486	4.5667	4.4831	4.3978	4.3105
10	4.8492	4.7059	4.5582	4.4054	4.3269	4.2469	4.1653	4.0819	3.9965	3.9090
11	4.5393	4.3974	4.2509	40190	4.0209	3.9411	3.8596	3.7761	3.6904	3.6025
12	4.2961	4.1553	4.0096	3.8584	3.7805	3.7008	3.6192	3.5355	3.4494	3.3608
13	4.1003	3.9603	3.8154	3.6646	3.5861	3.3070	3.4253	3.3413	3.2548	3.1654
14	3.9394	3.8001	3.6557	3.5052	3.4274	3.3476	3.2656	3.1813	3.0942	3.0040
15	3.8049	3.6662	3.5222	3.3719	3.2940	3.2141	3.1319	3.0471	2.9595	2.8684
16	3.6909	3.5527	3.4089	3.2588	3.1801	3.1007	3.0182	2.9330	2.8447	2.7528
17	3.5931	3.4552	3.3117	3.1613	3.0835	3.0032	2.9205	2.8348	2.7459	2.6530
18	3.5082	3.3706	3.2273	3.0771	2.9990	2.9185	2.8354	2.7493	2.6597	2.5660
19	3.4338	3.2965	3.1533	3.0031	2.9249	2.8442	2.7608	2.6742	2.3139	2.4893
20	3.3612	3.2311	3.0880	2.9377	2.8594	2.7785	2.6947	2.6077	2.3168	2.4212
21	3.3098	3.1729	3.0299	2.8796	2.8011	2.7200	2.6359	2.5414	2.4568	2.3603
22	3.2576	3.1209	2.9780	2.8274	2.7488	2.6675	2.5831	2.4951	2.4029	2.3055
23	3.2106	3.0740	2.9311	2.7805	2.7017	2.6202	2.5353	2.4471	2.3542	2.2559
24	3.1681	3.0316	2.3887	2.7380	2.6591	2.5773	2.4923	2.4035	2.3099	2.2107
25	3.1294	2.9931	2.8502	2.6993	2.6203	2.5383	2.4530	2.3637	2.2695	2.1694
26	3.0941	2.9579	2.8150	2.6640	2.5848	2.5026	2.4170	2.3273	2.2325	2.1315
27	3.0618	2.9256	2.7827	2.6316	2.5522	2.4699	2.3840	2.2938	2.1984	2.0965
28	3.0320	2.1959	2.7530	2.6017	2.5223	2.4397	2.3535	2.2629	2.1670	2.0642
29	3.0045	2.8685	2.7256	2.5742	2.4946	2.4118	2.3233	2.2344	2.1378	2.0342
30	2.9791	2.8431	2.7002	2.5487	2.4619	2.3860	2.2992	2.2079	2.1107	2.0062
40	2.8005	2.6641	2.3216	2.3689	2.2880	2.2034	2.1142	2.0194	1.9172	1.8047
60	2.6318	2.4961	2.3523	2.1978	2.1154	2.0285	1.9360	1.8363	1.7263	1.6006
120	2.4721	2.3363	2.1913	2.0346	1.9500	1.8600	1.7628	1.6557	1.5330	1.3805
∞	2.3209	2.1848	2.0385	1.1783	1.7908	1.6964	1.3923	1.4730	1.3246	1.0000

LE A–4 (V) F. Ditribution $\alpha = 0.005$

V_2 \ V_1	1	2	3	4	5	6	7	8	9
1	16211	20000	21615	22500	23056	23437	23715	23925	24091
2	198.50	199.00	199.17	199.25	199.30	199.33	199.36	199.37	199.39
3	55.352	49.799	47.467	46.195	45.392	44.838	44.434	44.126	43.882
4	31.333	26.284	24.259	23.155	22.456	21.975	21.622	21.352	21.139
5	22.785	18.314	16.530	15.556	14.940	14.513	14.200	13.961	13.772
6	18.633	14.544	12.917	12.028	11.464	11.073	10.786	10.566	10.391
7	16.236	12.404	10.882	10.050	9.5221	9.1554	8.8854	8.6781	8.5138
8	14.688	11.042	9.5965	8.8051	8.3018	7.9520	7.6942	7.4960	7.3386
9	13.614	10.107	8.7171	7.9559	7.4711	7.1338	6.8849	6.6933	6.5411
10	12.826	9.4270	8.0807	7.3428	6.8723	6.5446	6.3025	6.1159	5.9676
11	12.226	8.9122	7.6004	6.8809	6.4217	6.1015	5.8648	5.6821	5.5368
12	11.754	8.5096	7.2258	6.5211	6.0711	5.7570	5.5245	5.3451	5.2021
13	11.374	8.1865	6.9257	6.2335	5.7910	5.4819	5.2529	5.0761	4.9351
14	11.060	7.9217	6.6803	5.9984	5.5623	5.2574	5.0313	4.8566	4.7173
15	10.798	7.7008	6.4760	5.8029	5.3721	5.0708	4.8473	4.6743	4.5364
16	10.575	7.5138	6.3034	5.6378	5.2117	4.9134	4.6920	4.5207	4.3838
17	10.384	7.3536	6.1556	5.4967	5.0746	4.7789	4.5594	4.3893	4.2535
18	10.218	7.2148	6.0277	5.3746	4.9560	4.6627	4.4448	4.2759	4.1410
19	10.073	7.0935	5.9161	5.2681	4.8526	4.5614	4.3448	4.1770	4.0428
20	9.9439	6.9865	5.8177	5.1743	4.7616	4.4721	4.2569	4.0900	3.9564
21	9.8295	6.8914	5.7304	5.0911	4.6808	4.3931	4.1789	4.0128	3.8799
22	9.7271	6.8064	5.6324	5.0168	4.6088	4.3225	4.1094	3.9440	3.8116
23	9.6348	6.7300	5.5823	4.9500	4.5441	4.2591	4.0469	3.8822	3.7502
24	9.5513	6.6610	5.5190	4.8898	4.4857	4.2019	3.9905	3.8264	3.6949
25	9.4753	6.5982	5.4615	4.8351	4.4327	4.1500	3.9394	3.7758	3.6447
26	9.4059	6.5409	5.4091	4.7852	4.3844	4.1027	3.8928	3.7297	3.5989
27	9.3423	6.4885	5.3611	4.7396	4.3402	4.0594	3.8501	3.6875	3.5571
28	9.2838	6.4403	5.3170	4.6977	4.2996	4.0197	3.8110	3.4487	3.5186
29	9.2297	6.3958	5.2764	4.6591	4.2622	3.9830	3.7749	3.6130	3.4832
30	9.1797	6.3347	5.2388	4.6233	4.2276	3.9492	3.7416	3.5801	3.4505
40	8.8278	6.0664	4.9759	4.3738	3.9860	3.7129	3.5088	3.3498	3.2220
60	8.4946	5.7950	4.7290	4.1399	3.7600	3.4918	3.2911	3.1344	3.0083
120	8.1790	5.5393	4.4973	3.9207	3.5482	3.2849	3.0874	3.9330	2.8083
∞	7.8794	5.2983	4.2794	3.7151	3.3499	3.0913	2.8968	2.7444	2.6210

TABLE A–4 (V) F DISTRIBUTION α = 0.005 (CONTINUED)

V_2 \ V_1	10	12	15	20	24	30	40	60	120	∞
1	24224	24426	24630	24836	24940	23044	23148	25253	25359	25465
2	199.40	199.42	199.43	199.45	199.46	199.47	199.47	199.48	199.49	199.51
3	43.686	43.387	43.085	42.778	42.622	42.466	42.308	42.149	41.989	41.829
4	20.967	20.705	20.438	20.161	20.030	19.892	19.752	19.611	19.468	19.325
5	13.618	13.384	13.146	12.903	12.780	12.656	.12.530	12.402	12.274	12.144
6	10.250	10.034	9.8140	9.5888	9.4741	9.3583	9.2408	9.1219	9.0015	8.8793
7	8.3803	8.1764	7.9678	7.7540	7.6450	7.5345	7.4225	7.3088	7.1933	7.0760
8	7.2107	7.0149	6.8143	6.6082	6.5029	6.3961	6.2875	6.1772	6.0649	5.9505
9	6.4171	6.2274	6.0325	5.8318	5.7292	5.6248	3.5186	5.4104	5.3001	5.1875
10	5.8467	5.6613	5.4707	5.2740	5.1732	5.0705	4.9659	4.8592	4.7501	4.6385
11	5.4182	5.2363	5.0489	4.8552	4.7557	4.6543	4.5508	4.4450	4.3367	4.2256
12	5.0855	4.9063	4.7214	4.5299	4.4315	4.3309	4.2282	4.1229	4.0149	3.9039
13	4.8199	4.4429	4.4600	4.2703	41726	4.0727	3.9704	3.8655	3.7577	3.4465
14	4.6034	4.4281	4.2468	4.0585	3.9614	3.8619	3.7600	3.6553	3.5473	3.4359
15	4.4236	4.2498	4.0698	3.8826	3.7859	3.6867	3.5850	3.4803	3.3722	3.2602
16	4.2719	4.0994	3.9205	3.7342	3.6378	3.5388	3.4372	3.3324	3.2240	3.1115
17	4.1423	3.9709	3.7929	3.6073	3.5112	3.4124	3.3107	3.2058	3.0971	2.9839
18	4.0305	3.8599	3.6827	3.4977	3.4017	3.3030	3.2014	3.0962	2.9871	2.8732
19	3.9329	3.7631	3.5866	3.4020	3.3062	3.2075	3.1058	3.0004	2.8908	2.7762
20	3.8470	3.6779	3.5020	3.3178	3.2220	3.1234	3.0215	2.9159	2.8058	2.6904
21	3.7709	3.6024	3.4270	3.2431	3.1474	3.0488	2.9467	2.8408	2.7302	2.6140
22	3.7030	3.3550	3.3600	3.1764	3.0807	2.9821	2.8799	2.7736	2.6625	2.5455
23	3.6420	3.4745	3.2999	3.1165	3.0208	2.9221	2.8198	2.7132	2.6016	2.4837
24	3.5870	3.4199	3.2456	3.0624	2.9667	2.8679	2.7654	2.6585	2.5463	2.4276
25	3.5370	3.3704	3.1963	3.0133	2.9176	2.8187	2.7160	2.6088	2.4960	2.3765
26	3.4916	3.3252	3.1515	2.9685	2.8728	2.7738	2.6709	2.5633	2.4501	2.3297
27	3.4499	3.2839	3.1104	2.9275	2.8318	2.7327	2.6296	2.5217	2.4078	2.2367
28	3.4117	3.2460	3.0727	2.8899	2.7941	2.6949	2.5916	2.4384	2.3689	2.2469
29	3.3765	3.2111	3.0379	2.8551	2.7594	2.6601	2.5565	2.4479	2.3330	2.2102
30	3.3440	3.1787	3.0057	2.8230	2.7272	2.6278	2.5241	2.4151	2.2997	2.1760
40	3.1167	2.9531	2.7811	2.5984	2.5020	2.4015	2.2958	2.1838	2.0635	1.9318
60	2.9042	2.7419	2.5705	2.3872	2.2898	2.1874	2.0789	1.9622	1.8341	1.6885
120	2.7052	2.5439	2.3727	2.1881	2.0890	1.9839	1.8709	1.7469	1.6055	1.4311
∞	2.5188	2.3583	2.1868	1.9998	1.8983	1.7891	1.6691	1.5325	1.3637	1.0000

Table A - 5 The t Distribution

	Level of significance for one-tailed test					
	.10	.05	.025	.01	.005	.0005
		Level of significance for two-tailed test				
	.20	.10	.05	.02	.01	.001
1	3.078	6.314	12.706	31.821	63.657	636.619
2	1.886	2.920	4.303	6.965	9.925	31.598
3	1.638	2.353	3.182	4.541	5.841	12.941
4	1.533	2.132	2.776	3.747	4.604	8.610
5	1.476	2.015	2.571	3.365	4.032	6.859
6	1.440	1.943	2.447	3.143	3.707	5.959
7	1.415	1.895	2.365	2.998	3.499	5.405
8	1.397	1.860	2.306	2.896	3.355	5.041
9	1.383	1.833	2.262	2.821	3.250	4.781
10	1.372	1.812	2.228	2.764	3.169	4.587
11	1.363	1.796	2.201	2.718	3.106	4.437
12	1.356	1.782	2.179	2.681	3.055	4.318
13	1.350	1.771	2.160	2.650	3.012	4.221
14	1.345	1.761	2.145	2.624	2.977	4.140
15	1.341	1.753	2.131	2.602	2.947	4.073
16	1.337	1.746	2.120	2.583	2.921	4.015
17	1.333	1.740	2.110	2.567	2.898	3.965
18	1.330	1.734	2.101	2.552	2.878	3.922
19	1.328	1.729	2.093	2.539	2.861	3.883
20	1.325	1.725	2.086	2.528	2.845	3.850
21	1.323	1.721	2.080	2.518	2.831	3.819
22	1.321	.1.717	2.074	2.508	2.819	3.792
23	1.319	1.714	2.069	2.500	2.807	3.767
24	1.318	1.711	2.064	2.492	2.797	3.745
25	1.316	1.708	2.060	2.485	2.787	3.725
26	1.315	1.706	2.056	2.479	2.779	3.707
27	1.314	1.703	2.052	2.473	2.771	3.690
28	1.313	1.701	2.048	2.467	2.763	3.874
29	1.311	1.699	2.045	2.462	2.756	3.659
30	1.310	1.697	2.042	2.457	2.750	3.646
40	1.303	1.684.	2.021	2.423.	2.704	3.551
80	1.296	1.671	2.000	2.390	2.660	3.460
120	1.289	1.658	1.980	2.358	2.617	3.373
∞	1.282	1.645	1.960	2.326	2.576	3.291

SOURCE: Table is abridged from Table of R. A. Fisher and F. Yates, *Statistical Tables for Biological, Agricultural and Medical Research* (1948) ed.), published by Oliver & Boyd, Ltd Edinburgh and London, by permission of the authors and Publishers