Application of Lean Production Techniques: A Survey of Large Construction Firms in Kenya

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DECLARATION

This project is my original work and has not been submitted for a degree in any other University

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ABSTRACT

Construction practitioners have focused their attention on conversion processes, with little attention given to flow activities, leading to uncertain flow processes, expansion of non value-adding activities and waste. This paper surveys the practices of lean construction techniques in large construction firms in Kenya. Data was collected via questionnaires targeting 30 respondents. A quantitative approach was adopted for this research utilizing the results of a questionnaire survey involving over 50 variables that relate to lean construction practice. This research has found no empirical evidence within construction practice to match lean practices and the empirical evidence showed that these were extremely scattered and poorly integrated in construction practice.

The paper illustrates the key waste categories, the key waste cause variables and leads the contractors to focus their attention on these issues in order to reduce the incidence of non value-adding activities during the construction process. Project controls have traditionally been focused on after-the-fact detection of variances. This study proposes a control system, the Last Planner system, that causes the realization of plans, and thus supplements project management's concern for management of contracts with the management of production.

There is need for further research in the area of developing appropriate ways for introducing this holistic thinking and implementation of lean production principles among managers and workers in the construction sector. It is important that customized, practical and cost effective in-house quality management systems for implementation by construction companies is developed to enable them satisfy their customer requirements and continuously seek improvements in their operations and processes.

1: INTRODUCTION

1.1 BACKGROUND

Kenya has experienced severe economic problems in the last decade that have seen declining growth in the construction sector (Figure 1.1). Low government budgetary allocations, limited investments in the sector, logging bans, governance problems etc. have contributed to the slowdown keeping economic growth below desired and optimum levels and resulting in dilapidated infrastructure that has effects on all other sectors of the economy. Additionally the construction sector has to rely on resources from Kenya's development partners as most of her limited resources are utilised for recurrent expenditure. The construction sector plays an important role in a developing country like Kenya by unlocking potential economic activities and lowering of business costs and consequently increased economic activities (Central Bank, 2003).

In Kenya the construction industry has performed poorly in the last ten years, averaging 1%–3 % of Gross Domestic Product (GDP) in contrast to manufacturing that contributes 10% – 15% of the GDP (Central Bank, 2003) as shown in figures 1.1 and 1.2 below. Weak economic performance in the building and construction sector kept the economy below the highest possible growth, which was predicated on the rehabilitation of the country's dilapidated infrastructure. The case for increasing productivity, within the construction industry is seen in the housing shortage with just a very small fraction of the population able to afford current housing costs (Central Bank, 2003).

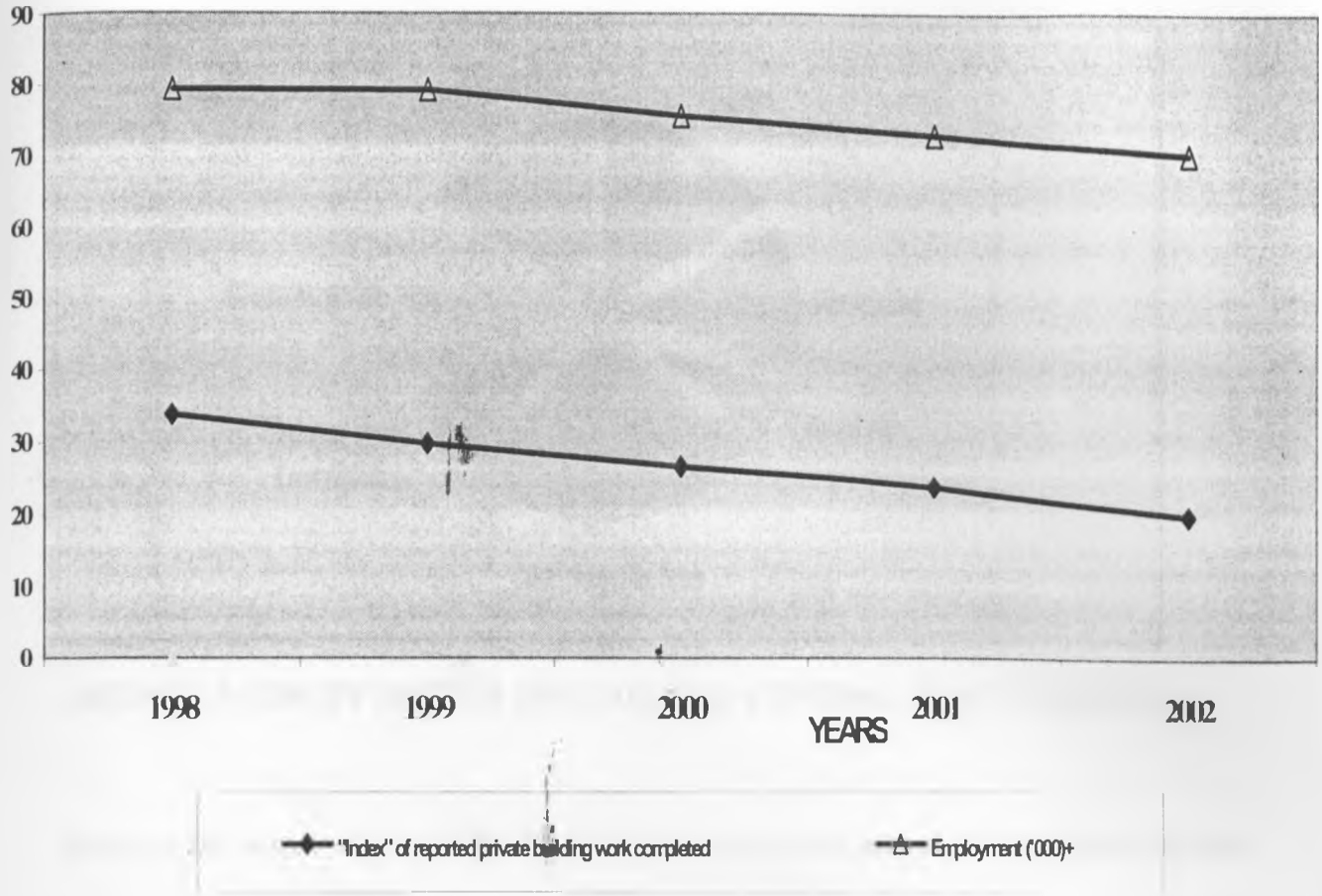

FIGURE 1.1: KENYA BUILDING AND CONSTRUCTION STATISTICS (SOURCE: CENTRAL BUREAU OF STATISTICS)

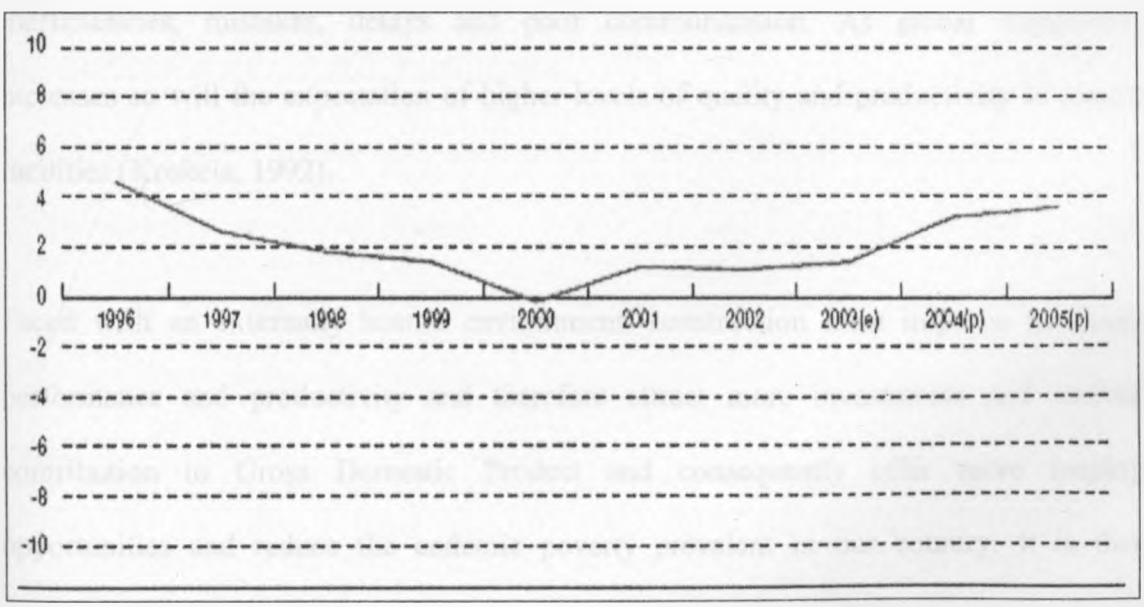

FIGURE 1.2: REAL GDP GROWTH (SOURCE: CENTRAL BANK OF KENYA)

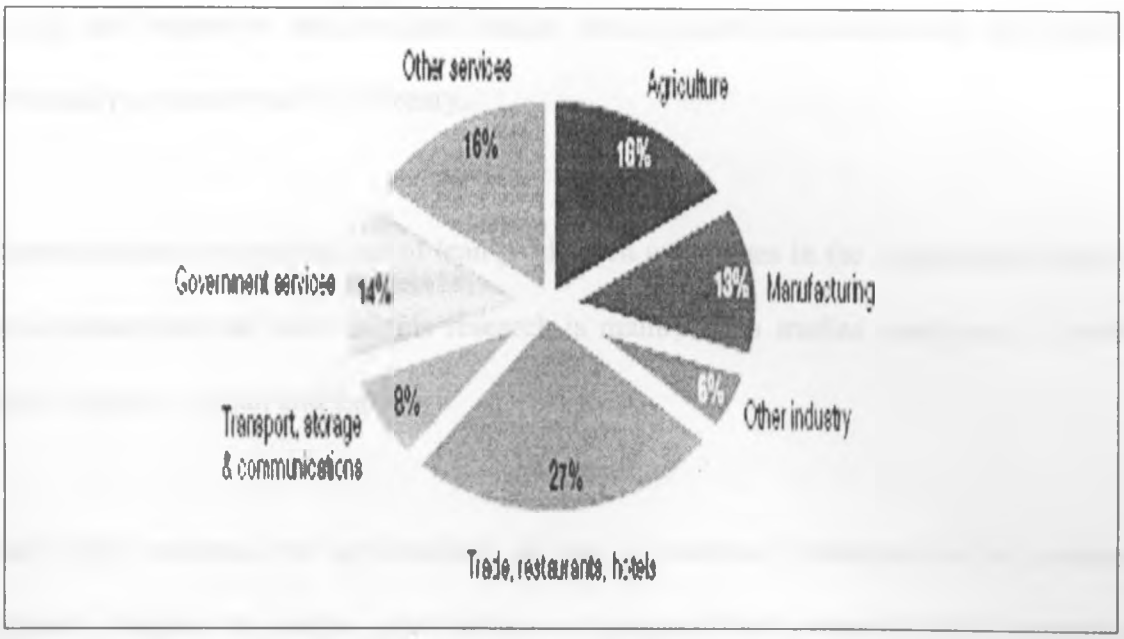

FIGURE 1.3: GDP BY SECTOR 2002 (SOURCE: CENTRAL BANK OF KENYA)

Waste in the sector remains high despite all the economic and social pressures indicated above. Increasing demands by a more aware public and legislation on environmental management are agitating for waste minimization. Supply chain deficiencies and high defect rates result in wasted labour and materials. Construction costs are further escalated by inefficiencies, mistakes, delays and poor communication. As global competitiveness increases so will the expectation of higher levels of quality and productivity in constructed facilities (Koskela, 1992).

Faced with an externally hostile environment, construction must improve its operations performance and productivity and therefore attract more investments and increase its contribution to Gross Domestic Product and consequently offer more employment opportunities and reduce the endemic poverty prevalent in our country. It is therefore important that the construction sector employs effective and efficient operations to utilise

scarce and expensive resources and realise steady growth in productivity and quality and eventually prosperity for its citizenry.

Kenyan studies on applications of lean production techniques in the construction industry are non-existent and the basis of this research is mainly from studies conducted in North and South America, Japan and Europe.

The study reviewed the applicability of lean production techniques to the construction industry, despite its unique peculiarities as compared with manufacturing companies. It investigated current practise and the state of operations in large construction firms in Kenya with particular regard to incidence of non-value adding activities and identification of key waste categories and work flow reliability to deliver customer satisfaction and competitive advantage for construction firms. A large construction firm is one licensed by the Ministry of public works under class "A" to undertake works of an unlimited amount.

1.2 STATEMENT OF THE PROBLEM

Construction projects are often unpredictable in terms of delivery time, budget, profitability and the standards of quality expected. A case study and the results of prior research on contemporary construction show that there are endemic management problems associated with design management and construction management that affect its performance (Koskela, 1992).

The design and construction of facilities poses difficult management problems to which the models and techniques based on the conversion view (input – output) have proven inadequate. Increasingly, projects are subject to uncertainty because of the pace of

technological change and the rapid shifting of market opportunities and competitor actions. Production management concepts and techniques based on the conversion model have not proven capable of solving these difficult problems. This is fundamentally a contracting mentality, which facilitates the management of contracts rather than the management of production or workflow (Ballard, 2000).

The levels of production waste in the sector remain high despite the economic and social pressures. Various studies have confirmed this argument, repeatedly showing high levels of unproductive time in construction sites, among them 26% in Brazil (Formoso *et al*, 2001). Further pressures for reducing waste come from the emergent demands of public opinion and the resulting legislation on environmental management. There is also an increased demand for the development of more environmentally benign products and processes (Santos, 1999).

Construction project management as applied in current practise must be reformed because it is inadequate today and its performance will continue to decline as projects become more uncertain and complex. The reason is that project management concerns itself with performance of activities within the plan and not management of those activities or their relationship (Koskela, 2000).

A number of solutions offered like prefabrication, modularisation, computer integrated construction, robotized and automated construction have not realised major improvements expected (Koskela, 2000). The results of a study of 129 plants in the electronics industry in USA (Sim, 2001) reinforced the findings of other researchers that investing in technology is not a panacea for all. Unless technology is managed in such a way that it will reinforce continuous improvement, companies are likely to be disappointed with the pay-off. When

Total Quality Management (TQM) and Just In Time (JIT) are implemented together there is synergistic improvement in performance i.e. simply investing money in new technologies guarantees nothing. Main differences in productivity, quality and flexibility seemed to be accounted for differences in organisational and managerial practices (Hayes and Clark, 1986).

The study "More Construction for the Money" was motivated by declining productivity of construction in the US (The Business Roundtable, 1983). Its findings were that more than half the time wasted during construction is attributable to poor management practices. It was stated that the construction industry was sluggish in adoption of modern management systems to plan and build projects.

This provides the background against which the study investigated lean operations management practices in large Kenyan construction firms and its role in obtaining competitive advantage and customer satisfaction through delivery of high quality projects in a timely and cost effective manner.

The study attempts to answer the following question:

- What are the distinguishable elements of lean production techniques and tools that are being implemented or practiced in the construction industry with the aim of obtaining sustainable competitive advantage for the organisations?

1.3 RESEARCH OBJECTIVES

The objectives of this research are:

i. Document key management initiatives and practices in the context of lean production techniques implemented towards improving construction production and operations to meet organisations objectives.

ii. Test the following hypothesis: Construction firms practicing lean production techniques realize increased competitive advantage as contrasted to firms that do not utilize the lean production techniques.

1.4 IMPORTANCE OF THE RESEARCH

The study adds to knowledge regarding the nature and role of operations strategy in the pursuit of sustainable competitive advantage in construction companies. The study is useful for literature and further research. The study provides knowledge on how construction organisations can improve their performance holistically by critically examining their operations through lean production techniques.

Managers in construction firms shall benefit from being able to access knowledge and practice of improved management techniques to deliver more value to their customers and meet expectations of their shareholders. By identifying incidences of non-value adding and wasteful activities it should lead contractors to focus their attention to these issues in order to eliminate or reduce their occurrences.

It shall equip managers with techniques and tools that shall enable them achieve operations excellence in delivery of all aspects of a customers needs without necessarily obtaining trade offs in competitive variables e.g. better quality at higher cost.

2 LITERATURE REVIEW

2.1 OPERATIONS STRATEGY

All leading organisations require a basis for sustainable competitive position to stay ahead of their competitors and maintain and grow market share. To achieve this state organisations require to develop an operations based strategy that produces superior operations effectiveness, based on capabilities of people and process. An organisation cannot adapt competitive priorities simply by making a single change in its operating system. A strategy that is easily replicated does not provide an effective strategy. A whole series of interlocked alterations is required that takes time as well as money. Such capabilities can rarely be developed quickly, people must be trained and given experience, new equipment and procedures must be developed and honed and new approaches to management must be tested, shaped and given time to insinuate themselves into the organisations culture (Hayes and Upton, 1998).

Moreover it is advisable to make the implementation of various improvement programs consistent with the pursuit of priorities set by such a strategy with a proactive, ongoing approach and not the more common reactive, undirected and costly response to crises and competitive threat (Rohr, 1998).

2.2 LEAN THINKING: ORIGINS AND DEVELOPMENT

In the spring of 1950 a young Japanese engineer, Eji Toyoda, set out on a three months pilgrimage to Ford's Rouge plant in Detroit. The Rouge plant was the largest, and most complex in the Ford family. It produced 7,000 cars per day, compared to Toyota's 2,685 cars. After much study, he went back to Japan and with the help of his production genius, Taiichi

Ohno, they concluded that mass production would never work in Japan. There was too much waste ("Muda") everywhere i.e. manpower, production inventories, excess processing, defects, waiting, transport and facilities. From this was born what Toyota came to call the Toyota Production System and ultimately lean production (Womack *et al*, 1996).

In the book "The Machine that changed the World" a benchmarking study of the world automotive industry, the authors concluded that the auto industries of North America and Western Europe were relying on techniques that had changed very little from Henry Ford's mass production system. Those techniques were simply not competitive with the new set of ideas pioneered by Japanese companies, which they named lean production. They presented evidence that there are common characteristics observable in all best production systems. Such production systems seem to require less human effort, less space, less product development time, less investments in new tools and at the same time their performance often exceeds that of competitors (Womack *et al*., 1990).

2.3 A CONCEPTUAL FRAMEWORK OF LEAN PRODUCTION

2.3.1 The Conventional model

The conceptual model dominating the conventional view of production is the conversion model i.e. a production process is a conversion of an input to an output used in the disciplines of economics and engineering. Therefore the total cost of the production process equals the sum of the costs of each operation (Koskela, 1992). Accordingly the conversion model accepts that, production can be divided into sub-processes, which are also conversion activities, cost can be minimized by minimizing the cost of each sub-process, and the output value of a process is associated with the costs of its input.

2.3.2 A critique of the conventional model

The focus in the model is conversions, and not the physical flows between conversions of moving, waiting and inspecting activities. These non-value adding activities are left out of consideration. Cost minimisation of sub processes leads to need for buffers that allow high utilisation rates. Performance improvement is focussed on improving the efficiency of sub processes with new technology. This in turn leads to improvement and investment in non-value adding activities better eliminated or suppressed, which neglects and deteriorates overall flow efficiency. Sources of waste are classified according to seven main categories: overproduction, inventory, repair/rework, motion, transport, processing and waiting (Koskela, 1992).

The conversion model does not include quality features in as far as the output of each conversion is usually variable (part of output has to be reworked, scrapped). The specification for each conversion only partially reflects the true requirements of subsequent conversions and the final customer. Improvement efforts are directed towards making conversions more efficient rather than more effective, hence products that poorly fulfil customer requirements (Koskela, 1992).

The conversion model was developed in the 19th century when production processes were simpler, flows shorter, organisations smaller but when applied to more complex production, problems have surfaced.

2.3.3 Conceptual basis of lean production philosophy

Traditional techniques used in the management of production make use of the conversion model, which is very useful for organizing and managing the entire network of production processes. However, managing production only from a wider perspective is not enough in today's business environment that is characterized by reduction in profit margins and an increase in customer awareness regarding quality. Thus, the flow and value concepts have to be understood and incorporated into the portfolio of ideas used by practitioners and researchers. Production managers using the conversion model often overlook reduction of waste and, increase in value is not among the main preoccupations (Koskela, 2000).

The new production model states that production is a flow of material and information from raw material to the end product. Flow processes can be characterized by time, cost and value (customer requirements). Material is processed, inspected, moved, stored (waiting). Processing represents the conversion aspect of production; inspection, moving and waiting represent the flow aspect of production. While all activities expend cost and consume time, only conversion activities add value to the material. The core the new production philosophy is the reduction or elimination of non-value adding activities and increase efficiency of value adding activities (Koskela, 1992). The difference with the value chain of Michael Porter is Porters assumption that all activities add value.

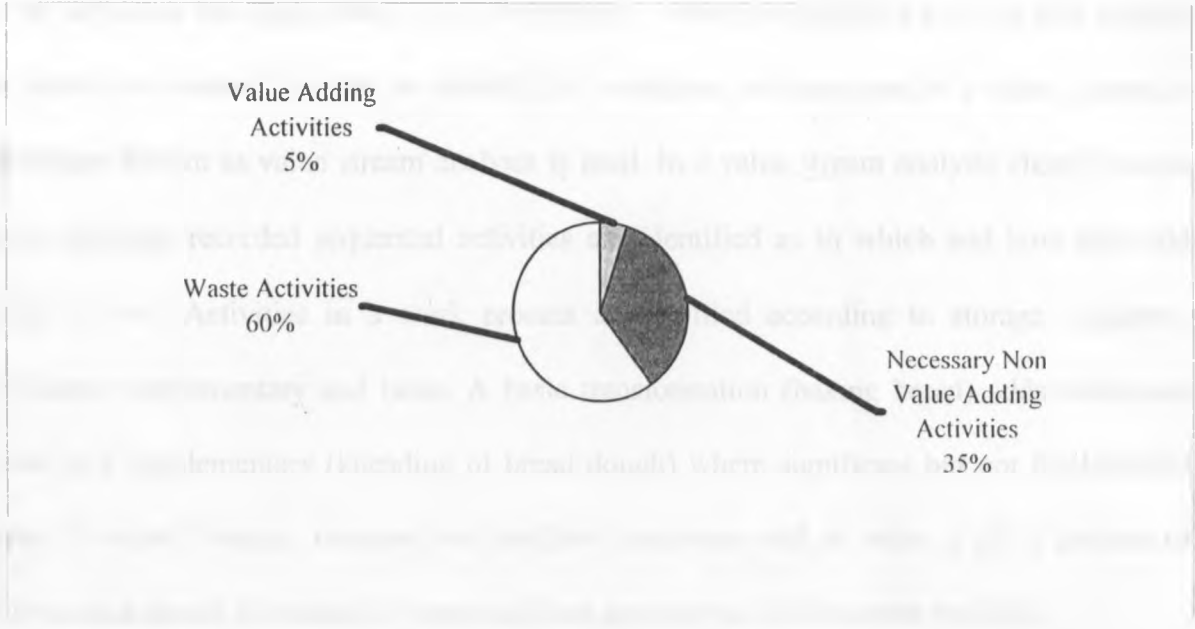

FIGURE 2.1: TARGET OF LEAN PRODUCTION: ELIMINATION OF WASTES

By clearly defining value for specific product or service from the end customer's perspective all non value adding activities or waste can be targeted for removal step by step. For most production operations only a small fraction of the total time and effort actually adds value to the end customer (Figure 2.1).

The interest on lean production and hence construction is mostly based on the empirical evidence that it improves the company's competitiveness (Oliver *et al.*, 1996). The primary goal of introducing any lean production program in a company is to increase productivity, reduce lead times, costs and improve quality (Sriparavastu and Gupta, 1997).

In Jones and Womack's book "Lean Thinking" (1996) they identify and elaborate five fundamental principles; value, value streams, flow, pull and perfection. After establishing the real value of a product or service, as determined by the final customer, a lean transformation process will then seek to eliminate all wasted effort, materials, time, space, etc. from the set

of all activities and operations – the value stream – which are executed to bring that product or service to market. In order to identify the operations and structure of a value stream, a technique known as value stream analysis is used. In a value stream analysis chart (process flow charting) recorded sequential activities are identified as to which and how they add value or not. Activities in a work process are profiled according to storage, transport, ancillary, supplementary and basic. A basic transformation (baking bread) adds maximum value and supplementary (kneading of bread dough) where significant but not fundamental value is added. Storage, transport and ancillary operations add no value at all to product or service and should be reduced or removed from process via improvement projects.

2.4 SUPPLY CHAIN MANAGEMENT

The supply function is pointed as being responsible for production process delays and stops, because a lack of material can impede the accomplishment of an activity, causing productivity loss. Quality systems, based on ISO 9000 series, can aid supply logistics improvement, particularly, through a standardization of procedures e.g. specifications and purchase orders; suppliers selection and qualification; material quality assurance; materials and components deliveries inspection; criteria for divergences solution in the relationships between the company and suppliers (Silva and Cordoso, 1999).

Just In Time is a philosophy of synchronized flow production system without stock. This philosophy is based on the principle that no activity should start in a system until it is necessary and no material or product should arrive on a processing site without being necessary. Associated management practices are: defects elimination; self quality control and immediate feedback information; waiting time between activities reduction; material handling volumes reduction; and transparency by visual control (Silva and Cordoso, 1999).

Challenges to the evolution of a relationship between a company and its suppliers are: to establish long term and stable relations; to limit the number of suppliers; do not to change suppliers frequently; to establish a global qualification system; to evaluate suppliers by total costs; to collaborate with suppliers to make their products more reliable, and less expensive (Silva and Cordoso, 1999).

2.5 WASTE AND VALUE LOSS IN CONSTRUCTION

Consequently when the flow in construction is neglected then current construction practice should demonstrate significant amount of waste, loss of value and non-value adding activities. Koskela (1992) argued that all those activities that produce costs, direct or indirect, and take time, resources or require storage but do not add value or progress to the product could be called non-value adding activities or waste. Waste in construction is not only focused on the quantity of waste of materials on site but also related to several activities such as overproduction, waiting time, material handling, processing, inventories, and movement of workers. Consolidating research from various authors Koskela (2000) shows that the main categories of waste during the construction process can be described as reworks / repairs, defects, material waste, delays, waiting, poor material allocations, unnecessary material handling and material waste.

Alwi *et al* (2002) in a study of Indonesian and Australian construction companies concluded that concepts of waste and value are not well understood by construction personnel. They often do not realize that many activities they carry out do not add value to the work. The findings were reinforced by a study conducted in Brazil and England that confirmed that generally there was a lack of knowledge among construction professionals on production

management core concepts (Formoso *et al*, 2001). Waste is not only associated with waste of materials in the construction process but also other activities that do not add value such as repair, waiting time and delays. These issues contribute to a reduction in the value of construction productivity and could reduce company performance.

2.6 IMPROVING WORK FLOW RELIABILITY

The functions of production management systems are planning and control. Planning establishes goals and a desired sequence of events for achieving goals. Control causes events to approximate the desired sequence, initiates re-planning when the established sequence is either no longer feasible or no longer desirable, and initiates learning when events fail to conform to plan. When environments are dynamic and the production system is uncertain and variable, reliable planning cannot be performed in detail much before the events being planned. Experiments were performed to test the hypothesis that failures were in large part a result of lack of adequate work selection rules. Quality criteria were proposed for assignments regarding definition, sequence, soundness, and size. As a result of applying these criteria, plan reliability (the percentage of assignments completed) increased, and with it, crew productivity also increased (Ballard, 2000).

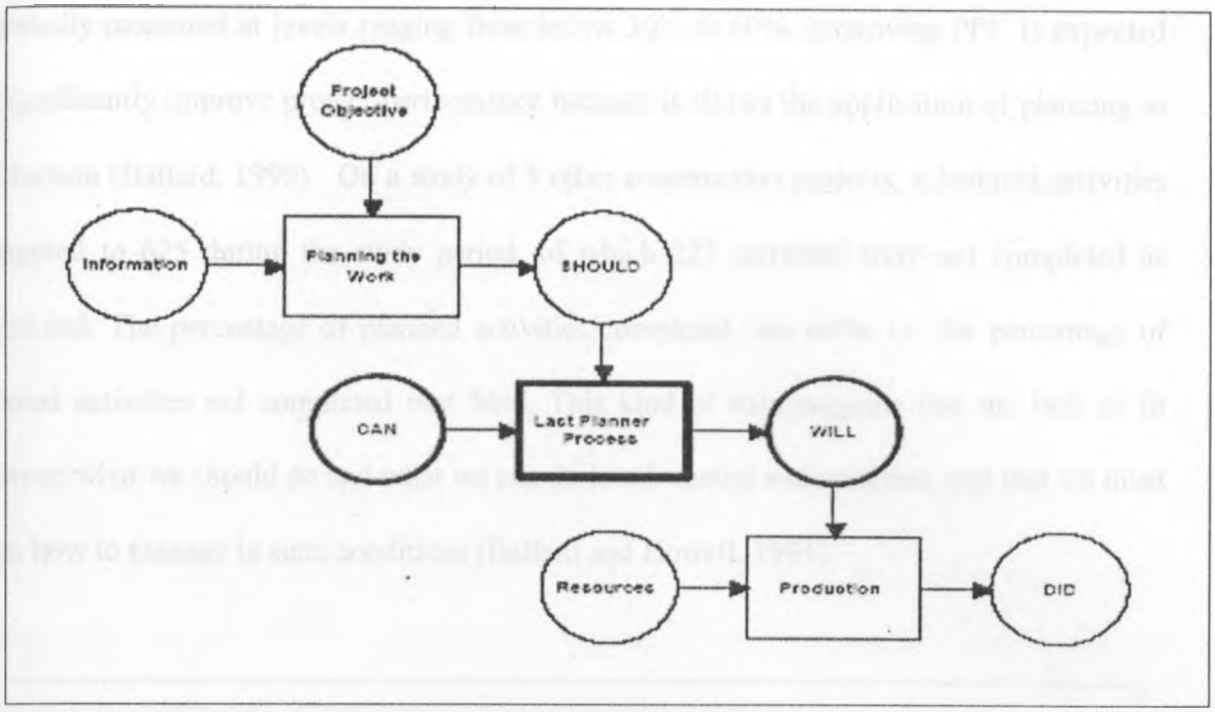

FIGURE 2.2: THE LAST PLANNER SYSTEM

In work planning and materials management, the emphasis should change to complete flow processes rather than discrete activities. Adapted from manufacturing, a system for production control, the Last Planner system, exemplifies the concept of control as causing events to conform to plan, as distinct from the traditional conception of project control in terms of after-the-fact variance detection. Appropriate application of the production control system is shown to improve workflow reliability, which promises substantial benefits in project cost and duration reduction. This is achieved by ensuring that assignment are well defined, the right sequence of work is selected, the right amount of work is selected and work selected is practical or sound; i.e., can be done (Ballard, 2000).

A measure of workflow reliability is Percent Plan Complete (PPC), calculated by dividing the number of near term assignments completed by the total number of assignments made for the plan period typically 1 – 2 weeks. Workflow reliability in the construction industry has been

repeatedly measured at levels ranging from below 30% to 60%. Improving PPC is expected to significantly improve project performance because it allows the application of planning to production (Ballard, 1999). On a study of 5 other construction projects, scheduled activities amounted to 625 during the study period, of which 227 activities were not completed as scheduled. The percentage of planned activities completed was 64%; i.e. the percentage of planned activities not completed was 36%. This kind of data suggests that the lack of fit between what we should do and what we can do is substantial and systemic, and that we must learn how to manage in such conditions (Ballard and Howell, 1994).

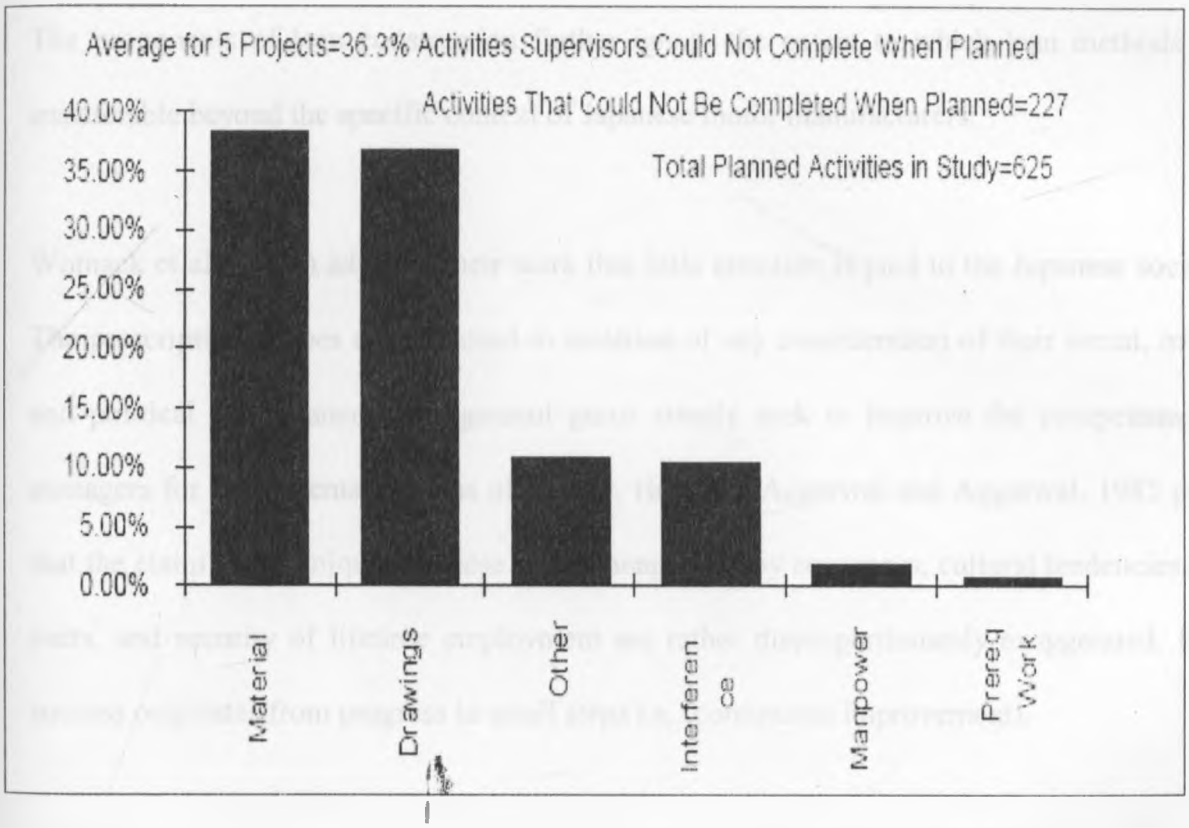

FIGURE 2.3: CONSTRUCTION LAST PLANNER, COMPARING 'SHOULD' WITH 'DID'

2.7 THE DISADVANTAGES OF LEAN CONSTRUCTION

Green, 1999 describes the agenda for change in the UK construction industry to lean thinking to be as a result of dogma and ideology than thoughtfulness and critical reflection. He postulates that the assumed neutrality of management techniques reflects an absence of critical reflection among management academics.

The benefits of lean production are the result of instrumental rationality (concerned only with the most efficient means of achieving a given end). Economic externalities such as traffic congestion, pollution and the human cost of lean methods fall outside the frame of reference. The proponents of lean construction further ignore the extent to which lean methods are transferable beyond the specific context of Japanese motor manufacturers.

Womack et al (1996) admit in their work that little attention is paid to the Japanese society. The prescriptive recipes are proposed in isolation of any consideration of their social, moral and political significance. Management gurus simply seek to improve the competence of managers for instrumental reasons of control. However Aggarwal and Aggarwal, 1985 posit that the claim about unique Japanese style management by consensus, cultural tendencies and traits, and security of lifetime employment are rather disproportionately exaggerated. Real success originates from progress in small steps i.e. (continuous improvement).

2.8 LEAN CONSTRUCTION IMPLEMENTATION BARRIERS

The results of a research undertaken in Chile of twelve construction companies with the objective of implementing lean planning systems identified the following barriers to implementation. The lack of time for implementing new practices in the projects already underway, therefore there were instances of partial implementation and insufficient

preparation. There was lack of conceptual appreciation of training undertaken, which sought to deliver the knowledge to allow project personnel to carry out implementation. It was necessary to create or fortify organizational elements by involvement of top management in key activities. There was concurrent implementation of other competing and parallel improvement efforts such as quality management. Additionally human elements like resistance to change, lack of self-criticism and short-term vision (Alarcon et al, 2002).

3: RESEARCH METHODOLOGY

3.1 RESEARCH DESIGN

The research is a cross sectional study of the construction industry. All data in this study was collected by structured questionnaire surveys (Appendix 1). The primary data was collected by expression of respondents' opinions or perceptions. Therefore the data collected was largely subjective.

The respondents in this study were top managers in the operations functions of the construction companies designated as construction managers, cost engineers, operations managers, contract managers and project managers.

3.2 POPULATION

The focus of the study were large construction companies. Results from prior findings are that average use of lean indicators was significantly greater in large companies than in small and medium sized firms. Some lean production practices i.e. flexible information systems or JIT production – require resources that smaller firms cannot afford (Sanchez, 2001).

There are a total of approximately five thousand registered contractors in Kenya as at October 2000. The sampling frame was derived from the Ministry of public works; Class "A" registered contractors. The 196 contractors in class "A" classification are licensed to execute works of an unlimited value. A complete list of contractors registered in class "A" is enclosed in the Appendix 2.

3.3 SAMPLE

A proportionate stratified random sample of 65 firms of foreign and local ownership, with headquarters located in Nairobi was selected by use of random numbers generated by "Microsoft Excel" computer spreadsheet. Construction firms have their operations at sites located and dispersed throughout the country and therefore practices investigated were representative of all regions. Construction firms with incomplete information in the sampling frame were removed prior to selection of sample.

A total of 65 questionnaires were mailed. The questionnaire solicited information pertaining to lean construction practices as well as construction performance in multiple dimensions (refer Appendix 1). In total, 30 out of 65 surveys were received, which is a response rate of 46 percent, which matched the intended target of 30 responses.

3.4 DATA COLLECTION

The structured questionnaire is divided into seven parts A to G. Part A provides for general information of the characteristics of the companies. Part B captures the overall focus and attitude of the organisation. Part C evaluates issues of competitive advantage and performance measures by customer satisfaction of the firms with regard to number and nature of projects acquired, manner of procuring the works and reasons attributed to the success of procuring projects and their rating of importance of customer satisfaction.

A number of variables related to key areas of quality management, supply chain management, waste and workflow were derived from the literature review. In Part D to Part G, the first section of dichotomous questions investigating existence of programs and

practices within the organisation in the broad areas provided above. The second section identifies frequency of occurrences of various attributes and variables in organisations.

3.5 DATA ANALYSIS AND PRESENTATION

Data collected was prepared for analysis by editing and coding to ensure accuracy of the data and conversion from raw form to reduced and classified forms more appropriate for analysis. The data was explored, displayed and examined to reveal meaningful descriptions, patterns and relationships. Exploratory data analysis with emphasis on visual and graphical representation was carried out (Cooper and Schindler, 2002).

Descriptive statistics (measures of location and spread) and their graphical presentation by use of frequency tables, bar charts, pie charts, histograms, etc. are utilized for preliminary examination of the data. Relationships between independent variables (Part D to G of the questionnaire) are analyzed by use of cross tabulation of dependent variable (Part B of questionnaire).

4: RESEARCH FINDINGS

4.1 CHARACTERISTICS OF RESPONDENTS

In all 73% of the respondents reported a turnover of between Kenya shillings 100 million to 500 million with the remaining 27% below 100 Million shillings. This corresponds with the Ministry of public works contractor classification of class "A" registration; to carry out works valued at more than 100 million shillings. 78% of the construction firms have less than 200 employees with another 19% percent with between 200 and 250 employees and 3% with more than 300 employees.

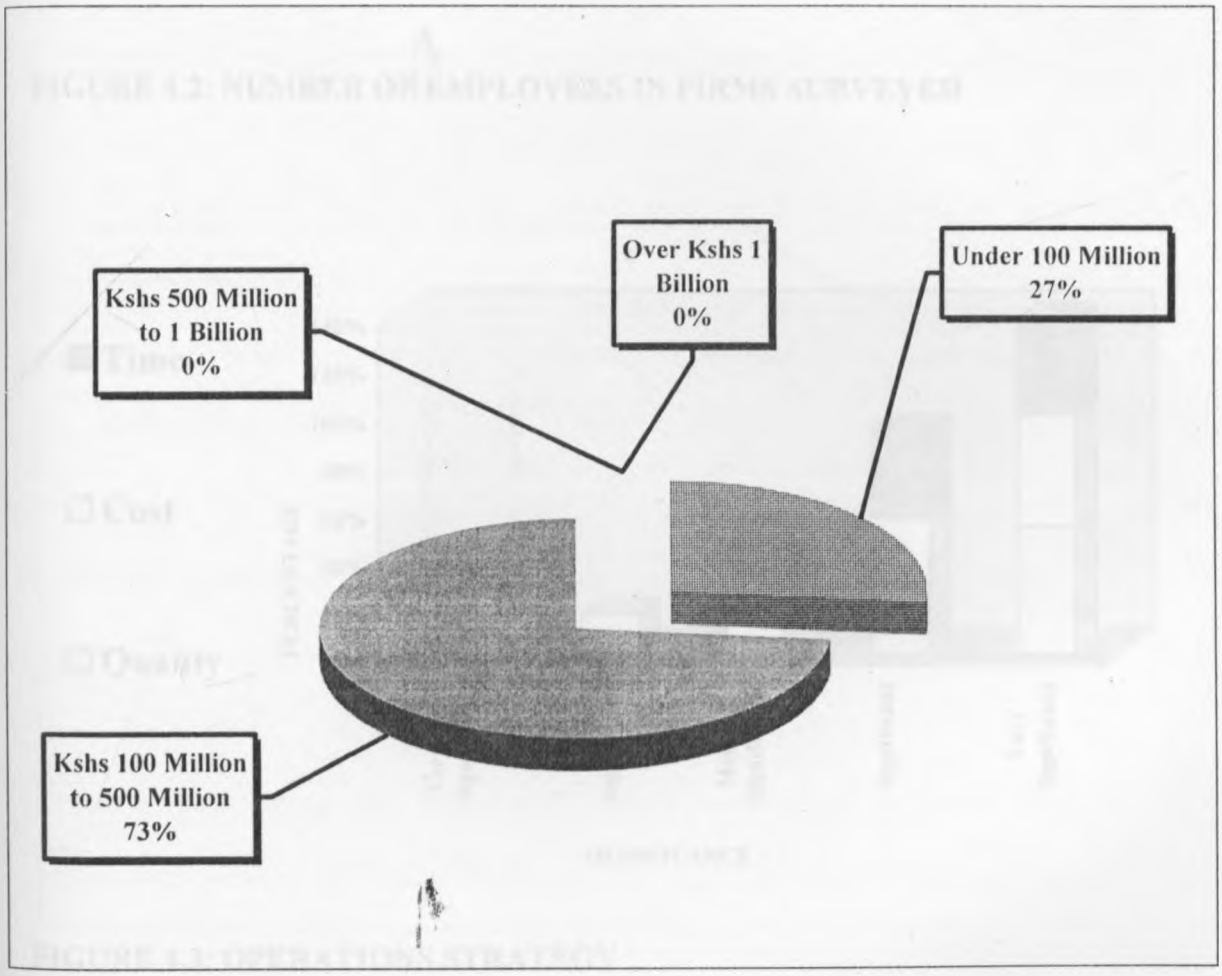

FIGURE 4.1: APPROXIMATE AVERAGE ANNUAL CONSTRUCTION TURNOVER (KSHS) OVER THE LAST THREE YEARS FOR CLASS "A" CONSTRUCTION FIRMS THAT WERE THE SUBJECT OF THE STUDY

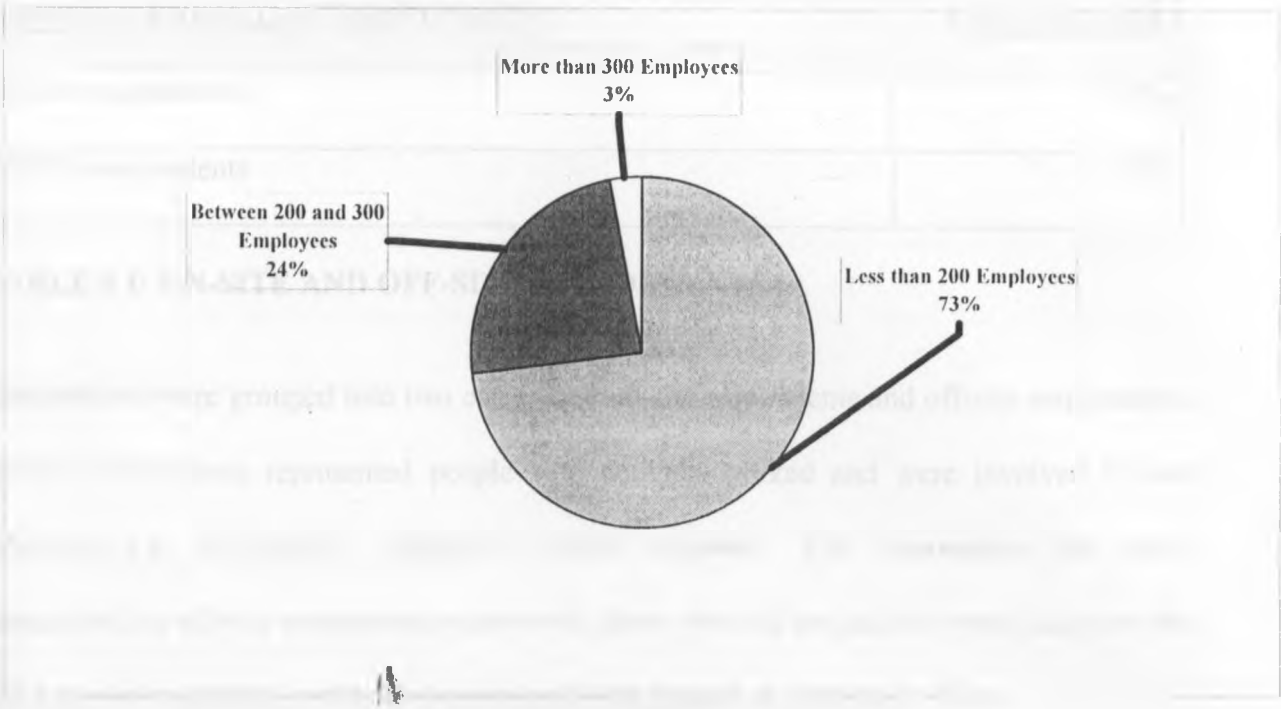

FIGURE 4.2: NUMBER OF EMPLOYEES IN FIRMS SURVEYED

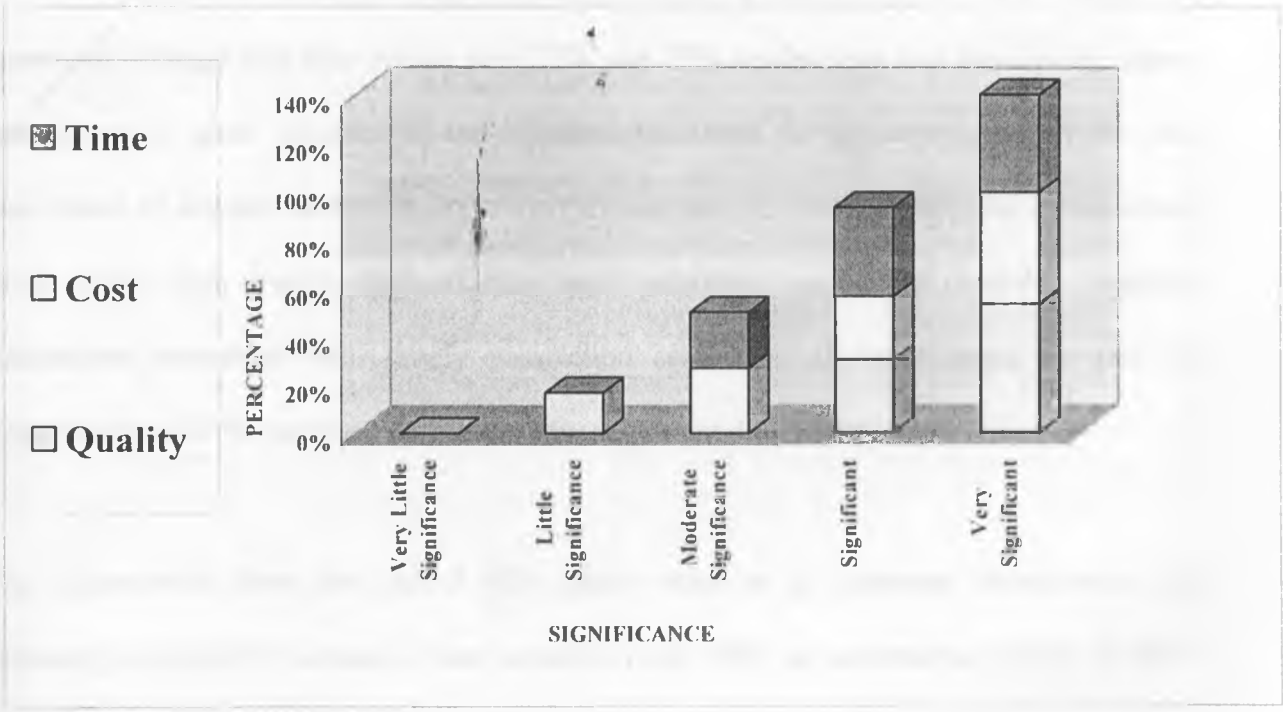

FIGURE 4.3: OPERATIONS STRATEGY

CHARACTERISTIC OF RESPONDENT	PERCENTAGE
On-Site respondents	57%
Off-Site respondents	43%

TABLE 4.1: ON-SITE AND OFF-SITE RESPONDENTS

Respondents were grouped into two categories: on-site respondents and off-site respondents. On-site respondents represented people who actively worked and were involved in site activities e.g. construction managers, project engineers. The respondents that were categorized as off-site respondents represented those who did not actively work daily on the site e.g. cost engineers, contract managers and were located at their head offices.

83% of respondents identified high quality work as a significant or very significant operations strategy that they pursue with 73% and 77% scoring cost and time on the same parameters. A good majority of the constructions firms do acknowledge therefore the importance of delivery to their customers on all competitive fronts. 80% of the construction firms scored high quality work as their most important reason for obtaining superior competitive advantage with timely completion scored by all respondents as next in importance and 83% perceived cost as the least important dimension.

The construction firms that scored high quality work as an important characteristic in obtaining competitive advantage were awarded most (90% in construction value) of their work by non-governmental clients (e.g. publicly held companies, private limited companies) and were evenly matched between competitive and negotiated awards (45% and 55% respectively). However firms that secured their work through lowest cost were mostly working for the government and were competitively awarded the works based on lowest cost.

This may be explained by the fact that the government awards work to the firms that offer the lowest cost in accordance with their procurement procedures while non-government clients will award projects based on delivery of multiple criteria i.e. quality, time and not solely cost and will in some instances negotiate award with firms that they know will deliver on this other attributes i.e. high quality.

4.2 QUALITY MANAGEMENT

QUALITY MANAGEMENT	YES	NO
Has your organisation been ISO 9001:2000 certified?	3%	97%
Has your organization adopted an in-house quality management program based on ISO 9001?	0%	100%
Have you documented / mapped processes in the organisation	3%	97%
Do you have an Employee Suggestion scheme?	0%	100%
Do you use Continuous Process Improvement within your organization as a quality improvement methodology?	3%	97%

TABLE 4.2 (A): QUALITY MANAGEMENT SYSTEM

Only 3% (or 1 of the 30 respondents) of the construction firms have obtained ISO 9001:2000 certification while none of the remaining firms have implemented an in-house quality management system. It is considered that ISO 9001:2000 can be a tool that can be used as an effective control mechanism which seeks to reduce waste and labour inefficiencies in a process so that quality in the production and delivery process can be ensured. This statement was supported by research undertaken by the Australian Construction Industry Development Agency in 1995 (Alwi *et al* 2002). The research claimed that when a formal quality management system was used by construction organizations, the cost of waste decreased significantly. The systems, based on ISO 9000 series, can aid supply logistics improvement,

particularly, through a standardization of procedures, that are in fact operational tools like suppliers selection and qualification, material quality assurance, materials and components deliveries inspection.

QUALITY MANAGEMENT	RESPONSE
The time the organization's management staff devote to quality improvement	Rarely
The time spent working with suppliers to improve their quality	Never
The effort (both time and cost) spent in preventive maintenance to improve quality	Occasionally
The effort spent on inspecting materials or completed works to detect defects?	Rarely
The effort (both time and cost) spent in providing quality related training to the organization's employees?	Never
The effort spent on problem prevention, resolution and corrective action	Rarely
The continuous inspection and scrutiny of all incoming materials and components	Rarely
The training and education of employees to enhance skills and staffing flexibility	Occasionally
The involvement of employees in resolution of problems	Rarely
What percentage of the organization's employees has quality as a major responsibility?	25%

TABLE 4.2 (B): SUMMARY QUALITY MANAGEMENT PRACTICES

The initial infusion of quality into the product requires first class incoming raw materials. Defective raw materials will render all future inputs of quality ineffective. Quality does not simply rely on the inspection of incoming raw materials, but it seeks to establish and promote long-term relationships with suppliers. Furthermore, it must have reliable equipment, committed and dedicated employees (Davidson et al, 2000).

Most striking was the lack of participation of workers in problem solving activities and the little use of systematic procedures for identifying the root cause of problems. The firms it seems may be paying only lip service to their quest for improved quality or just doing the

absolute minimum necessary to ensure compliance with customer provided specifications. The effort and resources spent and training offered in pursuing improved quality is not matched by the assertion that firms consider quality as their main source of competitive advantage. In order to realise their objective of improved quality of their products constructions firms should pursue certification with ISO standard or develop an equivalent in-house quality system procedures as a first step in improving and standardising their operations. In a study of Portuguese construction companies (Curado *et al*, 1995) the main reasons for seeking certification was given as having the ability to improve product or service quality, efficiency and productivity, customer confidence and competitive advantage. Criticism of ISO standards relates to the high level of paperwork and documentation, producing a rigid system that does not support creativity or empowerment, a standard that aims for consistency but not continuous improvement.

4.3 WASTE

CAUSES OF DELAYS	RESPONSE
Too much work was planned	Rarely
Failure in coordination of shared resources	Rarely
Prerequisite work not complete	Occasionally
Lack of required resources e.g. equipment, labour, materials	Occasionally
Unplanned change in priority	Occasionally
Design error and / or Unavailable drawings or other details	Often
Permit, Approvals, Inspections not available or carried out	Often
Contractor Submittals (method statement, designs, safety issues) not provided	Rarely
Cluttered, untidy, congested site caused by neglect of proper housekeeping	Rarely
Number of design errors / omissions / lack of clarity	Often
Number of change orders / variations	Often
Waiting for instructions	Often

TABLE 4.3: WASTE CAUSES

The firm that was ISO 9001:2000 certified measured waste and continuously sought ways of reducing waste as per the ISO guidelines. All other firms did not measure or implement measures to reduce waste. Off-site and on-site respondents showed different perceptions for the following variables, equipment frequently breaks down or is not available for work, material does not meet specification or is damaged and lack of materials on site. The results suggest that off-site respondents who do not actively work on daily activities scored waste variables higher than respondents who are involved actively on-site. The reason on why they may have scored those variables higher than other participants are, bias and misinformation by their colleagues, leading to overstating the problems. Other sources of waste were reported as never or rarely occurring. Waiting time caused by lack of design and documentation especially for site instructions (Table 4.3) has often contributed to waste, primarily arising from actions of third parties i.e. consultants.

4.4 SUPPLY CHAIN MANAGEMENT

SUPPLY CHAIN MANAGEMENT	RESPONSE
Has your organization adopted a just in time philosophy?	No
Do you subject your suppliers and subcontractors to a formal and documented pre-qualification process?	No
Do you have long-term collaborative partnerships with suppliers / subcontractors?	Yes
How consistent is preventive maintenance to equipment adhered to?	Often
Selection of subcontractors and suppliers mainly on price quoted	Often
Suppliers make late deliveries of materials and components to site	Occasionally
Inspection of all materials and components delivery to the site	Often
Receipts of poor quality of materials delivered to site that require to be returned?	Occasionally

Suppliers are able to deliver small lots to sites periodically without holding large inventory	Rarely
Consistently order similar materials from the same supplier	Often
Maintain large stocks of materials on site, allowing for safety stocks and wastage	Occasionally
Use of materials prefabricated off site in lieu of fabrication on site	Rarely
Consistently seeking to reduce the overall number of our suppliers	Rarely

TABLE 4.4: SUPPLY CHAIN MANAGEMENT

None of the companies studied adopt Just In Time (JIT) systems. JIT is a philosophy and terminology that construction industry practitioners are not familiar with. There are however some methods and tools being utilized in order to improve logistics efficiency, although not necessarily in a systemic way. The large material stocks that the firms hold on the site will usually hide problems like non-punctuality in materials deliveries, inability of the suppliers of doing deliveries in small lots and lack of knowledge of materials loss rates as is evident from firms responses on this issues. The push systems tend to increase the amount of waste e.g. excessively large inventories because they are estimate driven and include percentages to compensate for uncertainty.

Supply Chain Management, relates to the company's capacity to manage the supply chain and integrate its processes with them. Although the firms have established collaborative partnerships with suppliers it is mostly based on the lowest price, hence other considerations i.e. compete on quality, flexibility, innovativeness etc are rarely considered and suppliers are not usually subjected to a formal pre-qualification process to ensure delivery on other significant parameters like quality, time etc, hence the findings of high return rates due to poor quality. Some challenges to the evolution of a relationship between the firms and their

suppliers are, to limit the number of suppliers, not to change suppliers frequently and to establish a global qualification system.

4.5 WORK FLOW

100% of the respondents often or always managed projects by use of bar charts or network planning and therefore devoted energy and resources to planning projects and developing the schedules using bar charts that collectively tell project personnel what they should do. Project management thereafter monitors and enforces conformance of did to should. Planning at the beginning of the project is replaced by control during project. Therefore project management is only concerned with the performance of activities within the plan and not with the management of those activities or their relationship. This is a system for managing contracts and must assume that all coordination and operational issues are managed within those boundaries. Value is apparently completely defined by scope, budget and schedule. This is the traditional method of project planning.

PLANNING & CONTROL	RESPONSE
Do you measure and monitor the realization of individual tasks and assignments?	Often
All tasks and assignments are always carried out as planned	Occasionally
Continuous effort exerted towards realizing the project program or schedule as planned?	Often
Consistent effort towards identifying causes of schedule slippages and delays and pursuit of their elimination	Often
Projects completed within planned and scheduled periods	Rarely

TABLE 4.5: PLANNING AND CONTROL

In contrast all respondents never or rarely used flow planning to manage project schedules. Stabilizing the work environment begins by learning to make and keep commitments. Select assignments from workable backlog; i.e. from activities you know can be done. When this rule is not observed, direct workers inherit the uncertainty and variation of workflow we have not prevented. The result is a high percentage of non-productive time and a de-motivated work force less and less willing to fight through these obstacles.

5: RECOMMENDATIONS AND CONCLUSIONS

5.1 SUMMARY

The main body of this project has attempted to document use of lean production techniques used by the construction industry. The principles investigated were quality management, waste, workflow and supply chain management. The analysis uses empirical evidence collected in Kenya. Therefore, the study used these techniques and principles as the referential benchmark for analyzing and determining existence and improvement needs of construction practices. The analysis revealed a substandard situation in construction, shown by a low level of systemic integration of practices.

A major hypothesis set at the start of this study was that there would be empirical evidence in construction sites of lean working practices matching all four principles and leading to superior firm performances in regard to project procurement. Concomitantly with the search for lean techniques was the need to determine the degree to which construction integrated those principles in relation to the descriptions found in the literature. Again, the empirical evidence confirmed the hypothesis that construction practice lacks the systemic integration of the flow principles. In most construction firms' practices were dispersed among poor practices and frequently lacked other fundamental complementary tools.

This research has found no empirical evidence within construction practice to match lean practices and the empirical evidence showed that these were extremely scattered and poorly integrated in construction practice. Current practice is dominated by input output model and the following changes in thinking considering the peculiar nature of construction needs to be made.

5.2 NON VALUE ADDING ACTIVITIES

Concepts such as waste and value are not well understood by construction personnel. They often do not realize that many activities they carry out do not add value to the work. Waste is not only associated with waste of materials in the construction process, but also other activities that do not add value such as repair, waiting time and delays. These issues contribute to a reduction in the value of construction productivity and could reduce company performance.

The evidence gives a clear indication that waste goes beyond the waste of materials on-site, but also includes other activities that do not add value to the construction projects. By identifying the incidence of non value-adding activities during the process, construction managers are able to easily identify the best solutions and ways to apply any new technique for reducing the amount of waste, leading to increased project productivity.

5.3 LAST PLANNER SYSTEM

Control in lean construction is a matter of causing specific actions to happen. Reasons for failure to complete are identified and action taken to prevent recurrence. Look-Ahead planning or the Last Planner System under lean production is the progressive reduction of uncertainty to assure constraint free assignments are available. The result is a growing awareness that reducing variation in workflow allows both time and cost to be reduced. Time is reduced because work is more precisely matched to labour and resources, and cost is reduced because predictable workflow allows just in time delivery of prerequisite work and supplies. So lean construction manages both activities and the flow of resources between. The

delays found in the research as persistent in construction firms will therefore be reduced drastically.

5.4 IMPLEMENTING A QUALITY MANAGEMENT SYSTEM

Implementation of a quality management system often seems to be a good first step. Improve on quality by designing and improvement of processes to have low variability. Establish means for rapid detection and correction of any defect and deviation and improve the mechanism by which specifications are defined for each conversion activity.

Work processes are initially made transparent by charting them. The inherent waste in processes must be made visible through suitable measures, and targets and monitoring. Safety is an issue of concern in construction. The new production philosophy can contribute in this area. Standardized, systematized and regularized production can be expected to lead to better safety as a side effect (Kobayashi, 1990).

5.5 CONSTRUCTION INDUSTRY PECULIARITIES

Construction peculiarities refer especially to the following features and are often presented as excuses when established and useful procedures from manufacturing are not implemented in construction. Peculiarities of construction, like one-of-a-kind products, site production, temporary project organizations and regulatory intervention necessitate an industry-specific interpretation of the general principles of lean production philosophy, which currently exist only in outline. The peculiarities tabulated below violate principles of flow design and improvement, and therefore result in increasing the share of non-value adding activities.

Various operational solutions as summarized in the table alleviate control problems and improvement problems.

Peculiarity	Process control problems	Process improvement problems	Structural solutions	Operational solutions for control	Operational solutions for improvement
One of a kind	➢ No prototype cycles ➢ Unsystem atic client input ➢ Coordinati on of one of a kind activities	No repetition thus long term improvement unlikely	Minimize one of a kindness not necessary (pre-engineered solutions)	➢ Upfront requirement analysis ➢ Set up artificial feedback cycles ➢ Buffer uncertain tasks	➢ Enhance flexibility of products and services to cover a wider variety of needs ➢ Accumula te feedback information from projects executed
Site production	External uncertainties e.g. weather, geology, Complex work & material flow coordination, Changing work environment layout planning, visual controls laborious, Variability of productivity of manual labour	Difficulty in transferring improvement across sites by procedures and skills	Minimize the activities on site (prefabrication , modularization , pre-assembly)	➢ Use enclosures for eliminating external uncertainty ➢ Detailed and continuous planning ➢ Multi-skilled work teams	➢ Enhance planning and risk analysis capability ➢ Systemati zed work procedures
Temporary organization	Internal uncertainties, exchange of information Across organization borders (flow disconnects)	Difficulty of stimulating and accumulating improvement across organization borders	Minimize temporary organizational interfaces (interdependen cies)	➢ Team building during the project ➢ Clear definition of roles and interfaces (Project Quality Plan)	Integrate flows through partnerships
Regulatory intervention	External uncertainty, approval delay			Compression of approval cycle, self inspection	

TABLE 5.1: OVERVIEW ON PROBLEMS RELATED TO CONSTRUCTION PECULIARITIES AND CORRESPONDING SOLUTIONS

5.6 SUGGESTIONS FOR FURTHER RESEARCH

The challenges facing the construction industry in Kenya are surmountable. Although the industry is facing real external threats as low budgetary allocations, logging bans, environmental concerns, there exist real possibilities for improving its practices by use of lean production techniques. The construction industry in any economy is key as it provides the required infrastructure that affects all other sectors of the economy thereby unlocking potential economic activities and lowering of business costs and consequently increased economic activities.

The study was based on specific objectives and therefore had limited scope and was therefore not exhaustive. There is need for further research on the improvement of the operations function in construction industry that has been neglected by project management.

Managers in the manufacturing sector are familiar and are less averse to the implementation of new ideas and modern operations concepts in better managing their businesses as compared to their counterparts in the construction industry. Therefore there are enormous benefits to be derived from research into developing appropriate ways of introducing this holistic thinking and implementation of lean production techniques and principles among managers and workers in the construction sector.

The research showed that practitioners in the construction industry have a very narrow view of waste and waste causing mechanisms. These results in wasted resources, an occurrence a developing country like Kenya can ill afford given the lack and/or scarcity of resources. Consequently a study into the magnitude and occurrences of waste and their causes and hence their elimination or minimization would be of untold benefit to the sector and country as a

whole. A first step in obtaining a reduction of waste is for researchers to develop a workable framework for a practical and cost effective in-house quality management system for implementation by construction companies to enable them meet their customer requirements effectively and efficiently and continuously seek improvement in their operations and processes.

Project management provides an "after the event" control mechanism that is not appropriate in a dynamic, uncertain and variable environment. Planning cannot be performed in detail long before the events being planned in today's fluid and fast changing environments. Managers have to be concerned with management of production in construction i.e. recognize and manage the flows in conversion activities. There is a need to promote the awareness on the effectiveness and encourage the use of the Last Planner System to achieve higher Percent Plan Complete and therefore increase workflow on sites and realize better completion times on construction projects.

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APPENDIX 1: QUESTIONNAIRE

COMPANY PROFILE

1 Name of Construction Organisation _____

2 Title of Respondent (e.g. Project Manager) _____

3 Approximate Average Annual Construction Turnover (Kshs) over the last three years

Under 100 Million	
Kshs 100 Million to 500 Million	
Kshs 500 Million to 1 Billion	
Over Kshs 1 Billion	

4 Approximate number of employees?

	1-3	3-10	10 – 50	50 – 100	>100
Head Office (Senior Staff)					
Head Office (Other Staff)					
Site Management					
Site Staff & Workers					

A. OPERATIONS STRATEGY

5 What is the attitude and focus of your organisation towards the following attributes?
(Anchored by 1 = Very little significance 3 = Moderate, and 5 = Very significant)

	1	2	3	4	5
Quality (Performance to quality as specified)					
Cost (Performance of projects within budget)					
Time (Completion of projects within stipulated delivery periods)					

B. PERFORMANCE MEASURES

PROJECTS

6 Rank the following factors according to importance in aiding your organization to secure contracts?
(Ranked as follows; 1 – Most Important, 2 – Next in Importance, 3- Least Important)

Lowest Cost	
High quality work	
Speedy completion	

7 Please state the number of contracts you have performed for the following clients in the period 2000 – 2004?

	Nil	1-3	>3
Government or Local authorities			
Publicly held companies			
Private companies			
Others (Specify_____)			

8 How were the above contracts secured by your organization?

	Nil	1-3	>3
Competition			
Negotiated			

9 Please state the approximate number of projects of the following approximate values you have performed in the period 2000 – 2004?

	Nil	1-3	>3
More than 500 Million Shs			
Between 500 and 100 Million Shs			
Between 100 and 10 Million Shs			
Less than 10 Million Shillings			

CUSTOMER SATISFACTION

10 Do you measure customer satisfaction based on your performance? Yes ☐ No ☐

(Anchored by 1 = Never / None 2=Rarely, 3=Occasionally, 4=Often, 5=Always / A great deal)

	1	2	3	4	5
11 How much effort (time and cost) is directed towards obtaining feedback on your performance from customers?					
11 How much effort (time and cost) is directed towards attending to customer complaints?					
12 How much effort is directed to delighting your customer with your performance? (Carrying out activities beyond what is required or providing extra services than is stipulated to more than just satisfy your clients)					

C. QUALITY MANAGEMENT

14 Has your organisation been ISO 9001:2000 certified?	Yes ☐	No ☐
15 Has your organization adopted an in-house quality management program based on ISO 9001?	Yes ☐	No ☐
16 Have you documented / mapped processes in the organisation	Yes ☐	No ☐
17 Do you have an Employee Suggestion scheme?	Yes ☐	No ☐
18 Do you use Continuous Process Improvement within your organization as a quality improvement methodology?	Yes ☐	No ☐

(Anchored by 1 = Never / None) , 2=Rarely, 3=Occasionally, 4=Often, 5=Always / A great deal

	1	2	3	4	5
19 The time the organization's management staff devote to quality improvement					
20 The time spent working with suppliers to improve their quality					
21 The effort (both time and cost) spent in preventive maintenance to improve quality					
22 The effort spent on inspecting materials or completed works to detect defects?					
23 The effort (both time and cost) spent in providing quality related training to the organization's employees?					
24 The effort spent on problem prevention, resolution and corrective action					
25 The continuous inspection and scrutiny of all incoming materials and components					
26 The training and education of employees to enhance skills and staffing flexibility					
27 The involvement of employees in resolution of problems					

28 What percentage of the organization's employees has quality as a major responsibility? _____ %

D. SUPPLY CHAIN MANAGEMENT

29 Has your organization adopted a just in time philosophy?	Yes		No	
30 Do you subject your suppliers and subcontractors to a formal and documented pre-qualification process?	Yes		No	
31 Do you have long-term collaborative partnerships with suppliers / subcontractors?	Yes		No	

(Anchored by 1 = Never / None , 2=Rarely, 3=Occasionally, 4=Often, 5=Always / A great deal)

	1	2	3	4	5
32 How consistent is preventive maintenance to equipment adhered to?					
33 Selection of subcontractors and suppliers mainly on price quoted					
34 Suppliers make late deliveries of materials and components to site					
35 Inspection of all materials and components delivery to the site					
36 Receipts of poor quality of materials delivered to site that require to be returned?					
37 Suppliers are able to deliver small lots to sites periodically without holding large inventory					
38 Consistently order similar materials from the same supplier					
39 Maintain large stocks of materials on site, allowing for safety stocks and wastage					
40 Use of materials prefabricated off site in lieu of fabrication on site					
41 Consistently seeking to reduce the overall number of our suppliers					

E. WASTE AND VALUE LOSS

42 Do you measure occurrences and amount of wastage on project sites Yes ☐ No ☐

43 How do you perceive the occurrences of various categories of waste causes across recent projects your company executed?

(Anchored by 1 = Never / None, 2=Rarely, 3=Occasionally / Moderate, 4=Often, 5=Always / A great deal)

		1	2	3	4	5
a	Number of defects					
b	Waste caused by reworking defects					
c	Number of design errors / omissions / lack of clarity					
d	Number of change orders / variations					
e	Excess consumption of materials					
f	Lack of materials on site					
g	Lack of supervision					
h	Material does not meet specification or is damaged					
i	Equipment frequently breaks down or is not available for work					
j	Waiting for instructions					
k	Continuously seek ways of ensuring that wastage on sites is minimized?					

F. WORK FLOW

(Anchored by 1 = Never / None, 2=Rarely, 3=Occasionally / Moderate, 4=Often, 5=Always. A great deal)

		1	2	3	4	5
44	Do you manage projects by use of Network Planning (Bar Charts or CPM)?					
45	Do you manage projects by use of Flow planning (Look Ahead Schedule or Last Planner System)?					
46	Do you measure and monitor the realization of individual tasks and assignments?					
47	All tasks and assignments are always carried out as planned					
48	Continuous effort exerted towards realizing the project program or schedule as planned?					
49	Consistent effort towards identifying causes of schedule slippages and delays and pursuit of their elimination					
50	Projects completed within planned and scheduled periods					

51 How often do you experience incomplete or delayed tasks or assignments (by due date) caused by

(Anchored by 1 = Never / None, 2=Rarely, 3=Occasionally / Moderate, 4=Often, 5=Always / A great deal)

1	2	3	4	5

(a) Too much work was planned
(b) Failure in coordination of shared resources
(c) Prerequisite work not complete
(d) Lack of required resources e.g. equipment, labour, materials
(e) Unplanned change in priority
(f) Design error and / or Unavailable drawings or other details
(g) Permit, Approvals, Inspections not available or carried out
(h) Contractor Submittals (method statement, designs, safety issues) not provided
(i) Cluttered, untidy, congested site caused by neglect of proper housekeeping

APPENDIX 2: LIST OF CLASS "A" CONTRACTORS AS AT OCT. 2000

	Reg.	Name	Box	Directors	Ownership	Town
1	4655	Aler Limited	25233	Jacob Atler	Non Citizen	Nairobi
2	1578	Ajanta Investment	47899	J V Patel	Non Citizen	Nairobi
3	3519	Albany Management Construction Group	18000	Kishan Singh Gehlot	Non Citizen	Nairobi
4	392	Alcon International Ltd	47160	Hanspal I S	Non Citizen	Nairobi
5	1143	APV Hall Equatorial Ltd	30663	JRD Kidd, B Wilson	Non Citizen	Nairobi
6	400	Aqua Plumbing	46388	Ramji Halai	Non Citizen	Nairobi
7	5767	Arctic Construction Ltd	57694	Machira Njeru	African	Nairobi
8	5977	Aristocrats Concrete Limited	30118	Joseph Schwartman, P M Patel	Non Citizen	Nairobi
9	61	Atlas Plumbers (K) Ltd	10661	Bhanderi S V	Citizen	Nairobi
10	4755	Baccara Enterprises Ltd	28246	PK Baber	NA	Nairobi
11	2893	Berta Limited	59642	BA Ali / B Okudo	African	Nairobi
12	547	Bhudia Construction Ltd	85752	KH Patel / RD Patel	Non Citizen	Nairobi
13	5088	Bieco (Singapore) Development Pte Ltd	76187	Ding Yan Wang Jiaming	Non Citizen	Nairobi
14	3392	Birdi Civil Engineering	58223	AS Birdi / JS Birdi	Citizen	Nairobi
15	1062	Bomco Building Contractors Ltd	18249	CS Devgun / BS Devgun	Citizen	Nairobi
16	1963	Broadways Construction Ltd	46695	MS Chandry	Citizen	Nairobi
17	177	Capital Construction Co Ltd	30604	HS Panesar / SS Rehal	Citizen	Nairobi
18	26	Carpentocraft Building Contractors		NN Patel	Non Citizen	Nairobi
19	836	Castle Engineering & Construction Co Ltd	31161	AS Sandhu / DS Birdi	Non Citizen	Nairobi
20	2670	Cementation Contractors Ltd	32802	MR Patel / BA Chaudhary	Citizen	Nairobi
21	538	Cementers Limited	42426	KV Jetha / RK Vishram	Non Citizen	Nairobi

	Reg.	Name	Box	Directors	Ownership	Town
22	832	Chania Builders Ltd	10778	SL Patel / HL Patel	Non Citizen	Nairobi
23	5523	Chao Yang Trade Company	21589	Dong Xiuxin	Non Citizen	Nairobi
24	3914	Charansons Ltd	12437	PS Virdi / RS Virdi	Citizen	Nairobi
25	3443	Chebon Contractors Ltd	125	JK Cheboy	African	Kabarnet
26	6090	China Chengdu Overseas Dept Ltd	16567	Ding Rongxiang	Non Citizen	Nairobi
27	5934	China Fashun Number One Building Engineering Company	14385	Yang Liwei	Non Citizen	Nairobi
28	5836	China Gleco (EA) Ltd	19805	Xie You Gao Wei	Non Citizen	Nairobi
29	5918	China Huashi Enterprises Corp	19489	Huang Xiao Quan	Non Citizen	Nairobi
30	4920	China National Overseas Engineering Corp	47030	Wang Ming Po	Non Citizen	Nairobi
31	2832	China Sichuan Corporation	19666	Ding Changhe Wang	Non Citizen	Nairobi
32	5553	China Suzhow International	63415	Ziu Xiao Hone Ge Wang	Non Citizen	Nairobi
33	596	Clearspan Construction (A) Ltd	83767	AJ Dickinson	Non Citizen	Mombasa
34	3043	Coast Projects Ltd	87532	P Francescon	Non Citizen	Mombasa
35	930	Coast Kenya Enterprises	46925		Citizen	Nairobi
36	1142	Comecons	18429	HS Bhangra PS Bhangra	Citizen	Nairobi
37	5711	Construction Engineers & Builders (k) Ltd	28321	Ak Kegode, P Singh	African	Nairobi
38	63	Continental Buiders	41845	KS Roopra / HS Roopra	Citizen	Nairobi
39	850	Coronation Builders	41593	R Rahman / B Singh	Citizen	Nairobi
40	5152	Crescent Construction Company	49094	Mohammed Anwar, K Ashraf	Non Citizen	Nairobi
41	4372	Cyperr Projects International	73179	S Jirongo / GD Patel	Citizen	Nairobi
42	1393	D Manji Construction	22841	DM Patel / HD Patel	Non Citizen	Nairobi
43	44	Danny Construction	49057	DR Patel / RR Bhudia	Non Citizen	Nairobi
44	1010	Deweto Kenya Limited	43239	Edmon Van Tongereno, FN Namoya	Citizen	Nairobi
45	2426	Dhanjal Brothers Ltd	82909	JS Dhanjal / BS Dhanjal	Citizen	Nairobi

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46	442	Dien Builder Ltd	11366	Ngugi Mugo / Kimani Mugo	African	Nairobi
47	5946	Dillingham Construction International	74358	WR Catin / WL Higgins	African	Nairobi
48	5300	Dimken Kenya Limited	12473	DM Githanga	African	Nairobi
49	151	Dinesh Construction	49057	KB Patel / Sr Halai	Citizen	Nairobi
50	1037	Donwoods Company Limited	73667	DK Mwaura / J Wangunyu	African	Nairobi
51	2594	Draft & Develop Engineers	28862	Pk Mwangi	African	Nairobi
52	1647	Epco Builders Ltd	55628	RD Varsani	Citizen	Nairobi
53	1633	Ernie Campbell & Co Ltd	47284	PL Halai / ML Halai	Non Citizen	Nairobi
54	849	Facta Construction Company	42337	GB Rocca / AK Kiptanui	Non Citizen	Nairobi
55	3091	Fairclough International Construction Ltd	60404	R Barber / D Green	Non Citizen	Nairobi
56	2754	Firoze Construction Ltd	46448	M Bashir / S Farooq	Non Citizen	Nairobi
57	1916	Franvi Construction Co	70084	FK Gathuo	African	Nairobi
58	938	C Campagnola	14340	C Campagnola	Citizen	Nairobi
59	2246	G Issaias & Co	43500	N Zannetos / P Issaias	Non Citizen	Nairobi
60	570	Gachara GG	43989	GG Gachara	African	Nairobi
61	3991	Gajipara Builders	1009	RH Patel	Citizen	Nakuru
62	5942	Gasjo Construction Ltd	75523	G Sarapay / D Muteru	African	Nairobi
63	5247	Grey Rock Limited	56032	SM Ethanatha	African	Nairobi
64	5710	Guangxi Int' Construction Engineering Co	76984	Zhao Yong	Non Citizen	Nairobi
65	84	H Young & Company	30118	Norman William Jamblin	Non Citizen	Nairobi
66	1403	HZ & Company	74358	G Zeevi	Non Citizen	Nairobi
67	5917	Hanan International Ltd	47030	Li Shong / Shen Shenguo	Non Citizen	Nairobi
68	3429	Haricons (K) Limited	70884	GD Patel / HD Patel	Citizen	Nairobi
69	3012	Hayer Bishan Singh & Sons	253	CS Hayer / GS Hayer	Citizen	Kisumu
70	225	Hirani Construction Co Ltd	40239	KMR Hirani / NK Hirani	Non Citizen	Nairobi

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71	4224	Hojgaard & Schaltz A/S	43238	PE Hansen / Jorgen Mejiholm	Non Citizen	Nairobi
72	1557	Indus Construction Limited	55047	MM Ratna / PM Ratna	Citizen	Nairobi
73	3041	Industrial Contractors & engineering Ltd	53870	NA	African	Nairobi
74	4049	Ingram Construction & engineering	44941	na	Non Citizen	Nairobi
75	3218	Intex Construction Ltd	60293	PS Tak / VH Dave	Citizen	Nairobi
76	2786	Intime Limited	40408	A Medirata / H Medirata	Citizen	Nairobi
77	66	Jadva Mulji & Sons	32034	MJ Mulji	Non Citizen	Nairobi
78	2431	Jambo Construction Company	2482	JC Kariuki	African	Kisii
79	5572	Janki Enterprises Ltd	734 Nbi	MV Patel / VV Patel	Citizen	Nairobi
80	1607	Jina Ramji & Company	46488	SJ Patel / Ramesh Chandra	Citizen	Nairobi
81	219	Jina Ratna Contractors	40812	PJ Ratna / KJ Ratna	Citizen	Nairobi
82	4574	Jipsy Civil & Building Contractors	58824	JR Ngacha	African	Nairobi
83	201	K Naran Builders	31357	K Naran / R Naran	Citizen	Nairobi
84	74	KS Kalsi & Sons	10766	Singh Kalsi	Non Citizen	Nairobi
85	3523	Kargua (K) Construction Co	60893	Katugu Guandai	African	Nairobi
86	4286	Kariuki Construction Co	70220	Julius Kariuki Ngugi	African	Nairobi
87	4919	Karsan Murji & Co Ltd	40900	Devshi Ramji Patel	Citizen	Nairobi
88	422	Katar Singh Nyeri Ltd	5	MS Sokhi / JS Sokhi	Citizen	Nyeri
89	747	Karuri Civil Engineering Limited	32126	JM Kaiuki / P Kariuki	African	Nairobi
90	858	Kay Construction Co	43114	KK Patel / DK Patel	Citizen	Nairobi
91	597	Kaydee Construction Co	81141	KD Patel / DK Patel	Citizen	Mombasa
92	3239	Kentract Construction & CE Co	40583	na	Citizen	Nairobi
93	831	Kilimanjaro Construction Ltd	48663	KN Patel / JG Kanyokoh	Citizen	Nairobi
94	3030	Kilombe Contractors Ltd	2690	JK Kimetto / PK Rotich	African	Nakuru
95	2140	Kirethi Gen Coontractors Co Ltd	52542	D Muthoga	African	Nairobi
96	224	Kirinyaga Construction Ltd	48632	EM Maina	African	Nairobi
97	182	Kishen Singh & Sons	446	G Singh	Citizen	Nakuru

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98	393	Kishore Construction Ltd	43598	GS Hirani	Citizen	Nairobi
99	3549	Kitek Limited	65582	Sk Kimani / JK Kimani	African	Nairobi
100	5539	Konoike Construction Co	59236	T Matsumoto / H Yoshi	Non Citizen	Nairobi
101	3524	Kundan Singh Construction Limited	15018	KS Ubhi / AS Ubhi	Citizen	Nairobi
102	631	Kurji Ramji & Co Ltd	48139	Kurji Ramji / Nk Patel	Citizen	Nairobi
103	2177	Kuverji Govind Patel Ltd	45	MK Patel / KG Patel	Citizen	Nyeri
104	3018	LZ Engineering Construction	60366	S Hewett Arthur Eastwood	Non Citizen	Nairobi
105	4058	Lagi Enterprises	57013	P Kinyanjui / L Gichuki	African	Nairobi
106	69	Lalji Bhimji Sangani	10286	LB Sanghani	Non Citizen	Nairobi
107	403	Lalji Meghji Patel & Co	48514	PM Patel / PP Patel	Non Citizen	Nairobi
108	6063	LangMark Holdings Ltd	66537	MS Sethi	Citizen	Nairobi
109	402	Latis Construction	46334	Titus Kitara	African	Nairobi
110	646	Laxmanbhai Construction Ltd	44706	LB Raghuani / PK Karsan	Non Citizen	Nairobi
111	1912	Lima Limited	18346	Kn Biwott / F Addly	African	Nairobi
112	546	MR Shah Construction Company	10351	MR Shah / KK Chandaria	Non Citizen	Nairobi
113	147	MS Sian & Company	40869	S Kaur / JS Sian	Non Citizen	Nairobi
114	1090	Magic General Contractors	28548	B Mbaria	African	Nairobi
115	638	Mahavir Construction Co	41350	DM Patel	Citizen	Nairobi
116	4788	Main Building Construction Co	83833	KS Main / FS Main	Non Citizen	Mombasa
117	3822	Makwata Construction & engineering Co	53992	P Makwata / P Ododa	African	Nairobi
118	242	Manjit Building Contractors	1630	HR Rehal	Citizen	Kisumu
119	3305	Maridadi Building Contractors Ltd	43518		Non Citizen	Nairobi
120	2678	Maru Construction Limited	42840	KV Maru	Citizen	Nairobi
121	2850	Mascon Limited	48524	F Dicaro	Non Citizen	Nairobi
122	3503	Masosa Construction Limited	3067	MO Mogere	African	Kisii

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123	4313	Matic General Contractors Ltd	60920	Sk Mburu / OW Kinyanjui	African	Nairobi
124	548	Mavji Construction Co Ltd	84452	M Ratna / BM Ratna	Citizen	Mombasa
125	3341	Mavji Devji Patel & Company	49816	MD Patel / SM Patel	Non Citizen	Nairobi
126	3291	Megdev Construction Ltd	75655	Devraj Karsan Varsani	Non Citizen	Nairobi
127	1628	Meghjibhai Pancha & Co	41319	NR Gopal / VD Pindoria	Non Citizen	Nairobi
128	1517	Miharati Investment Co	59018	GG Kamatu	African	Nairobi
129	4510	Minikin Services Ltd	8481 Nbi	HP Rabadia / MJ Gohil	Citizen	Nairobi
130	1082	Mistry Jadva Parbat & Co Ltd	90643	MJ Parbat /	Citizen	Mombasa
131	551	Mistry Verji Shamji & Co Ltd	83285	DV Halai	Non Citizen	Mombasa
132	629	Model Builders	10489	HS Bhogal / JS Bhogal	Non Citizen	Nairobi
133	5282	Mondola Limited	39462	MS Chandry	Citizen	Nairobi
134	954	Mowlem Construction Co Ltd	30078	PL Poppy / Rh Vincent	African	Nairobi
135	2249	Mugoya Construction & engineering Co Ltd	47011	James Mugoya Isibirye	African	Nairobi
136	447	Mulji Devraj & Brothers	82261	HK Halai / KR Halai	Non Citizen	Nairobi
137	80	NK Brothers	10709	Pravin Chandra / Mavji Govind	Citizen	Nairobi
138	1459	Naciti Engineers Ltd	73196	F Mwaura /	African	Nairobi
139	1705	Ndugu Transport Co Ltd	940	HS Sembi / C Omboyo	Citizen	Kisumu
140	2700	Neliwa Builders & Civil Engineers Ltd	51337	JC Muchai / SM Muchai	African	Nairobi
141	5151	New Baron Leveque Intl' Ltd	NA	P Pairous	Non Citizen	Nairobi
142	4201	New Con Building Construction Co Ltd	18485	PS Bhangra	African	Nairobi
143	1531	Njama Construction Engineering Builders Ltd	52399	FN Githiari / J Macharia	African	Nairobi
144	4	Njuguna Builders & Plumbers Drain Layers Ltd	53621	JM Gitau	African	Nairobi

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145	1648	Njuka Consolidated Co Ltd	55	P Wachira / M Macharia	African	Makuyu
146	1013	Nyakio General Contractors Ltd	63053	Wilson Mwangi	African	Nairobi
147	258	Okeno & Sons Building Contractors	1307	R Okeno	African	Kisumu
148	214	Nyoro Construction Company Ltd	74416	J Njuguna / S Njuguna	African	Nairobi
149	3723	Oropoi Building & General Contractors	95	R Kagicha / P Kariuki	African	Lodwar
150	1046	P & C Ltd	47384	HA Vincent / SW Allison	Non Citizen	Nairobi
151	561	Pan African Builders	18837	SK Patel / KM Patel	Non Citizen	Nairobi
152	3346	Panafcon Engineering Limited	22484	P Moi / J Njuguna	African	Nairobi
153	674	Parkash Building & Construction	236	BS Varma	Citizen	Thika
154	4672	PEC Company (K) Ltd	30292	Duan Chang Guo	Non Citizen	Nairobi
155	2176	Patrick Thuita Ndegwa & Sons	48	PT Ndegwa	African	Naro Moru
156	1784	Pelican Engineering & Construction Co Ltd	18755	Mike Maina	African	Nairobi
157	3034	Pwani Fabricators	88734	H Haji	African	Mombasa
158	1605	Ramji Ratna & Company	31990	NS Pindoria	African	Nairobi
159	4494	Ramji Shamji & Sons	80982	NR Patel	African	Mombasa
160	799	Raw Construction Ltd	49087	VL Gopal / DL Gopal	African	Nairobi
161	4389	Rosbang Construction Ltd	54846	BS Bhangu / MM Ouma	Citizen	Nairobi
162	1979	Royal Construction Ltd	3307	Av Shah / S Singh	Citizen	Eldoret
163	3076	Ruaha Concrete Co Ltd	18129	HS Sethi	Citizen	Nairobi
164	371	Sajjan Building Contractors	949	BS Bhambra	Non Citizen	Webuye
165	1950	Salama Construction Co Ltd	48196	MK Merali	Citizen	Nairobi
166	9	Samuel Muchai & Sons	566	Samual Muchai	African	Eldoret
167	5102	Sanaka Engineering & Construction Co	55837	N Osiemo / M Vadgama	Non Citizen	Nairobi
168	6125	Sanober Ltd	13639	AH Niaz	Non Citizen	Nairobi
169	3075	Seyani Brothers Co	60070	KK Seyani	Non Citizen	Nairobi
170	4987	Sebhan Enterprises Ltd	18485	PS Bhangra / HS Sethi	Citizen	Nairobi
171	738	Shiv Construction Company Ltd	2140	S Virji	Citizen	Nairobi

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172	2608	Sicon Construction Company Ltd	73898	J Muriuki	African	Nairobi
173	6036	Siesta Investments Ltd	21313	VS Patel	Citizen	Nairobi
174	4786	Sino Construction (A) Ltd	17982	T Mibei	Non Citizen	Nairobi
175	3061	Skanska International	61436	LB Ekman / EA Ericsson	Non Citizen	Nairobi
176	2922	Sobea	39367	Y Moulin	Non Citizen	Nairobi
177	3180	Soteen Limited	42476	R Moi / V Patel	African	Nairobi
178	2847	Spencon Services Ltd	14294	NP Sharma	Non Citizen	Nairobi
179	3486	Stirling Civil Engineering (K) Ltd	40770	S Antao / J Brennan	Non Citizen	Nairobi
180	530	Tara Singh	254	T Singh / S Singh	Citizen	Nyahururu
181	5062	First Highway Engineering Corp	38982	Sun Daquan / Chen Xiooli	Non Citizen	Nairobi
182	2544	Great Rift Valley Construction Co	59535	J Ojwang / P Lwande	Non Citizen	Nairobi
183	6171	Home Rectifiers	22108	M Gechau / E Deasi	African	Nairobi
184	2647	Thongire Constructin Co	40158	DN Karago	African	Nairobi
185	3574	Tradewise Limited	49492	PK Waruhiu / Thakrar	Non Citizen	Nairobi
186	640	Town Construction	10449	HK Patel / DA Omari	Non Citizen	Nairobi
187	64	Universal Furniture & Building Contractors	45695	C Singh / H Singh	Non Citizen	Nairobi
188	1453	VK Construction	11949	VK Patel / VV Patel	Non Citizen	Nairobi
189	1556	Vakkep Building Contractors	42147	Vishram R Halai	Non Citizen	Nairobi
190	163	Varsani Construction Co	11241	MV Varsani / NA Gopal	Citizen	Nairobi
191	70	Victory Construction Co Ltd	45329	A Suri / Gian Suri	Citizen	Nairobi
192	2247	Vishva Builders	1267	RD Vekaria / KN Halai	Citizen	Eldoret
193	45	W Greenhut Construction Co Ltd	43078	W Greenhut	Citizen	Nairobi
194	2341	Warren Enterprises Ltd	48139	J Schwartzman / J Kanyotu	Non Citizen	Nairobi
195	2979	Zakhem Construction	41196	IS Zakhem	Non Citizen	Nairobi
196	1134	Zenith Steel Fabricators Ltd	18134	JV Gohi / A Bivji	Citizen	Nairobi