ADVANCED MANUFACTURING TECHNOLOGIES IN KENYA: THE CASE OF AGRO-BASED INDUSTRIES

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DECLARATION

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

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This research project has been submitted for examination with my approval as the University Supervisor.

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DEDICATION

To my dear parents, brothers and sisters

for their love and support.

To my mother for her inspiration with which I have come this far.

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ABSTRACT

The world is rapidly changing to become a global village, which is necessitated by the advancement in information and communication technology. These days business is done online with the production and procurement being monitored on real time basis. The manufacturing firms have taken the challenge in technology by embracing the latest developments in the production systems.

This research was carried out to identify to what extent the advanced manufacturing technology has been adopted by Kenyan manufacturing firms. The scope of the study included identifying what types of technologies are available in the market and the benefits the organisations are deriving from them. The barriers preventing manufacturers from adopting these technologies were also identified. The research reports the findings from the food processing, beverage and tobacco sectors. From the findings, it was identified that Kenyan manufacturing firms are responding to the changes in technology by adopting the latest manufacturing technologies. These include Computer Aided Manufacturing, Computer Integrated Manufacturing Computer Aided Manufacturing among the available technologies. However it was identified that the scope of the adoption is quite low. The respondents singled out government policies, monopolies and ownership structures as the main barriers of adopting these technologies.

The scope of the research have enlightened the practices in the manufacturing firms and further gives some areas of possible research being on the integration of information and communication technologies with the production practices.

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1.0 Introduction

1.1 Background

The new manufacturing environment is characterised by intense global competition, rapid technological changes and product variety proliferation (Heim 1992). Organisations are striving to maintain product leadership through provision of quality products, at minimum production cost at the right time to the customer.

In the past, organisations focused in the production and economies of scale. This is because there was no stiff competition and each firm could easily differentiate its products. As the evolution of manufacturing continued, it became evident that there was need to review how the business was being done. Towards this end, organisations started adopting ways and means on how to improve their performances. High quality and efficiency were the necessary conditions for being competitive. As the dynamics of the business changes, manufacturers must be able to develop and produce customised products rapidly. This is the focus as the industries move from the industrial age to the information technology age (Sahay, 2001). Initially industries developed by how well they would capture the benefits of the economies of scale. This resulted from the concept of how much they would cut the costs of production and improve on the quality of the products manufactured. Successful companies incorporated the technological developments in the production of the physical assets that offered mass production of standard products (Skinner, 1969).

The emergence of the global market forced organisations to realign their manufacturing processes to enable them compete effectively. This was necessitated by the presence of stiff competition locally and as such organisations had to seek a wide market in which to do business (Ghalayini, 1996). These markets have different requirements and consumers as well. These demanded that the producers had to be able to efficiently and effectively deliver the products. To manage the demands, there was need to realign the manufacturing strategies and as such be flexible enough to accommodate the particular needs of the markets. This was the origin of the various manufacturing strategies, which would generate the required results. Many of these manufacturing strategies have been implemented in the manufacturing environment as well as in the service industry. This have spanned from the total quality management, Frederick Taylor's scientific approach to the most recent ones including Just in time production and reengineering. Each of these approaches has had its benefits to the organisations as well as its demerits. Many have focused in the approach of perfecting a particular approach, which has certainly proved beneficial and segmented the industry concerned as a leader. With the development of technology, which is fast paced, organisations cannot solely rely on these approaches without combining several of these operations strategies.

This is what has lead to the new wave manufacturing strategies in which each organisation is not only striving to be good as the competitor but to be the best in the particular industry. With the global competition all over the world, there is need to realign business strategies to be able to have a

competitive advantage over the other players. Many have adopted the approach of having the best management styles, team based production industries, real time analysis as well as the latest technology use in the production lines (High, 1997).

All these have improved the production efficiencies but we cannot compare industries from different economies to effectively compete on the same grounds. This is necessitated by the difference in the operating parameters in the specific locations. These include the economic stability, political environment, geographic locations as well as the particular products being made. The industry should be flexible enough to adapt to the particular changes that are happening. To be able to achieve this, they need to have the best technologies to facilitate these changes. They range from how fast will the data be acquired, the methods of measurement, the mode of production delivery as well as customer response. This can only be the best if the organisation has the most efficient and effective apparatus to facilitate this. These instruments are the products, the people and technology, (Ariss, 2000).

To be able to stay on the competitive edge, organisations have to adopt the latest process technology, have the best management styles and superior products (Schonberger, 1991).

The industrialised countries have gained competitive advantage over the developing countries through the use of superior manufacturing technologies that have improved on the quality of the products, the production costs and the lead times. Japan spearheaded this approach

using operations strategies such as the total quality management, Just in time and lean production (Dahlhaard, 1999).

1.2 Statement of the problem

As Kenyan organisations shift from the *industrial age,* where mass production was the key success factor into the *information age,* where flexibility is the key driver, then there is need to explore what impact the technology has had on the existing processes and how well have they been adopted. Advanced manufacturing technologies are instrumental for organisations to maintain their competitive advantages. Good management styles, the environment and the people employed contribute to the market leadership of organisations. Superior process performance is achieved by a superior design, the right people to perform it and the right environment (Hammer, 1996).

Previous studies conducted in Kenya have not addressed the issue of adoption of advanced manufacturing technologies and this study will analyse the gap created by the rapid development of manufacturing technologies. This survey will explore the extent advanced manufacturing technologies have been adopted in the Kenyan manufacturing firms.

1.3 Objectives of the study

The main objectives of the study are to explore:

- The position of advanced manufacturing technology in Kenya's manufacturing sector.
- Barriers on the use of advanced manufacturing technology in Kenya.
- Contribution of advanced manufacturing technologies towards manufacturing process improvement.

1.4 Importance of the study

The results to be generated from the study will be important to the manufacturing organisations. They will form a basis for comparisons while doing their investment decisions in the new equipment.

The findings of the survey will constitute an analysis of the problems encountered in the adoption of the advanced manufacturing technologies and will be of importance to government decision makers who can use the results in improving the business environment.

2.0 Literature Review

2.1 Operations strategies and competitiveness

A strategy is the direction and scope of an organisation over the long term, which achieves advantage for the organisation through its configuration of resources within a changing environment to meet the needs of markets and to fulfil stakeholder expectations (Johnson and Scholes, 1999). The organisation's corporate strategy must be aligned with both the business and operations strategy.

Operations strategy is the effective use of production capability and technology for achieving business and corporate goals (Kim, 1993).

These goals include profit, innovations, customisations, product flexibility, product reliability, quality, response, delivery reliability and after sales service (Meredith, 1992).

In order for an organisation to remain competitive, it has to implement strategies that facilitate the growth of the company. Organisations succeed in their business by implementing best practices to improve their competitiveness. They have always focused on the aspect of being as good as the competitors. This has always been triggered by the fact that manufacturing process has not been viewed as an area of competence and there was no alignment of the operations strategy with the corporate strategy. Over time this has changed and the focus has shifted to the area of being the best. Burgess (2000) argues that firms competing in the current environment need to implement the correct choice of operations strategies to provide considerable competitive advantage. Firms need to combine the components into a unique blend which optimises all areas of

the firms operations. According to Prokesch (1993), the secret of being ahead of competition lies with creativity and innovation, which involves introduction of new products, their review and redesign.

2.2 Best operating practices and operations strategies

To achieve the world class status organisations employ different strategies. The best operating practices are put in place to assist in the gaining of this status. A number of operational strategies are employed all at the same time. This could include TQM, JIT production, and computer aided manufacturing et al. Each of these strategies leads to particular outcomes e.g. JIT leads to efficient delivery, TQM improves on quality (Ahmed, 1996).

The manufacturing organisations today face an array of choices and challenges. The competitive environment for manufacturing firms has led to a process of downsizing paired with technology adoption with the hope of increasing chances of success in the market place.

In the new manufacturing environment it is not possible to compete only on the basis of costs without paying attention to other consumer preferences. New strategies focus to reacting to the dynamic marketplace where increased competition and globalisation have greatly affected the distribution of market share and profit margins. World class manufacturing tries to get the best approaches from each strategy and comes with a basis of manufacturing approach. Organisations that adopt this strategy strive to be the best along their own production schemes. They go further than matching or being as good as to being the best and all the times

make adjustments to sustain the leadership. The manufacturing excellence is attained through a combination of several approaches (Worley, 1996).

2.3 Technology in Manufacturing

The technological choice, which is evolutionary in nature, depends on the prevailing technological development in the industry and adoption by firms to achieve competitive capabilities in the areas of product design, manufacturing, and testing. Advanced manufacturing technologies is defined as a group of integrated hardware- and software-based technologies designed to improve the efficiency and effectiveness of the firm in manufacturing a product. This is seen through the developments in the computer revolution whereby the transactions are conducted in real time nowadays (Kutschker, 1994).

Excellence in manufacturing is one of the drivers of success. This due to perfect measurement, real time analysis, advancement of design process and co-ordinated operations. This has helped improve the customer satisfaction. Ignoring technological developments is like doing away with the core competencies. Although technology provides an advantage in the production function, there are some failures as a result of its use. The problems are as a result of managers' failure to match the companies manufacturing control approach to the overall organisational structures and corporate goals (Miller, 1981).

Methe (1991) notes that the use of industrial computer networks have changed the approach towards manufacturing and significantly contributed to process improvement.

2.3.1 Co-ordinated Manufacturing

Global competition has put pressure to reduce the cost of production. Cost-quality improvement through co-ordinated manufacturing ensures that organisations reduce the cost of production while at the same time improving the quality of the products and all aspects of customer service (Harrison, 1998). Strategies employed to achieve this are just in time production as well as overall quality improvement programs. Co-ordinated manufacturing is the use of the available technology to ensure that all activities are properly aligned. The emergence of real time production and automated machines has greatly contributed to this (Sahay, 2001).

Kenyans firms borrow much of the technology from the developed world. These trend shows that the industries based in Kenya are lagging in terms of technology transfer. The Multinationals operating in Kenya use technologies which have been implemented in other production sites.

2.3.2 Concurrent Engineering

Concurrent engineering addresses the issues arising from continual improvement. Cost quality improvement through concurrent engineering uses integrated teams that bring together product design, engineering and manufacturing (Harrison, 1993).

The manufacturability, packaging, distribution, marketing research and development are all addressed here. This approach ensures everything is co-ordinated through the use of multidisciplinary teams to come up with

ideas and products which get customer satisfaction and at the same time delivering quality products (Ghalayini, 1996).

2.3.3 Order Cycle

Customers needs are changing day by day and the need for the recognition of their particular needs is ever increasing. This has prompted the manufacturers to change their approach and focus on the particular needs. There is need to customise the products developed to the needs of the customers. This is more predominant in industries where the customer normally specifies what his particular needs are and thus the product will be different across customers (Methe, 1991). An example is the motor vehicle industry where the user might need to specify what his particular needs are. The products are built to customer specification.

The order cycle begins immediately when a customer places an order and ends with the delivery of the product. In the sectors where competition is stiff, the duration of the cycle time is important since it restores the customer confidence with the supplier. This is very common in job orders where each customer gives his particular specifications like in machining plants.

2.3.4 The design cycle

This is the time it takes to conceive a new product, design it, put it into manufacturing and deliver it to the market. This period is generally getting shorter as time progresses. This is necessitated by the technology involved and the people resource used. Leadership is all being there the

first time but the sustainability of leadership is a great challenge. There is need to be more innovative and creative having the capabilities of generating new ideas and converting them into products as quickly as possible. The key to achieving competitive advantage is not reacting to chaos, but the production of the chaos (Prokesch, 1993).

In the Kenyan context there has been a lot of dynamics in the understanding that the consumer needs are changing and organisations need to react positively before the customers demand for it. This has been evident with the success stories of organisation which have brought in products all the time to address the needs of the consumers.

2.3.5 Flexible Manufacturing

Glorier (1987) states that the more likely that frequent changes in design will occur, the more necessary it becomes to build flexibility into the production equipment. Manufacturing flexibility is the ability to respond to production demands in minimum time and cost.

Globally co-ordinated flexible manufacturing involves the sourcing of components and sub assemblies, global distribution into multiple markets, efficient use of global manufacturing and assembly parts. In this style of flexible manufacturing the objective is to co-ordinate production planning and scheduling among multiple plants in many countries and across product lines to respond to changing market and production conditions. Kenyan manufacturers are using these tactics to produce through the sourcing of different material inputs from various economies. Many are

sourcing their inputs from the Far East countries as an alternative from the European countries.

2.4 Advanced Manufacturing Technologies, (AMT)

Advanced manufacturing technologies relates to the physical transformation of materials, their movement, inspection and storage (Harrison, 1997). AMT include computer-aided design, computer-aided engineering, computer-aided manufacturing, manufacturing resource planning, and computer integrated manufacturing. It includes flexible manufacturing cells Automated Guided Vehicle Systems, and robots. AMT can also be considered to include computer-aided process planning and computer numerical control machining. Information technologies, e-mail, advanced telecommunications systems, bar coding or tracking systems, automatic software, downloading links, and office technologies such as word processors and spreadsheets can be considered advanced technologies for manufacturing organisations.

The benefits of AMT include reduced direct labour costs, reduced product development time, reduced inventory, more efficient layout and use of machinery, reduced floor space requirements, better quality, less waste, improved productivity, shorter manufacturing lead time and quicker response to market shifts.

2.4.1 Automation

Automation is the addition of handling and control equipment to automatic machines for continuous production through a series of operations without human guidance and control (Glolier, 1987).

The automation of production lines is a critical area of investing. The co-ordination done by the machines as they are interlocked (interrelated) helps improve the efficiencies. This is more important in firms where there are many activities to be performed at the same time. The more the tasks the higher the need to automate. The industrial age organisations were much more mechanical oriented with most of the functions performed manually. This was increasing the number of human resource requirements but the skills needed were simple communication. With the development in automation, most of the activities are performed by the machines themselves and this has drastically reduced the human resource requirement and called for professional workers who understand the machine functions and have the technical skills hence the technical operators.

2.4.2 Centralised production

This is where the production functions are controlled from the same point. This is enhanced through the use of information technology. The use of computers in production lines has enabled the networking of machines such that they are able to co-ordinate and share information. This is facilitated through the use of programmable logic controllers. These are

computer based machine controllers, which are programmable to suit the particular operations. Harrison (1995) notes that computerised production control uses data processing equipment.

2.4.3 Computer aided design (CAD)

Computer aided design is the use of computers to interactively prepare engineering drawings which are used in the design of the particular products (Gilgeous, 1997).

The speed and ease with which sophisticated designs can be manipulated, analysed and modified make an organisation to have a competitive advantage. This is through faster decisions, better products and accurate flow of information (Heizer, 1995).

2.4.4 Computer Aided manufacturing (CAM)

Computer aided manufacturing is the use of specialised computer programmes to direct and control manufacturing equipment (Heizer, 1995). The machines' activities are programmed and the execution of the instructions is done by the machine.

2.4.5 Computer integrated manufacturing (CIM)

This is where the computers are used in almost all aspects of the production. Gilgeous (1997) defines it as the planning and control of manufacturing using computer and technology.

The computer integrated manufacturing is both combination of computer aided design, (CAD), where the design processes are computer controlled and the computer aided manufacturing, (CAM), where the production of manufacturing function is also computer controlled. These are both integrated together to provide the, (CIM).

They are microprocessor based and all the production is regulated from the instructions given to the machines. These are facilitated by the use of systems developed to handle the operations. This is through supervisory control and data acquisition, (SCADA), systems that are computer based and are used to network various machines through industrial communication networks. This can then be incorporated to Local area networks, (LAN), for use in monitoring of operations on the shopfloor. Manufacturing resource planning is part of the tools used to incorporate the manufacturing activities in the management. It relies on tested best operational practices, (Kaniaru, 1999).

2.4.6 Computer Numerical control (CNC)

Numerical control is the use of magnetic tapes to electronically control machines. The machines are operated using instructions stored in a magnetic tape (Harrison, 1993). Computer numerical control is an advanced form of numerical control. Machines have their own microcomputer and memory to store computer programs.

2.5 AMT adoption in Kenya

Kenyan companies that have well defined strategies recognise that to be competitive they have to adopt the latest methods of production. Companies have realised that to compete in the global market there is need to identify their strengths. However these companies are not able to compete effectively in the world market because the cost of the goods produced from the Kenyan industries do not have a price advantage when compared with the competitor brands from other regions. This is because most of the industries have ignored the value of reinvesting in the production facilities and only focus on getting the best from the existing production systems (Kimuyu, 2001).

The ability of a company to stay in competition depends on its awareness and speed of adopting new technological innovation. Companies should engage in research and development to provide continual process improvement, which not only benefit the existing products but will also benefit future products. All the same technology alone cannot make the company have a sustainable competitive advantage since technology can be bought by the competitors.

The selection of this technology is a complex process that is based on technological alternatives and organisational strategy. There is need to match the technology with the problem to be solved. The times of the machine being a black box are no more since the operators do understand what really happens in the machines (Laumann, 1996).

The role of advanced manufacturing technologies is to facilitate the processes and make them efficient. Through computer networking access of information to majority of the workers is availed.

Exposure to global competition reveals that Kenyan Manufacturing can no longer be a simple conversion of raw material into goods, but a process of conversion constantly reinventing itself. Realising the need to reduce manufacturing costs, improve quality, and respond to the changing needs of customers, many firms have introduced advanced manufacturing technologies (AMT) in the existing resources

The AMT taken include the use of Enterprise resource programmes which enable to link the manufacturing functions with the day to day administration.

The supervisory control and data acquisition (SCADA) systems used in the manufacturing control, Electronic data interchange (EDI) used to link the suppliers and the manufacturers, Materials resource planning programmes for the managing of inventories and planning schedules.

There are no studies carried out in Kenya to address the extent of the adoption of AMT and as such a gap has been identified.

This survey will focus on the use of these advanced manufacturing technologies, the extent to which it has benefited the Kenyan manufacturing firms, and barriers encountered.

3.0 Research Methodology

This section describes the methodology on how the study was carried out. It contains the necessary steps in the execution of the study to fulfil the study objectives. It defines the population, the sample, the sample size and the instruments used in carrying out the study.

3.1 Population

The study was a cross sectional survey carried out by the researcher regarding the use of advanced manufacturing technologies in Kenyan manufacturing firms. The population of the study is the manufacturing firms operating in Kenya.

3.2 Sample and sample size

The sample is the agro-based manufacturing firms listed in the directory of the Kenyan Association of Manufacturers, 2001 (Appendix 2). The sample represents the agro-based industries situated in Nairobi. The sectors of the manufacturing industry can be classified according to value added to the economy into the following:

- Agro-based sector, which accounts for 68% of the value added to the economy by the manufacturing sector.
- Engineering and construction sector accounting for 12% of the value added to the economy by the manufacturing sector.
- Chemicals and minerals sector accounting for 20% of the value added to the economy by the manufacturing sector.

The agro-based industrial sector consists of seven sub-sectors namely food processing, animal feeds, beverages and tobacco, miscellaneous food products, tanneries and leather products, woods and wood products, pulp and paper. A random sample of three sub-sectors was taken which consisted of food processing, beverages and tobacco. The sample size was 49 industries being the ones based in Nairobi representing the three sub sectors.

3.4 Research Instruments

The study used primary data which was collected by the researcher through a questionnaire with both open and close-ended questions.

The closed-ended questions provided quantitative data for statistical analysis. The open-ended questions provided qualitative data on the views of the respondent regarding the adoption of advanced manufacturing technologies. Data was collected from factory managers and operations managers who are in positions to provide the details regarding the operations of the companies. The "drop and pick later" method of administering the questionnaire was found suitable for the respondents and follow up was done through telephone calls.

3.5 Data Analysis

Data analysis was done through descriptive statistics. The analysis showed the relationships between the variables collected across the firms within which the study was done. Statistical package, SPSS, was used in the analysis of descriptive statistics is in form of tables, graphs and charts.

4.0 Results and findings

This chapter describes the findings of the research study.

4.1 Summary of responses

A total of 49 questionnaires were issued out to the respondents. Out of these, 40 were successfully returned to the researcher. This represented a response rate of 81.6%. This was deemed fit for the analysis.

Table 4.1.1 Company Ownership

Company ownership

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Local	20	50.0	50.0	50.0
	Foreign	4	10.0	10.0	60.0
	Both	16	40.0	40.0	100.0
	Total	40	100.0	100.0	

Source: Research Data

From the analysis it showed 50% of the respondents were local companies.

Table 4.1.2 Number of Employees

Number of employees

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	0-50	6	15.0	15.0	15.0
	51-100	7	17.5	17.5	32.5
	101-200	11	27.5	27.5	60.0
	201-500	10	25.0	25.0	85.0
	Over 500	6	15.0	15.0	100.0
	Total	40	100.0	100.0	

Source: Research Data

The data indicate that 52.5% of the respondents have between 100 and 500 employees. 15% of the respondents have over 500 employees.

Table 4.1.3 Company Turnover

Annual company turnover

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	0-50 Million	6	15.0	15.0	15.0
	51-500 Million	9	22.5	22.5	37.5
	501M to 1Billion	19	47.5	47.5	85.0
	Over 1billion	6	15.0	15.0	100.0
	Total	40	100.0	100.0	

Source: Research Data

70% of the respondents have a revenue of between Kshs 50 million and Kshs 1 billion.

Table 4.1.4 Products Marketed

Products market

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Local	2	5.0	5.0	5.0
	Regional	27	67.5	67.5	72.5
	International	11	27.5	27.5	100.0
	Total	40	100.0	100.0	

Source: Research Data

The respondents indicated that 67.5% manufacture products which are meant for regional usage. This means that the products must compete with others made in the others markets. The production systems must then be efficient to ensure that the cost of production is maintained as low as possible.

Table 4.1.5 Production Process

Nature of production

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Batch	10	25.0	25.0	25.0
	Continuos	21	52.5	52.5	77.5
	Both	9	22.5	22.5	100.0
	Total	40	100.0	100.0	

Source: Research Data

4.2 Advanced Technology Usage

From the data collected, the various technologies used were captured and the extent to which each of this is used as analysed. It is evident that the manufacturing firms have not embraced the technologies in the market. This is attributed to the sizes of the firms the ownership structure as well as the nature of products.

Table 4.2.1 Programmable Logic Controllers

Use programable logic controllers

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Yes	25	62.5	62.5	62.5
	No	15	37.5	37.5	100.0
	Total	40	100.0	100.0	

Source: Research Data

62.5% of the respondents indicated that they are using programmable logic controllers. This is attributed to the fact that this is the recent trend in technology and any new machines being installed especially if from the developed countries has these controllers. The reason for the usage is that they are flexible and normally perform many functions which are put in simple computer based processors.

Table 4.2.2 Computer Aided Design

CAD

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Yes	6	15.0	15.0	15.0
	No	34	85.0	85.0	100.0
	Total	40	100.0	100.0	

Source: Research Data

Only 15% of the respondents use Computer Aided Design. This technology has not been properly embraced in Kenya. The reasoning behind it is that there is little design done in Kenya. The manufacturers normally buy their machines from the original equipment manufacturers and only give their specifications to them for machine fabrication.

Table 4.2.3 Computer Aided Manufacturing

Technology	CAM		CIM		CNC	
	Freq.	%	Freq.	%	Freq.	%
Yes	10	25%	13	32.5%	10	25%
No	30	75%	27	67.5%	30	75%
Total	40	100	40	100	40	100

Source: Research Data

The respondents indicated that there is low usage of AMT with Computer Aided Manufacturing taking 25%, Computer Integrated Manufacturing 32.5% and Computer Numerical Control taking 25%. This is generated from the fact that these require massive investments and few companies are investing in new machines especially from the depressed nature of the economy. Many have not been able to justify the investment in the upgrading of their production functions.

Table 4.2.4 E-mail Usage

	Frequency	Percentage	Cummulative Frequency
Yes	40	100%	100%
No	0	0%	100%
Total	40	100%	100

Source: Research Data

100% of respondents use email in their communication. This is as a result of its cost and the convenience. All the manufacturers use email to communicate with their suppliers. The same is used to communicate within the factory where employees share information in the computer networks.

Table 4.2.5 SCADA systems

	Frequency	Percentage	Cummulative Frequency
Yes	6	15%	15%
No	34	85%	100%
Total	40	100%	100%

Source: Research Data

Only 15% of the respondents use SCADA systems in their manufacturing facilities. Its use is very limited in the manufacturing sector. This is due to the fact that these are expensive computer based investments used to manufacture and acquire reporting data for management's usage.

4.3 Information Shared

Table 4.3.1 Information Shared

Information shared by network

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Emails and Ememos	22	55.0	55.0	55.0
	Process/Batch costing	6	15.0	15.0	70.0
	Inventory	6	15.0	15.0	85.0
	Production and accounting data	6	15.0	15.0	100.0
	Total	40	100.0	100.0	

Source: Research Data

55% of the information shared by the respondents is basically communication notes in form of emails. Few of the companies share information out of the production facilities. The few companies sharing professional information were the ones with industrial computer networks from which there is the enterprise resource programmes.

4.4 Cross Tabulations

Table 4.4.1 Ownership Vs CAD

Crosstab

			CAD		
			Yes	No	Total
Company ownership	Local	Count	2	18	20
		% within Company ownership	10.0%	90.0%	100.0%
		% of Total	5.0%	45.0%	50.0%
	Foreign	Count	2	2	4
		% within Company ownership	50.0%	50.0%	100.0%
		% of Total	5.0%	5.0%	10.0%
	Both	Count	2	14	16
		% within Company ownership	12.5%	87.5%	100.0%
		% of Total	5.0%	35.0%	40.0%
Total		Count	6	34	40
		% within Company ownership	15.0%	85.0%	100.0%
		% of Total	15.0%	85.0%	100.0%

Source: Research Data

Table 4.4.1 Ownership Vs CAM

Crosstab

			CAM		
			Yes	No	Total
Company ownership	Local	Count	6	14	20
		% within Company ownership	30.0%	70.0%	100.0%
		% of Total	15.0%	35.0%	50.0%
	Foreign	Count	2	2	4
		% within Company ownership	50.0%	50.0%	100.0%
		% of Total	5.0%	5.0%	10.0%
	Both	Count	2	14	16
		% within Company ownership	12.5%	87.5%	100.0%
		% of Total	5.0%	35.0%	40.0%
Total		Count	10	30	40
		% within Company ownership	25.0%	75.0%	100.0%
		% of Total	25.0%	75.0%	100.0%

Source: Research Data

Table 4.4.2 Ownership Vs CIM

Crosstab

			CIM		
			Yes	No	Total
Company ownership	Local	Count	6	14	20
		% within Company ownership	30.0%	70.0%	100.0%
		% of Total	15.0%	35.0%	50.0%
	Foreign	Count	2	2	4
		% within Company ownership	50.0%	50.0%	100.0%
		% of Total	5.0%	5.0%	10.0%
	Both	Count	5	11	16
		% within Company ownership	31.3%	68.8%	100.0%
		% of Total	12.5%	27.5%	40.0%
Total		Count	13	27	40
		% within Company ownership	32.5%	67.5%	100.0%
		% of Total	32.5%	67.5%	100.0%

Source: Research Data

It was observed of the respondents using CAD, 15% were local industries and 5% were foreign.

Table 4.4.2 Ownership Vs CNC

Crosstab

			CNC		
			Yes	No	Total
Company ownership	Local	Count	6	14	20
		% within Company ownership	30.0%	70.0%	100.0%
		% of Total	15.0%	35.0%	50.0%
	Foreign	Count	2	2	4
		% within Company ownership	50.0%	50.0%	100.0%
		% of Total	5.0%	5.0%	10.0%
	Both	Count	2	14	16
		% within Company ownership	12.5%	87.5%	100.0%
		% of Total	5.0%	35.0%	40.0%
Total		Count	10	30	40
		% within Company ownership	25.0%	75.0%	100.0%
		% of Total	25.0%	75.0%	100.0%

Source: Research Data

From the cross tabulations it is evident that 15% of the companies adopting the AMT are locally owned. The proportion of the local companies is basically from the fact that these are small companies which have been set up when technology was being embraced in the developed world.

4.3 Technology and competitiveness

This section analyses the responses regarding the competitiveness of the industries in regard to adoption of the AMT. The general trend is that all the respondents regarded highly the adoption of technology to increasing the competitiveness of the companies.

Table 4.5.1 Quality, cost and flexibility

	Quality		Flexibility		Cost	
	Freq.	%	Freq.	%	Freq.	%
Very Important	26	65%	22	55.0%	27	67.5%
Important	14	35%	18	45.0%	13	32.5%
Total	40	100	40	100	40	100

Source: Research Data

100% of respondents indicated that they regard cost, quality and flexibility as very important for a company to be competitive.

Table 4.5.2 Reliability and competitiveness

Reliability

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Very important	25	62.5	62.5	62.5
	Important	9	22.5	22.5	85.0
	Moderately important	6	15.0	15.0	100.0
	Total	40	100.0	100.0	

Source: Research Data

62.5% of the respondents observed that the reliability of the production facility and product reliability to the customer was very important.

Table 4.5.3 Product Features and competitiveness

	Product Features		Capacity	
	Frequency	%	Frequency	%
Very Important	12	30%	19	47.5%
Important	13	32.5%	10	25.0%
Moderately Important	7	17.5%	4	10.0%
Not important	8	20%	7	17.5%
Total	40	100%	40	100%

Source: Research Data

The results from the tabulation show that 80% of the respondents regard cost, quality, flexibility and reliability are very important. This competitive importance is regarded to be achieved from the adoption of the AMT. Product features, innovation and capacity are regarded moderately important to the technology.

Table 4.5.4 Quality and CIM

Crosstab

			CIM		
			Yes	No	Total
Quality	Very important	Count	10	16	26
		% within Quality	38.5%	61.5%	100.0%
		% of Total	25.0%	40.0%	65.0%
	Important	Count	3	11	14
		% within Quality	21.4%	78.6%	100.0%
		% of Total	7.5%	27.5%	35.0%
Total		Count	13	27	40
		% within Quality	32.5%	67.5%	100.0%
		% of Total	32.5%	67.5%	100.0%

From the cross tabulation, it was observed that the 38.5% of the respondents who regard quality as very important have adopted CIM in their companies. This is 25% of the total respondents.

Table 4.5.5 Cost and CAM

Crosstab

			CAM		
			Yes	No	Total
Cost	Very important	Count	4	23	27
		% within Cost	14.8%	85.2%	100.0%
		% of Total	10.0%	57.5%	67.5%
	Important	Count	6	7	13
		% within Cost	46.2%	53.8%	100.0%
		% of Total	15.0%	17.5%	32.5%
Total		Count	10	30	40
		% within Cost	25.0%	75.0%	100.0%
		% of Total	25.0%	75.0%	100.0%

Source: Research Data

Table 4.5.6 Cost and CIM

Crosstab

			CIM		
			Yes	No	Total
Cost	Very important	Count	6	21	27
		% within Cost	22.2%	77.8%	100.0%
		% of Total	15.0%	52.5%	67.5%
	Important	Count	7	6	13
		% within Cost	53.8%	46.2%	100.0%
		% of Total	17.5%	15.0%	32.5%
Total		Count	13	27	40
		% within Cost	32.5%	67.5%	100.0%
		% of Total	32.5%	67.5%	100.0%

Source: Research Data

From the above cross tabulations, it is observed that the respondents who have adopted the AMT regarded cost, quality and reliability as the main drivers of competitiveness.

4.4 Barriers of adoption of AMT

From the data analysed it was observed that the barriers which prevent the adoption of the AMT were mainly driven by the organisation.

Table 4.6.1 Liberalisation

	Liberalisation		Trading blocks		Monopolies	
Very Significant	**4**	**10%**	**2**	**5.0%**	**15**	**38%**
Significant	**9**	**22.5%**	**14**	**35.0%**	**8**	**20.0%**
Moderately significant	**10**	**25.0%**	**11**	**27.5%**	**7**	**17.5%**
Not significant	**11**	**28%**	**12**	**30.0%**	**10**	**25%**
Not Significant at all	**6**	**15%**	**1**	**2.5%**	**0**	**0%**
Total	**40**	**100%**	**40**	**100%**	**40**	**100%**

Source: Research Data

From the data analysed it was observed that over 57.5% of the respondents indicated that the barriers that prevent the adoption of AMT were monopolies liberalisation and trading blocks.

Over 58% singled out monopolies as a very significant barrier to adoption of AMT. The reason behind this is that when there is no competition, the industry does not respond to improving the methods of production and as such they ignore the developments in technology.

Table 4.6.2 Politics

	Politics		Ownership		Government policies	
Very Significant	11	28%	14	35.0%	11	28%
Significant	14	35.0%	10	25.0%	12	30.0%
Moderately significant	8	20.0%	13	32.5%	10	25.0%
Not significant	7	18%	3	7.5%	7	18%
Not Significant at all	0	0%	0	0.0%	0	0%
Total	40	100%	40	100%	40	100%

Source: Research Data

Over 82% of the respondents gave government policies, politics and company ownership as the other significant barriers to adoption of the AMT. The respondents indicated that the ownership structure influences the investment decisions and hence quite influential in the adoption of AMT.

Table 4.6.3 Infrastructure

Infrustructure

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Very significant	11	27.5	27.5	27.5
	Significant	11	27.5	27.5	55.0
	Moderately significant	16	40.0	40.0	95.0
	Not significant	2	5.0	5.0	100.0
	Total	40	100.0	100.0	

source: Research Data

The barriers which make the adoption of the AMT difficult have been analysed and the government policies, infrastructure, ownership and politics were identified as the most significant in the prevention of the technology adoption. This is again attributed to the fact that all businesses operate in environments, which are governed by the policies of the

government. The other influential barriers are the owners of the business since they provide the strategic.

4.5 Maintenance systems.

All respondents indicated that they have a maintenance system in place. These systems ranged from manual controlled systems which had preventive and scheduled systems to advanced computerised systems. This depended on the nature of the business. The latest systems in the industry were identified which indicated that industries were moving towards acquiring the state of art technology.

5.0 Summary and conclusions

In this chapter the conclusions arrived at from the research findings are discussed in light of the objectives of the study.

5.1 Position of AMT in Kenya

From the findings, it can be concluded that Kenyan manufacturing firms have adopted to some large extent the use of AMT in their processes. This is seen from the response rate from the different types of AMT's in use. The most significantly used technology is the computer aided manufacturing and the computer integrated manufacturing. The reason for this use is that the technology helps to reduce the requirements in manpower and increased efficiencies. This can be seen from the staff reduction schemes implemented by companies when they engage in new technology. The other aspect, which was noted, is that organisations have fully invested in the best media of communication with which they are able to reach their suppliers and customers. Of importance is that the companies have fully embraced the e mail method as one of the easiest and efficient to use. However, the companies are still using the old methods of communication like fax, telephone and post.

These analysis shows that Kenya is moving towards the globalisation trend in which the whole world is a global market. This in itself shows that we need to efficiently compete in the market and one way to improve this is through the adoption of AMT.

5.2 Barriers of AMT adoption

There are many barriers which have hindered Kenyan companies from acquiring the latest technology in the manufacturing setup. The most singled out are the government policies which hinder the technology adoption. These can be summarised as the tax structures which force the manufacturers not to compete effectively in the global markets and as such they ignore in investing. The depressed economy has greatly prevented investors from putting more resources to Kenya. This is clearly seen from the fact that many companies are turning Kenya to a marketing economy where they produce from other countries and come there only what they have produced elsewhere. In the last five years, we have seen production plants close down because they cannot be able to compete with the imported goods.

Liberalisation has opened the Kenyan market to unfair competition through imported goods. This is because the government regulations have not taken care of the local industries. The other barriers encountered mainly are trading blocks which provide some advantage to some countries with the example of COMESA which has favoured the South African market. This has put the competitiveness of the Kenyan products at low levels since the cost of production in the different countries is not the same.

5.3 Advantages of AMT

From the research it was observed that numerous benefits are derived from the adoption of AMT. Improvement in quality was singled out as one of the advantages. The manufacturing firms are able to reduce their

production costs and effectively offer the products at competitive prices. The other benefits were rated as reliability and reduction of lead times. Computer based manufacturing also helps improve the production efficiencies. Kenyan manufacturing firms have benefited from these technologies and are they are able to reduce their production overheads. However, the production costs in Kenya are quite high when compared with the costs in other countries like South Africa and Egypt. Technology alone cannot make a firm to be more competitive but it has to be taken together with management styles and the manufacturing environment.

5.4 Recommendations

From the findings of the study, it is important to note adoption of AMT increases the efficiencies of the production systems. This is generally from the fact that quality products are achieved at minimum costs. It is thus noted that for new investments the engagement of computer technology simplifies the works of the production teams. This can then be tied together the existing computer networks and information shared by all members of staff. This is enabled through the use of enterprise resource programmes which interface the shopfloor and the management to be able to effectively and efficiently manage the business.

The government should put up policies which are supposed to safeguard the local industries. This will help create employment and have a sound economy in which more investors will be willing to venture into.

5.5 Limitations of the study

This study was concluded but has some limitations which need to be cited together with the findings.

The study was a survey which concentrated in the industries in Nairobi. It is important to point that the respondents were mainly factory managers, operations managers and engineering managers. There were areas where personal judgement was involved but this was taken care of by closed-ended questions.

Another limitation was the scope of the industries covered. It concentrated mainly in the food industries in Nairobi and its environs. This was a convenient sample due to the limitations in time and cost of the research

The other limitation of the study is that the study was focused on three sub sectors of the agro based industry. The whole sector was not covered due to the limitation of the location of most of the large agricultural based industries like sugar, tea and paper. The sample can be enlarged to incorporate all the industries in the country.

5.6 Areas of further research

This was an exploratory study involving the study of the technologies in use. The study can be extended to research on the particular technologies that have been embraced, the benefits the organisations have achieved and the suitability of these technologies in the Kenyan markets.

Another area of study could be the difficulties Kenyan organisations have encountered while trying to embrace these technologies. It can be extended to cover all the industries in the country. Equally more can be researched regarding how information technology has been adopted in the manufacturing industries especially the area of enterprise resource programs.

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DATE: 05/05/2002

TO WHOM IT MAY CONCERN

The bearer of this letter: PAUL M. MWANGI

Registration No: D/61/P/8504/99

is a Master of Business & Administration student of the University of Nairobi.

He/~~she~~ is required to submit as part of his/her coursework assessment a research project report on some management problem. We would like the students to do their projects on real problems affecting firms in Kenya. We would, therefore, appreciate if you assist him/~~her~~ by allowing him/her to collect data in your organization for the research.

Thank you.

DR. MARTIN OGUTU
LECTURER & CO-ORDINATOR, MBA PROGRAMME

MO/ek

APPENDIX 1

Research Questionnaire

This is a research questionnaire aimed at getting an understanding of how your company and other companies in Kenya have adopted Advanced Manufacturing Technologies in their operations. The results will purely be used for academic purposes. Thank you in advance for your co-operation in understanding the position of Kenya's technological advancement.

Part 1 Company History

1 Company Name_____

2 Year of establishment in Kenya_____

3 Company ownership

a) Local [ ]

b) Foreign [ ]

c) Both [ ]

4 Number of employees

0 to 50 [ ]

51 to 100 [ ]

101 to 200 [ ]

201 to 500 [ ]

Over 500 [ ]

5 Annual company turnover (KShs)

0 to 50 million [ ]

51 to 500 million [ ]

501 million to 1 billion [ ]

Over 1 billion [ ]

6 Products market

a) Local [ ]

b) Regional [ ]

c) International [ ]

Part 2 Technology

1. Indicate the nature of your production

a) Batch [ ]

b) Continuous [ ]

c) Other [ ]

2. Do you use programmable logic controllers

Yes [ ]

No [ ]

3. Indicate whether you use the following technologies

a) Computer aided design, CAD

Yes [ ]

No [ ]

b) Computer aided manufacturing, CAM

Yes [ ]

No [ ]

c) Computer integrated manufacturing, CIM

Yes [ ]

No [ ]

d) Computer numerical control, CNC

Yes [ ]

No [ ]

e) Email

Yes [ ]

No [ ]

f) Industrial computer networks

Yes [ ]

No [ ]

g) Supervisory control and data acquisition, SCADA system

Yes [ ]

No [ ]

4 Indicate any other technology that you use.----------

5 Do you have a computer network in the factory?

Yes [ ]

No [ ]

7 Are the technical/manufacturing staff connected to the network?

Yes [ ]

No [ ]

8 What information do you share from the network?----------

9 Please specify your inventory control system.----------

10 Do you have a maintenance system?----------

Yes [ ]

No [ ]

11 Do employees have access to the Internet?----------

Yes [ ]

No [ ]

12 Do you have training programme for employees?----------

Yes [ ]

No [ ]

13 How do you communicate with your suppliers?

a) Telephone [ ]

b) Fax [ ]

c) Post [ ]

d) E mail [ ]

e) Others (Specify)_____

14 How do you communicate with your customers?

a) Telephone [ ]

b) Fax [ ]

c) Post [ ]

d) Email [ ]

e) Others (Specify)_____

Part 3

Listed below are competitive priorities for manufacturing firms. Please tick (✓) in the appropriate box to indicate the extent to which you consider advanced manufacturing technologies important to these competitive priorities.

		Very Important		Moderately Important		Not Important
1	Quality	( )	( )	( )	( )	( )
2	Flexibilty	( )	( )	( )	( )	( )
3	Cost	( )	( )	( )	( )	( )
4	Lead times	( )	( )	( )	( )	( )
5	Reliability	( )	( )	( )	( )	( )
6	Product Features	( )	( )	( )	( )	( )
7	Volume variability	( )	( )	( )	( )	( )
8	Capacity	( )	( )	( )	( )	( )
9	Innovation	( )	( )	( )	( )	( )
10	Profits	( )	( )	( )	( )	( )

Indicate other benefits of adopting latest manufacturing technologies

a)

b)

c)

d)

Part 4

Listed below are some of the barriers which prevent manufacturing firms from embracing the current manufacturing technologies. Please tick (✓) in the appropriate box to indicate the extent to which you consider these barriers significant.

		Very Significant		Moderately Significant		Not Significant
1	Liberalisation	( )	( )	( )	( )	( )
2	Trading blocks	( )	( )	( )	( )	( )
3	Monopolies	( )	( )	( )	( )	( )
4	Politics	( )	( )	( )	( )	( )
5	Ownership	( )	( )	( )	( )	( )
6	Government policies	( )	( )	( )	( )	( )
7	Infrastructure	( )	( )	( )	( )	( )
8	Technical difficulties	( )	( )	( )	( )	( )
9	Skills deficiencies	( )	( )	( )	( )	( )

Name respondent _____

Position held in organisation_____

Thank you for your co-operation.

APPENDIX 2
Listing of KAM members

1 Alpha Fine foods
2 BAT Kenya
3 Bidco Oil refineries
4 Bio food products
5 Broadway bakery
6 Brokebond
7 Brookside Dairy
8 Cadbury Kenya Ltd
9 Centralfoods Industries
10 Cirio Del monte
11 Coca Cola Africa
12 Coffee Board of Kenya
13 CPC Kenya ltd
14 Cut tobacco
15 Dorman Ltd
16 East Kenya Bottlers
17 Excel chemicals
18 Glaxo smithkline
19 Highlands Mineral water
20 Jambo biscuits
21 Kabansora millers
22 Kapa oil Refineries
23 KCC 2000 ltd
24 Kenya breweries
25 Kenya fruit processors
26 Kenya maltings
27 Kenya sweets Ltd
28 Kenya wine Agencies
29 Ketepa
30 Kilimanjaro minehral water
31 KPCU
32 Kuguru food complex
33 Limuru Milk processors
34 London Distillers
35 Mastermind tobacco
36 Mini bakeries Nairobi
37 Nairobi bottlers
38 Nestle foods
39 Pembe Flour mills
40 Premier food Industries
41 Proctor and Allan
42 Rift valley botttlers
43 Spin Knit
44 Trufoods
45 UDV kenya Ltd
46 Umoja manufacturers
47 Unga ltd
48 Unilever K ltd
49 Wrigley Ltd

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