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ADVANCED MANUFACTURING TECHNOLOGY, ORGANIZATIONAL RESOURCES AND PERFORMANCE OF LARGE MANUFACTURING COMPANIES IN KENYA

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Abstract

The purpose of this paper was to investigate the relationship between Advanced Manufacturing Technology (AMT), organizational resources and performance of large manufacturing companies in Kenya. A descriptive cross sectional survey method was used in the study. Purposeful sampling was used to identify the population of the study which comprised 55 large manufacturing companies in Kenya and that were members of Kenya Association of Manufacturers. A self-administering questionnaire with questions on each variable in the study was administered on the population of the study. Senior managers in these companies were requested to complete the questionnaires and a total of 45 questionnaires representing a response rate of 81.8% were returned. Statistical tests using linear regression were used to test hypothesis and also determine the relations between the study variables using the collected data. Findings on the dimensions of advanced manufacturing technology revealed a significant relationship between manufacturing technology dimension, planning technology dimension and performance of large manufacturing companies in Kenya. Design technology dimension was not significant in this relationship. The results also show a significant relationship between advanced manufacturing technology and performance of large manufacturing companies in Kenya. Further, the results revealed that organization resources do not moderate the relationship between advanced manufacturing technology and performance of large manufacturing companies in Kenya, but have a significant positive effect on the coefficient of advanced manufacturing technology. Arising from these findings, the study concluded that advanced manufacturing technology, manufacturing technology dimension and planning technology dimension allow organizations to improve their performance using resources they own, when the technologies are implemented correctly. The implication of the study findings is that organizations need to determine the optimal mix of the three technology dimensions of advanced manufacturing technology during implementation to realize maximum benefits from their investment in advanced manufacturing technology. Further, from the low application of industrial robots in the manufacturing process by large manufacturing companies in Kenya observed in

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the study, there is an opportunity to develop capabilities to increase the rate of their application and further enhance performance of large manufacturing companies in Kenya. The results of this study can be used by Managers to improve performance in small, medium and large manufacturing companies.

Key words: Advanced Manufacturing Technology, Organizational Resources, Large manufacturing Companies and Organizational Performance.

1.0 INTRODUCTION

Production costs in a manufacturing company have an adverse impact on profitability and performance of the company. Companies that have high production costs compared to their competitors in the same industry use other product attributes to compete in the market other than price (Hosseini, Soltani, & Mohammad, 2018). One of the responsibilities for Managers in manufacturing companies is to manage production costs within approved budgets and keep them as low as possible, as product prices have an impact on consumer choice. Manufacturing companies use production processes that are efficient to reduce the unit product cost as one way of making their products/services compete favorably with similar products and increase their contribution margins and profitability.

To manage production costs, traditional manufacturing methods employ low cost high volume methods that include mass production (Tanisha, John & Potgieter, 2019). Mass production make jobs become easy and simple for employees, allows managers to develop the same or similar products that are easy to manufacture, make routine jobs become standard and optimize all tasks in the production process to minimize waste (Kronos, 2016). A second method which manufacturing companies use to achieve low production costs, improve production efficiency and achieve high productivity in their production process is advanced manufacturing technology (Nyori & Ogolla, 2015; Mohanty, Padmavati Gahan, & Choudhury, 2014; Kronos, 2016; Gunawardana, 2006; Swamidass, & Kotha, 1998).

Advanced manufacturing technology is broadly defined as the application of stand-alone, intermediate or integrated computer systems used by manufacturing companies in their production process with the objective of improving organizational performance (Gunawardana, 2006). This study has conceptualized advanced manufacturing technology as groups of computer based technologies with three dimensions used by manufacturing companies to increase production efficiency and reduce operation costs. The dimensions of advanced manufacturing technology used in this study include design technology dimension, manufacturing technology dimension and planning technology dimension.

Advanced manufacturing technology can be used jointly with mass production to increase productivity. This is especially when manufacturing companies practice small batch production runs. Further, advanced manufacturing technologies help companies to develop objectives in line with generic strategies by aligning the manufacturing strategy to the desired organizational objectives (Garrido-Vega, Jimenez, 2015). Manufacturing companies

incorporate technology in implementing generic strategies to gain competitive advantage and position themselves in their operating industry (Szwejczewski, Sweeney, & Cousens, 2016). One of the advantages companies achieve by using advanced manufacturing technology in their operations is production flexibility, which allows them to respond to the changing business environment and fully meet the needs of their customers. This in turn helps them to improve their performance.

Although several researchers have observed a positive relationship between advanced manufacturing technology and performance, other studies have also observed that on its own, advanced manufacturing technology is not sufficient to enable organizations achieve lower costs of production, better quality, and better performance (Ergüden, Kaya, & Tanyer, 2018). These findings show varying outcomes on performance observed in organizations that have implemented advanced manufacturing technology, as some organizations observe better performance while others do not observe any change in their performance. Some of the reasons for this discrepancy in performance by organizations that apply advanced manufacturing technology have been identified to be their selection and implementation of technology and availability of strategic resources besides other factors (Saberi, Yusuff, Zulkifli, & Megat Ahmad, 2010).

Performance in organizations is viewed as valuable outcomes, contributions or achievements by an individual, group, formations or teams towards an objective of the organization without considering the method that they employ. Performance is also viewed as the achievement or completion of specific measurable and meaningful goals to a particular objective in the organization (Enos, 2007). Organizations use either financial or non-financial indicators to measure performance. Arising from the behavioral school of management placing emphasis on observable performance indicators in place of subjective behavioral performance indicators, there is increased emphasis on organizations to use non-financial indicators to measure performance. There are several factors that affect performance of a manufacturing company (Ismail, 2016). This study used nonfinancial indicators to measure organizational performance.

Manufacturing companies view resources they own as consisting of all the inputs they use to create value in their production process that include capital equipment, raw materials, employee skills, patents, and experience of talented managers (Ying, Hassan, & Ahmad, 2019). These resources can be grouped into two major groups: tangible resources which include; financial, physical, human or intangible resources that consist of technology, reputation, trademarks and copyrights. Studies have given emphasis on tangible resources providing competitive advantage to organizations compared to intangible resources (Ying, Hassan, & Ahmad, 2019). This study considered resources to include assets owned by the organization, physical facilities, and employee capabilities.

Manufacturing companies gain competitive advantage when the resources they own are strategic and exhibit characteristics that include being valuable to their manufacturing processes, rare in the industry they are operating in, imperfectly imitable and there being no strategically equivalent substitutes for

competitors to use in manufacturing the same or similar products. Further, resources on their own do not confer competitive advantage to manufacturing companies (Musebe, 2012, Dimba & K'Obonyo, 2009). Manufacturing companies develop a price based competitive advantage or a differentiated competitive advantage when they optimally combine their capabilities with strategic resources they own. Manufacturing companies also attain low production costs, enhance their product quality, improve their product availability and increased brand awareness when they use strategic resources they own in an optimal way.

In all economies, manufacturing companies complement the initiatives of governments towards growing their GDP. The manufacturing sector has the highest employment multiplier and governments rely on this sector to generate and provide employment opportunities as one (1) job in the manufacturing sector can lead to the creation of approximately 2.91 jobs in the other sectors of the economy (Bivens, 2019; World bank, 2018). Economies that adopt technology in their manufacturing sector continue to industrialize more compared to those that do not. Economies that fail to adopt technology in their manufacturing processes witness premature de-industrialization or non-industrialization similar to what is observed in developing economies. Advanced manufacturing technology and industrialization continue to play a key role in the growth of developing economies (Haraguchia, Fang, & Eveline, 2016).

Countries achieve economic prosperity by providing a business environment that would nurture a competitive manufacturing industry, full employment and wealth creation. Further, industrialization is one of the drivers that countries use to develop, generate rapid structural change, drive development, alleviate poverty and unemployment, and improve their GDP (Sheena, 2008). Despite most African Countries having manufacturing potential and promising trajectories, they are still developing economies due to the limited manufacturing activity. The limited industrial development represents an opportunity for economic transformation and quality employment generation that alleviates poverty. Manufacturing companies in Kenya have an opportunity to contribute in transforming the economy and improve their performance by applying advanced manufacturing technology in their production processes.

The structure of Kenya's manufacturing sector is made up of micro, small, medium and large firms. The sector is dominated by micro, small and medium firms that make up over 80% of the total number of companies while large manufacturing companies constitute less than 20% of the companies (Kenya Economic Review, 2018). Large manufacturing companies in Kenya have been found to contribute 80% to GDP by the manufacturing while the other firms in the sector contribute about 20%.

Arising from the makeup of the manufacturing sector in Kenya, there is need to develop and implement policies that encourage large manufacturing companies to operate efficiently for the country to achieve faster economic growth. Efficient performance of large manufacturing companies in Kenya will lead to creation of more jobs that will reduce the current high unemployment levels in the country (Kenya economic review, 2018). Further, acceptance of

Kenyan manufactured goods at the global market will enhance the export market and improve the balance of trade which was at a deficit of US$ 11.33 billion in 2018 (World Bank, 2018).

For large manufacturing companies in Kenya to benefit from new and existing manufacturing policies, they need to identify and adopt effective production methods that efficiently transform input resources into finished products that are appealing and competitive in the global market. This justifies the need for Kenya to develop policies skewed towards large manufacturing companies and the need to study the relationship between advanced manufacturing technology, organizational resources and performance of large manufacturing companies in Kenya.

2.0 LITERATURE REVIEW

Recognizing sources of sustained competitive advantage that impact on organizational performance is a major area of study in strategy. Researchers use data linked to competitive advantage to investigate why organizations in the same competitive environment achieve different performance (Bridoux, 1997). Several studies using the resource based view (RBV) theory of strategy have been done to explain the difference in performance between organizations in the same industry and environment (Conner, 1991; Peteraf, 1993; Wernerfelt, 1984; Barney, 2001).

The RBV theory complements both the neo-classical economics which focuses on how market forces determine the quantity, quality, and price of goods and services sold in a market and evolutionary economics which examines the implications of three fundamental processes: variation, selection, and retention on the performance of organizations (Nelson, & Winter,1982). The RBV theory, was used in this study to investigate the relationship between advanced manufacturing technology, organizational resources and performance of large manufacturing companies in Kenya.

The RBV theory is founded on the basis of organizations competing using strategic resources and capabilities they own and are under their direct control (Barney, 1991; Barney, 2001). Resources can be broadly described as being either tangible or intangible and having different contributions to the total observed performance in an organization. Empirical studies have shown that intangible resources easily fulfil the inimitability requirement of a resource to enable organizations that own them to develop competitive advantage compared to tangible resources due to the difficulty associated with their acquisition, not being available on the factor market and difficulty by other companies to easily copy them (Greco, 2013; Baron & Kenny, 2018; Kor & Mesko, 2013). Causal ambiguity, which is one of the characteristics of intangible resources, includes social complexity, intellectual property and unique organizational culture which are part of the mechanisms required to attain resource inimitability to give an organization the ability to develop competitive advantage and attain above average performance (Barney, 1991; Chari & David, 2012; Grimpe, & Hussinger, 2014; Gupta, Briscoe, & Hambrick, 2017).

Organizations always own both types of resources and they jointly impact performance although with varying magnitudes. Studies reveal that the relationship between intangible resources and tangible resources enable

organizations to develop competencies and capabilities that are then used in the overall business level organization strategy (Grimpe & Hussinger, 2014). Competencies are observable and measurable individual knowledge, skills, abilities and personal attributes that improves individual performance which in turn leads to the development of organizational competencies. Further, Core competencies are activities that an organization can do better than its competitors and are attributes of the organization that cannot be sold or purchased as they are organization specific involving the efficient use of resources under their control (Hayes & Pissano, 1996). Studies have also revealed that when organizations apply resources alone in their strategies, they do not automatically lead to improved performance and confirm that resources are enablers for organizations to carry out tasks that lead to improved performance (Porter, 1991).

Besides resources, studies also reveal that technology enables organizations to develop core competencies in their manufacturing processes to efficiently transform raw materials (input resources) into finished products that meet customer requirements e (Amit & Shoemaker, 1993; Grunert & Hildebrandt, 2004). Manufacturing organizations find it easy to incorporate technology in their manufacturing strategies that use either cost leadership or differentiation strategies to achieve both their short term and long term goals (Porter, 1980; Porter, 1985). Advanced manufacturing technology enables organizations to achieve these outcomes through material and product storage, retrieval and management information systems and, the manufacturing process among other functions (Kotha & Swamidass, 2000).

Having the requisite information before making a decision that affects customers is important in developing and maintaining good customer relationships. Advanced manufacturing technology allows organizations to have real time information when they are making decisions on both consumer products and industrial products. Further, studies reveal that advanced manufacturing technology allows organizations change their manufacturing plans and processes to meet customer requirements, lower the unit cost of production, enhance product quality, attain flexibility in the production process and increase productivity which improves their productivity (Nyori & Ogolla, 2015; Kotha & Swamidass, 2000; Gunawardana, 2006; Baldwin, & Sabourin, 1999).

When organizations apply advanced manufacturing technology in their production process, one of the outcomes they expect is understanding the imagination and ideas of the customer about a product, transforming them into production ideas and finally producing and delivering the desired products that excite their customers. For organizations to achieve this outcome, they utilize resources under their control and internal capabilities. Further, studies show that organizations achieve different capabilities and different performance levels using different resources (Tuan & Takahashi, 2009). When organizations own strategic resources that are valuable, rare, inimitable and apply unique processes to transform them into products they achieve better results and performance compared to their competitors who do not have the same or similar production inputs (Barney, 2001; Swink & Nair, 2007).

Due to effects of globalization, organizations are facing new and dynamic operating environments, rapid growth in technology, informed investors demanding high returns on their investments, and steadily increasing competitive requirements (Tuan & Takahashi, 2009). Organizations create sustainable competitive advantage to address these emerging realities in the business environment in order to sustain their profitability by engaging in manufacturing processes and routines that champion development and renewal of strategic resources. Studies have shown that advanced manufacturing technology contributes positively to competitive advantage and performance when it is viewed as an aid to the manufacturing process in helping organizations change and adapt to the product market fluctuations and in accordance with the strategic resources they own (Small & Yasin, 1997).

The market determines the consumption rate and capacity of goods and services on offer by manufacturing organizations while the appetite of the market to consume products is determined by the nature of the distribution channel and whether the organization is practicing a push or pull marketing strategy. Studies show that organizations use advanced manufacturing technology to improve their market offering to maintain loyal customers by consistently delivering quality products (Shortridge, 2004).

Manufacturing organizations incorporate advanced manufacturing technology in their process of developing both their corporate and manufacturing strategies. This allows manufacturing organizations to understand their internal strengths and weaknesses, identify appropriate competencies among employees, and focus on improving the production processes. Empirical studies show that advanced manufacturing technology helps managers to implement strategies that improve their performance by facilitating managers with a system that make them have a clear focus on end-to-end process perspective, implement new, efficient, and flexible manufacturing processes to reduce waste, improve information management and resource utilization (Swink, 2000; Watson, 2019; Swink & Nair, 2007; Sohal, 1996).

Further, other studies have also found that application of advanced manufacturing technology in production and owning strategic resources enable organizations to have a clear understanding of their customer feedback, customize their products to meet special customer needs and reduce turnaround time from receipt of order to delivery of the product (Nyori & Ogola, 2015; Meredith, 1987; Mansfield, 1993; Kotha & Swamidass, 2000).

3.0 METHODOLOGY

Arising from the literature review, a conceptual framework was developed to test the relationships between the three study variables and the moderating effect of organizational resources on the relationship between advanced manufacturing technology and performance of large manufacturing companies in Kenya. The study employed the positivist research philosophy in collecting and analyzing data while descriptive cross-sectional research design was adopted because of the distinctive features it has, that were important to the study (Crotty, 1998). The population of the study comprised of 55 large manufacturing companies in Kenya and which were members of the Kenya Association of Manufacturers as at December 31st 2018.

Data was collected using a self-administering structured questionnaire and the Likert scale was used to rate the responses of the collected data. A total of 45 questionnaires were returned by the respondents representing a response rate of 81.8%. This was deemed to be acceptable as the average response rate in qualitative research is 55.6% with a standard deviation of 19.7 (Baruch, 1999).

Advanced manufacturing technology was operationalized through: design technology dimension; manufacturing technology dimension and planning technology dimension. Performance of large manufacturing companies in Kenya was operationalized using customer satisfaction while the third variable, organizational resources was operationalized using assets, physical facilities, and employee capabilities. In order to use regression analysis to test the data on the relationships between the variables in the study, the main assumptions of regression analysis, normality and reliability tests were done. Descriptive statistics was used to determine the relationship between the study variables while ANOVA was used in inferential statistics involving the determination of correlation, simple linear, stepwise and multiple regression analysis to test the hypothesis that was developed in the study.

4.0 RESULTS AND DISCUSSION

The study used the skewness test to investigate normality of the data. Results confirmed that the data used in the study was normally distributed. The test shows that all the skewness values for the variables in the study were close to zero allowing the research to proceed to perform parametric tests (Razali & Wah, 2011). The normality test results are presented in Table 1.0.

Table 1.0: Normality Test

VARIABLE	Skewness	
	Statistic	Std. Error
Advanced Manufacturing Technology	-0.525	0.357
Competitive Advantage	-0.278	0.357
Organizational Resources	-1.134	0.357
Organizational Performance of Large Manufacturing Companies in Kenya	-0.424	0.357

7 K H V W X G \ X V H G & U R Q E D F K ¶ V . to test the reliability of the instrument used in the study. Results show that Cronbach's was above 0.8 indicating the reliability of the instrument used in the study. Results are presented in Table 2.0.

. F R H I I L F L H Q W I R U W K H W K U H H

Table 2.0: Reliability Test

Variable	Cronbach's alpha (α)
Advanced Manufacturing Technology	0.9
Organizational Resources	0.9
Organizational Performance	0.9
Minimum acceptable value of α for the study is 0.7 and above	

Results on the number of permanent employees in the companies show that 2.2% of the companies had less than 50 employees while 97.8% of the companies had more than 50 employees with 57.8% having more than 200 employees. Large manufacturing companies in Kenya employ more than 100 employees. These results show that 77.8% of the companies had more than 100 employees and therefore qualified to be considered as large manufacturing companies in Kenya Results are presented in Table 3.0.

Table 3.0: Number of Employees

Number of permanent employees in the organization	Frequency	Percentage (%)
Less than 50	1	2.2
Between 50-100	9	20.0
Between 101-200	9	20.0
Over 200	26	57.8
Total	**45**	**100**

Further, the results show that 8.9% of the employees had been in employment in the company for less than 1 year while 91.9% had been in employment for more than 1 year. Majority of the employees (35.6%) had been in employment in the companies for between 4-9 years, while 55.6% of the employees had been in employment in these companies for between 4-16 years. The number of years' employees work in an organization indicates employee retention rates. Results are shown in Table 4.0

Table 4.0: Number of Years in Organization

Number of Years Worked in Organization	Percentage (%)
Less than 1 Year	8.9
Between 1- 3 Years	31.1
Between 4 – 9 Years	35.6
Between 10 -15 Years	20.0
Over 20 Years	4.4
Total	**100.0**

The study sought to know the position held by the respondent in the organization structure. This is important as it helps validate the authenticity of the research data. From the data, results show that respondents used in the study were in Senior Management positions in their respective organizations Results are presented in Table 5.0.

Table 5.0: Job Title of Respondent

Job Position/Title	Percentage (%)
Engineering Manager	29
Director Technical services	26
Director Manufacturing	26
Factory Manager	20

The market coverage of the companies included national (15.6%) which is within the Kenyan market, Regional, covering the East African market region (53.3%), Continental, covering the whole of Africa market (2.2%) and International market covering Africa and beyond (28.9%). The results are presented in table 6.0. These results show that 28.9% of their market share is global indicating that the products meet global specifications with regard to quality, price, and delivery time. The results also show that large manufacturing companies in Kenya, a developing economy, are capable of manufacturing products that are appealing to the global market while maintaining a regional presence (53.3%).

Table 6.0: Markets

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Market	Percentage (%)
National	15.6
Regional (within East Africa)	53.3
Continental (Within Africa)	2.2
International (Africa and Beyond)	**28.9**

4.1 Application of Design Technologies in the Organization

Design technologies were used in the study to operationalize advanced manufacturing technology. Results in table 7.0 show the ranking of design technology indicators. Computer aided design (CAD) was ranked as the highest indicator applied by large manufacturing companies in Kenya and which has the highest impact on performance, the second group of technologies with equally high impact on performance were computer aided engineering (CAE) and computer aided process planning, while group technologies (GT) were ranked as having the least impact on performance. Managers in manufacturing companies are cognizant of the impact that advanced manufacturing technology has on development of competitive advantage in their operating environment. CAD has the most impact on performance in the design dimension of advanced manufacturing technology due to its high application in the production process especially with organizations that carry out new product development or product modifications to respond to customer needs. CAPP plays a key role in computer integrated manufacturing (CIM) which is in the manufacturing dimension of advanced manufacturing technology while GT are part of CAPP as they consist of a large population of apparently different advanced manufacturing technologies that are divided into groups having similar or the same outcomes in terms of performance.

Table 7.0: Application of Design Technologies Ranking

Design technology Indicator	***Mean***	**Rank**
Computer aided design (CAD)	3.2	1
Computer aided Engineering (CAE)	2.8	2
Computer aided process planning (CAPP)	2.8	2

Group technology (GT)	2.4	3

4.2 Application of Manufacturing Technologies in the Organization

The second dimension of advanced manufacturing technology in the study was manufacturing technologies. Manufacturing companies now have an option to use Industry 4.0 technology to manage the changes in Manufacturing technology to address the increasing complexity of customers and provide J U H D W H U À H [L E L O L W \ (Sheena, 2008; Bildstein & Seidelmann, 2014). Industry 4.0 technology can be inter-phased with advanced manufacturing technology to further improve equipment maintenance regimes to reduce operation costs, increase production equipment reliability and, increase product quality (Ergüden, Kaya & Tanyer,2018).

The results on the application of manufacturing technologies in the production process and their respective ranking on how they impact on performance revealed that: Computer Aided Manufacturing (CAM), Computer Integrated Manufacturing (CIM) was ranked the highest. Results are presented in Table 8.

The following technologies were second in rank: Numerically Controlled machines (NC)and Program Logic Controllers (PLC), Computer Numerically Controlled machines (CNC) were third, Computer integrated manufacturing (CIM) and flexible manufacturing systems were fourth in ranking. Industrial robots (IR) were ranked as having the least impact on performance and application within the production process. The following indicators were ranked as follows Computer aided inspection (CAI) (Rank = 5), Automated Guided Vehicles (AGV) (Rank = 6), and Automated Storage and Retrieval Systems (AG/ AS) (Rank = 5).

The results on application of manufacturing technology and its impact on performance indicates that large manufacturing companies in Kenya apply manufacturing technology to control the Operations in their manufacturing J U H D W H U À H [L E L O L W \ R U G X F W V operations to help them perform transportation, management, and storage activities. Numerically controlled machines technology got a high rating (2) from the respondents. This technology is used by large manufacturing companies to reduce their cycle times. Numerically controlled machines technology is also used to improve the machine cutting quality and accuracy and consequently improve performance.

Program logic controller technology, which is an industrial solid-state computer is used to monitor inputs and outputs in the production process and make logic-based decisions for automated processes or machines, had the same rating (2) as numerically controlled machines technology. The application of program logic controllers as noted from the results of the study reduces reliance on computer aided inspection which was ranked lower (6) by the respondents. Organizations have an opportunity to apply industrial robots in the manufacturing process as its use was the least (7) among all the technologies considered.

Table 8.0: Application of Manufacturing Technology Ranking

Manufacturing Technology Indicator	*Mean*	Rank
Computer aided manufacturing (CAM)	3.3	1
Numerically controlled machines (NC)	3.2	2
Programme logic controllers (PLC)	3.2	2
Computer numerically controlled machines (CNC)	3.1	3
Computer integrated manufacturing (CIM)	3.0	4
Flexible manufacturing systems (FMS)	3.0	4
Computer aided inspection (CAI)	2.3	5
Automated storage and retrieval systems (AS/RS)	2.3	5
Automated guided vehicles (AGV)	1.7	6
Industrial robots	1.5	7

4.3 Application of Planning Technologies in the Organization

The third dimension of advanced manufacturing technology in the study was planning technologies. The indicators for planning technology consisted of: materials requirement planning technology (MRP), Enterprise resource planning (ERP), Management Information Systems (MIS), Total Quality Management (TQM), Customer Relationship Management (CRM); Manufacturing Resource Planning (MRP II), Computer Preventive Maintenance Planning (CPM) and Just in Time (JIT).

Results show that ERP (1) had the highest ranking on application and impact on performance while JIT (5) had the least ranking. The other indicators of planning technology had the following rankings; CRM (2), MRP (3), MIS (3), TQM (3), MRP II (4) and CPM (4). Results are presented in Table 9.0

Table 9.0: Application of Planning Technologies Ranking

Planning Technology Indicator	*Mean*	Rank
Enterprise resource planning (ERP)	4.2	1
Customer relationship management (CRM)	3.9	2

Materials requirement planning (MRP)	3.7	3
Management information systems (MIS)	3.7	3
Total quality management (TQM)	3.7	3
Manufacturing resource planning (MRPII)	3.2	4
Computer preventive maintenance planning (CPM)	3.2	4
Just in time (JIT)	2.9	5

4.4 The Joint Effect on Application of Technology in the Manufacturing Process

The findings revealed that large manufacturing companies in Kenya on average use advanced manufacturing technologies in their production processes. The ranking of the three dimensions in terms of application and impact on performance of large manufacturing companies in Kenya show that Planning technologies had the highest ranking and impact to performance. Manufacturing technologies had the least rating and impact on performance while design technologies were rated moderately compared to the other two advanced manufacturing technology dimensions.

The top three advanced manufacturing technology indicators on ranking and their impact on performance were ERP (1), CRM (2), MRP (3), MIS (3), TQM (3). All the three indicators (100%) are planning dimension of AMT indicators and constitute 62.5% of the total planning indicators considered in the study. This further confirms the high effect of planning technologies on performance of large manufacturing companies in Kenya. The rating of the following technologies CAM (4), NC (5), PLC (5) and CNC (6) from the manufacturing dimension is also an indication that manufacturing technology impacts the performance of large manufacturing companies in Kenya.

The best ranked design technology indicator, is CAD (5) with the other design indicators being ranked low in terms of application and effect on performance compared to the other advanced manufacturing technology indicators. These include CAE (9), CAPP (9), and GT (10). Further the application and impact of CAI (11), AS/RS (11), AGV (12) and IR (13) was the least in the group of AMT technologies considered in the study. The use of AMT through CAI to assure quality is still rated low as most of the companies still carry out these function manually. There exists an opportunity for large manufacturing companies in Kenya to improve the quality of the product, increase the productivity in the inspection process and reduce the lead times in manufacturing by increasing the application of CAI in their production process.

The robotics industry is still young and can be seen in the very low rating (13) in the study. The manufacturing industry in Kenya is yet to adopt the use of robots, which is another opportunity they have in increasing manufacturing efficiency. AGV (12) which is used for autonomous logistic

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applications was equally rated very low by the respondents in the study.

Table 10.0: Joint Effect of Application of technology in the Manufacturing Process

AMT Indicator	Mean	Rank
Enterprise resource planning (ERP)	4.2	1
Customer relationship management (CRM)	3.9	2
Materials requirement planning (MRP)	3.7	3
Management information systems (MIS)	3.7	3
Total quality management (TQM)	3.7	3
Computer aided manufacturing (CAM)	3.3	4
Computer aided design (CAD)	3.2	5
Numerically controlled machines (NC)	3.2	5
Programme logic controllers (PLC)	3.2	5
Manufacturing resource planning (MRPII)	3.2	5
Computer preventive maintenance planning (CPM)	3.2	5
Computer numerically controlled machines (CNC)	3.1	6
Computer integrated manufacturing (CIM)	3	7
Flexible manufacturing systems (FMS)	3	7
Just in time (JIT)	2.9	8
Computer aided Engineering (CAE)	2.8	9
Computer aided process planning (CAPP)	2.8	9
Group technology (GT)	2.4	10
Computer aided inspection (CAI)	2.3	11

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Automated storage and retrieval systems (AS/RS)	2.3	11
Automated guided vehicles (AGV)	1.7	12
Industrial robots	1.5	13

4.5 Advanced Manufacturing Technology, Organizational Resources and Performance of Large Manufacturing Companies in Kenya

In investigating the relationship between advanced manufacturing technology, organizational resources, and performance of large manufacturing companies in Kenya, the study considered resources to include both tangible resources and intangible resources in the form of assets, physical facilities, and employee capabilities owned by the organization. Respondents were required to indicate the extent to which resources contributed to this relationship. Data was collected using a Likert scale where, 1 = Not at all: 2 = Small extent: 3 = Moderate extent: 4 = Great extent: 5= Very great extent.

Assets in the study included both tangible resources and intangible resources owned by the organization. These were used to determine the relationship between advanced manufacturing technology and performance of large manufacturing companies in Kenya. Respondents ranked the ability of leaders being able to access inventory using advanced manufacturing technology as having the highest impact with performance while patent of products had the least rating and impact on performance. Results are presented in Table 11.0.

Table 11.0: Assets and Advanced Manufacturing Technology

Assets Indicator	Mean	Rank
The leadership regularly access inventory of the organization	4.5	1
The organizational has developed a reputable brand name in the industry	4.5	1

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The leaders effectively pool resources and expertise toward a shared goal.	4.3	2
The organization is located in a prime area in relation to the customers	4.2	3
The organization has an effective product distribution network	4.1	4
The organization has its own registered trade marks	4.0	5
The organization has strategic partnership contracts with other global manufactures	3.7	6
The organization has patented its products	3.4	7

Respondents also ranked the ability of advanced manufacturing technology to help the organization develop a reputable brand name in the industry very high. To a great extent advanced manufacturing technology helped organizations to develop a reputable brand name in their industry and the organizations leadership team were able to regularly access the organizational inventory. Results revealed that advanced manufacturing technology helped leaders in organizations to pool resources and expertise toward a shared goal, have an effective product distribution network, locate companies in prime areas in relation to their customers, develop strategic partnership contracts with other global manufacturers, and the develop their own registered trademarks to a great extent and that to a moderate extent, organizations patent their products. Results are presented in Table 11.0.

Physical facilities are part of tangible resources owned by the organization and respondents were required to rank them with regard to how they facilitated the organization to improve its performance while using advanced manufacturing technology. Results of the study show that office space and production facilities had the highest rank while ownership of land and replacement strategy for production equipment was rated low. Findings are presented in Table 12

Table 12: Physical Facilities

Physical Facility Indicator	Mean	Rating
The organization has sufficient office and production space	4.3	1

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organization owns land for expansion of its facilities	4	2
The organization has a replacement strategy for its production equipment	4	2

Employee capabilities are intangible resources which organizations employ in developing strategies to achieve their goals. The employee capabilities used in the study included: Approach to human resource development, human resource development programs and the industry technological needs, training and development policies that supported use of technology in production, effective performance management system, employee own skills development, and embracing of coaching at the workplace towards employee capabilities. Human resource development is one of the activities that lead to organizational development through improving individual skills accompanied with organizational skills. Managers surveyed to a great extent associate training with associated technology that adds value to investments in technology for the organizations. Results are presented in table 13.

Table 13: Employee Capabilities

Employee Capability Indicators	***Mean***	***Ranking***
The organization encourages employee own skills development	4.2	1
The organization has a training and development policy that support use of technology in production	4.0	2
The organization practices an effective performance management system	4.0	2
The organization embraces coaching at the workplace	4.0	2
The organization has an overall approach to human resource development	3.9	3
Human resource development programs are tied to the industry technological needs	3.8	4

The results show that the ranking of development of own skills by employees was the highest. When employees develop their own skills relative to the work environment, they tend to be more motivated to accomplish the task and improve their work output. The second highest indicator from the result ranking on capability included having a training and development policy with a bias on

technology, an effective performance management system (PMS) and coaching at the workplace. Although there is no law that requires employers to have performance management systems, it is one of the initiatives that promises consistency at work by employees, highly motivated employees, high morale among the employees and high employee retention. These are factors that impact positively on performance in an organization.

4.6 Advanced Manufacturing Technology and Organizational Performance

The study used non-financial performance indicators to determine the relationship between advanced manufacturing technology, organizational resources, and performance of large manufacturing companies in Kenya. The study used customer satisfaction to operationalize non-financial performance of large manufacturing companies in Kenya. Customer satisfaction indicators included; Products from our organization are rated highly by our customers, Products from our organization meet the needs and expectations regarding quality and performance of our customers, Our organization always meets the timelines on delivery required by our customers, Our customers always find our products to be competitive and represent best value for total cost of lifetime ownership, Our customers rate how our organization responds to their concerns highly, Customers rate our organization highly with regard to dealing with them professionally, Our technical support meets the desired competence levels expected by our customers. The results are presented in Table 14.0.

Table 14.0: Advanced Manufacturing Technology and Customer Satisfaction

Customer Satisfaction Indicator	Mean	Ranking
Products from our organization are rated highly by our customers	4.4	1

Products from our organization meet the needs and expectations regarding quality and performance of our customers	4.3	2
Our organization always meets the timelines on delivery required by our customers	4.3	2
Our customers always find our products to be competitive and represent best value for total cost of lifetime ownership	4.3	2
Our customers rate how our organization responds to their concerns highly	4.2	3
Customers rate our organization highly with regard to dealing with them professionally	4.1	4
Our technical support meets the desired competence levels expected by our customers	4.1	4

Product rating by customers had the highest ranking while the competence level for the technical support by customers received the lowest rating among all the factors considered on customer satisfaction.

4.7 Design Technologies and Organizational Performance

The study investigated the relationship between design technology dimension and performance of large manufacturing companies in Kenya. Simple regression analysis was used to test the hypothesis that there was a significant relationship between design technology dimension and performance of large manufacturing companies in Kenya. The results are presented in Table 15 model 1. The model summary shows that the relationship between design technology dimension and performance of large manufacturing companies in Kenya is not significant at a confidence level of 95% ($F=3.59$; $p>0.05$). Arising from this results the study rejects the hypothesis that design technology dimension has a significant relationship with performance of large manufacturing companies in Kenya

4.8 Manufacturing Technologies and Performance of Large Manufacturing Companies in Kenya

The study investigated the relationship between manufacturing technology dimension and performance of large manufacturing companies in Kenya. Simple linear regression was used to test the hypothesis that there is a significant relationship between manufacturing technology dimension and performance of large manufacturing companies in Kenya. The results are presented in Table 15 Model 2.

The model summary shows a strong positive relationship between manufacturing technology dimension and performance of large manufacturing companies in Kenya ($R=0.480$). Results from the model summary also show that manufacturing technology dimension account for 23% of variations in performance of large manufacturing companies in Kenya ($R^2= 0.230$). Table 15 model 2 also provide the ANOVA summary statistics for the effect of manufacturing technology dimension on performance of large manufacturing companies in Kenya. The results show a

significant F-ratio at a confidence level of 95% (F=12.249, p< .05). This is evidence that the regression model attained goodness of fit and was thus appropriate for analyzing data for this study.

Regression coefficients for the effect of manufacturing technology dimension on performance of large manufacturing companies in in Table 15 model 2. show that manufacturing technology dimension statistically predicts the value of performance of large manufacturing companies in Kenya at a confidence level

R I

results, confirm that there is a significant relationship between manufacturing technology dimension and performance of large manufacturing companies in Kenya. Arising from these results, the hypothesis that there exists a significant relationship between manufacturing technology dimension and performance of large manufacturing technologies in Kenya was confirmed.

4.9 Planning Technologies and Performance of Large Manufacturing Companies in Kenya

The study also investigated the relationship between planning technology dimension and performance of large manufacturing companies in Kenya. Simple linear regression was used to test the hypothesis that there is a significant relationship between planning technology dimension and performance of large manufacturing companies in Kenya. The results are presented in Table 15 Model 3.

The model summary shows a moderately strong positive relationship between planning technology dimension and performance of large manufacturing companies in Kenya (R=0.574). Results from the model summary also show that planning technology dimension account for 32.9% of variations in performance of large manufacturing companies in Kenya (R^2= 0.329). The ANOVA summary statistics results in Table 15 model 3 for the effect of planning technology dimension on performance of large manufacturing companies in Kenya show a significant F-ratio at a confidence level of 95% (F=20.618, p< .05). This is evidence that the regression model attained goodness of fit and was thus appropriate for analyzing data for this study.

W S

Regression coefficients for the effect of planning technology dimension on performance of large manufacturing companies in Kenya in Table 15 model 3 show that planning technology dimension statistically predicts the value of performance of large manufacturing companies in Kenya at a confidence level

R I

results, confirm that there is a significant relationship between planning technology dimension and performance of large manufacturing companies in Kenya was confirmed. Arising from these results, the study confirmed the hypothesis that there is a significant relationship between planning technology dimension and performance of large manufacturing technologies in Kenya.

4.10 Advanced Manufacturing Technology and Performance of Large Manufacturing Companies in Kenya

The relationship between advanced manufacturing technology, which was the joint effect of design technology dimension, manufacturing technology dimension and planning technology

dimensions, and performance of large manufacturing companies in Kenya was also investigated in the current study. Simple linear regression was used to test the hypothesis that there is a significant relationship between advanced manufacturing technology and performance of large manufacturing companies in Kenya. The results are presented in Table 15 Model 4.

The model summary shows a moderately strong positive relationship between advanced manufacturing technology and performance of large manufacturing companies in Kenya (R=0.565). Results from the model summary also show that advanced manufacturing technology account for 31.9% of variations in performance of large manufacturing companies in Kenya (R^2= 0.319). From Table 15 model 4 which provides the ANOVA summary statistics for the effect of planning technologies on performance of large manufacturing companies in Kenya, results on the relationship between advanced manufacturing technology and performance of large manufacturing companies in Kenya show a significant F-ratio at a confidence level of 95% (F=19.662, p< .05). This is evidence that the regression model attained goodness of fit and was thus appropriate for analyzing data for this study.

Regression coefficients for the effect of advanced manufacturing technology on performance of large manufacturing companies in Kenya in Table 15 model 4 show that advanced manufacturing technology statistically predicts the value of performance of large manufacturing companies in Kenya at a confidence level

R I

results, confirm that there is a significant relationship between advanced manufacturing technology and performance of large manufacturing companies in Kenya. Arising from these results, the hypothesis that there is a significant relationship between advanced manufacturing technology and performance of large manufacturing companies in Kenya was confirmed.

Table 15.0: Model Summary

Model	Results						
	R	R Square	F	Sig	Coeff	t	sig
1	.285[a]	0.081	3.590	.067[b]	0.129	1.881	0.067
2	.480[a]	0.230	12.249	.001[b]	0.260	3.500	0.000
3	.574[a]	0.329	20.618	.000[b]	0.272	4.541	0.000
4	.565[a]	0.319	19.662	.000[b]	0.318	4.434	0.000

4.11 Moderation effect of organizational resources on the Relationship between Advanced Manufacturing Technology and Performance

The study investigated the moderating effect of organizational resources on the relationship between advanced manufacturing technology and performance of large manufacturing companies in Kenya. The three three-step model proposed by Baron and Kenny (2018) was used to test the hypothesis that organizational resources moderate the relationship between advanced manufacturing technology and performance of large manufacturing companies in Kenya Results are presented in Table 16.

The first step was regression analysis with advanced manufacturing technology predicting performance and to find out if this relationship was significant. The results confirmed a moderately strong and significant relationship between advanced manufacturing technology and performance of large manufacturing companies in Kenya (R=0.565, F=19.662, W

these results, the study proceeded to the second step. Results are presented in Table 16 (model 1)

In the second step of the three-step model, multiple regression with organizational resources (OR) and advanced manufacturing technology predicting performance (Y) was carried out to establish if the joint effect of organizational resources and advanced manufacturing technology on performance of large manufacturing companies in Kenya was significant. The results are shown in table 16 (Model 2).

The results confirmed a moderately strong and significant relationship between the joint effect of organizational resources and advanced manufacturing technology on performance of large manufacturing

companies in Kenya (R=0.698, F=19.429, p< .05). Arising from these results, the study proceeded to the third step. In the third step the interaction term (OR*AMT) was introduced into the model that already had the two predictor variables, advanced manufacturing technology and organizational resources. Performance of large manufacturing companies in Kenya was then regressed on the three predictors. Results are presented in Table 16 (Model 3).

Results show the strength of the relationship between advanced manufacturing technology, organizational resources, the interaction term OR*AMT and performance of large manufacturing companies in Kenya is strong (R=0.702) and the coefficient of determination is significant (R^2 = 0.493, p<0.05). Therefore, the three predictors jointly account for 49.3% of change in performance of large manufacturing companies in Kenya. Further, the results show a significant F-ratio (F= 12.952, p <.005).

Further, Table 17 presents the regression coefficients for the effect of advanced manufacturing technology, organizational resources and the interaction term on performance of large manufacturing companies in Kenya. The analysis results show that advanced manufacturing technology does not statistically predict the value of performance of large manufacturing companies in Kenya in the presence of organizational resources and the interaction term at a confidence level R I results also show that organizational resources statistically predict the value of performance of large manufacturing companies in Kenya in the presence of advanced manufacturing technology and the interaction term (OR*AMT) at a F R Q I L G H Q F H O H Y H C 2.079, p<.05).The results in Table 17 also show that the interaction term is not significant in the relationship between advanced manufacturing technology and organizational resources with performance of large manufacturing companies in . H Q -0.011, t = -0.697, p>.05)

The results in step three of the moderation model provided insufficient evidence to support the hypothesis that the relationship between advanced manufacturing technology and performance of large manufacturing companies in Kenya is moderated by organizational resources. The hypothesis was thus not confirmed.

Table 16: Regression Models for Moderation

Model Summary							
Model	R	R^2	F	Sig		Coeff	
1	.565[a]	0.319	19.662	.000[b]	0.318		
2	.698[a]	0.487	19.429	.000[b]	0.199	0.391	
3	.702[a]	0.493	12.952	.000[b]	0.471	0.565	-0.069

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Table 17: Regression coefficients for Moderation

Model		Coefficients				
		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error			
1	(Constant)	3.142	0.23		13.677	0.000
	Advanced Manufacturing Technology	0.318	0.072	0.565	4.434	0.000
2	(Constant)	1.912	0.392		4.876	0.000
	Advance Manufacturing Technology	0.199	0.071	0.353	2.802	0.008
	Organizational Resources	0.391	0.107	0.461	3.66	0.001
3	(Constant)	1.244	1.037		1.199	0.237
	Advanced Manufacturing Technology	0.471	0.397	0.837	1.186	0.242
	Organizational Resources	0.565	0.272	0.666	2.079	0.044
	(OR *AMT)	-0.069	0.098	0.611	-0.697	0.49

4.12 Discussion

The study investigated the relationship between advanced manufacturing technology organizational resources and performance of large manufacturing companies in Kenya. The dimensions of advanced manufacturing technology; design technology dimension, manufacturing technology dimension and planning technology dimension, were used in the study to investigate their role in the relationship between advanced manufacturing technology and performance of large manufacturing companies in Kenya.

First, the results show that there is no significant relationship between design technology dimensions and performance of large manufacturing companies in Kenya at 95% confidence ($F= 3.59$, $p>0.05$). This finding indicates that design technologies do not have a significant impact on the performance large manufacturing organizations in Kenya. Although the study findings indicate no significant relationship, design technology is a key factor for organizations that are involved in implementing innovation strategies in manufacturing. This result is an indication of low innovation or lack thereof by large manufacturing companies in Kenya. This has a negative impact on managing customer complaints regarding product attributes due to the low application of

design technologies that are used in developing new products or changing existing products by large manufacturing companies in Kenya.

Second, the findings reveal a strong positive and significant relationship between manufacturing technology dimension and performance of large manufacturing companies in Kenya at 95% confidence level ($R=0.480$, $F=12.249$, $p<0.05$). Arising from this finding, large manufacturing companies that apply manufacturing technologies appropriately in their production process will realize better performance in the industry than those that do not. Further, the results show that manufacturing technologies accounts for 23% of the variations in performance of large manufacturing companies in Kenya while 73% of the variations are accounted for by other extraneous factors ($R^2=0.23$). This result show that there are other variables that affect performance in large manufacturing companies in Kenya, besides manufacturing technologies. The coefficient of manufacturing technologies at 0.26 show that every unit change in manufacturing technologies explains 0.26 variance in performance of large manufacturing companies in Kenya W

this results, investments in manufacturing technologies have a positive impact to performance of large manufacturing companies in Kenya and will lead organizations to reduce their unit production costs and improve the quality of their products. Computer aided manufacturing which was ranked the highest, enables organizations to achieve high flexibility in their production process.

Third, the findings show a moderately strong positive and significant relationship between planning technology dimension and performance of large manufacturing companies in Kenya at 95% confidence level ($R=0.574$, $F=20.618$, $p<0.05$). Arising from these results, large manufacturing companies that apply planning technologies appropriately in their production process will realize better performance in the industry. Further, the results show that manufacturing technologies accounts for 32.9% of the variations in performance of large manufacturing companies in Kenya while 67.1% of the variations are accounted for by other extraneous factors ($R^2=0.329$). This result indicates that organizations should also consider investing in other initiatives that account for 67.1% of the variations outside planning technologies to improve their organizational performance.

The coefficients of planning technologies at 0.272 show that every unit change in planning technologies explains 0.272 variance in performance of large manufacturing companies in Kenya W

these results, investments in planning technologies have a positive impact on performance of large manufacturing companies in Kenya. Further, the results also indicate that planning technologies have the greatest impact on the dimensions of AMT that were considered in this study as they explain 32.9% of the variations in performance compared to 23% that is observed with manufacturing technologies, while design technologies explain only 8.1% of the variations in performance. The study also found that enterprise resource planning had the highest ranking due to its versatile characteristic in that it can be used by standalone systems, or fully integrated manufacturing systems.

Fourth, the results for the joint effect of design technologies, manufacturing

technologies and planning technologies show a moderately strong positive relationship between advanced manufacturing technology and performance of large manufacturing companies in Kenya (R=0.565). Results from this study also show that advanced manufacturing technology accounts for 31.9% of variations in performance of large manufacturing companies in Kenya while 68.1% of performance is accounted for by other extraneous factors (R^2= 0.319). These results show that advanced manufacturing technology has a positive effect on the performance of large manufacturing organizations and the finding suggest that organizations that invest in advanced manufacturing technology and implement it appropriately will realize better performance in the industry compared to organizations that fail to embrace advanced manufacturing technology or do not implement it appropriately. Further, summary statistics for the effect of AMT on performance of large manufacturing companies in Kenya show a significant F-ratio at a confidence level of 95% (F=19.662, p< .05). This is evidence that the regression model attained goodness of fit and was thus appropriate for analyzing data for this study.

Regression coefficients for the effect of advanced manufacturing technology on performance of large manufacturing companies in Kenya show that advanced manufacturing technology statistically predicts the value of performance of large manufacturing companies in Kenya at a F R Q I L G H Q F H O H Y H O R I 4.434, p< .05). This implies that a unit change in advanced manufacturing technology explains 0.318 of variance in performance of large manufacturing companies in Kenya.

These results also reveal that the joint effect of the three dimensions of advanced manufacturing technology used in the study is greater than the individual effects. This implies that organizations that implement all the three dimensions of advanced manufacturing technology, (design technologies, manufacturing technologies and planning technologies) in their production process achieve better performance compared to organizations that choose to apply one or two dimensions of advanced manufacturing technology.

Fifth, the study sought to investigate the moderating effect of organizational resources on the relationship between advanced manufacturing technology and large manufacturing companies in Kenya. The results reveal that organizational resources do not moderate this relationship as both the coefficient of the interaction term (AMT*OR) and advanced manufacturing technology are not significant in the last step of the 3-step moderation model.

Despite the results indicating that organizational resources do not moderate the relationship between advanced manufacturing technologies and performance of large manufacturing companies in Kenya, the coefficient of advanced manufacturing technology is observed to increase from 0.318 in the first step to 0.353 in the second step and finally to 0.837 in the third step. This finding reveals that a unit change in advanced manufacturing technology explains 0.837 of variance in performance of large manufacturing companies in Kenya in the presence of organizational resources and the interaction term (AMT*OR) compared to 0.353. Arising from this observation, organizational resources have a positive impact on the relationship between

advanced manufacturing technology and performance of large manufacturing companies in Kenya.

5.0 CONCLUSIONS

From the study, advanced manufacturing technology was found to positively and significantly influence performance of large manufacturing organizations in Kenya. The study also revealed that planning technologies as a dimension of advanced manufacturing technology has a greater impact on performance of large manufacturing companies in Kenya compared to design technologies and manufacturing technologies.

A unique finding of the study was that the relationship between design technologies and performance of large manufacturing companies in Kenya was not significant. The research therefore established that design technologies are not as critical in the manufacturing process in developing economies compared to either planning technologies or manufacturing technologies. This notwithstanding, design technologies should nonetheless be applied in the production process as the joint effect of AMT revealed that there is positive synergy among the three dimensions of advanced manufacturing technology with performance of large manufacturing companies in Kenya.

Further, the study also concludes that although organizational resources do not moderate the relationship between advanced manufacturing technology and performance of large manufacturing companies in Kenya, they contribute towards enhancing the overall effect of advanced manufacturing technology on performance. Hence, manufacturing companies that have strategic resources will achieve better performance when they apply advanced manufacturing technology in their production processes compared to companies that use traditional manufacturing methods.

6.0 IMPLICATIONS OF THE STUDY

First, the findings of this study show that from the three dimensions of advanced manufacturing technology adopted by the study, planning technologies are the most widely adopted by manufacturing companies in developing economies. Although design technologies are easier to adopt as their adoption has a low cost implication on organizations, they have a lower impact on performance compared to manufacturing technologies and planning technologies in developing economies. Further, there is evidence from the study that there is positive synergy between the three dimensions of advanced manufacturing technology. The implication of these findings are that Managers need to identify the appropriate optimal mix of design technologies, manufacturing technologies and planning technologies before applying the three dimensions in their production process.

Second, the application of industrial robots in the manufacturing process was low yet they have a great potential to improve performance of large manufacturing organizations, indicating there is an opportunity for large manufacturing organizations in Kenya to exploit by considering how they can incorporate the use of industrial robots in their operations to further benefit from the manufacturing technologies they use in the production process.

Third, large manufacturing companies in Kenya need to entrench the use of

enterprise resource planning technologies in their manufacturing processes to benefit fully from its wide abilities to interface with other advanced manufacturing technologies especially those related to industry 4.0 to realize their strategic goals.

7.0 SUGGESTIONS FOR FURTHER RESEARCH

First, the findings of the study reveal that the relationship between design technologies and performance of large manufacturing companies in Kenya, which is a developing economy is not significant. The study suggests that further research be carried out using a larger population compared to that used in the study to establish the relationship between design technologies and performance of large manufacturing companies.

Second, the results in the study show that organizational resources do not moderate the relationship between advanced manufacturing technology and performance of large manufacturing companies in Kenya. Therefore, further research should be done to find out the role of organizational resources on the relationship between advanced manufacturing technology and performance of large manufacturing companies in Kenya.

Third, the study on the relationship between advanced manufacturing technology, organizational resources and performance of large manufacturing companies was done in Kenya, which is a developing economy. The study also suggests that similar studies be done in other developing economies and examine the similarities and or differences between the results.

Finally, more in-depth analysis using a more homogenous and larger population than the one used in this study should be done to examine the similarities and or differences between advanced manufacturing technology, organizational resources and performance of large manufacturing companies.

REFERENCES.

Amit, R., & Shoemaker. P. J., (1993). *'Strategic Assets and Organizational Rent.'* Strategic Management Journal 13 (3): 33–46.

Barney J. B., (2001). *Resource-based theories of competitive advantage: A ten-year retrospective on the resource-based view.* Journal of Management

Barney, J. B., (1991). *"Firm Resources and Sustained Competitive Advantage",* Journal of Management.

Baron, M. R., & Kenny, D. A., (2018). *The Moderator-Mediator Variable Distinction in Social Psychological Research: Conceptual, Strategic, and Statistical Considerations.* Journal of Personality and Social Psychology

Baruch, Y. (1999). *Response Rate in Academic Studies - A Comparative Analysis.* Journal of Human Relations

Baldwin, R.J., & Sabourin, D., (1999). *Innovative Activity in Canadian Food Processing Establishments: The Importance of Engineering Practices.* International Journal of Technology Management.

Bildstein, A., Seidelmann, J. (2014). *Industries 4.0-Readiness: Migration zur Industrie 4.0-Fertigung. In Industrie 4.0 in Produktion, Automatisierung und Logistik*; Springer Vieweg: Wiesbaden, Germany, 2014; ISBN 978-3658046811.

Bivens (2019). *Updated employment multipliers for the U.S. economy*

Bogdan, R. & Taylor, S.J. (1975). *Introduction to Qualitative Research Methods: A Phenomenological Approach to the Social Sciences,* New York: John Wiley

Bridoux, F. (1997). *A resource-based approach to performance and competition: An*

Overview of the Connections between Resources and Competition Organization and Competitive Interactions.' Strategic Management Journal.

Chari, M.D.R. & David, P. (2012). *"Sustaining superior performance in an emerging economy: an empirical test in the Indian context",* Strategic Management Journal, Vol. 33 No. 2,

Conner, K. (1991). *An historical comparison of resource-based logic and five schools of thought within industrial organization economies: Do we have a new theory of the firm here?* Journal of Management, 17, 121–154.

Cook, J. S., & Cook, L. L., (1994). *Achieving Competitive Advantages of Advanced Manufacturing Technology. Benchmarking for Quality Management & Technology,* MCB University Press, 1351-3036.

Cresswell, J. W, & Plano C. V. L. (2011). *Designing and conducting mixed method research*. 2nd Sage; Thousand Oaks, CA

Crotty, M., (1998). *The foundations of social Research: Meaning and Perspective in the Research Process,* London: Sage Publication.

Dimba, B. A., & K'Obonyo, P.O., (2009). *The effect of strategic human resource management practices on performance of manufacturing multinational companies in Kenya: moderating role of employee cultural orientations and mediating role of employee motivation.* Semantic Scholar

Enos, D. D. (2007). *Performance improvement: Making it Happen.* Auerbach Publications.

Ergüden, A.E., Kaya, C.T., & Tanyer, B. (2018). *Re- & R Q V W U X F W L R Q the Rise of Revolutionary Changes in Industry 4.0. Account.* Audit Review, 18, 139–148.

Fahy, J. (2002). *A resource-based analysis of sustainable competitive advantage in a global environment.* International Business Review.

Garrido-Vega, M. M. P., Jimenez, C. H. O., (2015). *Implementation of technology and production strategy practices: Relationship levels in different industries.* International Journal of Production Economics 161, 201-216

Gichunge, E. M. (2007). *The Effect of Formal Strategic management on Organizational Performance: A Study of Selected medium sized Manufacturing Enterprises in Nairobi, Kenya.* PhD Dissertation University of Nairobi.

Grant, RM. (1996). *Toward a knowledge-based theory of the firm*. Strategic Management Journal.

Greco, M., (2013). *Relational Capital and Performances in Interuniversity Research Consortia*. Research Article sagepub.com

Grimpe, C. & Hussinger, K., (2014), *"Resource complementarity and value capture in firm acquisitions: the role of intellectual property rights",* Strategic Management Journal, Vol. 35 No. 12.

Grunert & Hildebrandt (2004). *Success factors, competitive advantage and competence development.* Journal of Business Research 57(5):459-461

Gunawardana, K., (2006). *Introduction of Advanced Manufacturing Technology a literature review.* Sabaragamuwa University Journal, vol 6, no.1, pp 116-134 116

Gupta, A., Briscoe, F. & Hambrick, D.C. (2017). *"Red, blue, and purple firms: organizational political ideology and corporate social responsibility",* Strategic Management Journal, Vol. 38 No. 5.

Haraguchia, N., Fang, C., & Eveline, S., (2016). *The Importance of Manufacturing in Economic Development: Has This Changed?* Elsevier

Haruna, S. M., Gakure, R., & Orwa, G., (2015). *Effect of advanced manufacturing technology on the product output of manufacturing small and medium scale enterprises in Nigeria*. International Academic Journal of Innovation, Leadership and Entrepreneurship Volume 1, Issue 5.

Hasan, Nuri, Turan, & Tolga (2013). *An empirical investigation of advanced manufacturing technology investment patterns: Evidence*

from a developing country. Journal of Engineering and Technology

Hayes & Pissano (1996). *Innovations in Competitive Manufacturing*. Springer

Healy, K., (2012). *Social work methods and skills; the essential foundations of practice*. Palgrave Macmillan

Hosseini, A. S., Soltani, S., & Mohammad M., (2018). *Competitive Advantage and Its Impact on New Product Development Strategy (Case Study: Toos Nirro Technical Firm)*. Journal of Open Innovation Technology

+ \ Q H N - *The Post-*D Q HMansfield, E. (1993). *The diffusion of flexible manufacturing systems in Japan, Europe and USA.* Journal of Management Science *Implementation Assessment of Advanced Technology* Utilization Journal of Competitiveness Vol. 4, Issue 3, pp. 3-13, ISSN 1804-171X (Print), ISSN 1804-1728

Ismail (2016). *The Application of Non-Financial Performance Measurement in Malaysian Manufacturing Firms*. Elsiever.

Kamasak, R (2017). *The contribution of tangible and intangible resources, and capabilities to a firm's profitability and market performance.* European Journal of Management and Business Economics

Kashan, A. J., & Mohannak, K., (2015). *An Empirical Study of Capability Development within Product Innovation Projects.* Journal of Technology Management Innovation.

Kenya Economic Review (2018)

Kor, Y. & Mesko, A. (2013), *"Dynamic managerial capabilities: configuration and orchestration of top executives' capabilities and the firm's dominant logic"*, Strategic Management Journal, Vol. 34 No. 2, pp. 233-244.

Kotha, S. & Swamidass, P. M. (2000). *Strategy, advanced manufacturing technology and performance: empirical evidence from U.S. manufacturing firms*, Journal of Operations Management 18 2000 257–277

Kotturu, C. M. V.V., & Mahanty, B., (2017) *"Determinants of SME integration into global value chains: Evidence from Indian automotive component manufacturing industry"*, Journal of Advances in Management Research, Vol. 14 Issue: 3, pp.313-331,

Kronos (2016). *The Future of Manufacturing: 2020 and Beyond The management and technology priorities enabling global competitiveness in the years ahead.* Industry Week

Levinthal & Myatt (1994). *Co-evolution of capabilities and industry: the evolution of mutual fund processing.* Wiley

Lippman, S. A., & Rumelt, R. P. (2003). *A bargaining perspective on resource advantage*. Strategic Management Journal.

Management Science

McGahan, A. M., & Porter, M. E. (1997). *How much does industry matter, really?* Strategic Management Journal, 18 (Summer Special Issue), 15–30.

Meredith, J. (1987). *The Strategic Advantages of new Manufacturing Technologies for Small Firms.* Strategic Management Journal 8: 249-258.

Mills (1995). *Time Series Analysis*. Wiley

Mohanty, M. K., Padmavati Gahan, P., & Choudhury, S., (2014). *Technology Management in Manufacturing Sector - A case study from Indian Manufacturing Industry and Application of Gregory Model.* Asian Journal of Research in Business Economics and Management Vol. 4, No. 8, pp. 216-233. ISSN 2249-7307

Musebe, E. A., (2012). *Resources, Capabilities and Competitive Advantage*. University of Nairobi Repository

Nelson, R. R., & Winter, S. G. (1982). *An evolutionary theory of economic behavior and capabilities.* Cambridge: Harvard University Press, 195–307.

Nyori, G. M., & Ogola, J.M., (2015). *Advanced manufacturing technology adoption in manufacturing companies in Kenya* International Journal of Research in Engineering and Technology

Oyedijo, A. (2013). *Business Policy and Strategic Management (2nd ed.).* Ikeja: Strategic International Press Ltd.

Peteraf, M. A. (1993). *The cornerstones of competitive advantage: A resource-based view*. Strategic Management Journal, 14, 179–192.

Porter, M. E. (1980). *Competitive Strategy*, New York, The Free Press

Prahalad, C. K., & Hamel, G., (1990). '*The Core Competence of the Corporation*.' Harvard Business Review 68 (3): 79–91.

Porter, M. E. (1985). *Competitive Advantage*, New York, The Free Press

Porter, M. E., (1991) *The Competitive Advantage of Nations*, The Free Press, New York, NY,

Putterill, M., Maguire, W., & Sohal, S. A., (1996). *Advanced manufacturing technology investment: criteria for organizational choice and appraisal.* Journal of Integrated Manufacturing Systems

Razali,N. M., & Wah,Y. B., (2011) *Power comparisons of Shapiro-Wilk, Kolmogorov-Smirnov, Lilliefors and Anderson-Darling tests* Journal of Statistical Modelling and Analytics Vol.2 No. I, 21-33,

Rumelt, R. (1991). *How much does industry matter?* Strategic Management Journal, 12, 167–185

Sheena, P. (2008). *Beyond industrialization: New approaches to development strategy based on service sector*. UNU-WIDER Research Paper No. 60.

Shortridge R. T. (2004). *Market valuation of successful versus non-successful R&D efforts in the pharmaceutical industry.* Journal of Business Finance Account. 31(9-10):1301-1325.

Small & Yasin (1997). *The dimensionality and utilization of performance measures in a manufacturing operational context: Organizational change implications*. Emerald Insight

Sohal, S. A., (1996). *Assessing AMT implementations: an empirical field study*, Technovation, Vol. 16 No. 377-383.

Sohal, A. S., & Schroder, R., (1999). *Organizational characteristics associated with AMT adoption.* International Journal of Operations & Production Management ISSN: 0144-3577

Swink M. (2000) *Core manufacturing competencies. In: Swamidass P.M.* (eds) Encyclopedia of Production and Manufacturing Management. Springer, Boston, MA

Swink , M., & Nair, A., (2007) *Capturing the competitive advantages of AMT: Design–manufacturing integration as a complementary asset* Journal of Operations Management Volume 25, Issue 3, , Pages 736-754

Tanisha, P., John, K., & Potgieter, J., (2019). *A comparison of traditional manufacturing vs additive manufacturing, the best method for the job, 14th Global Congress on Manufacturing and Management.* Procedia Manufacturing

Tanwar (2013). *Porter's Generic Competitive Strategies*. IOSR Journal of Business and Management (IOSR-JBM)

Teece and Pissano (1994). *The Dynamic Capabilities of Firms: An Introduction.* International Institute for Applied Systems Analysis A-2361 Laxenburg Austria

Tuan & Takahashi, (2009). *Resources, Organizational Capabilities and Performance: some empirical evidence from Vietnam's supporting industries.* International Review of Business Research Papers Vol. 5 No. 4

Unsal, E., & Cetindamar, D., (2015). *Technology Management Capability: Definition and Its Measurement.* European International Journal of Science and Technology Vol. 4 No. 2

Upton, D. M., (1997). "*Process range in manufacturing: An empirical study of À H [" Management Science Journal, vol. 43, no. 8, pp. 1092–1097, 1997.

Van de Ven, A., Hudson, R., & Schroeder, D. (1984). *Designing new business startups: Entrepreneurial, organizational, and ecological considerations.* Journal of Management, 10,

Watson, R. (2019) *Jump starting digital transformation in manufacturing*, Global Manufacturing Journal

Wernerfelt, B. (1984*). 'A Resource Based View of the Firm.'* Strategic Management Journal 5 (3): 171–80.

World bank (2018)

Ying, Q., Hassan, H., & Ahmad, H., (2019). *The Role of a Manager's Intangible Capabilities in Resource Acquisition and Sustainable Competitive Performance*. Journal of Sustainability