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ADVANCED MANUFACTURING TECHNOLOGY, COMPETITIVE ADVANTAGE 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), competitive advantage 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 of 55 large manufacturing companies in Kenya and were members of Kenya Association of Manufacturers. A self-administering questionnaire was administered on the population of the study and responses from 45 large manufacturing companies, which represented a response rate of 81.8% were received. Statistical tests using linear regression were used to test the developed study hypothesis and also determine the relations between the study variables using the collected data. Findings revealed a significant relationship between advanced manufacturing technology and performance of large manufacturing companies in Kenya and that other factors that were not considered in the study also affect this relationship. The study also found that competitive advantage does not mediate the relationship between advanced manufacturing technology and performance of large manufacturing companies in Kenya. Further, the results revealed that advanced manufacturing technology has a significant and positive relationship with competitive advantage. Arising from these findings, the study concluded that effective implementation of advanced manufacturing technology to manage the manufacturing processes enables organizations to improve their performance and large manufacturing companies can use advanced manufacturing technology to develop competitive advantage. The implication of the study findings is that organizations need to determine the other factors that affect the relationship between advanced manufacturing technology and performance of large manufacturing companies to realize the benefits associated with implementing advanced manufacturing technology in the production process. Large manufacturing companies also need to develop mechanisms of sustaining competitive advantage developed through advanced manufacturing technology.

Key words: Advanced Manufacturing Technology, Competitive Advantage, Large manufacturing companies and Organizational Performance.

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1.0 INTRODUCTION

Business and market environments have become increasingly dynamic and competitive due to effects of globalization and changing customer preferences (Fellix, 2015). Manufacturing companies implement strategies that help them develop or maintain their competitive advantage to effectively cope with emerging competitiveness in the industry. Manufacturing companies identify appropriate manufacturing strategies to manage factors in the business environment to improve or sustain their performance.

Manufacturing companies adopt world class production systems to become as good as the best in their industries. This does not give them competitive advantage in turbulent operating environments, neither does adopting initiatives such as total quality management, Just-in-time and lean manufacturing automatically lead to developing competitive advantage in their production process (Hayes & Pisano, 1994; Dangayach, Pathak & Sharma, 2006). Developing and sustaining competitive advantage requires more than benchmarking with the best companies as globalization has made the business environment become turbulent. Arising from this development, manufacturing companies have to develop and implement manufacturing strategies that specify the competitive advantage they intend to have in their industry and market. Advanced manufacturing technology is one of the strategies manufacturing companies adopt to manage the challenges in the new operating environment to improve their performance (Heinea, Groverb, & Malhotrac, 2003).

Advanced manufacturing technology has been defined by various researchers to include the use of standalone or integrated computer systems to manage the production system (Nyori & Ogolla, 2015; Gunawardana, 2010; Boyer, Keong Leong, Ward, & Krajewski, 1997). This study defines advanced manufacturing technology as the application and integration of both software and hardware computer systems in a standalone or integrated modular installation to help manufacturing companies design, plan and control their production processes with the objective of reducing the cost of production, enhancing product quality and improving their performance.

Advanced manufacturing technology has gained acceptance in manufacturing companies arising from the benefits that it offers including cost reduction, improved production efficiency, better customer relationship, improved product quality, flexibility and on-time deliveries (Díaz-Reza, Mendoza-Fong, Blanco, & Marmolejo, 2019).

Manufacturing companies in developing economies face a bigger challenge of defending their market positions or fight competing products in their markets for survival as they face a decline in both manufacturing value added and manufacturing employment (Haraguchi, Chen & Smeets, 2016). This decline is attributed to failure of development of manufacturing in a large number of developing economies against the backdrop of rapid development of manufacturing in a small number of developed economies, thus resulting in a concentration of manufacturing activities in few developing economies (Haraguchi, Chen & Smeets, 2016).

Manufacturing companies in Kenya, which is a developing economy, face similar challenges and have to compete with products from developed economies in the markets they choose to operate. Arising from these challenges, Kenya developed a strategic plan, vision 2030, that aims at

improving the manufacturing sector to make the country become a middle income economy by the year 2030. The economy of Kenya for a long time has relied more on agriculture which on average contributes 26 per cent of GDP and generates 40% direct employment positions (Takavarsha, 2020). Kenya has also developed another strategy, manufacturing agenda 2020, to actualize the objectives of vision 2030. The Kenya manufacturing agenda 2020 aims at establishing a competitive and manufacturing led economy by improving agro-processing for the manufacturing sector to grow and contribute 15% to GDP by the end of 2022, compared to 9.2% achieved in 2016 (KAM, 2020).

The manufacturing sector in Kenya consists of large manufacturing companies, medium companies and, small and micro enterprises (Bigsten, 2010). The make-up of the sector is such that Small and micro enterprises (SME's) constitute 80% of the companies in the sector, and account for 20% of the sector's GDP while large manufacturing companies constitute 20% of the companies in the sector and account for 80% of the sector's GDP (KER, 2017). Arising from the makeup of the manufacturing sector in Kenya, for the country to achieve the intended growth and contribution of 15% to GDP by the end of 2022, large manufacturing companies have to implement production processes that are efficient to reduce their costs of production, capable of transforming inputs into quality and appealing products, and develop competitive advantage to effectively manage threats from other manufacturing companies in the region. The motivation of this study therefore was to investigate the role of competitive advantage on the relationship between advanced manufacturing technology and performance of large manufacturing companies in Kenya.

2.0 LITERATURE REVIEW

Due to globalization, manufacturing companies are facing challenges of meeting and exceeding global customer expectations. Manufacturing companies use strategies that employ traditional production systems that rely on mass production systems or agile manufacturing systems to manage production costs and meet the needs of their customers (Soosay, Nunes & Bennet, 2016). Although mass production systems allow companies to achieve increased productivity, manage their production costs and achieve uniform product attributes, they have high set-up costs and do not have production flexibility, which hinders them from responding quickly to meet new customer needs. Arising from these disadvantages, studies show that mass production systems allow manufacturing companies to develop competitive advantage but are not able to maintain the advantage for long (Soosay, Nunes & Bennet, 2016). In order to develop and maintain competitive advantage, manufacturing companies adopt agile manufacturing systems that include advanced manufacturing technologies in their production systems.

Advanced manufacturing technology involves applying standalone or integrated computer systems to help manufacturing companies manage their production process. Advanced manufacturing technology employs semi or fully automated production systems that deploy machines, tools and human skills to plan, control the production process, purchase the required raw materials, manage the distribution networks, manage maintenance of production equipment, and maintain performance and reliability of finished products (Johnson, Newman & Hana, 2000; Nyori & Ogolla, 2015). Advanced manufacturing technologies continue to gain importance in industries as they address both current and future industry needs in meeting customer

preferences and managing manufacturing costs (Joseff, Vaclave, 2012).

In this study, advanced manufacturing technology was operationalized using three dimensions; design technologies, manufacturing technologies and planning technologies. Studies show that manufacturing companies pursuing the innovation strategy by applying design technologies in their manufacturing processes to reduce costs associated with this strategy (Saberi, Yusuff, Zulkifli, & Megat Ahmad, 2010). Innovation strategy costs include costs associated with time taken to determine how to manage the innovation strategy, develop organizational core capabilities that will drive the strategy, align the chosen strategy with the main business goals and make the strategy become the preferred way of working from product idea conception to product development and marketing. Further, studies have also found that design technologies reduce costs associated with product innovation by enabling marketing, R&D and Production functions share ideas in the product development process (Gunawardana, 2006). Design technologies are also associated with reducing costs associated with new product development as they help managers in manufacturing companies include customer feedback on the new product attributes and identify the most appropriate production process. Empirical studies reveal that design technologies lead manufacturing companies to adopt manufacturing strategies that build superior organizational capabilities and provide a competitive advantage that is sustainable (Hayes & Pisano, 1994).

Empirical studies reveal that design technologies are used by experienced designers to understand and figure out customer requirements when presented with a consolidated design brief as they are able to configure the needs of the customer with varying roles. This reduces the time between product inception and marketing. Design technologies consolidate the role of a technician, marketer and costing expert in delivering the desired product (Jonathan, Mahmoud, Jami, Larry, Julie, Steven, & Noe, 2013; Paton & Dorst, 2011). Manufacturing companies use design technologies as a single package incorporating the ‘what’ in terms of customer needs and the ‘how’ which is the methods to be used to deliver the product to the customer.

Design technologies are used by product design experts to improve existing products and also delve into new uncharted areas of new product development. Product design experts are inspired by using design technologies to shift from just improving current products to developing new high performance products and to think beyond satisficing customers. This process supports reflective, supportive cultures, multi-disciplinary working and facilitates communication transfer between teams (Petre, 2004; Gunawardana, 2006, Baldwin, & Sabourin, 1999). Design technologies have been found to have a disadvantage of failing to incorporate long term project concerns in their workings (Tovey,1986; Muller, 1989; Martin & Homer, 1986). The study considered the following technologies as indicators of design technology: Computer aided design (CAD), Computer aided Engineering (CAE), Computer aided process planning (CAPP) and Group technology (GT).

In order to determine the effect of manufacturing technologies on performance of large manufacturing companies in Kenya, the study considered the following indicators of manufacturing technologies; Computer aided manufacturing (CAM), Computer integrated manufacturing (CIM), Computer numerically controlled machines (CNC), Numerically controlled machines

(NC), Flexible manufacturing systems (FMS), Computer aided inspection (CAI), Industrial robots (IR), Automated guided vehicles (AGV), Automated storage and retrieval systems (AS/RS) and Program logic controllers (PLC). Studies have found that manufacturing companies widely use these technologies in the production process (Gunawardana, 2006; Nyori & Ogolla, 2015; Baldwin & Sabourin, 1999).

Manufacturing technologies are applied in production processes to increase efficiency and improve productivity. Empirical studies reveal that companies apply manufacturing technologies to help them improve both partial and total factor productivity, and improve corporate competitiveness (Lee, & Leem, 2016). Partial factor productivity is used to determine the relationship between outputs and single inputs (labor and capital), while total factor productivity measures the output in relation to multiple inputs and outputs. Empirical studies use productivity and performance interchangeably. Various methods including financial and non-financial measures are used to determine the performance of organizations (Sharpe, 2002). Further, studies reveal that manufacturing technologies allow companies to effectively manage factors that have adverse effects on performance (Syverson, 2010; Porter, 2000; Sharpe, 2002).

Manufacturing companies have to contend with business environments and competition patterns that are complex, dynamic, and uncertain with a variety of product offering targeting the same market (Singh & Khamba, 2010). Studies show that manufacturing technologies help companies to continue serving their markets and sustain their competitive advantage (Jabar, Soosay, & Santa,2010). In responding to the changes in the manufacturing environment, manufacturing technologies also change to cope with the evolving demands that require high performance. Therefore, manufacturing companies should re-define their strategies to address the new concepts required to keep their competitiveness.

Despite the favorable results from several studies on employing manufacturing technologies in their production process, manufacturing companies still have to manage challenges associated with these technologies that include planning, identification, acquisition, implementation and evaluating their effectiveness, which can lead to below average results (Ungan, 2007). Further, empirical studies have also revealed that implementing manufacturing technologies by itself is not sufficient to improve performance, internal and external environment factors are also important and should be considered before choosing the type of manufacturing technology to implement for good results (Waldeck & Leffakis, 2007).

To determine the effect of planning technologies on performance, the study considered planning technology to include: Materials requirement planning (MRP), Manufacturing resource planning (MRPII), Computer preventive maintenance planning (CPM), Just in time (JIT), Management information systems (MIS), Enterprise resource planning (ERP), Total quality management (TQM) and Customer relationship management (CRM). Studies reveal that manufacturing technologies are important in aligning the manufacturing strategy to the corporate strategy in achieving competitive advantage (Amoako-Gy-ampah & Acquuah, 2008; Olhager & Prajogo, 2012).

Studies show that manufacturing companies adopt advanced manufacturing technologies to manage direct labor costs which are low in developing economies but constitute a significant proportion of the manufacturing costs in developed economies where the cost

of labor is high (Gunawardana, 2010). Organizations use the manufacturing dimension and planning dimension of advanced manufacturing technology to lower their labor costs, increase their productivity and manage their distribution networks through efficient and optimal conversion of raw materials into high quality finished products (Joseff, & Vaclave, 2012).

When organizations implement advanced manufacturing technology in their operation, studies have found that they are able to benefit by: (1) reducing production cycle-time; (2) increasing their market share; (3) improving production efficiency; (4) achieving higher financial and non-financial organizational performance; (5) attaining flexible and focused production; (6) competitive advantage (Mohanty, Padmavati Gahan, & Choudhury, 2014). These benefits are associated with flexibility of advanced manufacturing technologies in terms of providing production processes that meet customer needs and help organizations to maintain their market share by adopting new production methods and engaging in both offensive and defensive marketing strategies, brought about by competition (Acar, Zehir, Özgenel, & Özşahin, 2013).

Organizations respond to competitor challenges in their industry differently. The response that promises to maintain competitive advantage and counter the challenge, complements implementation of strategies that promise results that are proportional to the threat of competition and sustain the already developed competitive advantage. Studies have shown that technology is one of the most effective strategies organizations use to counter competition beside increasing product visibility, managing production costs, offering better product prices, investing more resources in new product development, or considering accommodating the entrant as they study their impact in the market (Karakaya, & Yannopoulos, 2011).

Organizations are deemed to have competitive advantage when they deliver better or the same benefits in a product or service to their customers at a total reduced cost and higher customer experience compared to competing products/services (Ahmad, 2017). All organizations strive to deliver the best product as perceived by their customers, i.e. meeting all their expectations all the time and every time they use their product. There are two broad types of competitive advantage that are based on cost leadership and differentiated products processes (Porter, 1985). Organizations implement either of these strategies using their core competencies to develop solutions that address challenges posed in their operating and external environment.

The manufacturing sector is important in industrialization and most economies rely on this sector to create employment, provide opportunities for investment, manufacture products for consumption and, provide a mechanism/reason for global trade. Manufacturing is one of the routes that economies use to move from low income to middle and high income economies as they attain the industrialized economies status through structural transformation (Sheena, 2008). Economists have identified agriculture, manufacturing and service sectors of the economy as the key drivers to structural transformation of the economy. Countries use the three sectors to re-allocate their economic activity for industrial development and structural transformation of their economy (Achuka, 2016).

There has been slow growth in the manufacturing sector in Kenya (KNBS, 2019). The observed slow growth has an adverse impact on the development strategy adopted by Kenya to transition from a low economy to a middle level income economy.

The Country achieved an increase of real value add in 2018 of 4.2% compared to the anticipated growth of 0.5% in 2017 (KNBS, 2019). Formal employment in the manufacturing sector increased by 1.4 % in 2018 accounting for 11.1% of the total formal employment while the number of employees in the economic processing zones grew by 4.0% in 2018 (KNBS, 2019). Further, the unemployment rate in Kenya at 25% is higher than that observed in the region at 12.5% in 2015 (KNBS, 2019).

Economic reports reveal that the growth in the manufacturing sector in Kenya is slower than the growth of the economy. In 2016, the economy expanded by 5.6% while the manufacturing sector grew by 3.6% and contributed 10.3% to GDP (Andae, 2015, KNBS, 2019). Since the manufacturing sector provides a very big job multiplier effect in all economies, improving the manufacturing sector, will have a positive impact on reducing the observed unemployment levels in Kenya. This study used the resource based view theory to investigate the role of competitive advantage in the relationship between advanced manufacturing technology and large manufacturing companies in Kenya. Large manufacturing companies were used in the study due to their financial ability to invest in technology, the impact they have on increasing employment opportunities and their observed contribution to GDP in Kenya (Darbanhosseiniamirkhi & Wan Ismail, 2012; KNBS, 2019).

3.0 METHODOLOGY

A descriptive cross-sectional survey research design was used in the study because of the distinctive features it has and that were important to the study (Crotty, 1998). The population of the study comprised of large manufacturing companies in Kenya and which were members of Kenya Association of Manufacturers. The study considered Large manufacturing companies in Kenya to include manufacturing companies with a minimum annual turnover of Ksh. 100 million and at least 100 permanent or contract employees (Awino, 2011). Using this criteria, the study used purposeful sampling to identify 55 large manufacturing companies in Kenya which formed the population of the study.

Advanced manufacturing technology was operationalized using three dimensions, design technology, manufacturing technology and planning technology. The three technologies represent the complete spectrum of technology in manufacturing that was investigated by the study. A composite of the three technologies was used to test the relationships between the study variables. Competitive advantage was operationalized through the following competitive priorities, quality, cost and manufacturing flexibility while performance of large manufacturing companies in Kenya was operationalized by both financial and non-financial indicators.

Respondents in the study were asked to indicate the level to which they applied design technologies, manufacturing technologies and, planning technologies in their production process, on a Likert scale of 1-5 where 1= Not at all, 2= Small extent, 3= Moderate extent, 4= Great extent, and 5= Very great extent.

Respondents were also required to respond to questions related to competitive priorities in their production process, on a Likert scale of 1-5 where 1= Strongly disagree: 2=Moderately disagree: 3=Neutral: 4= Moderately agree: 5= Strongly agree. Finally, performance of the organizations was operationalized using customer satisfaction and on a Likert scale of 1-5 where 1= Strongly disagree: 2=Moderately disagree: 3=Neutral: 4= Moderately agree:

5= Strongly agree, the respondents were required to state the level to which they agreed with the provided statements that related to customer satisfaction.

In order to determine the credibility and authenticity of the collected data, respondents were asked to indicate the title of their job which indicated the level of responsibility and decision making they held in their companies and, the cumulative period they had been in this role. Further, the respondents were also requested to indicate whether the company had implemented a formal strategy or not and how long the company had been in operation. The period the company has been in operation is important in determining whether the company was a start-up or mature enough to have realized the impact of the formal strategies. A total of 45 questionnaires were received which was a response rate of 81.8%. This provided the study with the requisite data for analysis to determine the intended objectives of the study.

4.0 RESULTS AND DISCUSSION

Results show that majority of the respondents (51.4%) were at Director level (Director Technical Services 25.7% and Director manufacturing 25.7%) while 48.6% were directly responsible for manufacturing operations in their companies (Factory manager 20% and Engineering manager 28.6%). All the respondents (100%) held senior positions relating to manufacturing in their companies and therefore were knowledgeable about manufacturing operations and processes in their company. The results also show that cumulatively, 60% of the respondents had worked for the companies for more than four (4) years while only 8.9% of the respondents had been in employment with the current organization for less than one (1) year. The respondents also provided the following general information about their companies.

Most of the companies (57.1%) had more than 201 permanent or contract employees. The study used the total number of permanent or contract employees to determine the size of the company (Awino, 2011). The results show that companies with less than 50 employees were 2.2%, companies with between 51 and 100 employees were 20%, another 20% of the companies had between 101 and 200 employees on permanent or contract employment terms. Overall the results show that a total of 97.8% of the companies in the study had more than 50 permanent employees which enhances organizational performance while 77.8% had more than 100 employees. Results are presented in Figure 1.

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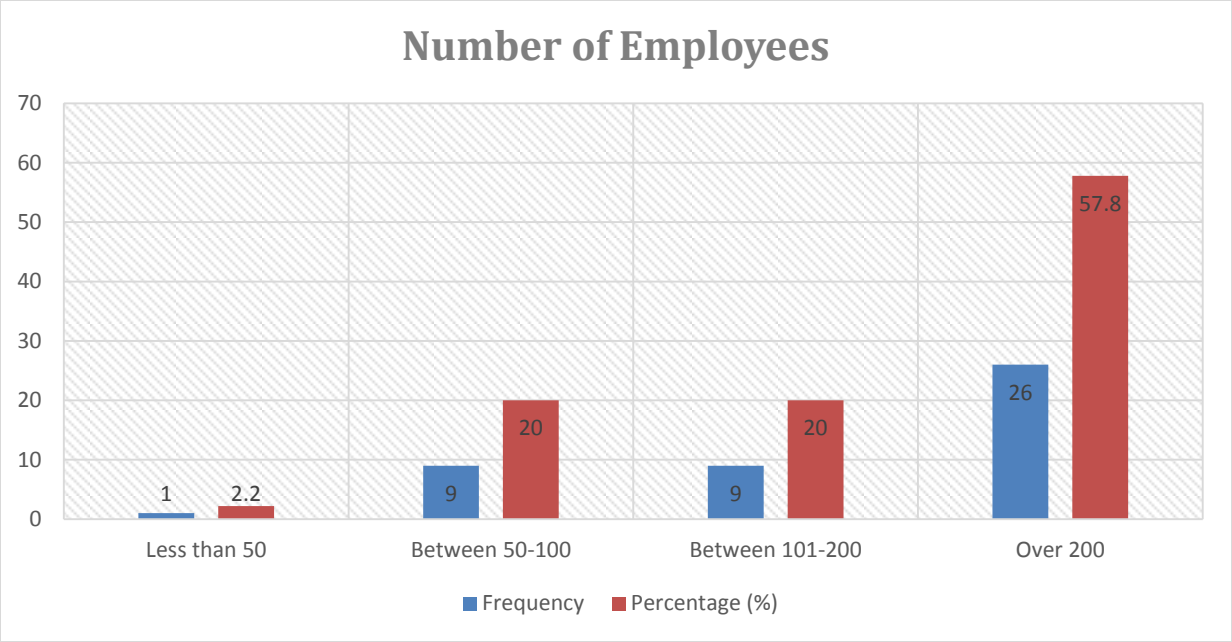

Fig.1: Number of employees in the Company.

The skewness test was done using the Shapiro-Wilk test and the results confirmed that the data used in the study was normally distributed. The results show that all the skewness values for the variables in the study were close to 1.0 allowing the research to proceed to use the data to perform parametric tests. The results for the Shakiro-Wilks test were: Advanced manufacturing technology (0.948), competitive advantage (0.98) and performance of large manufacturing companies in Kenya (0.942).

Multi collinearity test was done on the study variables and the value of VIF for the study variables were found to be between 1 and 5 indicating the absence of multi-collinearity which exists when VIF is less than 1 or greater than 5. The finding from the results on VIF of competitive advantage was 1.963 while that of advanced manufacturing technology was 1.531 with performance of large manufacturing companies in Kenya as the dependent variable.

Manufacturing organizations choose and implement formal/informal strategies that use the resources they own to give them competitive advantage (Cresswell, & Plano, 2011; Wen-Cheng, Chien-Hung & Yin-Chieng, 2011). The study focused on the formal manufacturing strategies that the companies had implemented. Results on implementation of manufacturing strategy revealed that 90.5% of the companies in the study had implemented a formal manufacturing strategy within the last six years. Lack of implementing a formal strategy does not imply that a company does not use any strategy in their operations. Results are presented in Table 1.

Table 1: Implementation of Manufacturing Strategy

Implementation of manufacturing Strategy	Percentage (%)
Yes	90.5
No	9.5

Market coverage is determined by the market share the company holds and is the volume of goods or service level the company controls within a given geographic area (Fahy, 2002). The study sought to determine the market in which the companies operated to find out if they were 'local' (operating only in Kenya) or they served other markets outside the 'local' market. Results for market coverage show that 15.6% of the organizations were operating in the Kenyan market, 53.3% were operating within the East African Region, 2.2% operated in the African market, while 28.9% operated in the International market. Overall, most of the companies in the study operate in the East African region (68.9%) and produce products that target the region. Companies operating in Kenya belong to the East African Community trading bloc and compete with other regional trading blocs like the proposed Africa Continental Free Trade Area (AfCFTA) whose aim is to create a competitive market for the companies in Africa and enhance trade between the members. Results are presented in Table 2.

Table 2: Market Coverage

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

4.1 Design Technologies

The results revealed that computer aided design CAD), computer aided engineering (CAE) and computer aided process planning (CAPP) are used to a moderate extent while group technology (GT) is used to a small extent by large manufacturing companies in Kenya. Results in Table 3 show the mean application of CAD is the highest (3.2), GT (2.4) is the least while the other two indicators of design technology CAE and CAPP are applied to the same extent (2.8). Manufacturing companies gain competitive advantage in their industry when they apply CAE in their production process to simulate performance of the process/product with a view of optimizing the performance of the process/product. Companies avoid expensive product re-calls from the market and easily identify the cause of inefficiency in the production process by using CAE. Overall, design technologies are applied to a moderate extent by large manufacturing companies in Kenya with a mean of 2.8.

Table 3: Application of Design Technologies

Design technology Indicator	Mean of the Technology Application
Computer aided design (CAD)	3.2
Computer aided Engineering (CAE)	2.8
Computer aided process planning (CAPP)	2.8
Group technology (GT)	2.4
Average	**2.8**

4.2 Manufacturing Technologies

Results on the application of manufacturing technologies in the production process revealed that: majority of the companies use computer aided manufacturing, computer integrated manufacturing, computer numerically controlled machines, numerically controlled machines, flexible manufacturing systems, and program logic controllers technologies to a were used by the companies to a moderate extent; while computer aided inspection, automated guided vehicles, industrial robots and Automated storage and retrieval systems were used to a small extent.

Manufacturing companies use advanced manufacturing technology to provide their customers with suitable products that meet their needs, to improve equipment maintenance regimes, reduce operation costs, increase production equipment reliability and, increase product quality (Bildstein & Seidelmann, 2014; Sheena, 2008; Ergüden, Kaya, & Tanyer, 2018). Attainment of any of these parameters improves the performance of manufacturing companies.

Table 4: Application of Manufacturing Technologies

Manufacturing Technology Indicator	Mean
Computer aided manufacturing (CAM)	3.3
Computer integrated manufacturing (CIM)	3
Computer numerically controlled machines (CNC)	3.1
Numerically controlled machines (NC)	3.2
Flexible manufacturing systems (FMS)	3
Computer aided inspection (CAI)	2.3
Industrial robots	1.5
Automated guided vehicles (AGV)	1.7
Automated storage and retrieval systems (AS/RS)	2.3
Programme logic controllers (PLC)	3.2
Average	**2.7**

Further, the results revealed that computer aided manufacturing (CAM) with an application mean of 3.3 is the most widely applied manufacturing technology while industrial robots (IR) with an application mean of 1.5 is the least applied technology by large manufacturing companies in Kenya.

The results also revealed that application of program logic controllers (PLC) and numerically controlled machines (NC) with a mean of 3.2 was also high**.** From these results, the top 3 manufacturing technologies applied by large manufacturing companies in Kenya are CAM, PLC and NC while the least three applied manufacturing technologies are CAI, AS/RS, AGV and IR. The results are presented in Table 4.

4.3 Planning Technologies

The results on application of planning technologies revealed that; materials requirement planning, Enterprise resource planning, Management Information Systems, Total Quality Management, and Customer Relationship Management were used to a great extent, while Manufacturing Resource Planning, Computer Preventive Maintenance Planning and Just in Time were used to a moderate extent. Further, the results revealed that enterprise resource planning with an application mean of 4.2 was the most applied planning technology while Just in Time with a mean of 2.9 was the least applied planning technology by large manufacturing companies in Kenya. Results from the study also revealed high application of Total Quality Management which incorporates equipment maintenance as a key requirement for reducing the number of defects in production. The results are presented in Table 5.

Table 5: Application of Planning Technologies

Planning Technology Indicator	Mean
Materials requirement planning (MRP)	3.7
Manufacturing resource planning (MRPII)	3.2
Computer preventive maintenance planning (CPM)	3.2
Just in time (JIT)	2.9
Management information systems (MIS)	3.7
Enterprise resource planning (ERP)	4.2
Total quality management (TQM)	3.7
Customer relationship management (CRM)	3.9
Average	**3.55**

Leaders in global manufacturing companies expect the performance of their companies to be enhanced through prudent use of planning technologies (Kronos, 2016). Manufacturing companies are constantly reviewing their planning technologies in view of the current industry trends that include embracing internet of things (IoT), predictive maintenance, shifting focus from B2B (Business-to-Business) to B2B2C (Business-to-Business-to-Consumer),

leveraging supply chain for competitive advantage and, streamlining the production process for greater production efficiency.

The findings revealed that large manufacturing companies in Kenya apply advanced manufacturing technologies to a moderate extent in their production processes (mean = 3.0). The average application of Planning technologies was to a great extent (mean 3.55) while Design technologies and Manufacturing technologies were applied to a moderate extent (mean=2.8 and 2.66 respectively). Manufacturing companies in Kenya are likely to use planning technologies in their production process compared to either manufacturing technologies or design technologies. The use of the various technologies within design, manufacturing and planning dimensions were observed to vary with application of industrial robots being the least (mean = 1.5) while enterprise resource planning was the most applied technology (Mean = 4.2). The results are presented in Fig. 2

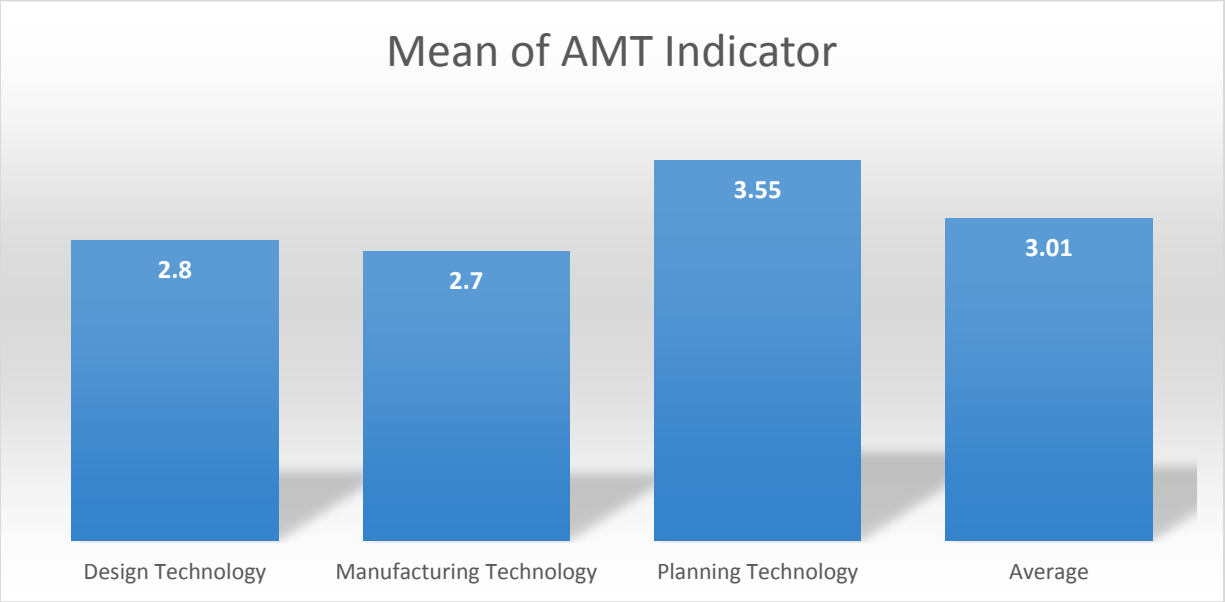

Fig.2: AMT Application Indicators

4.4 Advanced Manufacturing Technology and Cost Leadership

Respondents in the study were required to indicate the level to which they agreed with how advanced manufacturing technology impacted on seven aspects of the production process in their organization that relate to cost leadership strategy and the performance of the organization. The study used the following indicators to show how advanced manufacturing technology enabled large manufacturing companies in Kenya to attain cost leadership in their operating environment; High process engineering skills among employees (HPS), design of products for ease of manufacture (DPM), organization having sustained access to inexpensive capital (AIC), management exercising close supervision of labor (CSL), management always having tight control on production costs (PCC), Employee incentives based on quantitative targets (IQT), and management ensuring that all costs are kept at a minimum possible level (CML).

The results on the impact of advanced manufacturing technology on cost leadership strategies, on a scale of 1-5 were; HPS (4.0),

DPM (4.2), AIC (3.5), CSL (4.3), PCC (4.5), IQT (3.6) and, CML (4.4). The results show that to a great extent advanced manufacturing technology allows management to have a tight control on production costs. Cost management is the main pillar in cost leadership strategies and organizations attain this pillar by developing, implementing, and monitoring objectives that reduce the costs of direct material, direct labor, and manufacturing overhead. Further, the results show that managers have close supervision of labor (mean = 4.3) which leads them to keep all costs at the lowest possible level (mean=4.4).

The results also show the role of management in negotiating with finance providers to offer inexpensive capital (mean = 3.5) to attain cost leadership. The highest impact of advanced manufacturing technology on cost leadership strategies is evident by tight cost control (4.5) while the least impact is on incentives to employees (3.6). Further, the respondents agree that advanced manufacturing technology helps their companies to achieve cost leadership strategies through product design, management controlling operation costs and effective staff supervision. Respondents agree that the least effect of advanced manufacturing technology on cost leadership strategy is on access to in-expensive capital with a mean of 3.5. Indeed, companies cannot use advanced manufacturing technology to access low interest capital which depends on credit risk, repayment time, applicable tax and the ease of conversion of the capital loan.

The results also show that large manufacturing companies in Kenya rank the effect of advanced manufacturing technology low with respect to awarding employees incentives based on quantitative targets. The results are presented in table 6.

Table 6: Advanced Manufacturing Technology and Cost Leadership

Cost Leadership Indicator	Mean
High Process engineering skills among employees	4.0
Our products are designed for ease of manufacture	4.2
The organization has sustained access to inexpensive capital	3.5
Management exercises close supervision of labour	4.3
Management always has tight production cost control	4.5
Employees are given incentives based on quantitative targets.	3.6
Management always ensure that all the costs are kept at the minimum possible level.	4.4
Average	**4.1**

4.5 Advanced manufacturing Technology and Product Differentiation

Respondents in the study were required to indicate the level to which they agreed with how advanced manufacturing technology impacted on six aspects of the production process in their organization that relate to product differentiation and the performance of the organization. The following indicators were used in the study to show how advanced manufacturing technology enabled

large manufacturing companies in Kenya to attain product differentiation in their operating environment: Customer service offered for all products purchased (Service), Offered unique products to customers (Unique), Reputable brand image within their industry (Brand), Employing the most current technology in production (Technology), Use of dealers or agents in product distribution networks (Distribution), and Customer loyalty (Loyalty).

Results from the study revealed that respondents moderately agreed that advanced manufacturing technology enabled their companies to attain the differentiation aspects considered in the study. The results on the impact of advanced manufacturing technology on product differentiation on a scale of 1-5 were: Service (4.1), Unique (4.2), Brand (4.3), Technology (3.8), Distribution (4.1) and, Loyalty (4.2).

The results show that advanced manufacturing technology allowed companies to build a reputable brand around their products/service. A good brand image will help manufacturing companies to have a positive impact on customers' loyalty, which in the long run also influences customer perceived quality. The results are presented in Table 7.

Table 7: Advanced Manufacturing Technology and product Differentiation

Differentiation Indicator	Mean
The organization offers customer service for all purchases of our products	4.1
Our products are unique	4.2
The organization has cultivated a reputable brand image in the industry	4.3
The organization employs the most current technology in production	3.8
The organization uses dealers/agents to distribute its products	4.1
Our customers are loyal to our products	4.2
Average	**4.1**

4.6 Advanced manufacturing Technology and Organizational Performance

Organizations use either financial or non-financial indicators to understand how they are performing compared to the expected outcomes of the strategies and objectives they are implementing (Kaplan & Norton, 2015). Respondents in the study were required to indicate the level to which they agreed with how advanced manufacturing technology impacted on seven aspects of customer satisfaction in their organization that relate the non-financial performance of the organization.

The seven aspects of customer satisfaction were: rating of the response to customers about their complaints (Response), The professionalism attached to handling customers (Professionalism), Technical support given to customers (Support), Rating of the product compared to competing products (Rating), Products quality and performance in the perception of the customers (Quality), Ability to meet

product delivery timelines (Delivery), value offered by the products/service to customers (Cost).

The results show that the respondents moderately agreed that advanced manufacturing technology enabled their organizations to achieve the customer satisfaction indicators. Further, the results for the mean on how large manufacturing companies used advanced manufacturing technology to satisfy customers on a scale of 1-5 were: Response (4.2), Professionalism (4.1), Support (4.1), Rating (4.4), Quality (4.3), Delivery (4.3), and, Cost (4.3).

The results also show that large manufacturing companies in Kenya use advanced manufacturing technology to address customer complaints, improve the rating of their products in the perception of their customers and also produce, deliver and their products at low costs. Respondents agreed that the highest impact of advanced manufacturing technology on customer satisfaction was enabling the products from the companies to be rated highly by customers (4.4) while the least impact was on helping the companies to be rated high in the way they deal with customers professionally (4.1) and the quality and level of technical support offered to customers (4.1). The results also show that advanced manufacturing technology helped companies have products with high quality (4.3), meet timelines on delivery required by their customers (4.3) and, offer competitive products to their customers (4.3). Results are given in Table 8.

Table 8: AMT and Customer Satisfaction

Customer Satisfaction Indicator	Mean
Our customers rate how our organization responds to their concerns highly	4.2
Customers rate our organization highly with regard to dealing with them professionally	4.1
Our technical support meets the desired competence levels expected by our customers	4.1
Products from our organization are rated highly by our customers	4.4
Products from our organization meet the needs and expectations regarding quality and performance of our customers	4.3
Our organization always meets the timelines on delivery required by our customers	4.3
Our customers always find our products to be competitive and represent best value for total cost of lifetime ownership	4.3
Average	4.2

4.7 Advanced manufacturing Technology and Performance of large Manufacturing Companies in Kenya

The study investigated the relationship between advanced manufacturing technology and performance of large manufacturing companies in Kenya using simple linear regression 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 9.

The model summary shows a moderately strong positive relationship between advanced manufacturing technology and performance of large manufacturing companies in Kenya and that technology accounts for 31.9% of variations in performance of large manufacturing companies in Kenya (R=0.565, R^2= 0.319). The ANOVA summary statistics for the effect of advanced manufacturing technology 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 in Table 9 show that advanced manufacturing technology statistically predicts the value of performance of large manufacturing companies in Kenya at a confidence level of 95% (β=.318, t = 4.434, p< .05). These 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.

Arising from these results, the regression model for this relationship is substituted as follows:

$$\mathbf{Y= 3.142 + 0.318\ AMT +\varepsilon_1}$$

Table 9: Model Summary AMT and Performance

Model Summary					
Model	R	R^2	F	Sig	coefficient
1	.565[a]	0.319	19.662	.000[b]	0.318

4.8 Mediation Effect of Competitive Advantage on the Relationship between Advanced Manufacturing Technology and performance of Large Manufacturing Companies in Kenya.

The study investigated the mediating effect of competitive advantage on the relationship between advanced manufacturing technology and performance of large manufacturing companies in Kenya. The three four-step model proposed by Baron and Kenny (2018) was used to test the hypothesis that competitive advantage mediates the relationship between advanced manufacturing technology and performance of large manufacturing companies in Kenya. Results are presented in Table 10.

The results show that the relationship between advanced manufacturing technology and performance of large manufacturing companies in Kenya (model 1) is significant at 95% confidence level (F=19.992; p<0.05) and therefore the analysis proceeds to the second step in which simple regression with advanced manufacturing technology predicting competitive advantage is carried out. The results (model 2) show that the relationship between advanced manufacturing technology and competitive advantage is once more significant at 95% confidence level (F= 20.630, p <.005) and that advanced manufacturing technology is correlated with competitive advantage. Arising from this, the analysis proceeds to the third step of the mediation model as there is a high chance for mediation.

In the third step, simple regression with competitive advantage predicting performance of large manufacturing companies in Kenya is carried out to establish the significance of the relationship between them. The results (model 3) show that the relationship between competitive advantage and performance of large manufacturing companies is significant at 95% confidence level (F= 17.286, p <.005). These results confirm that the regression model attained model of fit justifying the use of simple linear regression. This result confirms that there is a high chance of mediation and arising from this, the analysis proceeds to the fourth and final step of mediation.

The fourth step involves a multiple regression model with competitive advantage and advanced manufacturing technology predicting performance of large manufacturing companies in Kenya to establish the significance of the effect of competitive advantage after controlling for advanced manufacturing technology. The results (model 4) show a significant F-ratio (F= 13.017, p <.005). These results confirm that the regression model attained model of fit justifying the use of multiple regression in analyzing the data and that there is a significant relationship between advanced manufacturing technology, competitive advantage and performance of large manufacturing companies in Kenya at a confidence level of 95%.

Table 10: Regression Models

Model Summary						
Model	R	R^2	F	Sig	coefficient	
1	.565[a]	0.319	19.662	.000[b]	0.318	
2	.574[a]	0.329	20.63	.000[b]	0.335	
3	.540[a]	0.292	17.286	.000[b]	0.521	
4	.623[a]	0.388	13.017	.000[b]	0.214	0.31

To confirm if competitive advantage mediates the relationship between advanced manufacturing technology and performance of large manufacturing companies in Kenya, it is required that, the coefficient for the effect of competitive advantage on performance of large manufacturing companies in Kenya must be significant while that of the effect of advanced manufacturing technologies on performance

of large manufacturing companies in Kenya should not be significant in the fourth step (Table 11). Arising from these results, mediation was not confirmed and the hypothesis two that competitive advantage mediates the relationship between advanced manufacturing technology and performance of large manufacturing companies in Kenya was not confirmed.

Table 11: Coefficients for fourth Step in Mediation

		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
Coefficients[a]	(Constant)	2.246	0.47		4.776	0.000
	Advanced Manufacturing Technology	0.214	0.084	0.380	2.547	0.015
	Competitive Advantage	0.310	0.144	0.322	2.158	0.037
a. Dependent Variable: Performance of Large Manufacturing Companies in Kenya						
b. Predictors: (Constant), Competitive Advantage, Advanced Manufacturing Technology						

4.9 Discussion

The study investigated the relationship between advanced manufacturing technology competitive advantage and performance of large manufacturing companies in Kenya. Design technologies, manufacturing technologies and planning technologies were used in the study to investigate the role of advanced manufacturing technology in the relationship between advanced manufacturing technology and performance of large manufacturing companies in Kenya.

First, the empirical results show a moderately strong and significant positive relationship between advanced manufacturing technology and performance of large manufacturing companies in Kenya ($R=0.565$, $F=19.662$, $p< .05$). 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 ($R^2= 0.319$), while the regression coefficients of advanced manufacturing technology (0.318) show a linear relationship between the variables and imply that a unit change of advanced manufacturing technology, impacts performance of large manufacturing companies in Kenya by 0.318 units.

These observations indicate that large manufacturing companies will benefit by adopting and using advanced manufacturing technology in their process. There is evidence that advanced manufacturing technology has a positive effect on performance of large manufacturing companies and the finding suggest that large manufacturing companies that invest in advanced manufacturing technology and

implement it appropriately will realize better performance in the industry compared to those that fail to embrace advanced manufacturing technology or do not implement it appropriately. Further, the results also show that besides advanced manufacturing technology, there are other factors that were not considered in this study that affect performance of large manufacturing companies in Kenya.

Second, the study sought to investigate the mediating effect of competitive advantage on the relationship between advanced manufacturing technology and performance of large manufacturing companies in Kenya. The results reveal that competitive advantage does not mediate this relationship as both the coefficients of advanced manufacturing technology and the coefficient of competitive advantage were found to be significant in the last step of the 4-step mediation model. Despite the results indicating that competitive advantage does not mediate the relationship between advanced manufacturing technologies and performance of large manufacturing companies in Kenya, the relationship between competitive advantage and performance of large manufacturing companies was found to be significant in the third step of the mediation model, with competitive advantage explaining 29.2% of the variations in performance of large manufacturing companies in Kenya ($R=0.540$, $R^2=0.292$). Further, the coefficient of competitive advantage was observed to be 0.521 in this relationship indicating that for every unit change of competitive advantage, there is a change of 0.521 units in performance of large manufacturing companies in Kenya. Arising from these observations, it is evident that competitive advantage improves that large manufacturing companies perform better in their markets when they develop competitive advantage in their industries.

Third, the study revealed that advanced manufacturing technology is positively related with competitive advantage in the second step of the analysis for mediation, with advanced manufacturing technology explaining 32.9% of the variations in competitive advantage ($R=0.574$, $R^2=0.329$). The results also show that a unit change in advanced manufacturing technology will cause a change of 0.335 units in competitive advantage from the results for the coefficient of advanced manufacturing technology. These results show that advanced manufacturing technology enables large manufacturing companies in Kenya to develop competitive advantage and therefore attain above average performance. Results also show that large manufacturing companies can use design technologies, manufacturing technologies or planning technologies to develop competitive advantage based on either cost leadership or differentiation depending on the manufacturing strategy they intend to implement.

Further, the findings of this study support the results by Stalk and Hout (1990) who found that organizations that use advanced manufacturing technologies in their production process develop competitive advantage in their industry. Stalk and Hout (1990) associate the improved performance of organizations through the substantial reduction of production cycle times by advanced manufacturing technology. Reducing production cycle times has immeasurable value in manufacturing companies as it determines when the company will deliver the desired product or offer required services to their customers and has a positive relationship to the organization's productivity, quality, and even innovation capability, which represent tremendous improvements in performance as shown by the results from the current study.

Fourth, the results of this study were not consistent with the results by Sheridan (1992) on the mediation effect of competitive advantage on the relationship between advanced manufacturing technology and performance of large manufacturing companies. Sheridan (1992) found that competitive advantage fully mediates this relationship when organizations implement cost leadership strategies or differentiation strategies in a study conducted on US manufacturing executives. The observed difference between the findings of this study and that by Sheridan (1992) may be due to the difference in the context of the economies considered in the two studies, Kenya is a developing economy while the USA is a developed economy.

Fifth, the finding in this study are also different to the findings by by Rangone (1998) who found in a study on small and micro enterprises that the relationship between advanced manufacturing technology and organizational performance is partially mediated by competitive advantage. The observed difference may be due to the difference in the size of companies used in the studies. Large manufacturing companies enjoy economies of scale unlike small and micro enterprises.

Further, the findings of this study are similar to the findings by McKenna (1992) who observed that advanced manufacturing technology enables organizations to re-engineer their production processes much more easily since they are flexible and as a result gain more dramatic performance, enabling organizations to develop competitive advantage and become competitive periodically before competitors discover the reason of their competitiveness, especially when their competitive advantage depends on process efficiencies.

5.0 CONCLUSIONS

From the current study, advanced manufacturing technology was found to positively and significantly influence performance of large manufacturing organizations in Kenya. Besides this finding, the study also observed that there are other factors that affect the relationship between advanced manufacturing technology and performance of large manufacturing companies. In order for large manufacturing companies to realize the expected benefits associated with advanced manufacturing technology, the other exogenous factors also need to be identified and managed appropriately.

The study also revealed that competitive advantage does not mediate the relationship between advanced manufacturing technology and performance of large manufacturing companies in Kenya. Despite this finding from the study on mediation of the relationship by competitive advantage, the results show that advanced manufacturing technology is positively related with competitive advantage. Arising from this observation, large manufacturing companies can develop competitive advantage by applying advanced manufacturing technology in their operations. This will lead to lowering their production costs, having better quality products and managing the distribution channels in an optimal way.

6.0 IMPLICATIONS OF THE STUDY

First, the findings of this study show that although a positive and significant linear relationship was observed on the relationship between advanced manufacturing technology and performance of large manufacturing companies, there exists other factors that affect this relationship that Managers in large manufacturing companies need to address to

realise the full benefits of applying technology in the production process.

Second, although the results from the study show that competitive advantage does not mediate the relationship between advanced manufacturing technology and performance of large manufacturing companies, the study observed a significant relationship between advanced manufacturing technology and competitive advantage. Managers therefore need to determine how this competitive advantage can be sustained to maintain the realized good performance.

7.0 SUGGESTIONS FOR FURTHER RESEARCH

First, the findings of the study reveal a significant relationship between advanced manufacturing technology and performance of large manufacturing companies, but also observe other factors to affect this relationship. The study suggests that further research be carried out to identify the other factors that affect this relationship.

The study used large manufacturing companies in Kenya that were members of Kenya Association of Manufacturers. It is possible that the purposeful sampling method used to determine the sample companies used in the study may have produced a biased outcome and suggest that a probability based sampling method be used to examine the similarities and differences between the results.

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.

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