ADVANCED MANUFACTURING TECHNOLOGIES AND FULL RATE PRODUCTION AMONG COMMERCIAL GOVERNMENT ENTITIES IN KENYA

BY:

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A RESEARCH PROJECT SUBMITTED IN PARTIAL FULFILMENT OF THE REQUIREMENTS FOR THE AWARD OF THE DEGREE OF MASTER OF BUSINESS ADMINISTRATION, FACULTY OF BUSINESS AND MANAGEMENT SCIENCE - UNIVERSITY OF NAIROBI

2022

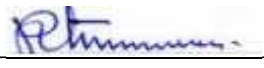
DECLARATION

I declare that this research project is my original work and has not been presented for examination award of a degree in any other University.

Signature…  …… Date …27th December 2021……

JOSHUA MAKORI NYABERI **D61/11827/2018**

This paper has been tendered for examination and I fully approve it in my capacity as project supervisor.

Signature:  Date: ___**28/07/2022** ___

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ACKNOWLEDGEMENT

I give thanks to Supreme God for enabling me to successfully complete the research work.

I cannot express enough thanks to my supervisor Dr. Peterson Magutu and my Moderator Mr. Ernest Akello. I offer my sincere appreciation for the guidance and learning opportunities provided to me during the entire research period. Besides my supervisor and moderator, I would like to thank the entire project defense panel led by the Department chair Prof. Kate Litondo. Thank you for the encouragement, insightful comments, and hard discussions.

Lastly, special thanks to my caring and supportive wife, Annette Changwony for the support and the countless times you took care of our two children during my hectic schedules. Your encouragement during the rough times is much appreciated and noted. My heartfelt thanks.

DEDICATION

I wholeheartedly and posthumously dedicate this project to my beloved parents; the Late Augustino Nyaberi and the late Loice Moraa. I know you are happily smiling for my greatest achievement.

To my wife Annette and our children, Mariana and Adriel, thank you for being my source of inspiration.

To my brothers, sisters and classmates who shared their words of encouragement during this study. Lastly, I devote this to the Almighty God, for the guidance, protection and good healthy life amid COVID 19 pandemic to complete the research.

ABSTRACT

The objective of the research was to analyze the effect of Advanced Manufacturing Technologies on Full Rate Production Among Commercial Government Entities in Kenya. The independent variable was Advanced Manufacturing technologies. On the other hand, dependent variable was Full rate production. The study entailed obtaining data through administering of questionnaires specifically to top managers of the identified commercial government entities within Nairobi. However, in instances where top managers were unreachable, middle level managers were consulted and sampled.

Based on the study outcome, there is a strong positive correlation between advanced manufacturing technologies and full rate production in the companies. These findings are in tandem with several previous studies; for instance, Hanes et al. (2019), established the fact that application of advanced manufacturing technologies is associated with high performance and production in organizations. Consequently, it was concluded unit increase in Advanced manufacturing technologies leads to a significant positive rise in full rate production.

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CHAPTER ONE: INTRODUCTION

1.1 Background of the Study

Within a global scale, constant technological changes have created a big threat to established business models and at the same time offering big business opportunities for novel service offerings and production rate increase in general. According to Niaki, Torabi and Nonino (2019), global leading firms currently seek to steer the evolution of technology devices and applications to their own advantage, and this include embracing of advanced manufacturing technologies. With the advanced and dynamic growth of manufacturing technologies, companies have shaped their full rate production models and there have been a number of researchers addressing the commercial entities adoption of new technologies across the globe. For example, Hanes et al. (2019) found that the uptake rates and energy reserves for advanced and efficient manufacturing technologies in the long run has increased across the world. This is because the advanced and energy-efficient manufacturing technologies help companies to improve their full rate production levels. The study also noted that the use of advanced manufacturing technologies helps to control energy wastage hence double the production rate among large scale companies. This is a clear indication that all global firms should adopt advanced and energy-efficient manufacturing technologies to improve their production rate.

This study was anchored under contingency theory and the technology acceptance theory or model (Donaldson, 2001). According to contingency theory, there is no ideal approach to model an organization and top management of organizations must adopt different ways of managing and managing important decisions in their operations (Drazin & Van de Ven, 1985). The decision or the strategies adopted must depend on the internal and external environment of operations. The

top management must be accommodative in selecting and implementing concise strategies to suit the dynamics of running the organization at a specified period. This may include the adoption of advanced manufacturing technologies to promote production levels (Schoonhoven, 1981). On the other hand, the technology acceptance theory demonstrates how workforce ultimately turn to embrace technology (Wu & Chen, 2017). This theory indicates that proper configuration of new technologies can promote the professed intuitiveness leading high productivity within a given firm (Rauniar et al., 2014).

In Kenya, many companies within the different industries are shifting from the traditional ways of doing things and a number of the firms are adopting advanced manufacturing technologies (AMT). The companies have realized that advanced manufacturing technologies are associated with extreme standards of quality management and minimal resource wastages. According to Niaki, Torabi and Nonino (2019), advanced manufacturing technologies are instrumental for organizations to maintain their competitive advantages and increase performance levels. This means that all companies including government entities should adopt the model. This will enable the firms to enjoy superior process performance as well as achieve full rate production through superior design and working with the right technologies. In that sense, this study investigated and established the relationship between advanced manufacturing technologies and full rate production among commercial government entities in Kenya.

1.1.1 Advanced Manufacturing Technologies

Hanes et al. (2019) defined the concept of Advanced Manufacturing Technologies (AMTs) as the use of computer-controlled models in the design, manufacturing as well as handling of the organization activities and operations. This is because the model includes the use of the use of innovative technologies and tools to improve operations within the organization (Makari and

Maima, 2017). Some of the typical applications of the AMTs include computer-aided engineering (CAE), computer-aided design (CAD); flexible machining centers' as well as the use of robotics, computerized guided vehicles, and automated storage and recovery systems (Sambasivarao & Deshmukh, 995). In most cases, the AMTs are interfaced by information systems (factory local area networks) and other integrated flexible manufacturing systems (FMS) such as the computer-integrated manufacturing system (CIM) tools (Lu et al., 2019).

Adoption of AMTs is in many cases perceived to attain higher quality standards, reduce manufacturing turnaround time and reduce ultimate costs given the fact that it allows for the integration of the full spectrum of production functions and manufacturing processes (Niaki, Torabi and Nonino, 2019). With the adoption of information technology, AMTs makes the data management seamless. This implies that the electronic data can be modeled and shared efficiently between systems. Organizations therefore embrace these technologies in a number of activities from scheduling to quality assurance (Yi, Gläßner and Aurich, 2019). In Kenya, Commercial Government Entities can adopt this model to increase their full rate production, which was the focus of the study.

1.1.2 Full Rate Production

The concept of Full-Rate Production (FRP) refers to the maximum level of production. This can be achieved through stabilization of the system design and validation of the production process using different methods. One of the methods can be the adoption of advanced manufacturing technologies. With FRP models, the firm can use mass-produce and deliver any size quantities of systems and components, and this is imperative towards promotion of high performance in the organization.

According to Gharbi, Hajji and Dhouib (2011), the concept of full-rate production is the maximum and stable production rate whereby optimal number of units can be produced over a specified period. This means that the required duration taken to output one unit is maximized and is at the required level. In non-manufacturing level, the full production rate implies to the level at which users are anticipated to conclude a specific segment, for instance a road or building. This rate depends on the speed at which users are anticipated to operate, which is normally considered as the best rate.

1.1.3 Commercial Government Entities in Kenya

A government entity is an organization that is closely affiliated with government ownership either with State or local governments. According to Rauniar et al. (2014), government Entity is any state, federal or provincial government, department, judiciary as well as the entities or agencies associated with government operations.

In Kenya, some of the well-known commercial governmental entities include the Industrial and Commercial Development Corporation, the Kenya Electricity Generating Company as well as the Kenya Electricity Transmission Company and the Kenya Pipeline Company Limited. Other organs such as the Kenya Pipeline Company, the Kenya Railways Corporation and the Kenya Standard Gauge Railway are well known commercial government entities in the country. Additionally, Public universities as well as the National Oil Corporation of Kenya and the Kenya Revenue Authority are also major commercial government entities in the country. These entities are critical stakeholders in the management, coordination, and support of government operations.

1.2 Research Problem

In the production process, the adoption of advanced manufacturing technologies (AMT) requires significant investment that leaders overlook many at times hence makes it challenging to connect their production operations. However, studies imply of a positive correlation between the levels of advanced manufacturing technologies implementation or adoption and the promotion of full rate production systems. When advanced manufacturing technologies are adopted, the company can enjoy faster production time, high rate of production as well as enhanced standards of the product throughout manufacturing and production processes. The advanced manufacturing technologies are also associated with an improvement to the efficiency of the organization operations in terms of increased productivity and a reduction in material wastage.

Several studies have been done to determine how advanced manufacturing technologies influence production. According to a study done in the U.K by Gioumouxouzis, Karavasili and Fatouros (2019) on the new developments in pharmacological dosage forms and devices using improved manufacturing technologies, it was evident that advanced manufacturing technologies promote production and reduce wastage within the drug application systems. Despite this, the study focuses on pharmaceutical industry and its implications may not apply within the current study. Additionally, Ordoobadi and Mulvaney (2001) conducted a study to determine the engineering a justification solution for advanced manufacturing technologies using a system-wide benefits value analysis in the USA. The study used a case study method and focused on AMT Company in the United States. However, this also left a gap since it was done in late 2001 and several advanced technologies have been developed currently. In China, Yi, Gläßner and Aurich (2019) investigated possibility to successfully integrate enhanced manufacturing technologies into manufacturing processes using different standpoint from the commercial industry. The study found out that

additive manufacturing technologies help to improve the manufacturing of the commercial vehicles.

On a local scale, Kiss et al. (2019) determine a model- based approach in quantifying of the impact of innovative manufacturing technologies on developing vaccine supply chain performance using a case study of the Kenyan market. The study found out that new manufacturing technologies promote the supply chain coordination and performance among developing countries. Additionally, Makari and Maima (2017) evaluated the advanced manufacturing technology and technical labor in manufacturing entities in Kenya. The study concludes that the adoption of advanced manufacturing technology has reduced a number of problems within the technical labor departments among various manufacturing companies in Kenya. Watonga et al. (2020) study points out that the adoption of advanced manufacturing technology improves the competitiveness and performance of massive manufacturing companies in Kenya. However, these studies failed to consider the current advanced manufacturing technologies and did not focus on how the new or modern technologies affects the full rate production levels. Some of these studies also focused mostly on pharmaceutical industry and this research was conducted to fill the gap by focusing on the commercial industry.

Importantly, it is true from the above analysis that few studies have been done in the country to determine the relationship between advanced manufacturing technologies and full rate production among commercial government entities. Therefore, the current study was to fill the gap by providing a research-based paper that determines the relationship between advanced manufacturing technologies and full rate production among commercial government entities in Kenya? The researcher worked to address the below mentioned research questions.

i. What are the advanced manufacturing technologies implemented by commercial government entities in Kenya?
ii. What is the influence of advanced manufacturing technologies on the full rate production among commercial government entities in Kenya?

1.3 Objectives of the Study

The major objective of this study was to determine the relationship between advanced manufacturing technologies and full rate production among commercial government entities in Kenya

i. To establish the advanced manufacturing technologies implemented by commercial government entities in Kenya
ii. To determine the influence of advanced manufacturing technologies on the full rate production among commercial government entities in Kenya

1.4 Value of the Study

Various stakeholders will gain from this study. For example, it will help different commercial government entities in Kenya. The commercial government entities will use the study findings to establish the major advanced manufacturing technologies that can be implemented in their daily operations. The study will also help the commercial government entities in the country to understand how advanced manufacturing technologies influence the full rate production levels and this is important in setting production standards within the organizations.

The study will also benefit policy makers and government agencies in the country and beyond. For example, the policy makers dealing with advanced manufacturing technology policies will find the

study useful in the process of formulating and implementing such programs. The policy makers use the outcome of this study in formulating full rate production policies. This will be imperative towards the promotion of standards associated with advanced manufacturing technologies and full rate production models.

Furthermore, the study will also benefit future researchers, scholars and academicians. This is because the future academicians and scholars will use the study results and findings to conduct further studies dealing with the determination of the relationship between advanced manufacturing technologies on the full rate production among commercial government entities in the world. In that sense, the results of this study will be very important and useful to future students as well as researchers as it will be a guide for their future research related to current topic of the study which is the impact of advanced manufacturing technologies on the full rate production among commercial government entities in Kenya.

CHAPTER TWO: LITERATURE REVIEW

2.1 Introduction

This section is focused on providing an overview of previous studies to form the framework of the study. It starts with the presentation of the theoretical framework, the discussion on the influence of advanced manufacturing technologies on the full rate production as well as reviews on empirical literature and presentation on the conceptual framework. It also covers the knowledge gaps in the literature review.

2.2 Theoretical Framework

The investigation was directed by the different theories. For example, it included the technology acceptance theory and the contingency theory. The above theories have been discussed in sections below.

2.1 Technology Acceptance Theory

According to Rauniar et al. (2014), the Technology Acceptance Theory is an information systems theory which focuses how users get to appreciate and utilize a technology. The theory agrees more precisely with the assumptions of possibility of embracing of a new technology in the operations of an organization. According to proponents of this model, organizations must build and create systems that can predict the level of acceptability of a technology as well as recognize the adjustments which should be applied to the existing systems to enable efficiency before the users. Importantly, the theory indicates that the acceptability of any technology in a firm is defined by the perceived effectiveness and assumed intuitiveness. This means that organizations must create ease of use of all the advanced technologies they have adopted.

The key assumption of this theory is that adoption of a modern technology is driven by the behavioral intention of the users. In contrast, the behavioral intention is ascertained by the user's perception towards the use of the technology and by his attitude of its utility. According to Okuno and Takahashi (1997), the attitude of an individual is not the only a factor that determines his appetite for use of a solution but is also based on the effect on performance. Therefore, even if a user does not embrace a technology, the probability for success is high if he perceives that the system will improve his productivity and performance. Moreover, the Technology Acceptance theory hypothesizes a direct impact between perceived effectiveness and perceived ease of use. With two technologies offering similar characteristics, a user will find the one that he finds easier to use more useful (Niaki et al., 2019).

In this study, the theory has been used to encourage commercial entities in the country to adopt advanced manufacturing tools that are easier to use by the users. According to Bertrand & Bouchard, (2008), the acceptance and decline of an information system can be anticipated by using the Technology Acceptance Model (TAM), which proves the relationship connecting belief, attitude and action purpose. The model would help the commercial entities top management to adopt logic in selecting and accepting different advanced technologies in their major operations. This would help to predict the production level and improve the firm performance after acceptance and usage of the correct technology.

2.2.1 Contingency Theory

According to Van de Ven and Drazin (1984), the contingency theory is closely related to the situational approach. The contingency theory of leadership was proposed by the Austrian psychologist Fred Edward Fiedler in his landmark 1964 article, "*A Contingency Model of Leadership Effectiveness" (*Donaldson, 2001). The theory emphasizes the importance of both the

leader's personality and the circumstance in which they operate. Fiedler and his associates studied managers in an array of contexts and indicate that a leader must adopt task-motivated and relationship-motivated approach. Task refers to activity accomplishment, and relationship-motivation refers to interpersonal relationships, plans to lead and promote productivity within the organization.

The key assumption of this theory is that management and leadership depend on the concept of the situation (Schoonhoven, 1981). This means that a manager must consider operating environment before adopting the new technology of operations. This is important in promoting work relations, whose ultimate objective is to deal with the generic environment of the group as well as the attributes for instance loyalty, trust, confidence, and belief that the employees have for their leader. The leader should also consider the activity structure, which is attributed to activity clarity and the process of accomplishing the task. The means that task accomplishment can be promoted in the organization using advanced technologies (Drazin & Van de Ven, 1985).

2.3 Advanced Manufacturing Technologies and Full Rate Production

According to Hanes et al. (2019), the use of advanced manufacturing technologies is attributed with high performance and production in organizations. This is because the AMTs relates to the physical transformation of materials as well as their movement and inspection. Some of the AMTs that promote performance and production in different operations of the organization include the manufacturing resource planning, computer-aided engineering, computer-aided design and computer-aided manufacturing. (Kiss et al., 2019).

Moreover, Makari and Maima (2017) noted that AMTs also includes adaptable manufacturing cells such as Automated Guided Vehicle Systems, and robotics. As a result, the model was

perceived to include computer-aided process planning and computer control machining. There are also those who argue that the use of automated technologies, e-mail, and other advanced information systems such as automatic software, tracking systems, bar coding and workplace enabling technologies such as Microsoft packages can also be categorized as advanced technologies for manufacturing organizations (Kiss et al., 2019).

The application of these technologies is important towards achieving full rate production (Yi, Gläßner and Aurich, 2019). This is because they are associated with minimized direct labor costs, condensed product development time as well as optimal inventory and effective design and use of automations. In manufacturing sector, the use of AMTs is also associated with decreased floor occupancy expectation, better conformance standards, improved productivity and improved production lead time and quicker go to market response. (Yi, Gläßner and Aurich, 2019).

Since AMTs is part of the automation models it is important in handling and control equipment to automatic production and this results into continuous production through a series of operations without human guidance and control (Kiss et al., 2019). Additionally, the automation of production lines is a critical area of investing since it helps improve the efficiencies in production and other operations in the firm. AMTs also promote the development and use of Computer aided design (CAD) in the production process, and this is important in promoting the speed and ease with which sophisticated designs can be manipulated within the production chain (Yi, Gläßner and Aurich, 2019).

Use of models such as Computer Aided manufacturing (CAM) is also important; This is because it includes the use of specialized computer programmes that help to control manufacturing equipment and improve production (Kiss et al., 2019). With computer integrated manufacturing

(CIM), the firm can enjoy high level of production of manufacturing function since all the operations are controlled. Other major AMTs models associated with high or full rate production include the Computer Numerical control (CNC) which involves the use of magnetic tapes to electronically control machines to promote performance in the production operations (Yi, Gläßner and Aurich, 2019).

2.4 Empirical literature Review

A wide array of studies has been performed to establish the influence of advanced manufacturing technologies on the full rate production among commercial government entities around the world. For example, in U.K Billo et al. (2015) determined the manufacturing process for a full-scale biodiesel micro reactor and noted that the adoption of advanced technologies promotes the reduction of cycle time in the production process. The study also found out that new technology instills anxiety and fear towards the new technology, and this has led to emotional uncertainty among AMT users and management must adopt rational ways to train employees to adopt advance technologies. Additionally, the outcome of this research emphasizes that regardless of the type of manufacturing technology and for an organization to be effective it needs to be as least mechanical as possible. However, this study was done in U.K and its implications cannot apply in Kenya since management is context sensitive.

Another study done in Germany by Gioumouxouzis, Karavasili and Fatouros (2019) to determine the improvements in pharmaceutical dosage forms and devices using superior manufacturing technologies noted that the advantages of advanced techniques can be achieved through applying of just a few components of Automated Manufacturing Technologies and consequently firms can increasingly invest in these technologies to realize optimal benefit from it. This may include

benefits associated with full rate production levels. The study also noted that larger companies often own sufficient business, human and technology resources to invest in AMTs and this has led high production and competitive advantage of their operations. The findings of the study also revealed that smaller companies with flexible structures can make rapid adjustment to dynamic environment and survive the fierce competition through adoption of AMTs. However, the study presented a contextual gap since it was done in Germany and its implications may not naturally imply in the Kenyan context.

In China, Wu and Chen (2017) investigated the consistent use of MOOCs and utilizing of task technology fit (TTF) model and technology acceptance model (TAM) the AMTs influence production in organizations. The study also reported no significant connection between manufacturing technology and organizational structure. This study first and foremost explored the AMT adoption and organizational structure using the current data to ascertain that there was a substantial relationship. The study was guided by case study design and may have ignored changes in different companies.

Moreover, a study done in Nigeria by Niaki, Torabi, and Nonino (2019) also noted that manufacturers should adopt additive manufacturing technologies to improve the production sustainability. The study noted that the operational principles to be applied in the firm depend on complex variety of critical environmental and internal contingencies and top management must consider the strategy, environment and size of the firm in adopting advance technologies. The study concluded that the fit of AMT adoption and organizational structure of a company depends upon employees' reactions to the new technology. However, the study did not consider the non-human considerations in the adoption of modern technologies.

In Kenya, Kis et al. (2019) determined a model- based measure of the influence of new manufacturing technologies on developing vaccine supply chain performance using a local case study while Makari and Maima (2017) investigated the advanced Manufacturing Technology and Technical Labor in Manufacturing Companies in Kenya. These studies confirmed that human factors are an important contingency in the use of new technologies. The studies also support the adoption of proper governance structure in the process of promoting the successful use of AMTs. However, these studies fail to consider how advanced manufacturing technologies impact performance and full rate production in organizations. Thus, this study was seeking to bridge the gap through establishing the impact of advanced manufacturing technologies on the full rate production among commercial government entities in Kenya.

2.5. Conceptual Framework

This describes the connection between the reliant and self-governing concepts of the study. In this model, the full rate production is the dependent variable. However, the use of manufacturing resource planning, automated machine handling, computer aided design, computer-aided engineering, computer-aided manufacturing, and robotics are the independent variables. This means that the full rate production depends on the advanced manufacturing technologies.

Independent Variables **Dependent Variable**

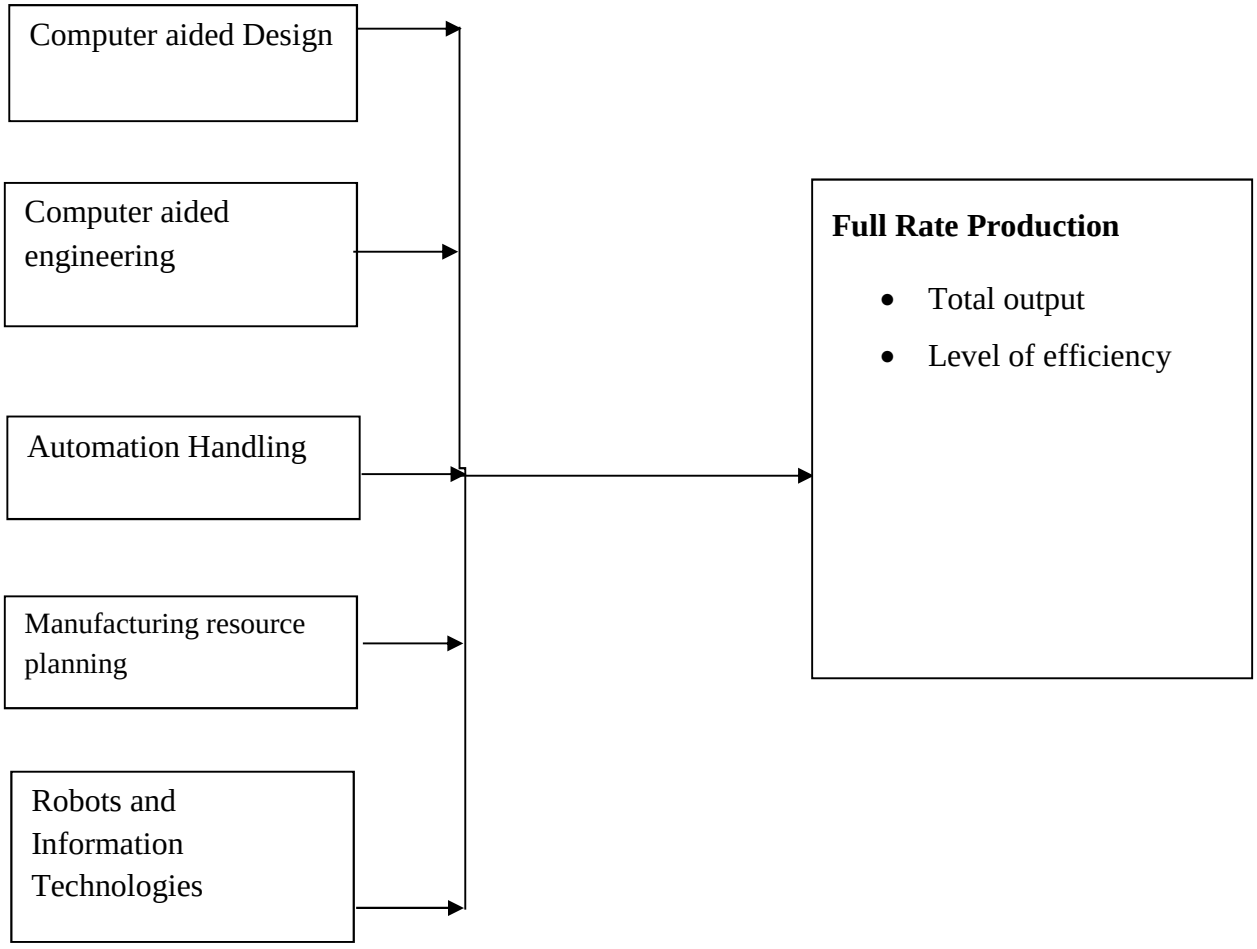

Figure 2.1-Conceptual Framework

The independent variable of this research is the Advanced Manufacturing Technologies which is supported by Computer-aided Design, Computer aided engineering, Automation Handling, Manufacturing resource planning and Robots and Information Technologies. The Dependent variable is Full Rate Production which is enabled by Total output and Level of efficiency. It is hypothesized that Advanced Manufacturing Technologies positively influences Full Rate Production among Commercial Government entities in Kenya.

CHAPTER THREE: RESEARCH METHODOLOGY

3.1 Introduction

This chapter defines the methodology which entailed research design, data collection and analysis techniques that were adopted during the study. It also included various processes that were deployed to guide the research. Notably, this chapter also details the blueprint that was followed to establish the influence of advanced manufacturing technologies on the full rate production among commercial government entities in Kenya.

3.2 Research Design

The research used a cross-sectional survey design as this was highly suitable due to its great reliability as well as low on cost and convenient for a large population. In addition, it was ideal to adopt a cross-sectional design since it focuses on multiple government entities.

This design involved collecting and analyzing data across an entire population sample to provide an in-depth view within a specific period.

3.3 Population

This entailed the commercial government entities in Kenya. As per the Ministry of Trade and Cooperatives, there are approximately 310 entities in the country referred to as State Corporations. Out of these, 43 are operating on Commercial principles and this formed the focus of the study because their primary objective is manufacturing.

Category	Entity	Total number of entities
A	Regulatory Agencies	53
B	Operating on Commercial Principles – Commercial Government Entities	43
C	Research Institutes	12
D	Education & Training Institutions	63
E	Development Agencies	11
F	Executive Agencies	87
G	Promotional Agencies	3
H	Social Services/Cultural	11
I	Public Fund Management	22
J	Revenue Collection	3

3.4 Sample Design

This generally constituted a number of commercial government entities in Kenya, especially within Nairobi. The selection of the commercial government entities in Kenya was driven by the reality that majority of the entities have their head offices within the capital city hence made it quicker to collect sufficient data. The study adopted a census on the identified population due to its representative size. Census is the study of entire population, consequently, it increases the authenticity of the data and outcome by incorporating all information in the study (Saunders, Lewis & Thornhill, 2009). Additionally, it reduces sampling error (Watson, 2001). The population used in this study was 43 commercial government entities in Kenya.

3.5 Data Collection

This included primary data which was gathered from the field through administering of the semi-structured questionnaires.

Semi-structured questions helped the researcher to evaluate and determine the influence of advanced manufacturing technologies on the full rate production among commercial government entities in Kenya. The questionnaire had three sections with section A containing generic information, section B containing questions investigating advanced manufacturing technologies and section C containing information on the relationship between advanced manufacturing technologies and full rate production among selected commercial government entities in Kenya.

3.6 Data Analysis

The researcher adopted a quantitative data analysis, and this was done as soon as data was collected by means of questionnaires. This data was processed in the Statistical Packages for Social Scientists then was evaluated using descriptive statistic. This was then analyzed based on the subject matter responses. Feedbacks with common trends were clustered into coherent groups.

Descriptive statistics involved the use of percentage frequencies, measures of central tendencies and dispersion (mean and standard deviation respectively). The data was then displayed in tables and graphs while the justification was outlined in text. Multiple linear regression analysis was applied to examine the level of analysis since it includes evaluation of a concept with the objective of extracting more insights of the topic. This helped in the establishment of more understanding of the main thoughts of the study.

A linear regression analysis model was applied to determine the level of influence of advanced manufacturing technologies on full rate production among commercial government entities in Kenya. Here is the model:

$Y= a+bx_1+ bx_{2+} bx_{3+} bx_{4+} bx_5……..+c +B_3$

Where Y= Full rate production

X_1= computer-aided design and engineering

X_2= manufacturing resource planning

X_3= computer-aided manufacturing

X_4= automated machines

X_5= Robotics

B_3=Error Factors

CHAPTER FOUR: DATA ANALYSIS, RESULTS AND DISCUSSION

4.1 Introduction

This section entails the analysis of the outcomes. It explores participants' response rate, demographics, and the characteristics of the sample population. The findings and corresponding analysis are illustrated in charts and tables.

4.2 The Participant Response Rate

Out of 310 commercial government entities in Kenya, 43 that are operating on Commercial principles formed the focus of this study because their primary objective is manufacturing. Data was obtained from 80 respondents in 40 entities, thus a response rate of 93.02%. The study targeted reachable population due to its small size and location. The census method ensured the whole population is targeted thus enhancing its validity of the data.

The response rate was high, at 93% of the respondents making it acceptable for statistical analysis purposes because a feedback rate of above 75% is deemed fit for analysis.

4.3 Background Information and Demographic Characteristics

The respondents were specifically top managers of the stated organizations. However, in instances where top managers were unreachable, middle level managers were consulted and sampled. From the 80 respondents, it was noted that 48 had served in their companies or positions for more than 10 years, 21 has served for between 5 and 9 years while the rest had served for less than 5 years. In addition, it was noted that 61 of the respondents (representing 76%) were top level managers while 19 (representing 24%) were middle level managers. Most of the participants (72%) were male while the remainder were female. Therefore, the outcome illustrated that gender bias is

prominent in the management of the listed organizations. Additionally, most of the respondent were aged above 50 years, indicating that such top management positions were a preserve of the elderly and most experienced managers. The results to the demographic information are presented in Tables 4.2 and 4.3.

Table 4.2. Respondents' Management Level

Management Level	**Frequency**	**Percentage (%)**	**Cumulative Percentage**
Top-Level	61	76.3	76.3
Middle-level	19	23.8	100
Total	**80**	**100**	

Table 4.3 Respondents' Work Experience

Year of Experience	**Number**	**Percentage (%)**	**Cumulative Percentage**
More than 10 years	48	60.0	60.0
5-9 years	21	26.3	86.3
Less than 5 years	11	13.7	100
Total	**80**	**100**	

The next target was to understand the level of education for the sampled managers because this would offer an insight regarding the quality of responses given. It was found out that most of the managers had a master's degree (47.5%) trailed by bachelor's degree at 26.2%. This data was critical in enabling the researcher to place the managers in categories that would enhance creation

of themes base on the level of academic of the respondents. The Table 4.3 below give the detains of the level of education attained by the respondents.

Table 4.4 Level of Education attainment by the Respondents

Education Level	Frequency	Percentage (%)	Cumulative percentage
Diploma	3	3.8	3.8
Bachelors	21	26.2	30.0
Masters	38	47.5	77.5
PhD	18	22.5	100
Total	**80**	**100**	

Respondent demographics is important in that it determines the quality and quantity of information obtained. For instance, it was noted that the longer a respondent has been in service, the more information he had regarding the study subject area. More than half of the respondents had worked in the companies or in their positions for greater than ten years. Evidencing the fact that the respondents were well versed with the corporate activities of their companies.

4.4 Advanced Manufacturing Technologies

The researcher wanted to establish the advanced manufacturing technologies that were used in the named organizations and thus the interviewees were expected to answer to the segment; To what extent they agree that your entity has adopted the following Advanced Manufacturing Technologies to attain Full Rate Production? This was done by asking a number of leading questions which the interviewees were to provide response in a rating of 1 (strongly disagree), 2

(Disagree), 3 (Somehow agree), 4 (Agree), 5 (Strongly agree). The results are here analyzed by working out the outcome as illustrated in table 4.5 below.

Table 4.5. Aspects of Advanced manufacturing technologies

Statement	**N**	**Mean**	**S. Dev**
There are computer-aided design tools in the major manufacturing operations	80	3.2810	0.7180
There are computer-engineering tools in major manufacturing operations	80	2.9831	0.6092
There is manufacturing resource planning models in major manufacturing operations	80	4.1245	0.8003
There are computer-aided manufacturing tools in major manufacturing operations	80	2.3117	0.7227
There are automated machines in major manufacturing operations	80	3.6720	0.8824
Robotics are used in major manufacturing operations	80	3.9008	0.5440

4.4.1 Computer-Aided Design and Engineering

The degree to which the commercial government entities in Kenya used computer aided design engineering practices was measured. The respondents were required to evaluate the level of incorporation and use of computer-aided design tools in their major manufacturing operations in a 5-point Likert scale. The mean for the responses for this parameter is 3.281 and a standard deviation of 0.718. This indicates that the respondents agreed with the statement that their

companies had adopted computer-aided engineering practices. The SD = 0.718 indicate that there was relative concurrence in the responses since an SD greater than 1 indicate large variation in the responses.

4.4.2 Manufacturing Resource Planning

The researcher wanted to ascertain to what degree the commercial government entities in Kenya employed the manufacturing resource planning models. The target audience was requested to assess the level of incorporation and use of these models in a 5-point Likert scale. The responses had a mean of 4.1245 with SD = 0.8003. The mean (M=4.1245) indicates that the respondents strongly agreed with the statement that their companies had adopted manufacturing resource planning models. The SD = 0.8003 on the other hand show that the responses were less varied.

4.4.3 Computer-Aided Manufacturing

The researcher wanted to establish the degree for the use of Computer-aided manufacturing by the commercial government entities in Kenya. The respondents were required to evaluate the level of incorporation and application of computer-aided manufacturing in a 5-point Likert scale. The responses had a mean of 2.3117 with SD = 0.7227. The mean (M=2.3117) indicates that the respondents did not agree with the statement that their companies had adopted computer-aided manufacturing practices. Despite an SD = 0.7227, the mean is lower than 2.5, implying that most of the respondents alluded that their companies did not use computer-aided manufacturing.

4.4.4 Automated Machines

The researcher wanted to establish the degree to which the commercial government entities in Kenya used automated machines in their major manufacturing operations. In 5-point Likert scale, the interviewees were required to rate the level of incorporation and use of automated machines in

their major manufacturing operations. The findings show that there was an agreement that the companies used automated machines in their main operations (M=3.6720) with SD = 0.8824. The mean reveals that the respondents agreed with the statement that their companies used automated machines; the responses were with minimal variations due to the standard deviation which is less than 1.

4.4.5 Robotics

The degree to which the commercial government entities in Kenya used robotics in their manufacturing practices was measured. The participants were required to rate the level of incorporation and use of robotics in major manufacturing operations using a 5-point Likert scale. The findings indicate a mean of 3.9008 and SD = 0.5440 on this parameter. The mean indicates that the respondents strongly agreed with the statement that their companies had adopted robotics use in their practices. The SD = 0.5440 is relatively low, implying that there was concurrence in the responses because standard deviations greater than 1 imply large variation in the responses.

4.5 Full Rate Production

Full-Rate Production (FRP) refers to the maximum level of production that can be attained by a company. To underscore the effect of advanced manufacturing technologies on full rate production, the interviewees were expected to rate their agreement or disagreement with the parameter of full rate production using the statements as shown in table 4.6 below and the findings are indicated using means and standard deviation.

Table 4.6

Statement	N	Mean	S. Dev
Adoption of computer-aided design tools has improved full rate production of our entity	80	4.1540	0.6143
Adoption of computer-engineering tools has allowed our entity to enjoy maximum level of production	80	3.9493	0.7193
Adoption of manufacturing resource planning models has led to high total inputs and total output ratio	80	4.0219	0.9803
Adoption of computer-aided manufacturing tools has led to maximum and stable production rate in our entity	80	3.5894	0.7000
Adoption of computer-aided manufacturing tools has led to improved total cycle time in the entity major operations.	80	3.8810	0.6074
Adoption of computer-aided manufacturing tools has led to improved level of capacity utilization in our entity	80	2.8062	0.7331
Adoption of automated machines has improved level of efficiency and time delivery of products in our entity	80	3.9763	0.5582
Adoption of Robotics has improved the speed and accuracy of performance and production of our entity	80	4.1394	0.6003
Overall Mean	**80**		**3.815**

These findings show that there was concurrence among the respondents that adoption of the different entities of advanced manufacturing technologies by the commercial government entities in Kenya has helped to enhance full rate production in the companies. The overall mean 3.8150 shows that the respondents agreed that the practices helped to increase full rate production. The standard deviation for all aspects also fell below 1, with the highest being 0.9803 showed that there was adequate concurrence in the responses.

4.6 The Influence of Advanced Manufacturing Technologies on the Full Rate Production

To adequately respond to the research question of what the influence of advanced manufacturing technologies on the full rate production among commercial government entities in Kenya is, regression analysis was conducted. SPSS v. 20.0 computer package was used to conduct linear regression for the variables in the study.

4.6.1 Regression Analysis

Regression analysis is critical in quantitative analysis because it helps to formulate a model that gives the correlation between the independent and dependent variables. A linear equation which helps to forecast the outcome of the dependent variable is derived when the coefficient of one predictor is kept constant.

Model Summary

Table 4.7 Regression Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of Estimate
1	.769[a]	.711	.662	.457

a. Predictors: (Constant), Computer-aided design and engineering, Manufacturing resource planning, Computer-aided manufacturing, Automated machines, Robotics

The model illustrates that the advanced manufacturing technologies has a strong positive relationship on the full rate production of the companies as shown by the coefficient (r = .769). The coefficient of determination measure (R^2 = .711) shows that full rate production of the companies is affected to an extent of 71.1% by the advanced manufacturing technologies that the company uses.

4.6.2 ANOVA

Analysis of Variance enables researchers to underscore the extent to which the regression equation can be relied on as a measure of the full rate of production in this case. The fitness of the regression model used here is explained by ANOVA shown in below table 4.8.

Table 4.8. ANOVA®

Model		**Sum of squares**	**df**	**Mean Square**	**F**	**Sig. (p-value)**
1	Regression	8.633	43	1.637	8.317	.000[a]
	Residual	3.383	55	0.228		
	Total	12.016	98			

a. Predictors (Constant), Computer-aided design and engineering, Manufacturing resource planning, Computer-aided manufacturing, Automated machines, Robotics

The analysis of variance in table 4.8 indicates that the data was good for deriving conclusions because the level of significance was 0.000 with a p-value below 0.05, which was the significance

value. The F- value was 8.317 at 5% critical level. This is above the critical value, implying that this model was statistically significant and good of fit to the model in predicting how the independent variables affected full rate of production of the firms. A *p*-value that is below or equal to the significance level indicate that not all population means are equal thus leading to rejection of the null hypothesis.

4.6.3 Coefficients

Beta coefficients show the extent to which the variables contribute to the regression model while T and P values show the impact of the predictor variables on the criterion variable.

Table 4.9. Summary of coefficients

	Unstandardized Coefficients		Standardized Coefficients	t – values	*p* – value
	Beta	Std. Error	Beta		
(Constant)	1.134	.730		0.864	.000
Computer-aided design and engineering,	.411	.189	.389	2.514	.029
Manufacturing resource planning,	.528	.209	.198	2.711	.028
Computer-aided manufacturing,	.361	.191	.411	1.040	.033
Automated machines,	.492	.202	.373	2.006	.019
Robotics	.622	.055	.277	2.573	.028

a. Dependent variable: Full rate of production

The regression analysis shows that the companies will be 1.134 at 95% confidence, showing that holding other independent variables at zero, a unit increase in computer-aided designing will increase full rate of production by 0.411. Therefore, a unit rise in manufacturing resource planning triggers a rise in full rate of production by 0.528; likewise, a unit rise in computer aided manufacturing triggers an increase in full rate of production by 0.361. All the t-values were greater than the critical value of .05 while all the p-values were below .05, affirming their statistical significance. From this analysis, the equation for the regression model is:

$$Y = 1.134 + 0.411X1 + 0.528X2 + 0.361X3 + 0.492X4 + 0.622X5 + B3$$

4.7 Discussions

The research is targeted at determining the effects of advanced manufacturing technologies on full rate of production. The independent variables were computer-aided design and engineering, manufacturing resource planning, computer-aided manufacturing, automated machines, and robotics and the dependent variable was full rate production. The study applied cross-sectional survey design on 43 organizations.

The mean of Computer-Aided Design and Engineering was 3.281 with a SD of 0.718 –indications that the interviewees agreed that their companies had adopted computer-aided engineering practices. The responses for manufacturing resource planning (Mean = 4.1245 with SD = 0.8003) indicates that that the companies had adopted manufacturing resource planning models. Computer aided manufacturing (mean = 2.3117 with SD = 0.7227) indicates that the respondents did not agree that their companies had adopted computer-aided manufacturing practices. The findings show that the companies used automated machines in their main operations (M=3.6720 and SD = 0.8824). The findings also indicate a mean of 3.9008 and SD = 0.5440 for robotics which is an

indicator that the respondents firmly approved their companies had adopted robotics use in their practices. The practices helped in ensuring full rate production in companies (Mean = 3.8150).

The coefficient of determination measure (R2 = .711) shows that full rate production of the companies is affected to an extent of 71.1% by the advanced manufacturing technologies that the company uses. A unit increase in computer-aided designing will increase full rate of production by 0.411. A unit growth in manufacturing resource planning translates to a rise in full rate of production by 0.528; unit growth in computer aided manufacturing confirms a rise in full rate of production by 0.361; unit shift in automated machinery pushes a rise in full rate of production by 0.492; unit increase in robotics use translates to a rise in full rate of production by 0.622.

CHAPTER FIVE: SUMMARY, CONCLUSION AND RECOMMENDATIONS

5.1 Introduction

The chapter provides a summary of the entire research document. This includes summary of its study findings, and the conclusions made. The chapter also includes the recommendations for the study, study limitations, and suggestions for upcoming researchers.

5.2 Summary of the Study Findings

The general objective of the study was to establish the relationship between advanced manufacturing technologies and full rate production among commercial government entities in Kenya. The aspects of advanced manufacturing whose effects were tested included computer-aided design and engineering, manufacturing resource planning, computer-aided manufacturing, automated machines, and robotics. The research has found a strong positive correlation between advanced manufacturing technologies and full rate production in the companies. These findings are in tandem with several previous studies; for instance, Hanes et al. (2019), established existence of high performance and production in organizations upon the application of advanced manufacturing technologies. Likewise, Kiss et al. (2019) established that aspects of advanced manufacturing technologies promote performance and production in different operations of the organization.

Computer-aided design and engineering has been found to have a positive effect on full rate production, which agrees with the findings of Yi, Gläßner and Aurich (2019) which established that the use of computer integrated manufacturing such as CNS promote production performance in companies. The findings of this study also agree with Makari and Maima (2017) findings which

involved a study to investigate the advanced Manufacturing Technology and Technical Labor in Manufacturing Companies in Kenya. This study emphasized the importance of human considerations in the use of new technologies. Therefore, this implies that in order to obtain full rate production through advanced manufacturing technologies, human factors must also be taken into consideration. Generally, this study also supports the adoption of advanced technology manufacturing in production to enhance full rate production; it thus adds to the available evidence of the critical role of AMTs in manufacturing companies.

5.3 Conclusion

The general objective for the study was majorly to establish the correlation between advanced manufacturing technologies and full rate production among commercial government entities in Kenya. Upon successful completion of this study, it was determined that there is a strong positive relationship between advanced manufacturing technologies and full rate production among commercial government entities in Kenya. The researcher also found that computer-aided design and engineering, manufacturing resource planning, computer-aided manufacturing, automated machines, and robotics significantly predicts full rate production. A unit increase in computer-aided designing, manufacturing-resource planning, computer-aided manufacturing, automated machinery, and robotics leads to a significant positive increase in full rate production.

5.4 Recommendations for the Study

Having found a significant relationship between computer-aided manufacturing, manufacturing resource planning, computer-aided design and engineering, automated machines, and robotics and full rate production, the researcher recommends the adoption of advanced technology

manufacturing in production to enhance full rate production; it thus adds to the available evidence of the critical role of AMTs in manufacturing companies.

5.5 Limitations of the Study

These are the study shortcomings and flaws which may be the caused by a small sample size, unavailability of resources, flawed methodology and so on. No research study is entirely flawless or inclusive of all possible elements. However, this doesn't mean that the study is useless. Stating limitations enables the reader to fully understand the parameters within which research outcome should be interpreted. Clearly describing limitations also shows that the researcher holistically understands the study.

The study claims to determine the relationship between advanced manufacturing technologies and full rate production among commercial government entities in Kenya but only focuses on Computer-aided design and engineering, Manufacturing resource planning, Computer-aided manufacturing, Automated machines, and Robotics as the only independent variables. Advanced manufacturing technology is an overarching term that has several variables and the ones used are not the only ones. Obviously, all of advanced manufacturing technology cannot be used in a study; otherwise, the regression equation would look ridiculous.

Another limitation is that advanced manufacturing technology variables are not the type of variables whose data can be effectively collected by a questionnaire. To fully harness the power of advanced manufacturing technology data, it has to be measured. For instance, if the researcher wants data regarding computer-aided manufacturing he or she can rely on the reports generated by the computer software to obtain numerical data. Full rate production data can also not be effectively collected by asking respondents whether they think the organization is operating at its

full potential in terms of production. Companies normally have periodical outputs in number formats. Therefore, the research could have done better with secondary data.

5.6 Suggestions for Further Research

This study proposes for addition of more advanced manufacturing technology variables. For instance, future research can study the relationships between artificial intelligence, predictive maintenance, big data and virtual reality (VR), and predictive maintenance and full rate of production. It is also recommended that when performing further research in the field, secondary data obtained from production reports, machine logs, and company records should be used in place of primary data.

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APPENDICES

Appendix I: Research Questionnaire

SECTION A: GENERAL INFORMATION

Kindly fill all the questions either by ticking (Ě) in the boxes or writing in the spaces provided.

1. What is the Name of the firm/organization you are working in?

   _____

What is your designation in the organization?

Senior Management [ ]

Middle level Management [ ]

General Staff/employee [ ]

Others (Specific)……...

What is the range of your Age?

a.20 to 25 [ ]

b.26 to 30 [ ]

c. 31 to 35 [ ]

d. Above36years [ ]

What is your Gender?

Male [ ]

Female[ ]

Which is your highest level of education/academic qualification?

Diploma [ ]

Bachelors [ ]

Masters [ ]

Doctorate [ ]

Other (Please specify)

What is the cumulative years of experience working within the Commercial Government Entity?

Less than 3years [ ]

3 –5years [ ]

6 –10years [ ]

More than10years [ ]

For how long have you worked in this organization?

a) 0 to 5 years [ ] b) 6 to10 years [ ]

c) 11 to 15 years [ ] d)16 years and above [ ]

SECTION B: Advanced Manufacturing Technologies Implemented by Commercial Government Entities

On a scale of 1 - 5, please tick the appropriate answer from the alternatives provided.

1 = Strongly Disagree

2 = Disagree

3 = Uncertain

4 = Agree and

5 = Strongly Agree

To what extent do you agree that your entity has adopted the following Advanced Manufacturing Technologies to attain Full Rate Production?

Feedback statement	**Strongly disagree**	**Disagree**	**Uncertain**	**Agree**	**Strongly agree**
Computer-aided design tools in major manufacturing operations	1	2	3	4	5
Computer-engineering tools in major manufacturing operations	1	2	3	4	5
Manufacturing resource planning models in major manufacturing operations	1	2	3	4	5
Computer-aided manufacturing tools in major manufacturing operations	1	2	3	4	5

Automated machines in major manufacturing operations	1	2	3	4	5
Robotics in major manufacturing Operations	1	2	3	4	5

SECTION C: Full Rate Production among Commercial Government Entities

To what level do you agree or disagree with the following statement on full rate production of your entity?

Feedback Statement	**Strongly disagree**	**Disagree**	**Uncertain**	**Agree**	**Strongly agree**
Adoption of computer-aided design tools has improved full rate production of our entity	1	2	3	4	5
Adoption of computer-engineering tools has allowed our entity to enjoy maximum level of production	1	2	3	4	5
Adoption of manufacturing resource planning models has led to high total inputs and total output ratio	1	2	3	4	5
Adoption of computer-aided manufacturing tools has led to maximum and stable production rate in our entity	1	2	3	4	5
Adoption of computer-aided manufacturing tools has led to improved total cycle time in the entity major operations.	1	2	3	4	5

Adoption of computer-aided manufacturing tools has led to improved level of capacity utilization in our entity	1	2	3	4	5
Adoption of automated machines has improved level of efficiency and time delivery of products in our entity	1	2	3	4	5
Adoption of Robotics has improved the speed and accuracy of performance and production of our entity					

From your personal perspective, what additional advanced manufacturing technologies should your company adopt to achieve full rate production?

……

Appendix II: List of Kenyan State Corporations

CATEGORY (B): PARASTATALS OPERATING ON COMMERCIAL PRINCIPLES – 43

1. Industrial and Commercial Development Corporation.

2.Miwani Sugar Company Ltd.

3.Agro-Chemical and Food Company.

4.Kenya Meat Commission.

5.Muhoroni Sugar Company Ltd.

6.South Nyanza Sugar Company Limited.

7.Chemelil Sugar Company Ltd.

8.Nzoia Sugar Company Ltd.

9.Kenya National Trading Corporation.

10.Kenyatta International Convention Centre.

11.Bomas of Kenya.

12.Kenya Literature Bureau.

13.University of Nairobi Enterprises Ltd.

14.East African Portland Cement.

15.Kenya Wine Agencies Ltd.

16.New Kenya Co-operative Creameries.

17.National Housing Corporation.

18.Kenya National Assurance Co. (2001) Ltd.

19.Kenya Reinsurance Corporation Ltd.

20.National Bank of Kenya.

21.Kenya National Shipping Line.

22.Kenya Broadcasting Corporation.

23.Postal Corporation of Kenya.

24.Kenya Airports Authority.

25.National Cereals and Produce Board.

26.Agricultural Development Corporation.

27.Kenya Electricity Generating Company.

28.Kenya Electricity Transmission Company.

29.Kenya Pipeline Company Ltd.

30.Kenya Ports Authority.

31.Kenya Power and Lighting Company.

32.Kenya Railways Corporation.

33.Kenya Seed Company.

34.National Oil Corporation of Kenya.

35.Numerical Machining Complex.

36.Kenya Investment Authority.

37.Nyayo Tea Zones Development Corporation.

38.Geothermal Development Company.

39.Kenya Safari Lodges & Hotels.

40.National Mining Corporation.

41.Post Bank Kenya Ltd.

42.School Equipment Production Unit.

43.The Kenya Ordinance Factories Corporation.