

**UNIVERSITY OF NAIROBI**

**INSTITUTE OF DIPLOMACY AND INTERNATIONAL STUDIES**

**THE IMPACT OF EMERGING TECHNOLOGY ON INTERNATIONAL TRADE: A  
CASE STUDY OF THE THREE-DIMENSIONAL (3D) PRINTING AND CUSTOMS  
AUTHORITIES IN THE EAST AFRICAN COMMUNITY**

**ISAAC AYUMA**

**REGISTRATION NUMBER R50/86924/2016**

**SUPERVISOR:**

**DR. EMMANUEL KISIANG'ANI**

**A RESEARCH PROJECT SUBMITTED IN PARTIAL FULFILLMENT OF THE  
REQUIREMENTS FOR THE AWARD OF THE DEGREE OF MASTERS OF ARTS  
IN INTERNATIONAL STUDIES**

**NOVEMBER 2018**

## **DECLARATION**

I, Isaac Ayuma, hereby declare that this research project is my original work and has not been presented for a degree in any other University.

Signed..... Date.....

This project has been submitted for examination with my approval as University Supervisor;

Signed..... Date.....

Dr. Emmanuel Kisiangani (PhD)

University Supervisor

Institute Of Diplomacy and International Studies

University Of Nairobi

## **DEDICATION**

To my great friends Kyle Nyaboke, Keagan Oyugi, Kelsey Chebet and Edith Kigen. You mean the world to me.

## **ACKNOWLEDGEMENT**

In this academic journey, I have received support from so many people that it would be almost mission impossible to name them all. Allow me to acknowledge a few. First, I wish to sincerely thank my supervisor Dr. Emanuel Kisiang'ani without whom completion of this study would not have been possible. His patience and systematic guidance is something that I will forever treasure. I particularly have no word to express my gratitude for the gentle nudges he gave whenever faltering and giving up seemed the easier option.

Secondly, I will like to acknowledge my seniors, mentors and friends at Kenya Revenue Authority; Mrs. M W. Njuguna, Mrs. Pamela Ahago and M/s N. Kayaywa for not only encouraging and cheering me on but also according me ample time whenever I requested for it. Their immense support enabled me to finish my study on time. May they be blessed abundantly. I would also thank my employer for the financial assistance that enabled me to undertake this study. I would also wish to extend my sincere gratitude to all the employees of the three East African Revenue Authorities namely Kenya, Tanzania and Rwanda who helped me in diligently filling in the questionnaires that I sent them. Hats off to Fidelis Kanyaitoju in Tanzania and Jean-Pierre Mwizerwa from Rwanda for being able assistants and standing in for me in their respective countries. In the same vein, I would most profoundly thank Davis Kiprop, Sharon Sakwa, Juliet Muema and Onesmus Nzuki for their immense support.

I should also acknowledge my friends and colleagues at Institute of Diplomacy and International Studies for the tonnes of advice and moral support. Particularly, I single out Edith Kigen and Loise Makato who offered to edit my work pro bono.

Above all, I appreciate my family for their unconditional love and support. The precious time I 'stole' from them was not in vain.

## TABLE OF CONTENTS

<b>DECLARATION.....</b>	<b>ii</b>
<b>DEDICATION.....</b>	<b>iii</b>
<b>ACKNOWLEDGEMENT.....</b>	<b>iv</b>
<b>LIST OF TABLES .....</b>	<b>ix</b>
<b>ABBREVIATIONS .....</b>	<b>x</b>
<b>ABSTRACT.....</b>	<b>xi</b>
<b>CHAPTER ONE: INTRODUCTION AND BACKGROUND TO THE STUDY .....</b>	<b>1</b>
<b>1.0 Introduction.....</b>	<b>1</b>
<b>1.1. Background .....</b>	<b>1</b>
<b>1.2 Statement of the Problem.....</b>	<b>2</b>
<b>1.3 Objectives of the Research .....</b>	<b>3</b>
1.3.1 General objectives .....	3
1.3.2 Specific objectives .....	3
<b>1.4 Research Questions.....</b>	<b>3</b>
<b>1.5 Scope and Limitation of the Study .....</b>	<b>4</b>
<b>1.6 Literature Review .....</b>	<b>4</b>
1.6.1 Industrial Revolution.....	4
1.6.2 Transportation .....	5
1.6.3 Containerization.....	7
1.6.4 Automation of Customs .....	8
1.6.5 X-Ray Scanners .....	9
1.6.6 Three Dimensional (3D) Printing .....	10
<b>1.7 Research Gap .....</b>	<b>10</b>
<b>1.8 Theoretical Framework.....</b>	<b>11</b>
1.8.1 Diffusion of Innovation Theory .....	11
1.8.1.2 Critiques of Diffusion of Innovation Theory.....	13
1.8.2 Economic Theory of Customs Taxation.....	14
1.8.3 Main Theory .....	14
<b>1.9 Research Methodology .....</b>	<b>14</b>
1.9.1 Research Design .....	15
1.9.2 Research Sites.....	15
1.9.3 Target Population .....	15
1.9.4 Sample and Sampling Technique .....	15
1.9.5 Data Collection Methods and Instruments .....	16

1.9.6 Data Analysis and Presentation .....	17
<b>1.10 Chapter Outline .....</b>	<b>17</b>
<b>CHAPTER TWO: LITERATURE REVIEW OF THE IMPACT OF EMERGING TECHNOLOGY ON INTERNATIONAL TRADE .....</b>	<b>19</b>
<b>2.1 Introduction.....</b>	<b>19</b>
2.1.1 Background: What sparks Technological Changes?.....	19
<b>2.2 First Industrial Revolution (1760-1840).....</b>	<b>22</b>
2.2.1 Key Inventions in the First Industrial Revolution .....	23
2.2.1.1 Steam Engine .....	23
2.2.1.2 Spinning Jenny and Power Looms.....	24
2.2.1.3 Iron.....	24
2.2.2 Transportation in the First Industrial Revolution: From Sail to Steam .....	24
2.2.3 Impact of First Industrial Revolution on International Trade .....	25
2.2.4 Impact of First Industrial Revolution on Customs Authorities Mandate .....	26
<b>2.3 Second Industrial Revolution (1870s-1914).....</b>	<b>26</b>
2.3.1 The Second Industrial Revolution and the Shift in Cargo Transportation .....	27
2.3.2 Containerization.....	27
2.3.3 Transportation in the Second Industrial Revolution:.....	29
2.3.4 Impact of Second Industrial Revolution on International Trade .....	29
2.3.5 Impact of Second Industrial Revolution on Customs Authorities Mandates.....	30
<b>2.4 Third Industrial Revolution.....</b>	<b>30</b>
2.4.1 Internet and E-commerce .....	31
2.4.2 Automation of Customs Processes .....	33
2.4.3 X-Ray Scanners.....	35
2.4.4 Impact of Third Industrial Revolution on International Trade.....	35
2.4.5 Impact of Third Industrial Revolution on Customs .....	36
<b>2.5 Fourth Industrial Revolution.....</b>	<b>36</b>
2.5.1 Three Dimensional (3D) Printing.....	37
2.5.2 3D Printing and Taxation.....	37
2.5.3 Three Dimensional Printing: Security and Safety Concerns.....	38
2.5.3.1 Security Concerns.....	38
2.5.3.2 Safety Issues.....	39
<b>2.6 3D Printing and Intellectual Property Rights .....</b>	<b>40</b>
<b>2.7 Summary of Gaps .....</b>	<b>42</b>

<b>CHAPTER THREE: EFFECTS OF THREE-DIMENSIONAL PRINTING ON THE ROLE OF CUSTOMS AUTHORITIES: A CASE STUDY OF THE EAST AFRICAN COMMUNITY .....</b>	<b>43</b>
<b>3.1. Introduction.....</b>	<b>43</b>
3.1.2 Background of the East African Community .....	43
3.1.3 Historical Perspectives of Customs Authorities in EAC.....	44
<b>3.2 Role of Customs in the East African Community .....</b>	<b>45</b>
<b>3.3 Legal Framework: The East African Community Customs Management Act 2004</b>	<b>45</b>
<b>3.4 Empirical Data on the Effect of Three-dimensional Printing on the Role of Customs Authorities in the East African Community .....</b>	<b>47</b>
<b>Table 1: Number of Questionnaires Administered and Received Back .....</b>	<b>48</b>
<b>Table 2: Age Distribution of the Respondents .....</b>	<b>48</b>
<b>Table 3: Level of Education .....</b>	<b>48</b>
<b>Table 4: Gender distribution .....</b>	<b>49</b>
<b>Table 5: Years of Service.....</b>	<b>49</b>
<b>3.5 Customs Control of 3D Printed Goods in the EAC Region .....</b>	<b>49</b>
3.5.1 Three Dimensional Printing and Revenue Collections .....	50
<b>Table 6: Impact of 3D on Customs mandates .....</b>	<b>51</b>
3.5.2 Three Dimensional Printing and Safety and Security.....	51
3.5.2.1 Security issues.....	51
3.5.2.2 Safety Issues.....	53
3.5.3 Collection of Trade Statistics.....	54
3.5.4 Intellectual Property Rights .....	55
3.6 Conclusion.....	56
<b>CHAPTER FOUR: EAC CUSTOMS AUTHORITIES AND OPTIONS FOR MITIGATING THE ADVERSE EFFECTS OF 3D PRINTING.....</b>	<b>57</b>
<b>4.1 Introduction.....</b>	<b>57</b>
<b>4.2 3D Printing and Revenue Collection .....</b>	<b>57</b>
<b>4.3 3D Printing and Safety and Security.....</b>	<b>61</b>
4.3.1 Safety Options.....	62
4.3.2 3D Printing and Security in East African Community.....	64
<b>4.4 3D Printing and Intellectual Property Rights .....</b>	<b>66</b>
<b>4.5 3D and Collection of International Trade Statistics .....</b>	<b>67</b>
<b>4.6 Conclusion .....</b>	<b>67</b>
<b>CHAPTER FIVE: CONCLUSION, POLICY RECOMMENDATIONS AND SUGGESTIONS ON AREAS FOR FURTHER RESEARCH .....</b>	<b>68</b>

<b>5.1 Introduction.....</b>	<b>68</b>
<b>5.2 Summary of Key Debates.....</b>	<b>68</b>
<b>5.3 Conclusion .....</b>	<b>70</b>
<b>5.4 Policy Recommendations.....</b>	<b>71</b>
<b>5.5 Suggestions on Areas for Further research. ....</b>	<b>71</b>
<b>REFERENCES.....</b>	<b>72</b>
<b>Appendix I: Questionnaire.....</b>	<b>74</b>
<b>Appendix II: Interview Guide.....</b>	<b>77</b>
<b>Appendix III: Map of East African Community .....</b>	<b>80</b>



## **LIST OF TABLES**

Table 1: Number of Questionnaires Administered and Received Back .....	48
Table 2: Age Distribution of the Respondents.....	48
Table 3: Level of Education.....	48
Table 4: Gender distribution .....	49
Table 5: Years of Service.....	49
Table 6: Impact of 3D on Customs mandates .....	51

## **ABBREVIATIONS**

3D Printing	Three Dimensional
CAD	Computer Assisted Design
CBRAs	Cross Border Regulatory Agencies
CCC	Customs Co-operation Council
CET	Common External Tariff
CIF	Cost, Insurance and Freight
CITES	Convention in International Trade in Wild Flora and Fauna
DOI	Diffusion of Innovation
EAC	East African Community
EACCMA	East African Community Customs Management Act
FIR	First Industrial Revolution
GATS	General Agreement on Trade in services
GATT	General Agreement on trade and Tariff
IPR	Intellectual Property Rights
NTB-	Non-Tariff Barrier
OECD	Organisation for Economic Co-operation and Development
PCA	Post Clearance audit
P2P	Peer to Peer
PVOC	Pre-verification Certificate of Conformity
SEZ	Special Economic Zone
TEU	Twenty-Foot Equivalent
TINs/PINs	Taxpayer/Personal Identification Numbers
TRIPs	Trade Related aspects of intellectual Property
UNCTAD	United Nations Conference on Trade and Development
USD	United States Dollars
VAT	Value Added Tax
WCO	World Customs Organization
WTO	World Trade Organization

## **ABSTRACT**

The study sought to examine how emerging technology has affected international trade in general and the role of customs authorities in particular. The study zeroed in on how three-dimensional printing-a form of additive manufacturing that allows manufacture of everyday products via printing from a computer assisted design will affect the role of customs authorities in the world. This new form of printing is contrasted with the earlier printing that not only revolutionized the world changing the way things were done, but also literary rendered the previous gatekeeper-the scribes-jobless. Taking a case study the East African Community, the study sought to establish the impact of emerging technology on international trade, evaluate the extent to which 3D printing affects the role of customs authorities in the region and to explore the options available to customs authorities in the region to mitigate the adverse effects of 3D printing.

It took an historical approach looking at emerging technologies at various points in time starting from the first industrial revolution through to the fourth industrial revolutions that combines cyber-physical aspects. The study found out that technologies can be grouped into five broad groups namely power delivery systems, materials, and transportation and information communication technologies. These technologies have increased international movement of goods which has invariably affected the role of customs authorities not only increasing the revenue collected but also making it more and more challenging to protect their borders but also facilitate trade.

The study employed two key theories-Diffusion of Innovation Theory and Economic Theory of Customs Taxation. Diffusion of innovation theory that looks at adoption rate of a new idea or technology by society was the main theory. The study utilized a mixed method approach looking at both primary and secondary data. Three East African countries namely; Kenya, Rwanda, and Tanzania were chosen as the study sites and samples drawn therefrom. Key informants were interviewed as well as focused group discussions supplemented by questionnaires administered in the study site.

The study found out that revenue collection, border protection and collection of international trade statics are among key mandates of customs authorities that will be negatively impacted and that measures need to be put in place urgently to counter the effects. It is the view of this study that a multi-agency and multi-pronged approach that holistically looks at the effects of 3D printing be employed to counter the potentially negative impact of 3D printing.

## **CHAPTER ONE: INTRODUCTION AND BACKGROUND TO THE STUDY**

### **1.0 Introduction**

This chapter covered the background of the study and included a brief overview of the study, the statement of the problem, research objectives, research questions and the justification. It further, reviewed literature on the subject, integrated the study's theoretical framework and methodology, and finally provided the chapter outline.

### **1.1. Background**

Customs authorities usually perform four key functions; revenue collection, border protection, collection of international trade statistics and trade facilitation. They accomplish this mandate by controlling international trade through physical presence at the gazetted entry and exit points.

Over the years, technological advancements have made the increased international trade in terms of both speed and volume. Considering customs authorities are mainly tasked with regulating international trade, the advancements have inevitably affected the way customs authorities perform these tasks. For instance, the emergence of faster and bigger ships, and containerization meant that more and more cargo was being imported and/or exported than before. Whereas this facilitated the first objective of customs i.e. revenue collection-more and more cargo coming which directly translated to increased revenue, the other two mandates of customs were put to test. Containerization of cargo was akin to a Trojan horse.<sup>1</sup> It became almost impossible to know what was carried in the container. This called for more and more controls by customs including mandatory 100 per cent verification of cargo to ascertain the contents of declarations.

In as much as these technological advancements had affected the role of customs, they have not threatened the 'gatekeeper' functionality of customs administrations. Customs officers still have the chance to check the cargo at the designated entry/exit points. However, the emergence of additive manufacturing also called 3D Printing is changing all this. Additive manufacturing is the printing of a three dimensional product that can be used for our day-to-day activities. This is done layer by layer hence the term 'additive.' The digital blueprint is

---

<sup>1</sup> In Greek mythology a hollow wooden statue of a horse in which the Greeks are said to have concealed themselves in order to enter Troy. It signifies something that looks innocuous but can cause serious damage.

printed using special printers.<sup>2</sup> This kind of technology bypasses the traditional customs entry-exit points and as such, they cannot be controlled by customs-at least yet.

This is put in the context of other technological transformations that have since time immemorial changed the way business is conducted. For instance, the printing press in the 14<sup>th</sup> century changed the literacy environment. Books and newspapers could be printed and availed to the mass market at a fraction of the cost of a traditional scribe. This not only increased the accuracy and speed of circulation but also made the role of the scribe redundant.

It is therefore telling that another set of printing is about to seriously disrupt the role of the customs officer and to some extent make customs administration less critical in the supply chain.<sup>3</sup> In order to survive, customs authorities must look for ways of coping with this major disruptive technology. This is because, unlike scribes who lost their jobs as individuals in the 14<sup>th</sup> century, custom authorities play a too important a role for them to be left to “die.” Anything that threatens their (customs authorities) existence needs to be given due attention.

## **1.2 Statement of the Problem**

In the EAC, revenue collection and border security are key functions that fall under the realm of customs authorities. Taxation of imports (and occasionally exports) is a key contributor to the region’s governments’ revenues. On average, close to 40 percent of revenue is collected by customs authorities. Border security is another important function of customs authorities. They have to ensure that restricted items such as weapons and/or weapon-making materials are only transacted by authorized entities. Terrorist attacks in the EAC region and beyond, and the prevalence of illicit cross-border trade in small arms in the region highlight the importance of border security. Customs authorities perform these functions by being gatekeepers at all gazetted entry and exit points and controlling international movement of goods.

---

<sup>2</sup> See Berman B, 3D Printing: The New Industrial Revolution  
<https://www.sciencedirect.com/science/article/pii/S0007681311001790>

Irene J. Petrick & Timothy W. Simpson 3D Printing Disrupts Manufacturing: How Economies of One Create New Rules of Competition, *Research-Technology Management*, 56:6, 12-16, 2013

Mohr S. and Khan O. 3D Printing and Its Disruptive Impacts on Supply Chains of the Future in *Technology Innovation Management Review* November 2015 (Volume 5, Issue 11)

<sup>3</sup> Supply chain refers to the process of moving goods from the producer to the final consumer. It is a complex web sometimes intertwining.

An emerging technology, 3D printing or additive manufacturing, is substantially changing how we view international movement of goods, and subsequently the role of customs authorities. 3D printing is bypassing traditional customs controls and using internet connection as a primary means of transportation. Potentially, this makes it difficult for customs authorities to regulate trade. Presently, other than applications in a few sectors and by a small group of (start-up) companies, the 3D printing revolution has barely taken off, more so in the EAC region. However, judging by the number of players that have mushroomed recently, including in the EAC region, and the accompanying improvements that have been done to this novel way of manufacturing, all indicators point to a technology that is on the verge of being mainstreamed. The time and cost savings it potentially has makes it a very attractive model. Inevitably, questions such as; what will be the impact of emerging disruptive technology on international trade with particular reference to the EAC region? What impact will 3D printing have on revenue collection and border protection? What will be the role of customs authorities in a '3D world' in the EAC region among others will be posed. It is the right time to start influencing policy answers surrounding these questions 3D printing raises.

### **1.3 Objectives of the Research**

#### **1.3.1 General objectives**

The general objective of the study is to assess the impact of emerging technology on the role of customs authorities in the EAC region.

#### **1.3.2 Specific objectives**

1. To establish the impact of emerging technology on international trade.
2. To evaluate the extent to which 3D printing affected the role of customs authorities in the EAC region
3. To explore the options that customs authorities in the EAC can utilise to mitigate the adverse effects of 3D printing.

### **1.4 Research Questions**

1. What is the impact of emerging technology on international trade?
2. To what extent 3D printing affects the role of customs authorities in EAC region?

3. What options can customs authorities in the EAC region utilize to mitigate the adverse effects of 3D printing technology?

### **1.5 Scope and Limitation of the Study**

The study focuses on the impact of emerging technology on the role of customs authorities in EAC region. Although there are many emerging technologies, the study only limits itself to additive manufacturing-popularly known as 3D printing only in as far as it has affected customs' authorities mandate.

### **1.6 Literature Review**

This section looks at the technological advancements and how they affect customs operations. The review adopts a thematic and historical approaches looking at three key areas that were central to customs operations namely; transport and logistics, cargo handling procedures and customs procedures. The review also concentrated on the various evolutions in manufacturing with a keen look at how they have affected customs authorities' mandates.

#### **1.6.1 Industrial Revolution**

Technological change has been central to the growth and development of human beings. Some issues we consider mundane now were at one point innovative technology that propelled humanity ahead of other species (and other human beings who lacked the ability to use the technology). Simple tools like stones and clubs made from branches were very vital in helping man get an edge over those who were not using them. The discovery that fire could be used to not only keep warm but also cook food was a step forward in as far as culinary tastes was concerned. Whereas these can be considered rudimentary, the advancements that were in the 18<sup>th</sup> century are the ones that had a far-reaching impact, which are now called the industrial revolution.

Industrial revolution is defined as a period when mechanical power of machines replaced animal and human power in the production process and production shifted from subsistence to mass production. The first industrial revolution began in Great Britain spontaneously with no government intervention. The years 1760-1830 are central to the technological changes

that reshaped the world in ways previously unimagined.<sup>4</sup> The industrial revolution was characterized by massive mechanization in the factories and farms. These resulted in mass production of goods and a corresponding demand for newer markets.

As Joel Mokyr notes

“Market size is a key factor that determines the growth of technological growth. For technological growth to be possible the market size must be bigger than the expected costs of the inventions.”<sup>5</sup>

In order to increase the market size, other factors and inventions came into play. They included improvements in transportation, increased population growth, integration of markets as well as profit-minded private individuals.<sup>6</sup> In chapter one of his book, *Wealth of Nations*, Adams Smith reckons that the main essence of a capitalistic society is division of labour, which can only be practised if, the market size is big enough to allow for the specialization.<sup>7</sup>

Whereas big technological inventions or (macro-inventions) had a tremendous impact, it is the small incremental improvements to the initial discoveries (micro-inventions) that could later have a bigger impact.<sup>8</sup> For example, while steam and steel discovery was an important milestone, allowing for production of steam-powered transportation modes, it was the micro-invention of Henry Bessener that unlocked the steam/steel potential allowing for production of better steam-powered engines.

The first industrial revolution was characterized by development in other technologies such communication modes including telephone and Morse codes that allowed a faster means of exchanging information. The further refined of steel allowed building of bridges, railroads and other tools. Henry Ford assembly line also revolutionized the mass production technique and was soon adopted by other countries.

### 1.6.2 Transportation

Between 1950-and 2004, world trade is estimated to have grown at an annual rate of 5.9%<sup>9</sup>while in 2016 it grew by 5 percent.<sup>10</sup> Technological development that resulted in a remarkable increase in speed and carrying capacity of various modes of transportation

---

<sup>4</sup> Ashton, Thomas S. *The First Industrial Revolution 1760-1830*. Oxford: Oxford University Press, 1948.

<sup>5</sup> <sup>5</sup> Mokyr, J. *The Lever of Riches*. Oxford University Press, 1999

<sup>6</sup> *ibid*

<sup>7</sup> Smith A, *An Inquiry into the Nature and Causes of Wealth of Nations*, Metalibri Amsterdam 2007

<sup>8</sup> Mokyr, Joel. *The Lever of Riches*. Oxford: Oxford University Press, 1999

<sup>9</sup> World Trade statistics 2005

<sup>10</sup> World Trade 2017



especially ocean and air, coupled with a decrease in transportation costs has been postulated as one of the causes of the increase. Economic historians aver that changes in technology resulted in a big drop in shipping costs in particularly in the period 1850-1913. Subsequent research has revealed a correlation between rapid growth in trade and decline in shipping costs in the first era of globalization.<sup>11</sup>

The 19<sup>th</sup> century saw the most significant technological changes in the transportation. The steam ship replaced the sail ship. For years, the sail ship relied on wind direction and speed had been the most reliable way of breaking the water barrier. It allowed countries that were separated by large bodies of water to trade. In its prime, it was an advanced technological innovation especially with its micro-inventions of multiple sails. In the east coast of Africa, the Monsoon winds (also called trade winds), which blow northeasterly from December to March with a reversal between April and September, were the drivers of trade between East Africa and Middle East. Whereas, the predictable pattern of the wind could allow the traders to plan their trade, it was impossible to trade all year round.

The steam ship was first introduced in the 1850s. *John Bowen* was the first steam ship with a capacity of 500 deadweight (dwt).<sup>12</sup> By 1880, this had grown exponentially. *Seawise Giant* had deadweight of 550,000dwt.<sup>13</sup> Steam ship made it easier to plan the journeys of ships without relying on wind directions. The two would exist side by side but by early 1900s, sail ship had been replaced as the major form of transportation.<sup>14</sup> Steam ships would later face competition from diesel-powered ships from the beginning of the 20<sup>th</sup> century. The later became the dominant form of sea transportation especially after the Second World War.

Other notable innovations include the invention of iron and steel to replace wood in the construction of ship hulls made it possible to have bigger watertight hulls that progressively made it easier to have bigger ships.

---

<sup>11</sup>Estevadeordal, A, B. Frantz, and A. Taylor.2003. “*The Rise and Fall of World Trade, 1870–1939.*” *Quarterly Journal of Economics*, 118(2):359–407

<sup>12</sup>Dead weight is the total weight of cargo, stores etc. that a ship can carry at any one time measured in tonnes.

<sup>13</sup>As per the Lloyds Register of shipping maintained by Lloyds Register Group an international body dedicated to technical and business services of maritime classifications

<sup>14</sup>Stopford, *Maritime Economics* 2<sup>nd</sup> edition Routledge, 1997 pg. 34

### 1.6.3 Containerization

Containerization<sup>15</sup> is one critical invention that also occurred in the 20<sup>th</sup> century.<sup>16</sup> It paved way for development of bigger and faster ships. Before it, cargo was carried as bulk cargo regardless of its volume and size. The process of ‘breaking bulk’<sup>17</sup> was very slow. Expensive liners spent as much as two-thirds of their time either loading or offloading cargo.<sup>18</sup> These delays were a great barrier towards making shipping cheaper to the commercial merchant without compromising on the profits of the shipping companies.

Containerization made it possible to solve the ‘break bulk’ problem while at the same time introducing safety and speed into the shipping industry. The container made this possible in a number of ways. One, the cargo was packed way in advanced into the container and thereafter transported to the port to wait for the liner to arrive. Secondly, specialized handling equipment such as cranes hoisted the containers and stacked them one on top of the other in a much faster way than previously imagined. Lastly, containerization made it possible to integrate multi-modal transportation of cargo. Containers could be readily transferable to either rail or truck with minimal effort.

In essence, containerization made it possible to build faster bigger ships making the world smaller and integrated. This made shipping cheaper and to an extent that it was possible to transport raw material from tens of thousands of kilometers away by ship than it was to transport the same raw material from a couple of hundreds of kilometres by road or rail.<sup>19</sup>

The *Almelia*<sup>20</sup> was the first ship designed to carry containers and had a capacity of 60 twenty-foot equivalent units (TEU) but compared to the modern liner that can carry in excess of 20,000 TEUs the ship looks smaller. Today, more than 90 percent of non-bulk cargo is transported via containerization.<sup>21</sup>

---

<sup>15</sup>Containerization is the packing of cargo in standard sized containers, which can be carried by road rail or sea with equal facility and ease. A container is typically a steel box usually 8ft (2.43m) wide by 8.5ft (2.59m) high. It is either 20ft (6.06m) or 40ft (12.2m) long.

<sup>16</sup>Stopford, *Maritime Economics* 2<sup>nd</sup> edition Routledge, 1997 pg. 34

<sup>17</sup>Breaking bulk is the offloading of cargo from the ship

<sup>18</sup>Op cit 12

<sup>19</sup> ibid

<sup>20</sup> ibid

<sup>21</sup> ibid

#### **1.6.4 Automation of Customs**

Traditionally, customs transactions were manual in every aspect. Importers had to present their documents to customs physically for the process to start. This was not only tedious considering the number of copies of documents<sup>22</sup> that had to be produced but was also had time limits because of the number of working hours in a day. This inevitably and unnecessarily increased the transacting cost and customs process being considered a non-tariff barrier (NTB). As noted by United Nations Conference on Trade and Development (UNCTAD) says that...

A single commercial transaction may involve tens of documents and parties and up to 200 data elements that may need to be captured more than once by the clearing agent/forwarder, shipping agent who need to communicate this information to other interested parties. This back and forth capture and recapture of information may increase the cost of the transaction by up to ten percent of the original commercial value.<sup>23</sup>

The delays inevitably and predictably led to room for extortion and corruption avenues as paper pushers 'promised to help jump the queue'.

The Revised Kyoto Convention (RKC), advocated for the Simplification and Harmonization of Trade Procedures<sup>24</sup> standardized as well as reduced the documents that could be requested by customs. This helped in making the process predictable and smoother. However, it was slow and tedious considering the increased number of transactions to be handled with little or no corresponding increase in number of customs staff.

Automation of customs procedures was also one of the key issues that were under discussion in WTO's Doha Development Round. The round was meant to discuss how to help developing countries improve and hasten its development. Trade facilitation using information technology systems in customs authorities as one of its key objectives.

RKC suggested a number of improvements key among them being the automation of customs processes. Because of this automation, there was a corresponding increase in revenue collected due to a number of things. One, there was uniformity in the calculation of the duties

---

<sup>22</sup>A typical customs transaction will require original and copies of bill of lading, invoices, declaration of value, declaration, packing list, customs duty payment receipts and certificate of exports among other documents. These documents must be provided in quadruplicates to customs. These copies must also be presented to other cross border regulatory agencies such as bureau of standards, plant health inspectorates among others.

<sup>23</sup> UNCTAD 2006

<sup>24</sup> Revised Kyoto Convention <http://customs.gov.ph/wp-content/uploads/2016/10/KYOTO-Convention.pdf>

thanks to a pre-set duty calculator. Secondly, there was increased transparency and predictability that made decision making faster.

Automation of customs procedures has made it possible to have pre-arrival declaration of cargo. This gives customs authorities enough time to do data analysis and profile cargo based on the pre-defined risk parameters. This was aided by improved management information systems that allow clearer post transaction audits, which ultimately led to increased compliance.

Thus, technology has helped customs authorities in facilitating trade. This was mainly done through processing transactions faster and in a cost effective manner to traders as well as effective risk assessment of documents provided in advance transactions lodged in advance. It has also facilitated collection of more revenue mainly by making it possible to scrutinize documents before or during post-transaction audits. This increased transparency and predictability has sealed many revenue leakage avenues<sup>25</sup>.

### **1.6.5 X-Ray Scanners**

Technological revolutions increased the physical movement of goods across international borders. In 2014, approximately 4 billion metric tonnes of cargo was moved through European ports.<sup>26</sup> This increase affected the role of customs authorities in as far as the holy trinity of customs i.e. revenue collection, border protection and trade facilitation was concerned. Increased cargo meant potentially more and more revenue to be collected by customs authorities especially if the goods were finished goods that attracted customs duty but also posed a threat in as far as border protection was concerned. In order to ensure that only legitimate cargo enters or exits, trade facilitation was negatively affected.

However, the temptation to smuggle also increased because of the challenge of verifying cargo that was coming into a country. Scanning has been used to ensure that the declared goods match the actual goods in all material aspects.<sup>27</sup> X-ray images after a scan is made will help goods that may have been mis-declared.<sup>28</sup> Other helpful information provided, include

---

<sup>25</sup> Mutema C Kenya Revenue Authority ,Nairobi, interview Bernard Kago April 2018

<sup>26</sup>Visseret *al.*, "Automated comparison of X-ray images for cargo scanning," *2016 IEEE International Carnahan Conference on Security Technology (ICCST)*, Orlando, FL, 2016, pp. 1-8.

<sup>27</sup>ibi

<sup>28</sup> Misdeclaration is the act of providing information in the customs entry that is factually false from what is actually stuffed in the container.

load homogeneity, total or partial weight, or the number of similar items. Because of this technology-x-ray scanning, a container can be verified in less than two and a half minutes.<sup>29</sup>

#### **1.6.6 Three Dimensional (3D) Printing**

In the conventional manufacturing world, brick and mortar products are the norm rather than the exception to be fully enjoy their utility. However, with advancement in technology, some products have been dematerialized and the physical form is no longer necessary in order to fully enjoy the product's utility. For example, digital photos and music are as good in the dematerialized form as in the material form. The materialized form makes the storage and transportation of some of these products much faster, easier and discrete. Sending a digital version of music needs only internet connection. At a click, you can transport it over thousands of kilometres, far much cheaper and faster than the conventional material forms would have been transported. The same case applies to newspapers, books and similar products.

Some products cannot however be dematerialized without losing their practical utility. For example, a digital form of a spoon is not a spoon in the strictest sense. It loses its utilitarian value and has to be converted into a physical form. This ultimately takes away the advantage that dematerialized forms have in terms of transportation. In order to get the best of both worlds that is to retain the utilitarian value as well as retaining the speed of transporting the product, a way had to be found of converting the digital form into something that has utilitarian value hence the birth of 3D printing.

As much as 3D printing offers practical value to the business world, it is a nightmare to customs. Its discrete nature potentially makes the gatekeeper powerless because he is unaware of what is coming in or out. The adage 'nothing is certain except death and taxes' is no longer valid in a 3D world.

#### **1.7 Research Gap**

A lot of research has been done on how emerging technology has impacted on international trade and how it impacts on the role of customs, but little seems to have been done regarding the impact of additive manufacturing(also called) 3D printing.

---

<sup>29</sup> Ayuma I, Interview with Joab Omole of Kenya Revenue Authority, Nairobi May 2018.

## **1.8 Theoretical Framework**

### **1.8.1 Diffusion of Innovation Theory**

Diffusion of Innovation (DOI) Theory has its roots in communication studies. Everett Rogers, who tried to explain how an idea is disseminated in a given set-up, is credited with the theory's formulation. Rogers sees innovation as "knowledge, drill, or an entity that is considered novel by someone and is fit for adoption because it has characteristics that are revolutionary and/or cutting age." This novel idea is in essence considered to have attributes that are useful in solving 'current' issues or challenges and would be worthwhile to embrace." Rogers considers diffusion as "the progression through certain channels, in a given period, that the innovation is disseminated to individuals in a given social strata."<sup>30</sup>

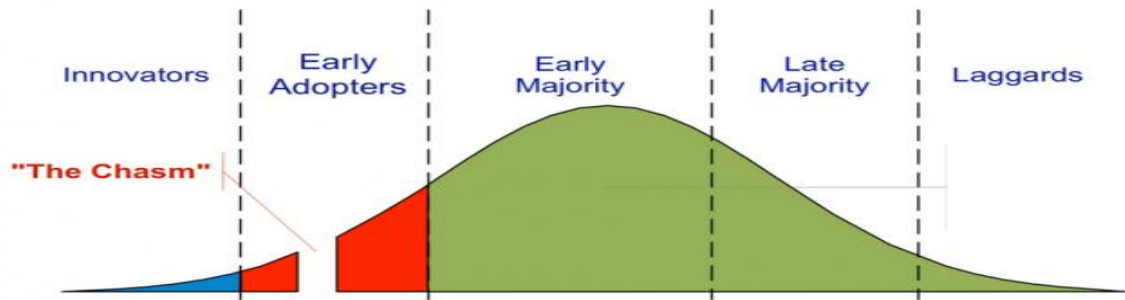
DOI theory tries to evaluate the reasons particular ideas are accepted and spread within a given social system. According to DOI, for the new idea to be popularly accepted, it must have certain attributes that are inherently absent in the old idea. Alternatively, the new idea must be technically superior to the older ideas. Rogers lists the aspects that are critical in the acceptance of an innovation as; comparative advantage, level of difficulty, compatibility, trialability and observability. The comparative advantage is the extent to which the adopter considers the innovation as being beneficial to their processes vis-à-vis the existing processes. The adoption follows a specific pattern but must reach critical mass for its real effects to be felt. The pattern usually begins with innovators, early adopters, early majority, late majority and finally the laggards. The graph below describes the pattern as adopted from Moore's book 'Crossing the Chasm.'<sup>31</sup>

#### **Chart one The Diffusion of innovation curve;**

---

<sup>30</sup>Rogers, E. (1995). *Diffusion of Innovations*, Edition. New York, NY: Free Press.

<sup>31</sup> Moore, Geoffrey A. 1991. *Crossing the chasm: marketing and selling technology products to mainstream customers*. [New York, N.Y.]: Harper Business.



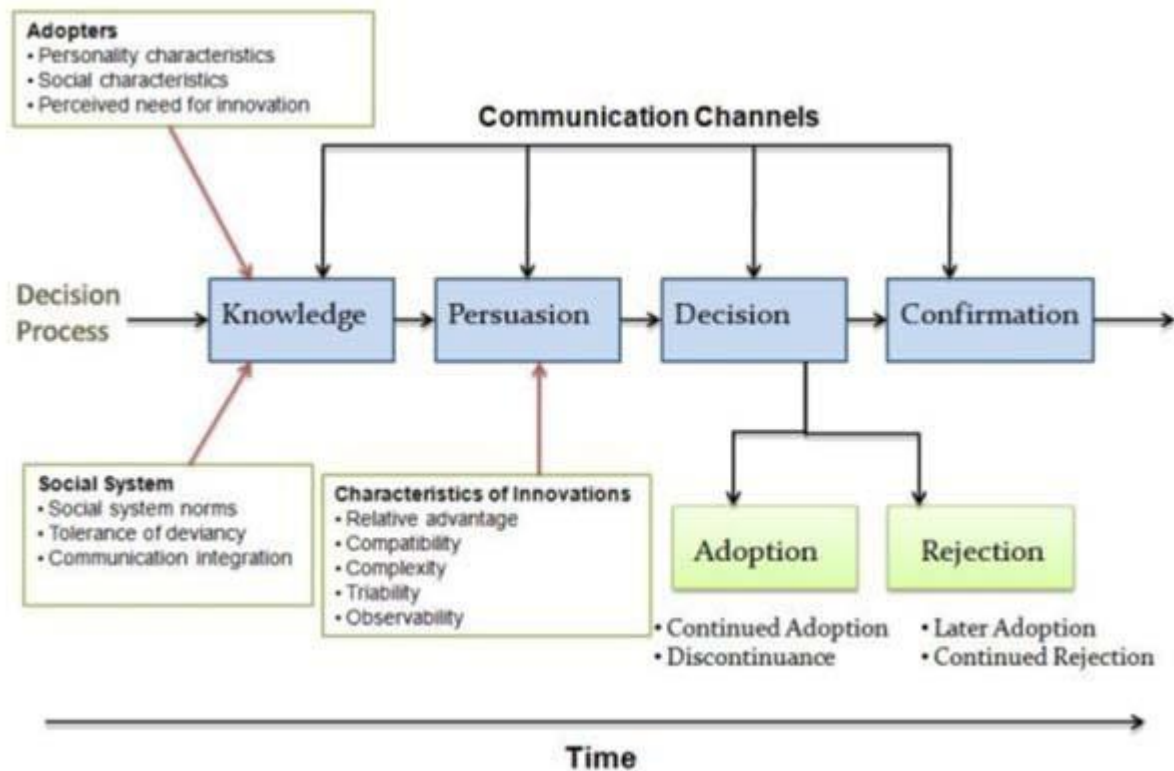
Moore famously categorizes the adoption not just into the five groups as had initially been envisaged by Rogers but goes ahead to describe what would make a product or idea succeed or not. He groups the individuals into two groups; the early market and the mass market. The divide between the groups is what he calls the chasm and that it must be crossed if the idea or technology is to succeed.<sup>32</sup> Certain aspects that include feeding the adopters with relevant information, through relevant channels of communications are critical in making the idea, product or technology acceptable to the masses.

DOI has been applied in various areas including marketing, economics, communication, technology, management as well as political science.

**The diagram 1 Summary the DOI theory.**

---

<sup>32</sup> ibid



Source: adopted from Hsia Ching Chang

### 1.8.1.2 Critiques of Diffusion of Innovation Theory

Kale Lythion and Jan Dasgaard are among scholars who have criticized the DOI theory claiming it is narrow and misses certain critical aspects affecting the adoption of a technology. To them, DOI overlooks certain crucial aspects in the spread of complex technologies.<sup>33</sup> They maintain that any researcher using DOI must contend with a complex interplay between role of institutional regimes, key players in the diffusion arena as well as historical nuances of the technology in question. Hsia-Ching Chang, quoting Baas claims that although DOI serves as a comprehensive framework for trying to understand the diffusion process, it lacks predictive power relating to dissemination of the technology.

In this study, the theory was applied to try to predict empirically the extent and pattern through which additive manufacturing (3D printing) technology was adopted and the point at which the adoption will affect customs operations significantly in the EAC region. Customs

<sup>33</sup> Lyytinen K., Damsgaard J. (2001) What's Wrong with the Diffusion of Innovation Theory?. In: Ardis M.A., Marcolin B.L. (eds) Diffusing Software Product and Process Innovations. TDIT 2001. IFIP — The International Federation for Information Processing, vol 59. Springer, Boston, MA



authorities ought to be cognizant of the stage of adoption in order to be in a position to assess the risks that the adoption can have on their customs operations.

### **1.8.2 Economic Theory of Customs Taxation**

Economic Theory of Customs Taxation is another theory that was of importance to this study. This is a theory that was developed by Karl Lamp to explain when and why customs authorities impose taxes on (certain) goods. According to this theory, customs taxation is directly attributable to the time a product is released into the market for home consumption.<sup>34</sup> The right to impose taxes by any customs authority is limited not just to the mere entry into a country but rather to the period when the goods are deemed to have been released for domestic circulation.<sup>35</sup> The key points to consider is when a product is deemed to have moved from foreign to the country of importation and has been released for home consumption. The rationale of this theory is that products that are merely imported temporary used for storage or are on transit should not be subjected to imposition of taxes. Domestic manufactured goods can therefore not be subjected to customs taxes as per this theory.

In this study, the theory is applied in order to determine when a product that was manufactured via 3D printing could be deemed to have been imported and what necessary controls if any can be applied to it. Put differently, will the products be deemed to have been domestic manufactured and thus outside the realm of customs control?

### **1.8.3 Main Theory**

For purposes of this study, DOI was the overarching theory especially as regarding matters to deal with the rate at which this new disruptive technology will or will not be adopted by the market. Economic theory of customs taxation only comes in to buttress DOI occasionally regarding when customs ought to have some level of ‘controls’ on good entering or deemed to have entered a country.

## **1.9 Research Methodology**

This section refers to the methodology that the researcher uses in conducting the research. It includes the research design, the research site, the target population, the sample size and sampling techniques among others.

---

<sup>34</sup> Home consumption is the utility of a given product within the jurisdiction of a given country permanently as opposed to a short period and consequent re-exportation in an unaltered state.

<sup>35</sup> Wolfgang H. M, Emerging Issues In European Customs Law,

### **1.9.1 Research Design**

Research design is an assemblage and organization of conditions of analysis of data in a fashion that tries to mix relevance to the research process and economy with procedure.<sup>36</sup>

This research employs a mixed method approach using both qualitative and quantitative methods. The main advantage of this method is that it cancels out any inherent bias that may be present in a singular methodological approach.<sup>37</sup>

### **1.9.2 Research Sites**

The research site is the East African countries specifically Kenya, Tanzania and Rwanda. The first two are founder members of the EAC while the later joined in 2009. The three countries are chosen largely because they have different economic histories. While Kenya, has adopted a largely capitalistic stance disguised as African Socialism, Tanzania has adopted a socialist economic approach called Ujamaa. Rwanda is chosen specifically to represent the newer members of the Community. It is a liberal economy with a vibrant Information and Communication Technology.

### **1.9.3 Target Population**

Population is an entire cluster of people, entities or things having similar attributes. Target population refers to all the individuals the researcher wants to study in order to draw conclusions.<sup>38</sup> The target population is revenue authorities in the EAC region namely Kenya, Uganda, Rwanda, Tanzania and Burundi. South Sudan, the latest member of the EAC, is purposely excluded because its revenue authority is young and has inadequate customs structures.

### **1.9.4 Sample and Sampling Technique**

Sampling is a practice of choosing individuals/things/objects for a study in such a manner that the chosen few have traits that are as close as possible to the lot they were picked from.<sup>39</sup>

A sample is simply a subcategory of the target population that is deemed to be having the salient features of the phenomena that is being studied. The sample size should be large

---

<sup>36</sup>Kothari, Research Methodology, Methods and Techniques, 2006

<sup>37</sup> Collins, K.M.T. , Onwuegbuzie, A.J. , & Jiao, Q.G. (in press). A mixed methods investigation of mixed methods sampling designs in social and health science research. Journal of Mixed Methods Research.

<sup>39</sup> Kothari, Research Methodology, Methods and Techniques, 2006

enough to allow for inference/generalization but small enough to be economically possible to study. The study will employ both probability and non-probability sampling.

Probability sampling allows selection of individuals or objects of the study that possess the characteristics of the target population. For probability sampling, the targeted groups of respondents were placed in strata. From each stratum, the researcher used systematic random sampling. In systematic random sampling, every  $K^{\text{th}}$  case in the sample frame is selected for sampling.<sup>40</sup> The sample frame should be as random as possible to make sure that the sampled group is representative. For the purpose of this study, the strata is countries.

In non-probability sampling, both purposive and snowball sampling are used. Non-probability sampling is used because part of the target population is statistically insignificant such that probability sampling may not adequately pick them out. In purposive sampling cases of subjects are handpicked because are informative or they possess required characteristics<sup>41</sup>. The individuals so selected by purposive sampling were then be requested to provide referrals to others who possess similar characteristics. The snowball sampling method is preferred because companies already using 3D printing in the EAC cannot be easily identified. Identified companies will be requested to give the researcher referrals to other similar entities.

For this study, 150 respondents were be targeted, 50 from each from the three countries (Kenya, Tanzania and Rwanda). These respondents were drawn from Customs and Border control departments of the respective countries. The staff list obtained from the human resource department was used as a sampling frame. For Key informants and members of the focused group discussions, key staff from policy and programmes divisions and related sectors of the respective countries were ideal.

### **1.9.5 Data Collection Methods and Instruments**

For primary sources, the researcher uses both questionnaires, guided interviews of key informants and focus group discussions. Interview refers to the oral administration of a questionnaire usually done through face-to-face interaction between the researcher and the

---

<sup>40</sup>Mugenda and Mugenda, Research Methods: Quantitative and Qualitative approaches (Acts Press 1999)pg. 46

<sup>41</sup>ibid

subjects.<sup>42</sup> From secondary sources, books, journals, magazines, any other written, audio visual, and any other media are used provided they have information relevant to the study

### **1.9.6 Data Analysis and Presentation**

Data obtained from the field is difficult to interpret in the raw. Such data must be cleaned, coded, keypunched into computer and analysed.<sup>43</sup> From the results, the researcher interprets the data and codes it numerically to allow quantitative analysis where necessary. To allow qualitative analysis, the data is aggregated into similar themes and patterns. These themes and patterns are coded to identify specific information in the text to enable the researcher identify and retrieve it.<sup>44</sup> The researcher then evaluates the themes and patterns to determine the adequacy of the information, credibility, usefulness, consistency and validity. The data is presented in tables, pie charts, and bar graphs. Codes are used to identify particular responses. Once the data is coded, it is entered into the computer for analysis. The Statistical Package for Social Sciences (SPSS) Version 12 is used to analyse the data. Descriptive statistics in form of means, standard deviations and percentages are used to analyse data from questionnaires.<sup>45</sup>

The interview results are analysed using thematic and narrative analysis. In this case, the responses are written down and grouped into similar arguments to draw a conclusion. Narrative analyses seeks to put together the experiences or events as the participants understood them. This method of data analysis is the most appropriate to analyse data gathered through in-depth interviews in order to make general conclusions about the topic at hand. Presentations are in narratives and themes.

### **1.10 Chapter Outline**

Chapter 1 introduces and defines what additive manufacturing or three-dimensional printing is. The chapter gives a brief background of what customs authorities do in general. The researcher also elucidates the main objective, general objective and specific objectives of the study that have been derived from the research problem. Justification of the study from three key areas; policy, academic and general public is also alluded to in this chapter. Examination

---

<sup>42</sup>Mugenda and Mugenda, Research Methods: Quantitative and Qualitative Approaches, 1999

<sup>43</sup> ibid

<sup>44</sup> ibid

<sup>45</sup>Dufour, H& Fortin, D. *Case Study Methods: Qualitative Research Methods*. Newbury Park

of various studies and work done by different scholars is done to show the nexus between adoption of 3D printing technology and the role of customs especially concerning revenue collection and border security. Research gaps are then derived. The researcher uses two theories namely Diffusion of Innovations and Economic Theory of Customs Taxation in an effort to build a theoretical framework. Diffusion of innovation theory is derived from Communication Studies. It looks at how and why people adopt innovations. Lastly, the researcher outlines the target population they intend to derive primary information from. The sample and sampling methods are also explained. Further techniques to that are used in data collection; the instruments to be used during data collection, analysis and presentation are elaborated.

Chapter 2 reviews literature touching on the impact of emerging technology on international trade over the years starting from the first industrial revolution. The review is organized in both thematic and chronological perspectives. The areas of focus includes technologies related to transportation, cargo handling and customs processes. This is looked at from the lenses of how it affects international trade in general and the role of customs authorities in particular.

Chapter 3 zeroes in on a case study of 3D printing and its impact on the role of customs authorities in the EAC region while Chapter 4 looks at options and solutions that the customs authorities in the EAC region can adopt in order to mitigate the negative effects of 3D printing technology. Lastly, Chapter 5 provides conclusions, policy recommendations and suggestions on areas for further study.

## **CHAPTER TWO: LITERATURE REVIEW OF THE IMPACT OF EMERGING TECHNOLOGY ON INTERNATIONAL TRADE**

### **2.1 Introduction**

This chapter reviews literature on emerging technology and how it has affected international trade in general and customs operations in particular. The review adopts a thematic and historical approach by focussing on the four industrial revolutions. Water and steam power were central to the first revolution while the second heavily relied on electric energy to create mass production. The third and fourth industrial revolutions are heavily centred on information technology. The review aims at deciphering the impact of these changes on international trade. It also tries to take a keener look at how these changes have affected the operations of customs authorities. In addition, the review critically analyses how customs authorities have responded to these changes.

#### **2.1.1 Background: What sparks Technological Changes?**

Technological change has been central to the growth and development of human beings. Some things that are considered mundane now were at one point innovative technology that propelled humanity ahead of other species and other human beings who lacked the ability to use the technology. Simple tools like stones and clubs made from branches were very vital in helping man get an edge over those who were not using them. The discovery that fire could be used to not only keep warm but also cook food was a step forward in as far as culinary tastes was concerned. Whereas this can be considered rudimentary, the advancements that were in the 18<sup>th</sup> century, famously referred to as industrial revolution are the ones that had a far-reaching impact. Industrial revolution saw human and animal power being replaced by mechanical power largely making it possible to produce more goods. This eventually made mass production possible contrasted with the previous domestic production.

While most people agree inventions and innovations were crucial in industrial revolution, there is no consensus on the possible causes and reasons. One school of thought, the neo-classic model, posits that exogenous factors were the key drivers<sup>46</sup> as advanced by Schumpeter and others. This implies that it had profound impact on the economic variables without being influenced by the economic causes. In this model, technological changes can

---

<sup>46</sup> Schumpeter, Joseph A., 1883-1950. *Capitalism, Socialism, and Democracy*. New York: Harper & Row, 1962.

be shown to shift production so that for the same amount of input, the output increases. For example, if one worker was producing 10 units manually or using whichever technology present, a change in the available technology should increase the number of units without any corresponding changes in the other inputs. The technical changes can either be Harrod Neutral or Solow Neutral changes.<sup>47</sup> This included scientific discovery after long periods of experimentation, amateur tinkering or ‘accidental’ discovery.

On the other hand, scholars such as Christopher Freeman and Nathan Rosenberg argue that technical change is responsive to economic signals such as prices and profits and can thus be said to be endogenous to the economic system.<sup>48</sup> According to these scholars, technical change is very expensive and can only be undertaken by big firms that have profit as their motives. These activities must therefore be responsive to economic signals such as changes in factors of production. For example, if one input, for example petroleum goes up, research and development will kick in in order to get fuel-efficient engines. Alternatively, cheaper substitutes to petroleum will kick in in order to lower the costs of productions.<sup>49</sup> The market size and cost of innovation were major drivers. If a market size was big enough, an innovator would gain a lot from the invention. The same case applies to the cost. The cost relative to the gains to be made had to be factored in before a profit-seeking individual could take a risk. Early invention, by making new processes possible thus opening up new opportunities for learning by doing leading to (further) micro inventions and occasional macro inventions have been the focus of most scholars

Lipsey, Carlaw and Baker postulate that technology has greatly changed the way we do everyday tasks. An excerpt from the book reads...

The consumption of the people of twenty first century is ten times that of the twentieth century. The increment is highly attributed to new products made from new technology. For example, people in the twentieth century were not aware of modern dental and health equipment, penicillin, bypass operations, control of genetically spread diseases, compact discs, TVs and vehicles. They also had not imagined cheaper modes of travel globally, inexpensive institutions of higher education, central heating, ACs, washing machines, dish washers, microwaves and a many other work saving household products which the current generation fails to appreciate. In the

---

<sup>47</sup> Harrod Neutral change is any technical change that aids or augments labour i.e. it makes more using less labour units while Solow Neutral change is that change that augments capital i.e. produces more using less capital.

<sup>48</sup> Rosenberg, N. 1982. *Inside the black box: technology and economics*. Cambridge University Press.

Freeman, Christopher, *The Economics of Industrial Innovation* University of Illinois.

<sup>49</sup> *ibid*

industrial sector, no one would have thought the robot-operated machines, computer controlled modern factories that have taken the place of the noisy hazardous factories that emitted coal smoke to the surrounding Environment.<sup>50</sup>

The changes remarkably improved the quality of life, greatly eliminating previous killer diseases such as smallpox, dysentery and plague because of newer modern. The changes also contributed to a corresponding increase in the world's literacy levels. The result was a bigger market that had better purchasing power and consumed more manufactured products.

Lipsey and Chrystal aver that in "1700, the average European life expectancy was 30yrs. In France, one in every 5 children died before the age of one and 50 per cent of registered babies were dead before the age of 10''<sup>51</sup> but this has more than doubled. This mainly because of advances in medicines to treat these diseases and knowledge of how to prevent some of the killer diseases that were common due to either food contamination or poor hygiene, were now commonplace leading to life expectancy more than doubling.

From a purely economic point of view, these technological changes have increased the quality and length of life leading to an increase in population with more disposable incomes that are able buy more goods. The increase in products hitherto unknown, using technology hitherto undreamed of, necessitated need for new markets for these products, in far off places hitherto unreachable that had been brought closer by cheaper and faster means of transportation hitherto unimaginable.

Snooks, editor of the book *Was industrial Revolution Necessary?*, takes a somewhat pessimistic attitude towards technological changes attributed to industrial revolution. To him, industrial revolution was not responsible for 'any rapid sustained economic growth.'<sup>52</sup> He argues that there exists an edition of pre-industrial economy that is blurred by Malthusian view of diminishing returns and zero technical change of which a critical analysis of historical trends in Britain and Western Europe, in general, will disprove and reveal cyclic pattern characterized by long periods of economic growth and periods of economic stagnations.<sup>53</sup> Thus, the technical changes that are assumed to have contributed to the changes

---

<sup>50</sup> Lipsey, R.; Carlaw, K & Bekar, C. *Economic Transformations: General Purpose Technologies and Long Economic Growth*. Oxford University Press UK 2010

<sup>51</sup> Lipsey, Richard G., K. Alec Chrystal, and Richard G. Lipsey. 1999. *Principles of economics*. Oxford: Oxford University Press

<sup>52</sup> Snooks G. D, *Was industrial Revolution Necessary?* London and New York: Routledge, 1994

<sup>53</sup> *ibid*



called “industrial revolutions” were just coincidental and did not contribute to the perceived growth.

However, a look at the number of goods traded, the speed of the transactions and effect of the various technological changes during the industrial revolutions, reveals that technological changes had a big impact in as far as general trade and industry growth in general and international trade in particular is concerned.

## **2.2 First Industrial Revolution (1760-1840)**

Industrial revolution began in Great Britain spontaneously with no government intervention. The years 1760-1834 are central to the technological changes that reshaped the world in ways previously unimagined.<sup>54</sup> The industrial revolution was characterized by massive mechanization in the factories and farms. This resulted in mass production of goods and a corresponding demand for newer markets.

As Joel Mokyr notes

“Market size is a key factor that determines technological growth. For technological growth to be possible the market size must be bigger than the expected costs of the inventions.”<sup>55</sup>

In order to increase the market size, other factors and inventions came into play. They included improvements in transportation, increased population growth, integration of markets as well as profit-minded private individuals.

In chapter one of his book *Wealth of Nations*, Adams Smith, considered the father of classical economics, reckoned that the main essence of a capitalistic society was division of labour, which can only be practised if, the market size is big enough to allow for the specialization.<sup>56</sup> He emphasized the advantages that a large market offered. To him, it encouraged the opportunity for division of labour and specialization. The seamless fusion of local, regional, national and international markets was a prerequisite for an industrial take off.

Advances in transport technology also heavily influenced national and international market integration processes. Because of these advances, the location of manufacturing centres was greatly altered. Before this, factors that were critical in industrial location included proximity

---

<sup>54</sup> Ashton, T. S. *The First Industrial Revolution 1760-1830*. Oxford: Oxford University Press, 1948.

<sup>55</sup> Mokyr, J. *The Lever of Riches*. Oxford University Press, 1999

<sup>56</sup> D. D. Raphael and A. L. Macfie (1976) II *An Inquiry into the Nature and Causes of the Wealth of Nations*, ed. R. H. Campbell and A. S. Skinner; textual editor W. B. Todd, 2 vols.

to fast flowing water, which was the main source of energy for powering machinery, access to water routes, and proximity to consumption centres

Big technological inventions or (macro-inventions) may have had an impact, but it is the small incremental improvements to the initial discoveries (micro-inventions) that could later have a bigger impact. For example, while steam and steel discovery was an important milestone, allowing for production of steam-powered transportation modes, it was the micro-invention of Henry Bessener that unlocked the steam/steel potential allowing for production of better steam-powered engines. Lipsey et al describes the minor incremental enhancements as general-purpose technologies (GPTs). They consider these GPTs as key drivers, which although starting relatively small, acquire modifications, which eventually evolve into complex innovative technologies.<sup>57</sup>

There are two dominant but conflicting views on how the first industrial revolution happened. One school contends that the revolution was an industry-wide ‘wave of gadgets affecting all spheres of British society and economy.’<sup>58</sup> The other school of thought considers the revolution to have been on a narrower scope affecting a few industries particularly iron and textile industries.<sup>59</sup>

### **2.2.1 Key Inventions in the First Industrial Revolution**

What are some of the inventions that made the first industrial revolution stand out? As noted before, Industrial revolution is a period when machines replaced human and/or animal power in the production and distribution process. It is a period when man discovered different sources of energy and industries started to sprout everywhere. Let us have a brief look at some of the technical changes that occurred during this period.

#### **2.2.1.1 Steam Engine**

The first usable steam engine was started when man discovered a new source of energy other than fast moving water in the form of steam. This was further advanced when Thomas Newcomen, made the first prototype steam engine used to expunge water out of mineshafts, a task previously performed by horses. Unfortunately, the first steam engines were slow and

---

<sup>57</sup> Lipsey, Richard G., K. and Chrystal A., *Economics*. Oxford University Press

<sup>58</sup> Ashton T. S. *An Economic History of England: 18<sup>th</sup> Century*, London Methuen.

<sup>59</sup> Ibid

inefficient, and it took the tinkering of James Watt, who added a separate condenser. This made the steam engine not only more powerful but also very fuel efficient resulting in the discovery of several other uses including powering the locomotive in the early 1800s.

### **2.2.1.2 Spinning Jenny and Power Looms**

The textile industry was another area that saw technological advancements. There was an increased demand for silk and cotton fabrics but the process of spinning the textile was slow and tedious because the materials were mostly hand-woven. An invention by a British weaver, James Hargreaves, called the Spinning Jenny led to a remarkable jump in productivity, with one worker producing eight times the number of threads previously produced.<sup>60</sup>

However, the demand of cotton and the advancements in other areas made it almost impossible for the Spinning Jenny to cope. Despite the invention of the application of the water frame to mechanize the process, the process was still slow. Edmund Cartwright's invention of the power loom truly mechanized the weaving process. Its combination with the steam engine saw an exponential increase in the output.<sup>61</sup>

### **2.2.1.3 Iron**

Increased use of machinery needed more and more metallic parts. At the time, the only ways to obtain iron was as either cast or wrought iron, which was hand-worked. The process was slow, tedious and lacked the precision needed. The iron had to be heated in a furnace and then beat into perfection. Henry Colt came up with a rather faster and less laborious way. He found a way of mechanically producing the iron using steam engines thus producing not only more iron faster but also a product that was more pure. His process was called puddling. It produced iron in bars in a ready to use format.<sup>62</sup>

## **2.2.2 Transportation in the First Industrial Revolution: From Sail to Steam**

Costello Ray notes that 'The first tentative attempt at utilizing steam power at sea was made in 1819 with the diminutive Savannah. The engine was used merely as an auxiliary to the sails, but the Savannah nevertheless managed to reach Liverpool from Georgia, USA, in 28

---

<sup>60</sup> Crafts N.F.R. *British Economic Growth during Industrial Revolution*. Oxford Clarendon Press

<sup>61</sup> *ibid*

<sup>62</sup> *ibid*

days.’<sup>63</sup> This in itself was a big improvement in the number of days by a big margin but an immediate build up to this milestone was not as immediate as many had hoped. It would take a number of years before the first continuous crossing of the Atlantic was attempted. This was also greatly hampered by the technological state of the time that could not allow the full application of the potential of the steam engine. For instance, there had to be regular breaks as the steamers were stopped to allow the removal of clogging deposits because of salt-water use.<sup>64</sup>

By mid 1850s, there was already significant progress in the manufacture and application of steam engines leading to construction of bigger ships in the 1850s with *John Bowen* being the first steamship with a capacity of 500 deadweight (dwt).<sup>65</sup> By 1880, this had grown exponentially. For instance, *Seawise Giant* had deadweight of 550,000dwt.<sup>66</sup> Steam ships made it easier to plan the journeys of ships without relying on wind directions. The two would exist side by side but by early 1900s, sail ship had been replaced as the major form of transportation.<sup>67</sup> Steam ships would later themselves also face competition from diesel powered ships from the beginning of the 20<sup>th</sup> century with diesel-powered ships being the dominant form of sea transportation by the end of World War II.

This was mainly facilitated by innovations; mainly the invention of iron and steel which replaced wood in the construction of ship hulls. This made it possible to have bigger watertight hulls that progressively made it easier to have bigger and bigger ships. The steam ship led to easier transportation of cargo on a regular basis leading to increased trade. For example, increased steamship operation between West Africa and Britain led to an over fourfold jump in the number of palm oil traders- from 25 to 150.<sup>68</sup>

### **2.2.3 Impact of First Industrial Revolution on International Trade**

Cumulatively, the first industrial revolution led to increased production. This increase depended primarily on two things. One, a ready market for the products had to be found. The local and national markets were inevitably not able to cope with the increase. International

---

<sup>63</sup>Costello, R. “From Sail to Steam.” Chapter. In *Black Salt: Seafarers of African Descent on British Ships*, 114–33. Liverpool University Press.2012

<sup>64</sup> Op cit 52

<sup>65</sup>Dead weight is the total weight of cargo, stores etc. that a ship can carry at any one time measured in tonnes.

<sup>66</sup>As per the Lloyds Register of shipping maintained by Lloyds Register Group an international body dedicated to technical and business services of maritime classifications

<sup>67</sup>Stopford, *Maritime Economics* 2<sup>nd</sup> edition Routledge, 1997 pg. 34

<sup>68</sup>Lynn, Martin. 1989. “From Sail to Steam: the Impact of the Steamship Services on the British Palm Oil Trade with West Africa, 1850–1890.” *The Journal of African History* 30 (2). Cambridge University Press: 227–45.

markets had to be sought. As noted by Mokyr, market size is key to any technological advancement. Adam Smith further stresses that specialization and division of labour are only possible if the market size is large enough, a fact that only an international market could provide. Thus, technological advancement in terms of mechanization of production had to be simultaneously matched with advancements in transportation in order to make it economical to centralize production in one area to allow for specialization and division of labour.

Secondly, a steady source of raw materials had to be found. As per industrial location theory, the location of most industries was mostly as close to the source of the main raw material as possible. However, as advancements in transportation that made it cheaper to source materials from thousands of kilometres away, the location of raw materials became less of a factor.

#### **2.2.4 Impact of First Industrial Revolution on Customs Authorities Mandate**

Customs authorities in the First Industrial Revolution (FIR) were not interested in tax collection. Protection of infant industries mainly through use of tariffs and quotas was the main motive. Tariff is a percentage of the value of a commodity that is levied by customs as duty for importing or exporting a commodity while quota refers to a fixed number that can be permissible to enter or leave a country.<sup>69</sup> Whilst tariffs are used as means of generating revenues currently, in the FIR period, they were meant to discourage the importation of commodities to protect domestic industries.

### **2.3 Second Industrial Revolution (1870s-1914)**

As noted by many scholars, there is no clear-cut way of dividing historical periods into neat eras with distinct timelines. As such, the second industrial revolution built can be said to have on the foundations of what had been laid down by the first industrial revolution. New industries sprung up to supplement the ones that existed during the first industrial revolution. Steel, oil and electricity became important. In fact, use of electricity created an era of mass production that was made famous by Henry Ford's assembly.

The second industrial revolution saw a remarkable increase in the pace of the technical changes witnessed more so in the areas of communication, transportation and manufacturing.

---

<sup>69</sup> Keen, M (ed) *Changing Customs: Challenges and Strategies for the Reform of Customs Administration*, International Monetary Fund, 2003

The telegraph, invented by Samuel Morse made it easier to communicate via dots that remarkably shortened the distance. Soon his invention was followed by a telephone that made transmission of voice possible. Alexander Graham Bell is credited as the inventor of this device. Soon after, Thomas Edison invented the first bulb. This invention made it possible for man to increase the number of hours in a day in a way never imagined before. For the first time people could work at night thus increasing productivity.

It is in the second industrial revolution that the automobile was invented. Carl Benz is credited with having manufactured the first commercially viable motor vehicles in history. Henry Ford worked up a way of mass-producing motor vehicles to make them available to the masses that really revolutionized the sector, and manufacturing as a whole. Ford replaced unnecessary human motions with machines by placing them close together creating the foundation for the modern an assembly line the precursor for mass consumption.

In essence, the second industrial revolution made the world smaller by having faster means of travel and communicating.

### **2.3.1 The Second Industrial Revolution and the Shift in Cargo Transportation**

#### **2.3.2 Containerization**

One remarkable shift in transportation of cargo in the second industrial revolution was containerization.<sup>70</sup> Containerization was introduced in in 1955 when Malcom Mclean, believing that pieces of cargo should be handled only twice when being loaded at source and when being offloaded at destination. He purchased and converted a used tanker to carry modified containers. People were very pessimistic about its impact and prospects. Coppieters captured the pessimism aptly when he said that ‘were the present container numbers to be matched to the possible capacities of terminals, it is evident that they (containers) cannot be used economically. The capital outlay is currently so excessive that even in future the container volume will not be able to offer prospects for achieving an equilibrium.’<sup>71</sup>

---

<sup>70</sup>Containerization is the packing of cargo in standard sized containers, which can be carried by road rail or sea with equal facility and ease. A container is typically a steel box usually 8ft (2.43m) wide by 8.5ft (2.59m) high. It is either 20ft(6.06m) or 40ft(12.2m) long

<sup>71</sup>Coppieters, F. (1968). Konventionelle Schiffsliegeplätze und Container Terminals. Beschreibung and Leistungsvergleich. Hinterland, no. 56, pp. 3

Barely ten years later, as noted by scholars such as Levinson and Burney, the tide had totally changed against the pessimists. Sentiments such as “Containerization has changed global trade in manufactured goods as radically as jet planes transformed the way we travel”<sup>72</sup> and “low cost transport help make it economical and sensible for a factory in China to produce Barbie dolls with Japanese hair, Taiwanese plastic and American colorants and ship them off to eager girls all over the world.”<sup>73</sup> Indeed looked over the years, containerization, especially with the multi-modal capability allowing seamless movement between different terminals, has contributed more to the globalization process.<sup>74</sup> The economic and physical geographical changes included how the production and physical distributions interacted necessitating changes such as shift from push to pull logistics.<sup>75</sup>

Containerization paved way to the development of bigger and faster ships.<sup>76</sup> Before the invention of containerized shipping, cargo was carried as bulk cargo regardless of its volume and size. The process of ‘break bulk’<sup>77</sup> was very slow. Expensive liners spent as much as two-thirds of their time either loading or offloading of cargo.<sup>78</sup> These delays were a great barrier towards making shipping cheaper to the commercial merchant without compromising on the profits of the shipping companies.

Containerization made it possible to solve the ‘break bulk’ problem while at the same time introducing safety and speed into the shipping industry. The container made this possible in a number of ways. One, the cargo was packed way in advanced into the container and thereafter transported to the port to wait for the liner to arrive. Secondly, specialized handling equipment such as cranes hoisted the containers and stacked them one on top of the other in a much faster way than previously imagined. Lastly, containerization made it possible to integrate multi-modal transportation of cargo. Thus, containers could be readily transferable to either rail or truck with minimal effort.

---

<sup>72</sup>Hesse, M., & Rodrigue, J.-P.. Global production networks and the role of logistics and transportation. *Growth and Change*, Vol 37 (2006), 499-509:500

<sup>73</sup>Levinson, M. *The box: How the shipping container made the world smaller and the world economy bigger*. Princeton: Princeton University (2006)

<sup>74</sup>Rodrigue, J.P, and Theo N. "The Geography of Containerization: Half a Century of Revolution, Adaptation and Diffusion." *GeoJournal* 74, no. 1 (2009): 1-5.

<sup>75</sup> A push-model supply chain is based on projected demands literary pushing more products to the market sometimes with no corresponding ‘actual’ demand while a pull strategy is based on just in time i.e. based on the demand that the market actually wants.

<sup>76</sup>Stopford, *Maritime Economics* 2<sup>nd</sup> edition Routledge, 1997 pg. 34

<sup>77</sup>Breaking bulk is the offloading of cargo from the ship

<sup>78</sup>Op cit 55

Containerization made it possible to build faster bigger ships making the world smaller and integrated. This made shipping cheaper to an extent that it was possible to transport raw material from tens of thousands of kilometers away by ship than it was to transport the same raw material from a couple of hundreds of kilometres by road or rail.<sup>79</sup>

The *Almelia*<sup>80</sup> was the first ship designed to carry containers and had a capacity of 60 twenty-foot equivalent units (TEU). The modern liner can carry in excess of 20,000 TEUs. Today more than 90 percent of non-bulk cargo is transported via containerization.<sup>81</sup>

### **2.3.3 Transportation in the Second Industrial Revolution:**

Between 1950-and 2004, world trade is estimated to have grown at an annual rate of 5.9%<sup>82</sup> while in 2016 it grew by 5 percent.<sup>83</sup> Technological development has resulted in remarkable increase in speeds and carrying capacity of various modes of transportation especially ocean and air, coupled with a decrease in transportation costs has been postulated as one of the causes of the increase. Economic historians aver that changes in technology resulted in a big drop in shipping costs in particularly in the period 1850-1913. Subsequent research has revealed a correlation between rapid growth in trade and decline in shipping costs in the first era of globalization.<sup>84</sup>

### **2.3.4 Impact of Second Industrial Revolution on International Trade**

Improvements in manufacturing process, especially the Henry Ford's assembly line made it to possible to produce goods for mass consumption. The subsequent need to automate processes that needed little human interventions increased the goods that were produced. As noted earlier in the first industrial revolution, the increase in production inevitably led to an increase in goods that were traded internationally both in terms of finished goods and raw materials. The assembly line made United States a key producer of finished goods, overtaking United Kingdom as the leading manufacturing centre. Cumulatively, changes in production especially automation coupled with advances in transportation including the jet plane, diesel powered ships and trains, and subsequent containerization that made intermodal

---

<sup>79</sup> ibid

<sup>80</sup>Op cit 56

<sup>81</sup>Op cit 59

<sup>82</sup>World Trade statistics 2005

<sup>83</sup>World Trade 2017

<sup>84</sup>Estevadeordal, A, B. Frantz, and A. Taylor.2003. "The Rise and Fall of World Trade, 1870–1939." *Quarterly Journal of Economics*, 118(2):359–407



transportation easier, international trade grew 1 percent per year essentially doubling every 17 years.

In order to facilitate the rapid growth of trade, it was felt needful to establish a body that would regulate and harmonize international trade and reduce tariffs hence the discussion regarding the formation of International Trade Organization (ITO), which sadly did not take off. However, General Agreement on Trade and Tariff (GATT), now World Trade Organization (WTO) was ratified by 23 countries in 1947.<sup>85</sup>

### **2.3.5 Impact of Second Industrial Revolution on Customs Authorities Mandates**

Second industrial revolution had a major impact to customs mandate. Focus on tariff reduction put a spotlight on the main bodies that was controlling over 98% of international trade related aspects-customs authorities. There was need to have a body that will coordinate custom related aspects of international trade hence the formation of Customs Co-operation Council (CCC) that became World Customs Organization (WCO) in 1995. Trade facilitation challenges calling for a need to have uniformity were factors that accelerated the formation of CCC in 1952.

## **2.4 Third Industrial Revolution**

To most scholars, the third industrial revolution is marked by the advances in electronics that led to the birth of the transistor and the microprocessor. The third industrial revolution, like the second one built on the foundations laid down by its predecessor. By 1950s the third industrial revolution had come up with semiconductors, mainframe computing, personal computing, and the internet that was sparked the digital revolution. Analogue gadgets were upgraded to digital technologies; The United States became the home of the digital revolution. US firms such as Facebook, Apple, Microsoft and Google etc. dominate the world's digital accounting for over a big share of the digital world.

Despite the seemingly one-sided statistics, the move from analogue to digital has seen gains being felt globally. Embracing electronics and information technology has seen the automation of production and made once local supply chains go global. The net effect has

---

<sup>85</sup> Goldstein, J. L., *et al.* "Institutions in International Relations: Understanding the Effects of the GATT and the WTO on World Trade." *International Organization* 61 (1). Cambridge University Press:2007

been an increase the quantity of tradable goods as well as in transport and communication, and clearance processes.

#### **2.4.1 Internet and E-commerce**

Gregory et al views the advancement of computers as having led to the ‘internet explosion’, which has enabled sellers to venture into newer markets. They manage to do this handling their new customers in a cost effective and efficient manner’<sup>86</sup> To them, it opened up the market place exponentially beyond what was in place in the pre-internet days by allowing buyers and sellers to interact almost instantaneously. Other scholars such as Hoffman and Novak, Javalgi and Ramsey, and Karadzic and Gregory have shown that internet has internationalized firms linking sellers from faraway lands to buyers as if they were in the same village market<sup>87</sup>

This interaction of firms and buyers over the internet is what has been described as e-commerce. E-commerce is a process of buying and selling or exchanging merchandise over the internet as defined by Turban, Mclean and Wetherbe. On the other hand, Gregory et al defines it as ‘an environment of presenting, trading, distributing, servicing customers, work together with business partners and carry out transactions electronically.’<sup>88</sup> According to World Trade Organization (WTO), e-commerce is the manufacture, supply, marketing, trade or conveyance of goods and services through electronic means. This definition has that has been adopted by most member states.<sup>89</sup>

While agreeing that e-commerce is itself a cost-cutting and revolutionary factor in uniting the buyer and seller, Enrico and D’Atri challenge the view that e-commerce is a technological change.<sup>90</sup> To them, e-commerce is closely related to the traditional way of ordering cargo over the mail. Ecommerce should be considered as ‘an updated version of the mail order business whose origins can be traced to the printing and depicting of products on catalogues.’ However, if we strictly look at the speed and efficiency of e-commerce when compared to the traditional mail order business, there are many positives and somewhat revolutionary aspects that e-commerce brings forth.

---

<sup>86</sup> Gregory, G. et al "The Effects of E-Commerce Drivers on Export Marketing Strategy." *Journal of International Marketing* 15, no. 2 (2007): 30-57..

<sup>87</sup>Turban, E., et al, *Information technology for Management*, 3rd ed. New York: John Wiley & Son 2002

<sup>88</sup> Op cit 36

<sup>89</sup> World Trade Organization, 1998

<sup>90</sup> Santarelli, E, and Samuele D'Altri. "The Diffusion of E-commerce among SMEs: Theoretical Implications and Empirical Evidence." *Small Business Economics* 21, no. 3 (2003): 273-83.

K'Onyango Tobias further illustrates that e-commerce, at least in the current form we know it, is not only revolutionary but has in itself benefited from technological revolution in the banking industry. He says that...

Banks have a key function in the E-Commerce environment. The automation of banking services globally has brought great support to the growth of E-Commerce. In particular, the automated teller machines (ATM's), leading to the use of such instruments as debit and credit cards have made it possible to conduct transactions with people in far-flung places without necessarily having to obtain letters from their banks. Advancement in banking in relation to electronic funds transfers (EFT) has equally made it easier for business-to-business transactions to be effectively executed through the Internet.<sup>91</sup>

Min Wang quoting Goldman Sachs predicted that 'e-commerce would have exceeded USD 235.3 billion by the year 2018 with the big portion of this trade being dominated by developed economies but also a very noticeable cross-border movement of the same.'<sup>92</sup> Wang further notes that it is becoming increasingly hard to come to consensus on how to regulate e-commerce mainly because of the imbalance in economic development and the attendant 'national' interests. The problem is further compounded by the fact that e-commerce there is potentially a thin line between General Agreement on trade and Tariff (GATT) and General Agreement on Trade in services (GATS) as it stands. Should goods previously traded in physical form but have now been dematerialized be treated as physical goods or now be considered services?

Organisation for Economic Co-operation and Development (OECD) further illuminates how 'advances in technology, together with liberalisation of trade policy and cutting down of the costs of conveyance, made it possible for business to take advantage of global markets as if they were local markets.'<sup>93</sup> In essence, what OECD is illustrating is that technology has enabled companies to manage key functions from a central position while at the same time able to locate plants in areas with lower taxes, skilled labour or abundance of raw materials.

---

<sup>91</sup> K'Onyango T, Impact of E-commerce on Taxation: Vat Perspectives of E-commerce, (paper presented in the 4<sup>th</sup> Commissioners Forum, Zimbabwe 2001)

<sup>92</sup> Wang M. *Establishment of International Framework for Cross-Border E-commerce: Dilemmas and Solutions*, World Customs Journal, Vol 11 NO. 2.

<sup>93</sup> OECD (2014), Addressing the Tax Challenges of the Digital Economy, OECD/G20 Base Erosion and Profit Shifting Project, OECD Publishing.

### 2.4.2 Automation of Customs Processes

The invention of the computer had a profound effect on customs operation at least as far as transforming the process is concerned. Prior to the invention, traditionally, all customs transactions were manual in every aspect. Importers had to present their documents to customs physically for the process to start. This was not only tedious considering the number of copies of documents<sup>94</sup> that had to be produced but also had time limits because of the number of working hours in a day. This inevitably (unnecessarily) increased the cost of transacting with customs thereby creating a non-tariff barrier (NTB). As noted by United Nations Conference on Trade and Development (UNCTAD)...

A single commercial transaction may involve tens of documents and parties and up to 200 data elements that may need to be captured more than once by the clearing agent/forwarder, shipping agent who needs to communicate this information to other interested parties. This back and forth, capture and recapture of information may increase the cost of the transaction by up to ten percent of the original commercial value.<sup>95</sup>

The delays inevitably and predictably led to room for extortion and corruption avenues as paper pushers promised to help jump the queue. Multiplicity of actors involved in international commerce and the increased cargo volumes made it necessary for customs to seek ways of coping mechanisms.

Antov Momchil claims that the ‘perforation of IT into the commercial activities has had a tremendous influence on the means in which these commercial activities are executed and the procedures advanced for.’<sup>96</sup> This should be put in view of the economic operators working in the current ever-changing global environment whose internal business process rely on timely and precise processing of specific information.

Wolfgang and Harden further posit that modern means of communication, together with sophisticated IT systems have increased communication speeds in such a manner that Customs authorities have no choice but to move their controls towards automation.<sup>97</sup> This has

---

<sup>94</sup> A typical customs transaction will require original and copies of bill of lading, invoices, declaration of value, declaration, packing list, customs duty payment receipts and certificate of exports among other documents. These documents must be provided in quadruplicates to customs. These copies must also be presented to other cross border regulatory agencies such as bureau of standards, plant health inspectorates among others.

<sup>95</sup> UNCTAD 2006

<sup>96</sup> Antov M, The Role of Information Technologies in the development of Customs Control in the Republic of Bulgaria, World Customs Journal, Volume 11 number 2.

<sup>97</sup> Wolfgang, H. M., and Harden K, The New European Customs Law, World Customs Journal

resulted in many customs authorities and operators discarding paper and moving into a modern electronic environment.<sup>98</sup>

The Kyoto Convention, that is big on Simplification and Harmonization of Trade Procedures<sup>99</sup> reduced and standardized the number of documents that would be requested by customs. This helped in making the process predictable and smoother albeit still was slow and tedious mainly because of increased number of transactions to be handled with little or no corresponding increase in number of customs staff. The speed was further enhanced by matching of data elements to enable customs systems ‘talk’ to each other.<sup>100</sup>

Automation of customs procedures has made it possible to have pre-arrival declaration of cargo. This gives customs authorities enough time to do data analysis and profile cargo based on the pre-defined risk parameters. This was aided by improved management information systems that allow clearer post transaction audits, which ultimately led to increased compliance.<sup>101</sup>

Automation of customs procedures, as advocated by The Revised Kyoto Convention, in conjunction with electronic exchange of information, such as cargo data and goods declarations, enables pre-arrival and/or pre-departure information processing. Processing of information in advance of the physical goods arriving in or departing from a country allows customs to verify information and perform a risk assessment on the consignment. With this data available, decisions on the release status of the goods can be transmitted electronically immediately the goods arrive, therefore facilitating their release. Because of better risk management procedures, needless examination of goods is avoided.

To streamline the clearance process and procedures, some customs authorities have separated the tax payment from actual physical clearance of goods with a deferred payment<sup>102</sup> of taxes preferred. This was aided by improved management information systems that allow clearer post-transaction audits, which ultimately led to increased compliance. Thus, technology has helped customs authorities in meeting their mandate of trade facilitation-by processing

---

<sup>98</sup> Op cit 82

<sup>99</sup> Revised Kyoto Convention <http://customs.gov.ph/wp-content/uploads/2016/10/KYOTO-Convention.pdf>

<sup>100</sup> Ayuma I, Interview with Caroline Mutema, Nairobi June 2018. System talking to each other implies that data elements are matched in such a manner that they are compatible to each other

<sup>101</sup> Hans-Michael Wolfgang, Emerging Issues In European Customs Law

<sup>102</sup> Deferred payment of taxes allows importers to pay for their taxes after taking possession of their cargo

transactions faster and in a cost effective manner to traders, as well as enhancing border protection through effective risk assessment of documents provided in advance. Transactions lodged in advance increases revenue collection by allowing thorough scrutiny of documents as well as facilitating post-transactions audits that provide a clearer and more complete picture of all the transactions. Consequently, revenue leakages were sealed by providing transparency and predictability.

### **2.4.3 X-Ray Scanners**

Technological revolutions increased the physical movement of goods across international borders. In 2014 alone, approximately 4 billion tonnes of cargo was handled by European ports.<sup>103</sup> Such huge inflow and outflow of consignments affects the holy trinity of customs i.e. revenue collection, border protection and trade facilitation. Increased cargo means potentially more revenue is collected by customs authorities especially if the goods are finished goods.<sup>104</sup> However, the increase poses a threat in as far as border protection was concerned. Chances of contrabands and dangerous goods being smuggled in also increases. In order to ensure that only legitimate cargo enters or exits, more checks could be preferred but this negatively affects trade facilitation.

In order to match transported goods with what was actually declared scanners are deployed by many customs authorities globally. X-ray images can quickly identify misdeclared goods quickly with a high degree of accuracy. Because of x-ray scanning, a container can be verified in less than two and a half minutes.<sup>105</sup>

### **2.4.4 Impact of Third Industrial Revolution on International Trade**

Internet has made the world a truly global village allowing more people to shop in places they would ordinarily not shop in. This has made international movement of goods increase dramatically. This coupled with faster, safer movement of cargo has seen a dramatic increase in the cross border trade.

---

<sup>103</sup>Visseret *al.*, "Automated comparison of X-ray images for cargo scanning," *2016 IEEE International Carnahan Conference on Security Technology (ICCST)*, Orlando, FL, 2016, pp. 1-8.

<sup>104</sup> In most states finished goods attract on average higher taxes compared to raw materials or semi-finished goods.

<sup>105</sup> Ayuma I, Interview with Onesmus Nzuki, Supervisor Kenya Revenue Authority, Nairobi, June 2018

### **2.4.5 Impact of Third Industrial Revolution on Customs**

Technological advances enable information processing to not only be faster but also more accurate. This dramatically expands capacity to process complex information. With automation of customs processes, service delivery is enhanced and hours of business extended beyond the normal nine to five hours. An OECD reports claims that increasingly manual tasks are considerably being reduced or eliminated altogether not only within tax administration but also in private sector. This allows employees to focus on complex tasks that require employees to apply their skill sets optimally.<sup>106</sup> Clients can make declarations at the comfort of their homes at whatever time of the day they so wish. This, combined with internet banking that allows round the clock payments, has increased the speed to which certain aspects of customs activities are done.

Tools such as scanners have made it much easier for customs authorities to non-intrusively inspect containerized cargo. This not only increases accuracy of inspection but also fosters compliance. Taxpayers usually look at compliance from not only a perspective of being caught but also the severity of punishment meted out for non-compliance.<sup>107</sup>

### **2.5 Fourth Industrial Revolution**

The fourth industrial revolution, like all other revolutions before it builds on the foundations of the ones preceding it. A variety of new technologies that are merging the physical, digital and biological spheres, affecting all everything we can ever think of. Klaus Schwab, author of the *Fourth Industrial Revolution*, is one of the early people credited with the use of the term fourth industrial revolution. To him the fourth industrial revolution is fundamentally changing the way we work, live and relate to one another.<sup>108</sup> Indeed, if you look around, we are in the era of robotics, self-driven cars, drones and 3D printings. These may not have been fully diffused to the whole world, but the potential disruptions and impact is huge. It is estimated that this new industrial revolution may pump in excess of 4 trillion dollars to the world's production.<sup>109</sup>

---

<sup>106</sup> Alink M., and Kommer V. Handbook on Tax Administration IBFD, 2011 pg. 151

<sup>107</sup> *ibid*

<sup>108</sup> Schwab Klaus, *Fourth Industrial Revolution*

<sup>109</sup> The Fourth Industrial Revolution and the factories of the future, World Economic Forum  
<https://www.weforum.org/agenda/2018/08/3-lessons-from-the-lighthouses-beaming-the-way-for-the-4ir>

Jeremy Rifkin oddly does not consider the fourth industrial revolution to be fourth. He calls it the third industrial revolution. Other than that, his outlook is similar to Schwab's. For instance, both consider the era of fossil fuel that characterized the previous revolutions to be waning and cleaner energy from solar and wind. Besides, they see a potential merger between internet and clean energy thus creating a new infrastructure of distributing energy. Manufacturing processes are also likely to require less energy and even remarkably less raw materials.<sup>110</sup> This will tremendously cut down on costs gaining an upper hand when juxtaposed with the current conventional manufacturing process.

### **2.5.1 Three Dimensional (3D) Printing**

3D printing or additive manufacturing is a novel process of making objects functional objects by printing them literally from a computer assisted design (CAD). A process that adds successive layers of material slice by slice eventually leads to an object that is in the shape and form of the CAD. The process is contrasted with ordinary subtractive manufacturing that relies on hollowing of materials in order to create objects. Because of this technology, items of shapes and designs never imagined before are produced faster using less material.

Estimates indicate that the world market share of 3D printed products will have doubled to 6 billion US dollars by the year 2019.<sup>111</sup> However, not all sectors and products will gain or rather be conducive for 3D manufacturing. For instance, Livermore posits that based on the current technological levels, 3D printing becomes cost-effective only if the product to be printed is complex. In cases where the products are simple, it is rather cheap to use the traditional forms of manufacturing.

### **2.5.2 3D Printing and Taxation**

Tax jurisdiction, according to international tax law confers a sovereign nation the right to exclusively and without any denial or foreign interference to collect taxes either by companies and/or individuals located within its jurisdiction or from its citizens irrespective of whether the income is generated within its territory or not. In this regard, tax authorities have the unfettered right to apply tax for everything and anything under their

---

<sup>110</sup> <https://patrickspannfoundation.org/wp-content/uploads/2015/08/The-Third-Industrial-Revolution.pdf>

<sup>111</sup> Livermore L., The Promise and Peril of 3D printing, Corporate Knights...pg. 16



Like all taxable items, taxation of 3D printed items must conform to principles of taxation as illustrated by Adam Smith. Principally, this means that the cost of collection should not be too high as to make it economically unviable. In the same vein, the principle of equity must also be observed.

### **2.5.3 Three Dimensional Printing: Security and Safety Concerns**

One of the main mandates of customs authorities is to ensure the security and safety of goods passing through it. In conjunction with other cross border regulatory agencies (CBRAs) such as bureau of standards, it ensures that only goods that meet certain specifications enter country. Critically, it also regulates the importation and exportation of goods that are restricted.

#### **2.5.3.1 Security Concerns**

As noted by Meselson, every major technology-ranging from metallurgy, internal combustion, nuclear energy, aviation, and electronics to name but a few, have always been exploited for both good and bad reasons.<sup>112</sup> For example, nuclear energy gave rise to the atomic bomb, which had disastrous consequences when it was used during World War II. 3D printing is less likely to be an exception to the rule.

Cody Wilson has already printed “Liberator” a one-bullet gun in 2013. The main components of the said gun were plastic materials with the exception being the common store nail that was used as the bullet. Worth noting, is that of the 16 parts that the Liberator was made of, all 15 could be 3D printed and the blue prints of the gun were easily and readily availed on the internet.<sup>113</sup> Tests by security experts revealed that the gun was functional astute save for a few shortcomings such as the barrel having to be changed after every shot. The quality was also heavily dependent on the quality of printer used and the main raw materials-plastic.<sup>114</sup> However, the shortcomings, if put in the context of current security checks that are primarily designed to detect metallic weapons became less significant. A plastic weapon would still cause enough damage. A reporter was able to beat the security checks that are metal-based by taking it on board a train in a disassembled state.<sup>115</sup> Metal printed 3D guns currently exist but

---

<sup>112</sup> Meselson 2010

<sup>113</sup> <https://all3dp.com/3d-printed-gun-firearm-weapon-parts/#3DGunsHistory>

<sup>114</sup> Op cit 111

<sup>115</sup> <https://www.dailymail.co.uk/news/article-2323158/How-Mail-On-Sunday-printed-plastic-gun-UK--took-board-Eurostar-stopped-security-scandal.html>

they are less of a concern because of the high cost of 3D metal printers. However, the rate at which the cost is coming down, is something that should be of concern.

This therefore raises a number of concerns; one, individuals interested in printing 3D guns are developing better models and may develop unique weapons. Two, advances in chemistry has resulted in better plastics that can support more than one firing thus allowing printing of 'real' guns. Lastly, with the cost of metallic 3D printers coming down considerably, it may be possible to produce 3D printed guns at home. Joshua Pearce already built one for less than USD 1500.

Laws regarding legal ownership of guns vary across the world. While some States such as the United States of America have a liberal approach to ownership of most types of guns, majority of the countries restrict access of guns and ownership and require special permits and licenses. On the other hand, USA allows manufacture of certain types of guns for self-use while majority of countries restrict the production and ownership of guns including antiques

#### **2.5.3.2 Safety Issues**

While 3D printing allows for the manufacture of items that would not have easily been manufactured using the conventional system, it does raise some safety issues. 3D printing essentially allows anyone with access to a 3D printer to be a manufacturer. This raises safety issues. Currently, safety controls depend on a centralized checks of goods as they are manufactured. Factories are inspected and passed safe for production. Bureaus of standards are mandated to enforce this requirement. Machines if checked properly will continue to make identical copies.

3D printing makes it difficult because of the decentralized nature of production. If it were one shop with one 3D printer, it would be possible to check the printer and pass it safe just like in a conventional factory machine. Printers that are scattered throughout make it difficult to inspect. Besides, the quality of raw materials to be used, even if the printer is inspected and passed fit, will determine the kind of product quality we shall get.

If the printed products are to be used for individual consumption, the safety issue will be of limited concerns. However, with the potential commercialization of 3D printing, consumers need to be protected. Societies acknowledge that the complexity and diverse nature of

manufactured products make it difficult for the average consumer to anticipate and safeguard themselves adequately hence the need for a body to do this on their behalf.

As we had noted before, when 3D printing is centralized, safety concerns are not a big issue. The issues arise when they are distributed in a ‘not manufactured’ state or what we can colloquially call design state. Products that are in a design state cannot be said to have been tested. When centrally produced, the produced article can be tested once the product has been manufactured allowing for modification if need be. However, with 3D printing, this is not only not the case but also that the product is heavily dependent on the type of printer used and the quality of raw materials used.

This calls for prosumers<sup>116</sup> to protect themselves. The most obvious way will be need for ratings by users on the safety and reliability of the distributed designs. However, this may be limited by the fact that the expertise of the ‘raters’ may not be guaranteed. In the current set-up, we are at least able to rest assured that the inspectors are qualified but in the internet, anybody can be anyone including an expert with 20 years’ experience. Secondly, we are not able to divorce subjectivity of the reviewers.

The other alternative will be to demand the designers to have the product tested by qualified inspectors before they are fully available for sale as it is the case currently and pass the cost to the buyers. However, this is also limited by the fact that the quality of raw materials to be used by the prosumers is as important as the product itself. Besides, the option may not be practical for blue prints that are freely available.

Another element requiring attention is open source provisions within the online community.<sup>117</sup> As Frandsen et al. explain, open source licenses often assert, “The licensor waive guaranties and liability to the largest extent allowed by the law to assure the risk of using the product is shifted from the licensor to the user.”

## **2.6 3D Printing and Intellectual Property Rights**

The Uruguay Round of General Agreement on Trade and Tariff (GATT) brought Intellectual property rights (IPR) to the fore. This round introduced the Trade Related aspects of

---

<sup>116</sup> Prosumers is a term that has been coined to define producers who are also consumers

<sup>117</sup> [http://www.sciencepolicyjournal.org/uploads/5/4/3/4/5434385/harris\\_new\\_ta1\\_1.2.2015\\_lb\\_mg.pdf](http://www.sciencepolicyjournal.org/uploads/5/4/3/4/5434385/harris_new_ta1_1.2.2015_lb_mg.pdf)

intellectual Property (TRIPS.) Intellectual Property Rights comprises of four key areas; trademark, patent, copyright and trade secrets law. It mainly arises on the need to reward the inventor for his engagement as well as a financial aspect to cushion the inventor. Proponents of intellectual property argue that without protection, very few people will be willing to spend money to create innovations. Early proponents like John Locke claimed that protection of intellectual property is essential because ‘As much land as a man tills, plants, improves and can cultivate and can use the product of so much is his property. He by his labour does, s it is as if it were exclusive from common’<sup>118</sup> 3D intellectual property infringement affects copyright, patent, trademark and trade dress differently. However, the focus remains on what needs to be protected and from whom can it be protected. Two issues arise. First, if you reproduce something for your own consumption, is it possible to deceive yourself? Secondly, if something is for personal use, the element of safety becomes less critical. The producer is responsible for their actions. That is why there are no legislation against extreme sport. But what if the parts that have been printed are to be used in a car (private) but that will use public roads?

Spinello notes that Locke’s view of intellectual property, although intangible in nature, isn’t removed from that of ordinary property a fact that scholars like Easterbrook claim that ‘it (intellectual property) is no less the fruit of one labour than physical property is.’

Spinello describes the four areas of IPR; trademark, patent, copyright and trade secrets briefly as follows. In copyright, IPR gives of a creator exclusive rights to make copies. For a lifetime plus 70years. The work needs however to be ‘an original form of expression.’ Patents applies to inventions and discoveries that have a utilitarian function as well as being unique i.e. beyond the scope of someone having ordinary skill and knowledge. They can cover design, utility or plant patent. Trademark refers to the exclusive right of an owner to the use of a commercial identity and prevents competitors from using it for profit, diluting it or slandering the trademark by associating it with things ‘unlike’ the trademark. Trademark protects consumers from being deceived into purchasing products that could be of ‘inferior’ quality.

Ironically, innovations that ordinarily would be subject to IPR protection are the ones that are making it easier to infringe on intellectual property rights. For instance, peer to peer (P2P)

---

<sup>118</sup> Spinello R. A, "Intellectual property rights", Library Hi Tech, 2007 Vol. 25 Issue: 1, pp.12-22, <https://doi.org/10.1108/07378830710735821>

sharing mechanism have made it easier to share music, videos and software costing companies like Nintendo to lose an estimated USD720million in China alone.<sup>119</sup> 3D printing may not be an exception due to the similarity it shares with P2P.

3D printing makes the issue of intellectual property complex to enforce. Currently, it is difficult to infringe on intellectual property on a large scale because to have a commercial production a person needs a factory set-up. However, with 3D printing, IP can be stolen in two aspects. One, if the person has a computer assist drawing(CAD) to share akin to the newspaper copies shared in portable digital files (PDF). Two, using a 3D scanner to scan and reproduce.

## **2.7 Summary of Gaps**

With each successive technological advancement, international trade transactions have increased. With the reductions of tariffs, the spotlight was on non-tariff barriers, which inevitably thrust the spotlight on the role of customs in the supply chain. This put pressure on customs to devise ways of discharging its mandate without being considered a barrier to trade. The measures included innovations such as automation of its processes and use of the technological advancements that exist or existed at the time including x-ray scanners to name but one.

However, with the new disruptive technologies in the fourth industrial revolution, especially 3D printing in particular, there is need to find ways of coping with the challenges it is posing. The review of the available literature reveals that a gap exists in this area and this study will seek to fill it.

---

<sup>119</sup> Op cit 114

## **CHAPTER THREE: EFFECTS OF THREE-DIMENSIONAL PRINTING ON THE ROLE OF CUSTOMS AUTHORITIES: A CASE STUDY OF THE EAST AFRICAN COMMUNITY**

### **3.1. Introduction**

This chapter assesses three-dimensional printing from a global angle and how it affects or is likely to affect customs authorities in the East Africa Community. The chapter relies on primary data obtained by the researcher mainly through questionnaires that were administered in three countries namely Kenya, Tanzania and Rwanda. The information is also supplemented by result obtained from a series of focus group discussions and interviews with key resource persons.

#### **3.1.2 Background of the East African Community**

Kenya, Uganda and Tanzania, the founder members of the East African Community, have enjoyed a long history of co-operation and regional integration arrangements dating back to the colonial period. This stretches back to the era of the Lunatic Express -the railway connecting Kenya and Uganda (1897-1901). the Customs Collection Centre (1900), the East African Currency Board (1905), the East African Postal Union (1905), the Court of Appeal of Eastern Africa (1909) the Eastern Africa Customs Union (1919), the East African Governors Conference (1926), the Eastern African Income Tax Board (1940) and the Joint Economic Council (1940). The East African High Commission (1947), East African Common Services Organization (1961-1967) and the East African Community (1967-1977) were established as joint organizations to manage matters regarding the three east African countries as well as regulate commercial and industrial relations and transactions between the partner states.<sup>120</sup>

From the above, it is clear how important commercial and industrial issues were to the community. For some reasons, the first East African Community (EAC) disintegrated. Some of the issues cited as having caused the disintegration included unequal sharing of the gains accruing from the integration mainly because of economic disparities and attendant inadequate policies to address the same.<sup>121</sup> The other members felt that Kenya was getting a

---

<sup>120</sup>Okello D. and Kirundi G, Enhancing Equity in the East Africa Regional Integration: an Overview, *in the East African Integration, Dynamics of Equity, Education, Media and Labour*, Society for International Development, 2011

<sup>121</sup>The East African Community Secretariat, *Treaty for the establishment of the East African Community*. Arusha: EAC secretariat 1999.

lion-share of the proceeds mainly because it had a developed manufacturing industry which had displaced the imports from outside the region.

Acknowledging the importance of pulling together, the East African states started exploring ways and means of reviving the union almost immediately. As early as 1984, even before they had fully shared the assets of the defunct community, the members started looking at how they would resuscitate the union. The three presidents of Kenya, Uganda and Tanzania committed themselves to finding mutual grounds from which they would revive the union.<sup>122</sup> This resulted in the *Treaty for the establishment of the East African Community* that was signed by Kenya, Tanzania and Uganda on 30<sup>th</sup> November 1999. The treaty came into force in July 2000.<sup>123</sup> Rwanda and Burundi became members in 2009 while the Republic of South Sudan joined in April 2016. The re-launched EAC was formed with a view to enhance economic co-operation in the region amongst other objectives. Like all regional integration efforts, it progressed through the stages- from free trade area, to a customs union where it is currently, with potential to further progress to common market, monetary union and eventually political federation.

### **3.1.3 Historical Perspectives of Customs Authorities in EAC**

The East African Community customs union<sup>124</sup> came into force on 2005 as defined in Article 75 of the Treaty of the Establishment of the East African Community. EAC has followed a linear integration model starting with a free trade area with an ambitious political federation being the ultimate goal.<sup>125</sup> Prior to this, the EAC customs union had been operational since 1919 in one form or another up to 1977 when the first EAC broke up.

Whereas the first EAC had a common body that was running the affairs of member states, the current customs union has a common external tariff (CET) but each member state has its own body responsible for administering the customs laws as per the EAC's Customs management

---

<sup>122</sup>Deya 2007 as quoted in Okello D. and Kirungi G, Enhancing Equity in the East Africa Regional Integration: an Overview, in *the East African Integration, Dynamics of Equity, Education, Media and Labour*, Society for International Development, 2011

<sup>123</sup>Okello D. and Kirungi G, Enhancing Equity in the East Africa Regional Integration: an Overview, in *the East African Integration, Dynamics of Equity, Education, Media and Labour*, Society for International Development, 2011

<sup>124</sup>In a custom union Partner States allow free trade (or zero duty imposed) on goods and services amongst themselves and agreed on a common external tariff (CET), whereby imports from countries outside the union are subjected to the same tariff when sold to member states.

<sup>125</sup>Trudi Hartzenberg, *Regional Integration in Africa* available on <https://ssrn.com/abstract=1941742>

act. With the break up, the three founder members were forced to establish their own customs authorities.

### **3.2 Role of Customs in the East African Community**

The East African Community became a Customs Union in 2005 with a primary objective of intraregional trade and subsequent enhancement of economic growth.<sup>126</sup> In the EAC region, like in most states or regions, tax revenue is critical for development. This tax revenue is one of the source of funds for development, including poverty reduction and delivery of public services.<sup>127</sup> The beauty of tax revenue is that it comes with virtually no strings attached to it. This is unlike official donor assistance and loans that have been blamed for leaving developing countries indebted. Indeed, ‘Debt is an efficient tool of colonising countries for it ensures access to other peoples’ raw materials and infrastructure on the cheapest possible term.’<sup>128</sup>

The integration of the EAC region has not been without challenges. Nnyanzi and others claim that, like in other regional economic blocs, the fear of losing revenue because of integration is real in the East African Community considering that taxes from customs account for over 43% of all revenues collected by the Partner states on average. This is further compounded by the fact that EAC region has a bigger shadow economy that averages about 40.2%.<sup>129</sup> Presently, the EAC member states administers a Common External Tariff (CET) jointly and changes in the CET have to be agreed jointly. Besides, goods originating from within the community are duty free provided they meet the rules of origin criteria.

### **3.3 Legal Framework: The East African Community Customs Management Act 2004**

For taxes to be levied, a legal framework ought to exist. In (almost) all countries, the principle that no taxes can be levied without the consent of the law is so important that it has been enshrined in the constitution-the most supreme of laws governing a sovereign state. In the East African Community, the legal framework governing collection of customs revenues is the East African Community Management Act (EACCMA) 2004. The Act was assented to on

---

<sup>126</sup> Nnyanzi J.B, Babyenda P. and Bbale J. M., Regional Economic Integration and Tax Revenue: East African Community Author(s): Journal of Economic Integration, Vol. 31, No. 4 (December 2016), Centre for Economic Integration, Sejong University

<sup>127</sup> OECD 2014

<sup>128</sup> George S, A Fate Worse Than Debt, New York: Grove Weidenfeld, 1990

<sup>129</sup> Op cit 116



31<sup>st</sup> December 2004 but came into force on 1<sup>st</sup> January 2005. It is applicable in the all member states of the community.

In principle, all goods entering and exiting the community whether dutiable or not, need to be reported to the commissioner and be placed under customs control. Section 16 of The EACCMA 2004 defines the kind of goods that are subject to Customs Control. They include *inter alia* imported goods, including goods imported through the post office, until when they are entered for home consumption or they are exported whichever come earlier and export goods that are subject to any customs control.<sup>130</sup>

Two questions come to mind. Is the EACCMA 2004 in any way legally capable of handling 3D printing? If yes, how can customs authorities in the EAC handle 3D Printing? To satisfy ourselves to these questions, we have to critically look at the legal provisions as provided in the EACCMA Act 2004.

EACCMA 2004 has elaborate legal provisions regarding goods arriving from foreign via aircraft, vessels, vehicles, trains or on foot. Sections 21, 29, 30 and 31 of the Act make it mandatory for persons arriving from foreign with goods that are deemed to be under customs control to make a report to the nearest port. Consequently, the customs officer may require submission of complete and accurate information of the goods in question including invoices, and any other information. Any person who contravenes this is committing an offence according to the act.

The provisions in the EACCMA clearly envisaged that the modes of importations and/or exportations could only be limited to air, sea and land. Other forms of importations such as e-commerce and 3D printing are not expressly mentioned as. However, looking at precedents and discussing with practitioners, some aspects of importation via the internet are taxable. One good example is the importation of software. Taxes are collectable on all software imported into Kenya regardless of media used.<sup>131</sup> This therefore means that a person who imports the

---

<sup>130</sup> EACCMA 2004 section 16(1)

<sup>131</sup> Ayuma I, Interview with Davis Kiprop, Manager Kenya Revenue Authority, Nairobi, September 2018

software via brick and mortar version will ideally pay the same rate as a person who imports it via the internet. The latter is mostly detected during post-clearance audits.<sup>132</sup>

Understandably, when the Act was being drafted, e-commerce and digital economy was still at its nascent stage. For instance, Kenya's Value Added Tax (VAT) Act 2013, published in August 2013 and hence much more current than EACCMA incorporates some elements of e-commerce. According to the VAT act..

‘Any supply of e-services, broadcasting and telecommunication made by a foreign supplier to a non- VAT registered customer in Kenya is deemed to be taking place in Kenya and is subject to VAT.’<sup>133</sup>

Therefore, VAT 2013 offers a pointer on how digital economy can be ‘legally’ handled. Unfortunately, it can only offer guidance for it is not applicable to Customs; the EACCMA 2004 is the only instrument that is applicable for importation/exportation of goods into East African Community. Even then, the said VAT Act is not fool proof for it has two main constraints as far as handling digital economy is concerned. One, the foreign business are only entitled to charge VAT non-VAT registered players i.e. business to consumers. In the absence of a database to identify who is registered or not, how viable is this proposal? Secondly, the foreign companies need to look for a local tax agent to filing their returns. The agent is for all purposes jointly and severally liable for tax issues, a fact that is making it difficult to get any willing local tax agent.

### **3.4 Empirical Data on the Effect of Three-dimensional Printing on the Role of Customs Authorities in the East African Community**

In order to understand the effects of emerging technology, in particular 3D printing, has on Customs authorities in the East African Community (EAC), the researcher administered questionnaires to respondents in three countries. (Kenya, Tanzania and Rwanda). In total, 150 questionnaires were administered but only 120 either were received back and/or were fully and correctly filled as illustrated in the table below representing an 80% return rate. The findings from the questionnaires together with results of focus group discussions conducted in the three countries will form the basis of the preceding chapter.

---

<sup>132</sup> Post Clearance audit involves examination of all records by a customs authority pertaining to an importer over a period in order to establish the correctness.

<sup>133</sup> Value added Tax Act 2013

**Table 1: Number of Questionnaires Administered and Received Back**

<b>COUNTRY</b>	<b>NO. OF QUESTIONNAIRES ADMINISTERED</b>	<b>NO. OF QUESTIONNAIRES RECEIVED BACK</b>
Kenya	50	43
Tanzania	50	38
Rwanda	50	39
<b>Total</b>	<b>150</b>	<b>120</b>

Majority of the respondents were aged 40 years or younger representing 80% of the respondents. Nobody was aged 60 years or over a fact that could be attributed to the retirement ages in the region.

**Table 2: Age Distribution of the Respondents**

<b>AGE BRACKET(YEARS)</b>	18 - 29	30 - 39	40 - 49	50 -59	OVER 60
<b>NUMBER</b>	35	45	25	15	0

Most of the respondents were diploma holders accounting for 42% of the total respondents. Bachelor and Masters Degrees holders were the next most populous group accounting for 23% and 20% respectively.

**Table 3: Level of Education**

<b>LEVEL OF DUCATION</b>	<b>NUMBER OF RESPONDENTS</b>
CERTIFICATE	15
DIPLOMA	50
BACHELOR	28
MASTERS	25
OTHERS	2
<b>TOTAL</b>	<b>120</b>

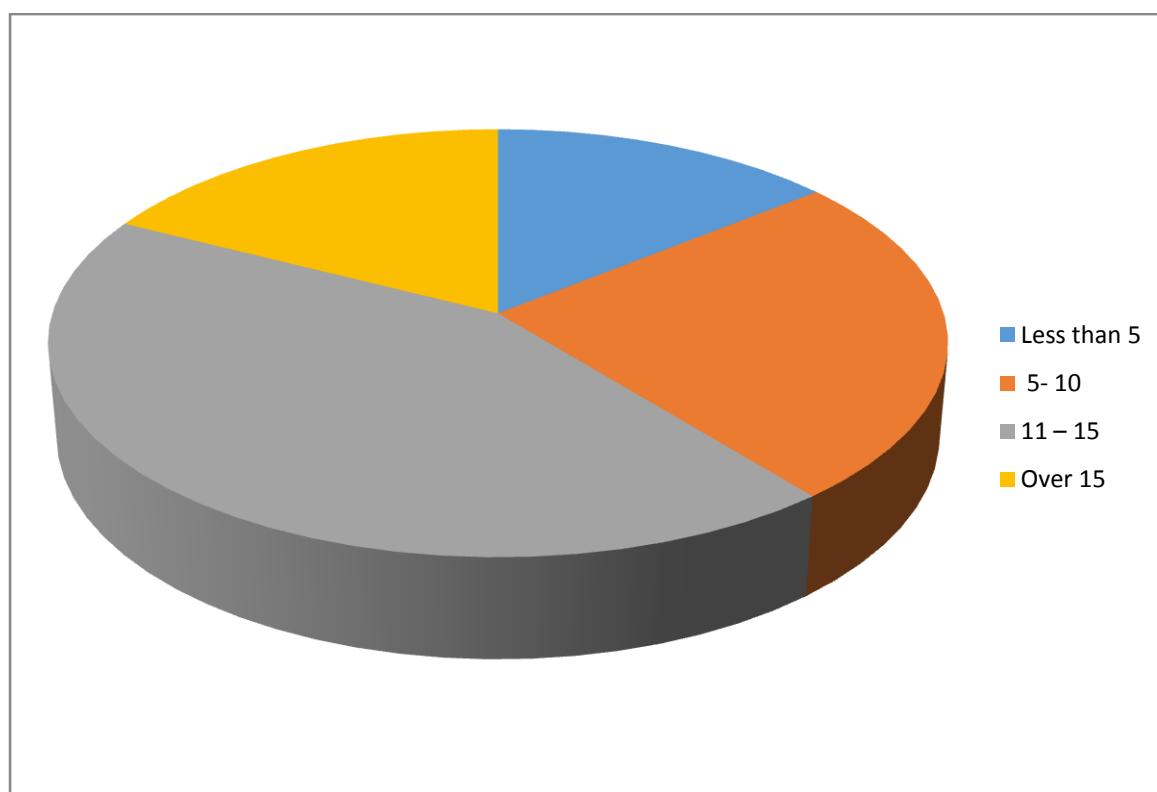
There were more males (66%) than females (34%) among the respondents.

**Table 4: Gender distribution**

GENDER	NUMBER
Female	41
Male	79
<b>Total</b>	<b>120</b>

Over 60% of the respondents had worked for at least 11 years. Only 14% of the respondents had worked for less than 5 years.

**Table 5: Years of Service**



### 3.5 Customs Control of 3D Printed Goods in the EAC Region

As mentioned previously, the mandate of customs in most jurisdictions mainly revolves around revenue collection, border protection and trade facilitation. Increasingly, collection of international trade statistics and protection of international property rights have become major components of customs administrations. To achieve these roles, the customs authorities have to be present physically at all entry/exit points with an aid of an enabling legal regime.

The customs authorities of the East African Community are no exception when it comes to the above-mentioned mandate. The only differences possibly lies in the emphasis that the EAC customs authorities may place on one or more of the mandates. In a 3D world, how would EAC customs authorities behave?

### **3.5.1 Three Dimensional Printing and Revenue Collections**

East African Community is primarily composed of either countries that are in the least developing category (Burundi, Tanzania, Uganda, South Sudan and Rwanda) or the developing countries category.<sup>134</sup> Therefore, as expected, revenue collection ranks highest. In essence, all imported goods that enter the EAC must be subjected to payment of import duty with four tariff bands being provided. The most common band is 25% for imported finished goods, while 10% and 0% are for semi-finished and raw materials respectively. The fourth band that are for products that are considered sensitive to the needs of local industries in the EAC and are charged duty bands that are range from 35% to 100%.<sup>135</sup>

Will 3D printing affect revenue collection in the EAC region? 74% of respondents felt that it was going to adversely affect revenue collection in the region. This can be attributed to the fact that the goods imported enter the country discretely by passing customs controls. It becomes impossible to know who has imported what. Even critically, it is not easy to effectively monitor what you cannot see more so coming from a regime where you have to physically stop the goods first. The other challenge that was noted is the EAC revenue authorities, as per the law must classify a product before they impose any taxes. Even if the importer declared a 3D printed product, the correct classification code to be used is bound to be problematic. Should they declare it as the finished product? Most probably no, because it has to incorporate other raw materials that are already duty paid. Were the importer to declare only the Computer assisted design, the tariff band will most likely change to one that attracts duty that is less than 25% and this will negatively affect revenue collections.

As much as post clearance audit could take care of this-all importers can potentially be subjected to post-clearance audit, it becomes not only difficult to cost effectively audit all 3D importers but also challenging to select cases for PCA. This is because the PCA model, as the name rightly suggests relies heavily on prior declarations. In essence, an importer has to

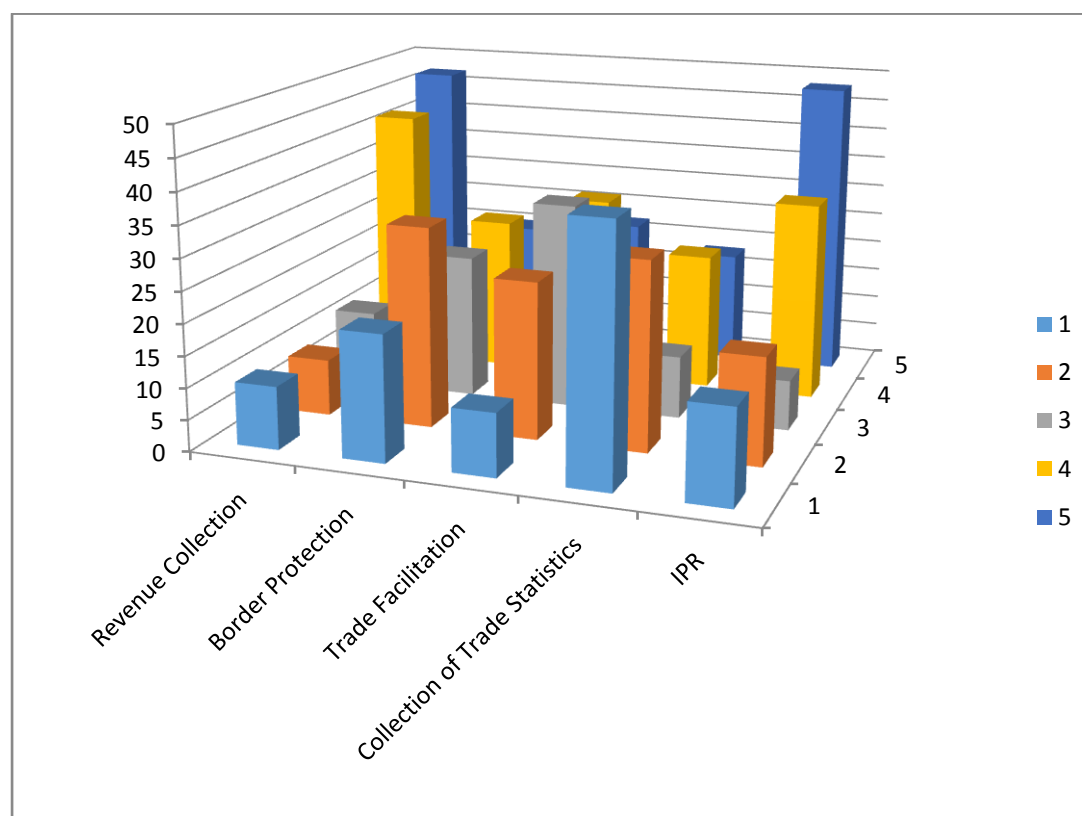
---

<sup>134</sup> World Statistics 2016

<sup>135</sup> East African Community Common External Tariff.

first declare the goods, clear them and then customs can on risk basis determine who will be audited.

**Table 6: Impact of 3D on Customs mandates**



### 3.5.2 Three Dimensional Printing and Safety and Security

When asked whether they thought 3D printing will greatly affect safety and security of goods entering EAC region, only 37% of the respondents felt that the impact will be great. However, the focussed group discussion felt that safety and security-components that principally fit under the border protection mandate of customs will be greatly affected. The finer details are discussed shortly

#### 3.5.2.1 Security issues

As noted in chapter two, 3D printed guns are no longer components belonging to science fiction. Cody Wilson pioneered the printing of the “Liberator” a one-bullet gun in 2013 which had the main components as plastic with the exception being the common store nail.

Worth noting, is that of the 16 parts that the Liberator was made of, all 15 could be 3D printed and the blue prints of the gun were easily and readily availed on the internet. The CAD was widely distributed over the internet initially before a court ruling temporarily halted the distribution.

With the CAD potentially being freely available over the internet, what would prevent anybody with a criminal intent from printing a gun in East African Community? The focus group discussion felt that whereas it was the duty of customs authorities in the EAC to secure their borders, making sure that 3D printed guns are not freely available is difficult. With the region having major issues with security- three of the six countries have already been hit big by terrorists, and almost all of them have raging internal conflicts that are fuelled by presence of small guns and related weapons, prioritizing border security and prevention of proliferation of weapons should be top of EAC's concern.

Surprisingly, only 37% of the respondents considered security issue to be a major concern as earlier noted. This could be attributed to the fact that 3D printed guns are at the very moment rudimentary and can only be used mostly once, and their level of reliability is not guaranteed. With a porous border and the availability of cheap guns that are not only reusable but are also of very high quality and can carry more than one bullet-unlike the liberator, 3D printed guns look slightly unattractive.

However, two issues should greatly concerns EAC customs authorities. One, the cost of printing 3D guns is becoming not only lethal but also cheaper to produce. Better 3D metal printer are becoming increasingly cheaper to find and soon printing of a reusable high quality gun will be normal. Two, even if the nature of guns do not improve in the near future, a single 3D printed gun can cause massive havoc if found in the wrong hands. For instance, due to its plastic nature, it is almost impossible to detect it using the standard metal detectors that are currently available. Should it find itself in let us say a plane, the damage will already have been done.

Interestingly, 3D printing could come in handy as far as helping customs authorities in the EAC region to deal with exportation of ivory is concerned. The EAC region has witnessed increased poaching as a result of high demand of ivory in the Far East. The focus group discussion noted that replica 3D printed ivory if supplied in the said region would lower the

demand for real ivory reducing demand and the attendant poaching. If this is done and anti-poaching measures beefed up, it is expected that poaching will reduce significantly in the EAC region.

### **3.5.2.2 Safety Issues**

Before goods are released for home consumption in the East African Community member states; they must be tested and certified to be conforming to certain minimum standards. This issue of quality is specifically by internal legislation of each member state. For instance, Kenya has the Standards Act Cap 476. It is therefore a requirement of bureau of standards that a Pre-verification Certificate of Conformity (PVOC) is issued by an authorized agent. Failure to do so, the goods so imported are subjected to a mandatory test to confirm the quality after paying a punitive fee equivalent to up to 15% of the cost, insurance and freight (CIF) value.

However, with 3D printing, the provision of testing the goods at source becomes not only impossible but also almost impractical. In the three focused group discussion, the recurrent issue was whether a product that is in its design stage can adequately be tested and passed fit. To them, a design is nothing more than a design and can only be tested once it has been put into a physical form. Therefore, requiring them to test goods before they are imported will be tricky for 3D Computer assisted designs (CADs).

Globally, if the printed products are to be used for individual consumption, the safety issue will be of limited concerns. However, with the potential commercialization of 3D printing, consumers need to be protected. Societies, including the EAC, acknowledge that the complexity and diverse nature of manufactured products make it difficult for the average consumer to anticipate and safeguard themselves adequately hence the need for a body to do this on their behalf hence the need for standardization.

Currently as it is in the East African community, products that are manufactured in the country are also tested before they are released to the market. This is done by bureau of standards bodies that check the calibration of machines and moulds used in the manufacture of the products. They also test the final products to ensure that they meet the specified standards for such products. Continued quality is assured by randomly testing future products produced by the very machines that had previously been checked. The focussed group



discussions felt that this was going to be a challenge in the East African Community because 3D printing is in its very nature decentralized, customized and too random to aggregate together. The main value it inherently has is the potential to allow individuals or companies to not only tailor make products to their specifications but also the flexibility to print them, as they demand them. The availability of many printer, that are scattered; with no assurance of similar input of raw material make it challenging to assure the quality of the final product.

The respondents felt that there is need to differentiate if something is of public or private consumption. If something is for personal use, the element of safety is less critical. A person is responsible for his or her own actions. That is why there are no legislation against extreme sport. Unfortunately, some of the parts that are deemed to be of personal nature and consumption can find themselves in the public realm. For instance, parts produced for a car may prima facie fall in personal space but the said car will be used on a public road and this can prove to be fatal should they malfunction and potentially cause an accident that will affect other road users.

### **3.5.3 Collection of Trade Statistics**

Customs authorities are mandated to collect international trade statistic. Although not a major requirement from customs authorities that are heavy into revenue, it is very important for policy makers and planners to know what moves to where, who moves it and during which periods are most popular. This will help them plan on whether to make policy adjustments if necessary to counter the adverse effects if any.

In East African Community, bureau of statistics and budget offices need to have reliable data not only for measuring gross domestic product (GDP) but also to offer factual basis for areas that could potentially be tweaked by the budget office to raise revenue for government. For instance, if certain products are increasingly being imported, the budget office can propose that taxes be increased.

With 3D printing, it becomes increasingly impossible to collect statistics of international trade mainly because of two things. One, it is difficult for revenue authorities to know with certainty and on a timely manner what is being imported and from where. Secondly, even if

the importation was known, with 3D printed products the line is increasingly blurred whether the products are locally produced or imported.

The respondents asked this question felt that collection of international trade statistics will be greatly impacted. Two things could have contributed to the bigger percentage having the view that collection of statistics will not be affected greatly by 3D printing. One, as earlier noted, EAC region is heavily wired to look at customs from a revenue perspective. Two, the respondents could be of the opinion that the statistics that would otherwise have skipped customs attention can be considered as domestic manufacture.

### **3.5.4 Intellectual Property Rights**

The Uruguay Round of General Agreement on Trade and Tariff (GATT) brought Intellectual property rights (IPR) to the fore. This round introduced the Trade Related aspects of intellectual Property (TRIPS.) Intellectual Property Rights comprises of four key areas; trademark, patent, copyright and trade secrets law. It mainly arises from the need to reward the inventor for his or her engagement as well as a financial aspect to cushion the inventor. Proponents of intellectual property argue that without protection, very few people will be willing to spend money to create innovations.

It is in the best interest of The East African Community member countries to protect intellectual property rights because of a number of reasons. One, as members of World Trade Organization (WTO) they are mandated to implement WTO's agreements. Secondly, protection of IPR will make the region attractive to investors. Early proponent of IPR such as John Locke claimed that protection of intellectual property is essential because 'as much land as a man tills, plants, improves and can cultivate and can use the product of so much is his property. He by his labour does it as if it were exclusive from common'<sup>136</sup>

In EAC, 3D intellectual property infringement affects copyright, patent, trademark and trade dress differently. The focus remains what needs to be protected and from whom should it be protected. The main issue has to do with the protection from deception. However, if one reproduces something for your own consumption, is it possible to deceive oneself?

---

<sup>136</sup> Spinello R. A, "Intellectual property rights", Library Hi Tech, 2007 Vol. 25 Issue: 1, pp.12-22, <https://doi.org/10.1108/07378830710735821>

Interestingly, issues to do with IPR ranked higher than security and safety issues. When asked whether IPR will be affected by 3D printing, 67 percent of the respondents felt that IPR would be greatly impacted. This highlights not only the increased awareness of IPR but also the realization that this disruptive technology is a bane to protection of these rights

### **3.6 Conclusion**

Discussions in this chapter reveal that revenue collection is what will be affected most in the EAC by the emergence of 3D printing. It probably shows how important it is to the customs authorities in the EAC. It therefore calls for urgent precautionary measures before the emergence of 3D printing takes a huge dent on the revenue collection on EAC member states. Other areas that potentially will be greatly impacted include intellectual property rights as well as border protection and collection of trade statistics. Trade facilitation is the area that will be least affected.

## **CHAPTER FOUR: EAC CUSTOMS AUTHORITIES AND OPTIONS FOR MITIGATING THE ADVERSE EFFECTS OF 3D PRINTING.**

### **4.1 Introduction**

This chapter looks at options that are available to Customs authorities in the East African Community (EAC) to counter the negative effects of 3D printing as highlighted in chapter 3. The chapter looks at the four key areas that customs fall under the ambit of customs authorities mainly revenue collection, border protection, enforcement of intellectual property rights and collection of trade statistics among others.

### **4.2 3D Printing and Revenue Collection**

Taxation is an instrument of fiscal policy and is more often than not a by-product of political decision-making processes.<sup>137</sup> The outcome of these processes differ from time to time but a good tax system should have the key principles as highlighted by Adam Smith in the *Wealth of Nations*.<sup>138</sup> The principles are; (a) Equality-subjects of every state should contribute to the support of the government, as nearly as possible in proportion to their abilities. (b) Certainty-taxes that individual ought to pay should be certain and not arbitrary. The time of payment, manner and amount ought to be clear to everyone. (c) Convenience-every tax ought to be levied at the time, or in a manner in which it is most likely to be convenient to the contributor and (d) Efficiency- every tax ought to be so contrived in as to both take out and keep out of the pockets of the people as little as possible over and above what it brings into the public treasury.

In other words, a good tax system should have minimal compliance costs to both the taxpayer and the revenue collector. Smiths' last principle has further been expounded by scholars such as Jean Baptiste who likened it to the art of collecting the largest possible amount of feathers from a goose without letting it hissing.<sup>139</sup> Therefore, any taxation measure that Customs authorities in the EAC region come up with must conform to the principles of taxation as highlighted above.

---

<sup>137</sup> Eisenstein, L. *The Ideologies of Taxation*, 1961.

<sup>138</sup> Smith Adam, *An Inquiry into the Nature and Causes of the Wealth of Nations*,

<sup>139</sup> Alink M., and Kommer V. *Handbook on Tax Administration IBFD*, 2011 pg. 34

As noted before, Customs revenue account for a big portion of revenue collected by Revenue Authorities in the East African Community countries. Therefore, measures ought to be put in place in order to mitigate the adverse effects 3D manufacturing could have on revenue collection. It is indeed difficult to control what can potentially come into the country via the internet. What this means is that customs authorities are virtually powerless to ‘control or regulate’ the inflows. However, being agents of the government in matters revenue collection, they cannot sit and watch as 3D printing bites a hole in their revenue collection targets. Therefore, it is imperative on them (customs authorities) to come up with measures to counter this. In doing so, they must be cognizant of the tenets of a good taxation policy.

The first question that was to ascertain whether there is an enabling legislation to cater for emerging technology in general, and 3D printing in particular. As noted earlier, the legal framework that governs customs authorities in the EAC countries is the East African Customs Management Act (EACCMA) 2004. The EACCMA clearly states that all imported goods are subjects to customs control. In Section 16 of EACCMA says that

16. (1) the following goods are subject to customs regulation

- a) All goods including goods imported through the post office from the time of importation until delivery for home use or exportation whichever happens first.<sup>140</sup>

In essence, this means that all goods regardless of the mode in which they were imported to the country are subject to customs control and therefore are liable to taxation if taxes are due and must be entered<sup>141</sup> in the prescribed format. Section 16(2) of the EACCMA further clarifies that goods that are under control of customs cannot be dealt with any other way except with the express permission of the commissioner of customs.<sup>142</sup> A customs officer may at any time cause the goods to be examined to determine the accuracy of material details and facts of the imported goods including value, description and quantities among other things. Section 16(4) of EACCMA makes it absolutely clear that...

A person who contravenes subsection (2) (b) Commits an offence and shall be liable on conviction to a fine not exceeding one thousand dollars or to imprisonment for a term not exceeding three years, or both and any goods in respect of which such offence has been committed shall be liable to forfeiture.<sup>143</sup>

---

<sup>140</sup> Section 16 (1) (a) of EACCMA 2004

<sup>141</sup> Entry of goods include other things a formal declaration of the goods in a prescribed form and taxes due paid thereof.

<sup>142</sup> Section 16(2) of the EACCMA 2004

<sup>143</sup> Section 16(4) of EACCMA 2004

From a legislation point of view, there is no lacuna as to whether 3D printed goods are taxable or not. However, the bigger issue lies on how to enforce this particular legislation.

In conventional importation through sea, air, road, or even the post office there is a barrier that prevents the importer from accessing the goods that are ‘subject to customs control.’ The commissioner is, thus, at liberty to enforce whichever conditions as are legally permissible within the EACCMA. However, in a 3D world, the importer already has access to the goods before the commissioner is even aware that an importation has taken place. What are the options available to the commissioner then?

One way in which customs authorities can arrest this situation is through Post Clearance audit (PCA).<sup>144</sup> It is through PCA that softwares that have been imported via the net have been identified previously. Indeed softwares share the same attributes as 3D printed items in the sense that they cannot be easily discerned by customs at the point of importation.

The main drawback to PCA route is that it cannot cover everyone. Due to limited resources, customs has to target only those whose audit can make economic sense. This simply means that companies and individual targeted ought to fit in the category that can yield more revenue when audited either immediately, and/or to induce future compliance. As noted in ‘Handbook of Customs Administration’ Compliance is something that is cajoled from taxpayer through punitive tax penalties and other sanctions.<sup>145</sup> Taxpayers have to weigh between getting away with non-compliance and the attendant sanctions that will be meted should they be caught.

Another possible route the EAC can explore is to demand that all importers of 3D printers be registered in a manner similar to importers of excisable goods. Their activities can then be monitored closely with periodic checks on their premises in order to determine the level of ‘importation’ of goods vide 3D printing. This route has certain clear advantages compared to the PCA route. As noted, PCA may not practically cover every 3D manufacturer. The owners of the 3D printers may be required to submit periodic reports of their activities to

---

<sup>144</sup> Post Clearance audit is a process of checking transaction of a trader over a specified period. It involves examining invoices, bills of lading, receipts and payments and even bank transactions in order to ascertain the correctness of the declarations made to customs.

<sup>145</sup> Alink M. and Kommer V. *Handbook on Tax Administration* IBFD, 2011

customs offices. They will equally be required to make the pre-requisite payments to customs, as may be the case.

Unfortunately, this method has a number of drawbacks. Firstly, the proposal to register importers of 3D printers, unlike that of excisable goods, does not have legal backing and can be challenged in a court of law. Secondly, 3D printers can clone themselves i.e. one printer can print several other 3D printers, which may not have been registered to customs. Thirdly, even if for argument sake it was possible to register all 3D printers including the cloned ones, it will be impossible to distinguish all the production in the given period that was solely from 'imported' Computer, aided design (CAD) from all that was sourced locally.

If registration of 3D printers is not a viable option, monitoring of international bank remittances may be an alternative. EAC countries can make it mandatory for banks to demand detailed reasons as to why the foreign remittances are being done. In addition, the banks should be required to demand for taxpayer/personal identification numbers (TINs/PINs) from all entities/individuals making the payments. The advantage of this method is that law already mandates banks to collect as much information as may be necessary before conducting foreign transactions in order to deter money laundering.

However, this alternative has certain, limitations too. One, it assumes that all transaction must be subject to immediate payment but in reality transactions can have delayed payments, cross transfer to other entities that include a local branch of the foreign supplier among other complications. It also fails to account for related party transactions that may involve later payment in terms of royalties/dividends.

A more ambitious method is to create certain incentives to manufacturers that include setting up a centralized place for 3D printers. This may involve having a 'special economic zone' (SEZ) that encourages purchase of the latest 3D printers that can print with the highest resolution possible. The SEZ could have certain incentives that make them attractive to would be investors. The rationale behind such SEZ is to concentrate the 3D manufacturers in one place to make it easier for Customs authorities to monitor them. These SEZ can then be controlled by resident(s) customs officers who would monitor local inflows and outflows of the goods. All duty paid 'raw materials' will be noted and deducted from the final duties to be paid.

The main advantage of this method is that it allows visibility of a hitherto invisible import. It thus allows customs authorities to have control almost in their traditional sense without unnecessarily getting in the way of emerging technology. This method also allows concentration of good high quality 3D printers in one place permitting for economies of scale. It is a fact that the best 3D printers, especially the ones that can handle metals and/or a combination of metals and other materials, are still very expensive and would not make economic sense to be owned by a single entity for work that comes occasionally. For instance, the latest HP printer that can print among other a chain link in 30 minutes that can support up to 5 tons of weight cost upwards from USD 100,000.<sup>146</sup> This is not a price that most companies in the EAC can comfortably afford despite the very many benefits the technology offers, more so if the printers are not utilized to their full potential. The option to outsource the printing services will therefore be very attractive.

However, SEZ option goes against the grain of flexibility that 3D technology promises. The rigid controls of customs authorities is something companies may not wish to subject themselves to (again). Besides, unless the option to outsource makes a big saving on the bottom-line, established companies may not wish to change their model and place it in the hands of third parties. If put in the context that third parties will have access to a company's blueprints-essentially their trade secrets, the level of reluctance becomes real.

The most realistic option in the time being is to shift the burden of collection to domestic taxes departments. The companies in one or the other have to pay income tax and or value added taxes (VAT) if they are trading. Since this method relies on input and output deduction to arrive on the taxes payable, the prosumers will need to declare what was paid for in importations. It is therefore advantageous for customs and domestic taxes departments to collaborate in order to deal with the issue.

### **4.3 3D Printing and Safety and Security**

Safety and security of a country's citizens is one of the main tasks a state has to perform. Safety as noted before refers to freedom from unintentional harm or threats that are caused to a system/person from factors outside of the system and/or person while security refers to

---

<sup>146</sup> <http://www8.hp.com/us/en/printers/3d-printers.html>



freedom from intentional threats or harms that are deliberately planned.<sup>147</sup> Safety and security are within the realm of domestic laws and institutions. As such, the onus is on every country to ensure that all products entering their jurisdiction meet certain minimum standards in regards to safety and security.<sup>148</sup>

With globalization and attendant increase in international trade, it is becoming harder for governments to ensure safety and security of their consumers even when still in the conventional world.<sup>149</sup> It becomes harder when you consider the potential difficulties that 3D printing will pose with its 'invisible' imports and exports. Customs authorities and standards body that are mandated to protect the society are therefore faced with a harder task.

The focussed group discussion that the researcher had with experts drawn from both revenue authorities and bureau of standards in Kenya and Tanzania suggested a number of ways in which customs authorities can use to ensure the safety and security of EAC in the wake of 3D printed products.

#### **4.3.1 Safety Options**

One possible option is to regulate the use of 3D printers and ensure that all products produced by the products are tested first. The available legislation from a standard's perspective is enabling. For instance in Kenya, the Standards Act Cap 476 requires that all products that are to be used in Kenya meet certain predefined standards as set out by the organization. The same applies to all the EAC countries. To enforce this requirement, the standards body must carry out inspection of products before they are released to the open market. The inspections are carried out by sampling the selected products and subjecting them to appropriate tests either before they are released from port, or upon a conditional release.<sup>150</sup> Therefore requiring that 3D printed products be subjected to tests is not in itself out of the ordinary.

However, due to the potential number of 3D printers and the geographical spread, it becomes challenging to effectively monitor them. It is (almost) impossible, with the limited number of

---

<sup>147</sup> [https://www.researchgate.net/profile/Maria\\_Bartnes/publication/289479187\\_Line\\_et\\_al\\_-\\_Safety\\_vs\\_Security\\_-\\_PSAM8\\_2006/links/568d02bc08aec2fdf6f50e92/Line-et-al-Safety-vs-Security-PSAM8-2006.pdf](https://www.researchgate.net/profile/Maria_Bartnes/publication/289479187_Line_et_al_-_Safety_vs_Security_-_PSAM8_2006/links/568d02bc08aec2fdf6f50e92/Line-et-al-Safety-vs-Security-PSAM8-2006.pdf)

<sup>148</sup> Coglianesi C., Finkel A.M. and Zaring D., Import Safety: Regulatory Governance in a Global Environment. University of Pennsylvania

<sup>149</sup> *ibid*

<sup>150</sup> A conditional release is when a consignment is released from the port of entry but is not allowed to be in free circulation until certain conditions imposed by the Bureau of Standards are met.

staff that Standards bodies in EAC have, to adequately maintain the standards especially considering how discrete and personal 3D printers can be.

The other available option is to ensure that the computer-aided designs (CAD) are tested before they are imported to the EAC. This will in essence ensure that the final product is safe for use by the consumer in the EAC. The designer may pass the cost of the testing to the buyer. *Prima facie*, this looks like a good option until you consider a number of things. One, it is impossible to test a CAD for a CAD or blueprint is exactly what the name say. It cannot be tested in its ‘intangible’ form unless it is transformed into a tangible product and subjected to appropriate tests. However, in as much as the seller can 3D print the CAD, they cannot guarantee that the buyer will use the exact material or is using a 3D printer that is of a certain minimum quality. Secondly, standards body are not in any way capable of quality assuring ‘intangible’ material whether in a 3D world or not. They can for instance guarantee that the quality of paper used to print a book is of certain minimum standard but they cannot be in a position to guarantee that the information in the book is useful. Thirdly, even if it were possible to test a CAD, there are certain CAD that are freely available and the designers will not be willing to incur extra costs for something that is not going to generate cash for them.

The other issue to contend with is that 3D printing in practical terms gives rise to a new breed of quasi producers and consumers who collectively the researcher will refer to them as prosumers. This group have stakes in the manufacturing process for they have played a part in one way or another. Strictly speaking, can these prosumers be protected from ‘unintended’ harm? To satisfactorily answer this, we have to acquaint ourselves to basic facts in the consumer protection issues. One, a consumer ought to reasonably be assured that by using particular products and/or group of products harm is unlikely to come their way under normal use.<sup>151</sup> Secondly, they ought to be assured that the producer of the product took considerable due care to ensure that every ingredient they used is of reasonable quality to ensure that it intends to, without any adverse effect, perform the utility it portends to. Lastly, a producer and/or a competent standardization body should have done due care to quality assure the said product as having met certain minimum standards and is therefore reliable.

---

<sup>151</sup> [https://www.rb.com/media/1256/rb-consumer-safety-policy\\_v1\\_feb-2016.pdf](https://www.rb.com/media/1256/rb-consumer-safety-policy_v1_feb-2016.pdf)

The legitimate expectations of a consumer is that products that are available freely in circulation for sale should have, or have been tested to and found to satisfy the said minimum criteria. In case of a breach of any of the above, the consumer can feel cheated and is free to sue one or several of the participants in that particular supply chain including but not limited to the producer, marketer and/or the standards body. However, when the said consumer is in one part a producer, can they reasonably be having certain legitimate expectations?

Tenets of natural justice dictate that you cannot sue yourself as yourself and expect the case to succeed because courts are meant to resolve disputes. Disputes require a plaintiff and a defendant, a scenario that becomes complicated if one person is both the plaintiff and the defendant. A court cannot waste its valuable time settling a case that is either moot or incontrovertible i.e. the facts are already resolved. In the case of a prosumers being hurt by a product they participated in making, they cannot reasonably claim to not have known of the potential defects.

#### **4.3.2 3D Printing and Security in East African Community**

As seen in the earlier definition, security has to do with ‘intentional’ treats especially from outside. Unlike safety elements, security threats are premeditated and meant to cause harm or profit from the threats of harm. In East Africa, customs authorities are by law mandated to keep the borders secure and make sure that only legitimate trade thrive. They (customs authorities) try to arrest smuggling of illicit weapons and weapon making material, dual use products, drugs and products on Convention in International Trade in Wild Flora and Fauna (CITES) in particular rhino horns, elephant tusks among others.

In the traditional sense, the containerization of cargo, increased trade but posed a challenge in controlling illicit trade. With increased volume of containers both on transit and exports, it is becoming easier and lucrative for dealers in CITES products as they just hide them in the containers disguised as either tea, coffee or scrap metal.<sup>152</sup> It is not a coincidence that with the increased uptake of containerized goods, population of elephants have taken a big dip. As much as this was a challenge, it pales into insignificance if you compare the potential harm 3D printing is likely to pose.

---

<sup>152</sup> <http://www.coastweek.com/3820-Singapore-customs-seize-another-illegal-ivory-shipment-from-Mombasa.html>

With 3D printing, anyone with access to a printer and a guns' CAD can and could print a gun as was seen in the case of liberator and similar guns. What then can Customs authorities in the EAC do? The first reference point is to look at legal framework particularly whether the East African Customs Management Act (EACCMA) 2004 allows the importation of guns and similar items. Section 18 of EACCMA gives a comprehensive list of goods that are prohibited and/or restricted. Restricted goods can only be imported subject to them meeting certain conditions that have been imposed including but not limited to obtaining certain certifications and permits from relevant bodies. On the other hand, prohibited goods cannot be imported whatsoever. This when juxtaposed with country specific statutes that regulate possession of firearms reveal that the items are heavily controlled. For instance, Kenya's Firearm's Act Cap 114 specifically allows only licensed people to purchase and possess firearms and related ammunition.

In essence, importation and possession of firearms is something that is strictly controlled. As such, any person who intends to possess and/or import them must obtain the necessary permits. In a 3D world, regulating them will somehow be impossible. Options available include requiring that all 3D printers entering EAC, to not only be registered but also be configured in a manner that cannot allow printing of 3D guns and similar weapons. With this, it will limit the potential of guns that could be printed. However, this option has a number of difficulties. One, it is almost impossible to register 3D printers because no legal mandate exist to enforce this requirement. Even if the mandate existed, 3D printers can print more 3D printers. Secondly, even if it was possible to register the printers, a printer cannot possibly identify whatever is being printed considering that guns are printed in parts, which are later assembled.

The focus group suggested that the most viable option is to ride on international conventions that limit the transfer and/or exports of arms to unauthorized groups. This will compel designers of guns CADs to limit whom they can send to unless they produce a valid permit from a competent authority in their country. The same CAD must have a provision to incorporate metallic part in it to aid in detection during security checks especially at vital installations such as airports. The only drawback is that restricting the availability of such guns when the CAD is freely available over the internet as the case of the 'liberator' is almost impossible. However, if this is combined with country specific laws that prohibit and/or restrict the possession, and/or manufacture of such guns, 3D guns may not be an issue.

Besides, in the EAC, the bigger problem is the proliferation of conventional arms that can be re-used multiple times with a guaranteed level of assurance. It should not escape our attention that as the technology is now; 3D guns are limited in their capacity to be re-used. Therefore, in essence, 3D printed guns may not be a threat as yet to the region.

The most interesting aspect as far as 3D printing and security is concerned is the possibility of using 3D printed replica of ivory.<sup>153</sup> At least four companies have expressed interest in printing replicas of ivory and flooding the illegal market of ivory. With a flooded market, they hope that the demand of illegal ivory and rhino horns will go down and make the market less lucrative. This way, 3D printing could help in killing the illegal trade of ivory and other products on the CITES list thus making work of customs easier.

However, conservationists are opposed to this move because it may spike the demand of ivory as people think it is ok to trade in ivory. Secondly, they view the move as a means of enriching the 3D printing companies at the expense of genuine conservation work.

#### **4.4 3D Printing and Intellectual Property Rights**

Customs authorities are meant to ensure that intellectual property rights (IPR) are not infringed on. In the conventional imports/exports, it is easier to control and monitor this. With 3D printing, how can this be enforced? There are two main ways in which IPR can be infringed upon. One, the legally distributed CAD can be redistributed to others without consent of the designer. Secondly, using a 3D scanner anyone can scan an object easily and the scanned image converted to a CAD for further reproduction.

These two IPR infringements could be resolved as follows. One, for illegal redistribution of CADs, it is up to the designer/seller to protect himself or herself. They ought to put in built in mechanisms and measures to prevent the redistribution or at least keep a track on who receives the copy illegally. Furtherance to that, they ought to have contracts that specifically outlaws illegal redistribution for the law does not protect the indolent. They can thus seek legal redress on the strength of contractual agreements between them and the buyer.

---

<sup>153</sup> <https://www.wired.co.uk/article/3d-printed-rhino-horns>

However, for scanned items, , majority of the respondents felt that this is a matter that is outside the realm of customs for it does not have the mandate to deal with items manufactured in the domestic front unless it is proven that the illegally scanning and subsequent distribution of the CAD originated from foreign. Thus, this is an issue better dealt with by anti-counterfeit authorities. However, since the issue is borderline, closer cooperation between customs and anti-counterfeit authorities is vital.

For private consumption, it is almost impossible for customs to monitor infringement of IPR due to a number of reasons. One, a prosumers cannot deceive themselves hence would not have been misled in consumption of the product they have knowingly produced. Two, it would be expensive for customs to monitor individuals consumption because of resource constraint. Unless the prosumers offer the products for sell, it will make sense to disregard private consumptions.

#### **4.5 3D and Collection of International Trade Statistics**

Customs authorities are mandated to collect international trade statistics. In a 3D world, devoid of mechanisms of controlling the 3D printing and/or making it mandatory for all imported items, collection of international trade statistics will be difficult if not impossible. The most viable option according to most respondents is to have international co-operation in this area.

#### **4.6 Conclusion**

In order to address possible negative effects of 3D printing, there is need to trace the location of 3D printers. Efforts must be put in place to ensure that they are visible. The need to set a special economic zone to tap into the potential of 3D printers is something that can be considered. This will need not only interagency collaboration but most critically government policy shift to look at this emerging industry. However, handling this emerging technology is rather delicate considering the past accusations levelled against Africa that it has been lagging behind in adoption of new technology. A proper balance of costs and benefits should be properly assessed in order reap the potential the industry has. In essence, Africa should try to eat the honey 3D printing offers without taking the stings.

## **CHAPTER FIVE: CONCLUSION, POLICY RECOMMENDATIONS AND SUGGESTIONS ON AREAS FOR FURTHER RESEARCH**

### **5.1 Introduction**

Broadly, this study sought to examine the impact emerging technology has on international trade. Emerging technology has been defined as any technology, which at that particular point in time alters the way things were initially done. The changes could be as rudimentary as stones or branches in as far as early man was concerned, at least when looked at from modern lenses or they could be as advanced as the invention of the internet in the 1960s.

The study narrowed on the role emerging technology has on customs mandates. Using three-dimensional printing (or additive manufacturing) as an example, it took a case study of the East African Community to illustrate the particular impact emerging technology will have. The study had three specific objectives namely; to establish the impact of emerging technology on international trade, to evaluate the extent to which 3D printing affects the role of customs authorities in the EAC region, to explore the options that customs authorities in the EAC could utilise to mitigate the adverse effects of 3D printing. In order to achieve this, the study utilised a mixed method approach looking at both primary and secondary data. As illustrated below these are the key debates that emerged.

### **5.2 Summary of Key Debates**

The study noted that technological changes have been incremental and mostly began as crude technologies with limited uses. The technologies evolved to be useful in solving certain problems of the time leading to increased production, movement and utility of goods. The changes can be grouped into five broad groups namely power delivery systems, materials, transportation and information communication technologies. An increased international movement of goods was preceded by an increased production of goods. This increase was mainly because of a number of issues. One, as more products were being manufactured, newer markets were needed to cater for the increase. The increase in products also made it necessary to source for raw materials from everywhere. Two, faster and cheaper means of communication that made the world smaller made it economically viable to move tonnes of raw material thousands of kilometres away from the source. This thus reversed the earlier paradigm where manufacture had to be as close as possible to the sources of raw materials.

This increase in international trade affected the mandate of customs authorities because they are mandated to control movement of goods across international borders. By their very nature, customs are mandated to collect revenue, protect borders collect statistics among other roles. An increase in trade would invariably lead to clashes in these mandates. For instance as the research has shown, increased movement of goods would lead to potentially increased revenues but put a strain on trade facilitation as the goods were being verified to ascertain that no harmful products entered or left the country. Newer technologies such as containerization, faster, bigger ships and related means of transport that was reliable all year round meant that customs had more cargo to deal with at any one time. The increase in trade was not always accompanied an increase in staff resources in customs offices. Fortunately, technological changes also in essence aided customs authorities. Automation of customs processes and related changes such as scanners and faster ports handling mechanism made the customs work easier.

All the above technological changes pale in significance when compared to at how one particular emerging technology is going to affect the role of revenue authorities in the East African Community. Whereas the earlier changes still allowed customs to still control the goods at the entry and exit points albeit with differing speeds and efficiency, 3D printing or additive manufacturing literally bypasses customs. 3D printing, which involves the manufacture of goods from computer assisted designs and special printers is making customs control difficult. As noted, by its very nature, customs authorities control goods movement by being present at entry and exit points. However, with the changing nature of transportation in the cases of 3D printed goods, customs authorities in the EAC will potentially see a reduction in revenue collection if more and more people decide to import their goods via the internet and manufacture them using 3D printing. The same applies to the other subsets of customs including border protection with 3D printed guns being increasingly popular in other states especially United States. As such, customs authorities will become under increasing pressure to find ways of mitigating the potentially negative effects of 3D Printing.

Left unaddressed, these developments would make customs authorities “die” as scribes did with the invention of the printing press earlier in history. In order to mitigate the negative effects, a number of measures are to be explored. One of them is tweaking the legal framework to make it mandatory to register all 3D printers. As such, customs can periodically check the printers against what the owners have declared as having been imported and



relevant taxes collected on all the goods that have been imported. Alternatively, it should be made mandatory for all financial institutions to demand for complete and accurate reasons for all monies that are being remitted outside the country. This should also include documentary evidence such as invoices that can then be submitted to revenue authorities for reconciliation. Another key issue that emerged is on modalities to be put in place to ensure that safety issues are adequately dealt with. Ultimately, closer collaboration with other relevant government agencies including bureau for standards, anti-counterfeit agencies among others is crucial. It will also be great if the countries considered offering incentives in to concentrate the 3D printers in one place that will make customs and related government agencies have greater visibility of the products 'coming from foreign.' This will be a win-win situation-letting the customers enjoy the benefits of having the benefits of 3D printing especially when economies of scale are pulled together but at the same time allowing customs and other cross border regulators have 'traditional' control of the goods.

Whichever route customs will take, it is essential to keep in mind that 3D printing, and other emerging technologies are here to stay and the faster customs authorities adopt to the challenges and opportunities they offer, the better for their (customs authorities) survival

### **5.3 Conclusion**

This research has established that with each successive technological change, there has been a remarkable increase either in the ease in which international trade has been conducted and/ or the speed with which the same (international trade) has been transacted. With the increase in volumes and speed, the fortunes of international trade have affected the role of customs authorities differently. Increased trade meant that more revenue was collected by customs. However, this has had an opposite effect in as far as border protection was concerned. Increased cargo mostly containerized, with little corresponding increase in resources for customs authorities meant that it was easier to smuggle weapons, drugs and/or products on the Convention against international trade of wild flora and fauna (CITES) list of banned products. Trade facilitation was also taking a hit as customs authorities were struggling to balance their role of revenue collection and border protection.

All this was, at least in the normal sense of it, happening through the conventional customs 'gatekeeper' model. Customs officer stationed at border points could check the flows in and out of a country and intervene whenever called upon. However, a new technology, additive

manufacturing better known as 3D printing is changing all this. This technological change is making it easy to possibly by-pass current customs controls. 3D printing, if not dealt with can have a negative implication to customs twin mandate of revenue collection and border protection, especially to countries in the EAC that rely on customs to finance their budget.

#### **5.4 Policy Recommendations**

In order to deal with possible (negative) impact of 3D printing, the research suggests that customs authorities in the EAC need to...

Ensure a multi-agency, multi-departmental approach to deal with 3D printing in order to have a 360 degree of companies/individuals engaged in 3D printing. This should include making it mandatory for everyone receiving/and or sending money abroad to not only declare the intention but also to use their Personal Identification number (PIN) to identify and track them easily just in case an audit trail is needed.

Consider setting up an industrial park with attendant tax and/or fiscal incentives to encourage concentration of 3D printers in a centralized place to make it easier to not only monitor them but also encourage the growth of the industry. The potential the industry has could be beneficial to the EAC region

#### **5.5 Suggestions on Areas for Further research.**

This research focused on the role 3D printing has in as far as customs mandate is concerned in the East African Community. Little has been done to establish the possible effects 3D printing may have on the economy of the EAC considering that the technology (3D printing/additive manufacturing) may make it lucrative to manufacture goods closer to their target market. Arrangements such as Africa Growth and Opportunity Act (AGOA) may be at risk if manufacturing moves closer to their home markets as advantages that Africa had in terms of cheaper labour fast fading away.

## REFERENCES

- Alink M. and Kommer V. *Handbook on Tax Administration* IBFD, 2011
- Ashton, Thomas S. *The First Industrial Revolution 1760-1830*. Oxford: Oxford University Press, 1948
- Ashton T. S. *An Economic History of England: 18<sup>th</sup> Century*, London Methuen
- Berman B, 3D Printing the New Industrial Revolution
- Costello, Ray. From Sail to Steam. Chapter. In *Black Salt: Seafarers of African Descent on British Ships*, Liverpool University Press, 2012
- Coppieters, F. (1968). Konventionelle Schiffsliegeplätze und Container Terminals. Beschreibung und Leistungsvergleich. Hinterland,
- Crafts N.F.R. *British Economic Growth during Industrial Revolution*. Oxford Clavenon Press
- Deya 2007 as quoted in Okello D. and Kirungi G, Enhancing Equity in the East Africa Regional Integration: an Overview, in *the East African Integration, Dynamics of Equity, Education, Media and Labour*, Society for International Development, 2011
- Dufour, H& Fortin, D. *Case Study Methods: Qualitative Research Methods*. Newbury Park
- Estevadeordal, A, B. Frantz, and A. Taylor.2003. "The Rise and Fall of World Trade, 1870–1939." *Quarterly Journal of Economics*, 118(2):359–407
- Eisenstein, L. *The Ideologies of Taxation*, Harvard, Harvard University Press1961.
- Freeman, C, *The Economics of Industrial Innovation*. University of Illinois, 1982
- George S, A Fate Worse Than Debt, New York: Grove Weidenfeld, 1990
- Goldstein, L *et al.* "Institutions in International Relations: Understanding the Effects of the GATT and the WTO on World Trade." *International Organization*. Cambridge, Cambridge University Press 2007
- Gregory, G *et al.* "The Effects of E-Commerce Drivers on Export Marketing Strategy." *Journal of International Marketing* 15, no. 2 (2007): 30-57.
- Hans-Michael Wolfgang, Emerging Issues in European Customs Law
- Hesse, M., & Rodrigue, J.-P. Global production networks and the role of logistics and transportation. *Growth and Change*, Vol 37 issue 4(2006)
- <http://www.coastweek.com/3820-Singapore-customs-seize-another-illegal-ivory-shipment-from-Mombasa.html>
- <https://www.wired.co.uk/article/3d-printed-rhino-horns>
- Irene J. Petrick & Timothy W. Simpson (2013) 3D Printing Disrupts Manufacturing: How Economies of One Create New Rules of Competition, *Research-Technology Management*, 56:6, 12-16, DOI: 10.5437/08956308X5606193
- Keen, Michael (ed) *Changing Customs: Challenges and Strategies for the Reform of Customs Administration*, International Monetary Fund, 2003
- K'Onyango T, *Impact of E-commerce on Taxation: VAT Perspectives of E-commerce*, 4<sup>th</sup> Commissioners Forum, Zimbabwe 2001
- Kothari, *Research Methodology, Methods and Techniques*, 2006
- Levinson, M. (2006). The box: How the shipping container made the world smaller and the world economy bigger. Princeton: Princeton University
- Lipsey, Richard G., K. and Chrystal A, *Economics*. Oxford University Press
- *Principles of economics*. Oxford: Oxford University Press, 1999
- Lipsey, R.; Carlaw, K & Bekar, C. *Economic Transformations: General Purpose Technologies and Long Term Economic Growth*. Oxford University Press UK 2010
- Lynn, Martin. 1989. "From Sail to Steam: the Impact of the Steamship Services on the British Palm Oil Trade with West Africa, 1850–1890." *The Journal of African History* 30 (2). Cambridge University Press:

- Mohr S. and Khan O. 3D Printing and Its Disruptive Impacts on Supply Chains of the Future in *Technology Innovation Management Review* November 2015 (Volume 5, Issue 11)
- Mokyr, Joel. *The Lever of Riches*. Oxford: Oxford University Press, 1999
- Mugenda and Mugenda, *Research Methods: Quantitative and Qualitative approaches* (Acts Press 1999)
- Nnyanzi J.B, Babyenda P. and Bbale J. M., Regional Economic Integration and Tax Revenue: East African Community Author(s): *Journal of Economic Integration*, Vol. 31, No. 4 (December 2016), Centre for Economic Integration, Sejong University
- Okello D. and Kirundi G, *Enhancing Equity in the East Africa Regional Integration: an Overview, in the East African Integration, Dynamics of Equity, Education, Media and Labour*, Society for International Development, 2011
- OECD *Addressing the Tax Challenges of the Digital Economy, OECD/G20 Base Erosion and Profit Shifting Project*, OECD Publishing, 2014
- Revised Kyoto Convention <http://customs.gov.ph/wp-content/uploads/2016/10/KYOTO-Convention.pdf>
- Rodrigue, Jean-Paul, and Theo Notteboom. "The Geography of Containerization: Half a Century of Revolution, Adaptation and Diffusion." *GeoJournal* 74, no. 1 (2009): 1-5. <http://www.jstor.org/stable/41148425>.
- Roger Lloyd-Jones, *The Economic History Review*, vol. XLVIII, no. 4, November 1995, p. 855.
- Rosenberg, Nathan. 1982. *Inside the black box: technology and economics*. Cambridge [Cambridgeshire]: Cambridge University Press.
- Santarelli, Enrico, and Samuele D'Altri. "The Diffusion of E-commerce among SMEs: Theoretical Implications and Empirical Evidence." *Small Business Economics* 21, no. 3 (2003): 273-83. <http://www.jstor.org/stable/40229292>
- Schumpeter, Joseph A., 1883-1950. *Capitalism, Socialism, and Democracy*. New York: Harper & Row, 1962.
- Smith A, *An Inquiry into the Nature and Causes of Wealth of Nations*, Metalibri Amsterdam 2007
- Snooks G. D, Was industrial Revolution Necessary? London and New York: Routledge, 1994
- Spinello R. A, "Intellectual property rights", *Library Hi Tech*, 2007 Vol. 25 Issue: 1
- Stopford, *Maritime Economics* 2<sup>nd</sup> edition Routledge, 1997
- The East African Community Secretariat, *Treaty for the establishment of the East African Community*. Arusha: EAC secretariat 1999.
- Trudi Hartzenberg, *Regional Integration in Africa* available on <https://ssrn.com/abstract=1941742>
- Turban, E., E. McLean, and J. Wetherbe (2002), *IT for Management*, 3rd ed. New York: John Wiley & Son
- Visseret al., "Automated comparison of X-ray images for cargo scanning," *2016 IEEE International Carnahan Conference on Security Technology (ICCST)*, Orlando, FL, 2016, pp. 1-8.
- Wang M. *Establishment of International Framework for Cross-Border E-commerce: Dilemmas and Solutions*, World Customs Journal, Vol 11 NO. 2.
- World Trade statistics 2005
- World Trade 2017

## **Appendix I: Questionnaire**

Letter to the respondents

Isaac Ayuma

C/O University of Nairobi,

Institute of Diplomacy and International Studies

P.O. Box 30197,

Nairobi.

Date:.....

.....

Dear Sir/Madam

### **QUESTIONNAIRE ON IMPACT OF EMERGING TECHNOLOGY (3D PRINTING) ON THE ROLE OF CUSTOMS AUTHORITIES IN THE EAC REGION**

I am a Masters of Arts student at the University of Nairobi undertaking research on the captioned subject above. To be able to do this study, I am required to get information from Customs authorities in the East African Community. I am seeking your assistance through responding to the suggested questions contained in the questionnaire forwarded by this letter. I have tried to make the questions precise and short to take as little of your time as possible.. You can be assured that your honest response to each one of the questions will not only be invaluable to the study but also be treated with utmost confidentiality. The said information will only be available to my research staff and me. Any publication of these findings will be purely for statistical purposes and with formal authorization of the University of Nairobi.

Your assistance will be greatly appreciated and will help us to gain knowledge about the impact of emerging technology (3D printing) on the role of customs authorities in the EAC region.

Yours faithfully,

Isaac Ayuma

## **PART A: BACKGROUND INFORMATION**

1. What is your age bracket?
  - a. 18-29 [   ]
  - b. 30-39 [   ]
  - c. 40-49[   ]
  - d. 50-59[   ]
  - e. Over 60 years[   ]
2. What is your highest academic qualification
  - a. Certificate [   ]
  - b. Diploma[   ]
  - c. Bachelor[   ]
  - d. Masters[   ]
  - e. Other (please specify.....)
3. Gender
  - a. Male
  - b. Female
  - c. other
4. Nationality.....
5. Employer.....
6. Specific job title.....
7. years of service
  - a. Less than 5 years
  - b. 5 – 10 years
  - c. 11-15 years
  - d. Over 15 years

**PART B IMPACT OF EMERGING TECHNOLOGY ON INTERNATIONAL TRADE**

On a scale of 1-5 where five is highest and 1 lowest please rate the impact the following technological changes have impacted international trade

	1	2	3	4	5
Internet and			-		
Bigger ships					-
containerization					-
x-ray scanners		-			
Improved cargo handling technology					

Do you think the following technological changes have affected the mandate of customs authorities?

	1	2	3	4	5
Internet and			-		
Bigger ships					-
containerization					-
x-ray scanners					-
Automation					
Cargo handling technologies					

Have you ever heard of 3D Printing/Additive Manufacturing?

If yes briefly describe what it is?

To what extent will 3D printing affect customs authorities in the areas listed below?

	1	2	3	4	5
revenue collection					
Border protection					
Trade facilitation					
Collection of trade statistics					
Protection of Intellectual property rights					

**PART C OPTIONS AVAILABLE TO CUSTOMS AUTHORITIES IN EAC TO DEAL WITH IMPACT OF 3D PRINTING**

What are the options available to customs authorities in resolving the challenges of 3D printing?

- a. Revenue collection
- b. Safety and Security of our borders
- c. Trade facilitation

- d. Protection of Intellectual property rights

## **Appendix II: Interview Guide**

### **Interview Guide**

Isaac Ayuma

C/O University of Nairobi,

Institute of Diplomacy and International Studies

P.O. Box 30197,

Nairobi.

Date:.....

Dear Sir/Madam

### **INTERVIEW GUIDE ON IMPACT OF EMERGING TECHNOLOGY (3D PRINTING) ON THE ROLE OF CUSTOMS AUTHORITIES IN THE EAC REGION**

I am a Masters of Arts student at the University of Nairobi undertaking research on the captioned subject above. To be able to do this study, I am required to get information from Customs authorities in the East African Community. I am seeking for your assistance through responding to the suggested questions as asked in this interview. I have tried to make the questions precise and short to take as little of your time as possible. You can be assured that your honest response to each one of the questions will not only be invaluable to the study but also be treated with utmost confidentiality. The said information will only be available to my research staff and me. Any publication of these findings will be purely for statistical purposes and with formal authorization of the University of Nairobi. I would also request your consent to record the conversation for purposes of crosschecking during data analysis.

Your assistance will be greatly appreciated and will assist all of us to gain knowledge about the impact of emerging technology (3D printing) on the role of customs authorities in the EAC region.

Yours faithfully,

Isaac Ayuma



## **SECTION ONE: PERSONAL DETAILS**

Name of respondent (optional)

Age and gender

Education level (highest)

Profession

Location of interview

Date

## **SECTION TWO:**

### **IMPACT OF EMERGING TECHNOLOGY ON INTERNATIONAL TRADE**

1. Do you think technological changes in the last 50 years have affected international trade
2. If yes, can you name and briefly explain some of the technological changes that have had greater impacts on international trade?
  - transportation
  - communication
  - internet and automation
  - mechanization
3. In your opinion, have the changes had any corresponding impact on customs mandates?
4. If yes, can you briefly explain how they have affected the following customs mandates
  - revenue collect
  - border protection
  - collection of international trade statistics
  - trade facilitation

## **IMPACT OF 3D PRINTING ON ROLE OF CUSTOMS AUTHORITIES IN THE EAC REGION**

1. Have you heard of 3D printing?

If yes, in what way will 3D printing affect the customs authorities in EAC in the following areas

- Revenue collection
- border protection
- collection of international trade statistics
- trade facilitation

2. Do you think the legal regime as it is currently is equipped to handle 3D printing?

### **SECTION 3**

#### **OPTIONS AVAILABLE TO CUSTOMS AUTHORITIES TO MITIGATE THE ADVERSE EFFECTS OF 3D PRINTING IN EAC REGION**

1. Do you think the legal regime as it is currently is equipped to handle 3D printing?
2. In your opinion, is it possible for customs to continue executing their mandate in a 3D world?

Briefly explain measures that can be put in

Revenue collection

- border protection
- collection of international trade statistics
- trade facilitation

3. What are the challenges that customs authorities are likely to face in executing their mandate?

4. How can we mitigate the challenges?

### Appendix III: Map of East African Community

