DETERMINANTS OF ADOPTION OF CLEANER PRODUCTION IN MANUFACTURING INDUSTRIES: A STUDY OF SELECTED INDUSTRIES IN NAIROBI

BY

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A PROJECT REPORT SUBMITTED TO THE DEPARTMENT OF GEOGRAPHY AND ENVIRONMENTAL STUDIES, FACULTY OF ARTS, UNIVERSITY OF NAIROBI IN PARTIAL FULFILMENT OF THE REQUIREMENTS FOR MASTER OF ARTS DEGREE, ENVIRONMENTAL PLANNING AND MANAGEMENT

SEPTEMBER, 2017

DECLARATION

Declaration by Candidate

I certify that this project is my original work and has not been submitted for exam in any other university.

Signed: …… Date: ……..

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Declaration by Supervisors

This project has been submitted for examination for the Degree of Master of Arts, Environmental Planning and Management, of the University of Nairobi with our approval as the Candidate's supervisors.

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DEDICATION

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ABBREVIATIONS AND ACRONYMS

CCII	China Coal Information Institute
CP	Cleaner Production
CTs	Cleaner Technologies
EAs	Environmental Audits
EABL	East African Breweries Limited
EIAs	Environmental Impact Assessments
EMCA	Environmental Management and Coordination Act
EMS	Environmental Management Systems
EOP	End-of-Pipe
EST	Environmentally Sound Technology
FHNW	University of Applied Sciences North Western Switzerland
GDP	Gross Domestic Product
GDRC	Global Development Research Center
GIZ	German Agency for International Cooperation
GoK	Government of Kenya
IAPA	Industrial Accident Prevention Association
IPCC	Intergovernmental Panel on Climate change
ISO	International Organization for Standardization
KAM	Kenya Association of Manufacturers
KeBS	Kenya Bureau of Standards

KNCPC	Kenya National Cleaner Production Center
KPLC	Kenya Power and Lighting Company
NCPCs	National Cleaner Production Centers
NEMA	National Environment Management Authority
OECD	Organisation for Economic Co-operation and Development
OHS	Occupational Health and Safety
RECP	Resource Efficient and Cleaner Production
RECPnet	Resource Efficient and Cleaner Production Network
RSS	Royal Scientific Society
SBA	Sustainable Business Associates
SCP	Sustainable Consumption and Production
SD	Sustainable Development
SECO	Swiss State Secretariat for Economic Affairs
TBL	Triple Bottom Line
UN	United Nations
UNEP	United Nations Environment Program
UNIDO	United Nations Industrial Development Organization
WCED	World Commission on Environment and Development

ABSTRACT

Globally, industrial development has over the past few decades resulted into environmental and social impacts like resource constraints, climate change, food shortages and waste management in turn affecting the population's life quality. As a solution to these problems, there has been a growing concern towards environmental protection. Industries are being encouraged to adopt resource efficient practices which will also eliminate wastes; this is what cleaner production entails. The purpose of this study was to assess the determinants of cleaner production in manufacturing industries in Nairobi. The specific objectives were to: examine the cleaner production practices that have been adopted by the industries; discuss the impacts of cleaner production implementation in the industries; and evaluate the challenges to effective cleaner production adoption and implementation in the industries. Primary data for the study was collected using questionnaires while secondary data was obtained from published and unpublished reports. The study found out that some cleaner production practices like onsite recycling and products re-design had not been implemented in 20% of the industries while changes in technology or raw materials had not been realised in 10% of the industries. However, the industries had reaped a number of benefits from cleaner production implementation. For instance, 70% had noted positive changes in water consumption since adoption of cleaner production. The most significant determinants of cleaner production adoption from the study included expected business profits and cost savings while the least significant were pressure from customers, community and business organizations. The industries were experiencing challenges that included financial constraints and lack of a national cleaner production policy. Based on the results of this study, the researcher came up with various recommendations. Policy makers need to scale up their efforts to come up with a cleaner production policy. In addition, government incentives to facilitate cleaner production adoption need to be availed to the industries. For further research, studies are necessary on the impact of cleaner production on emissions and waste reduction as well as improving occupational health and safety in industries.

CHAPTER ONE
INTRODUCTION

1.1 Background of the Study

Recently, environmental issues have become a matter of concern for all sectors and pressure has been mounting on all industrial sectors to improve their environmental performance. Companies are becoming more informed and are taking up resource efficient measures (UNEP, 2014). The World Commission on Environment and Development (WCED, 1987), recommended industrial operations that are more efficient in resource use, generate less wastes and pollution, and that minimize irreversible impacts on human health and environment. The Commission's report, Our Common Future, became the drive of the concept of cleaner production (CP) in the 1980's whose ultimate goal is Sustainable Development (SD). Several current global trends are causing CP to grow in relevance and importance as more and more companies become aware of low inefficiency with which they use their material and energy resources. Inefficiency results into higher production costs which affect competitiveness and profitability, reduction in populations' life quality and rapid environmental degradation in terms of resource constraints, climate change, waste management and food shortages (Schaltegger *et al.*, 2008; Thatcher, 2014).

The National Cleaner Production Centers (NCPCs) program was established by the United Nations Industrial Development Organization (UNIDO) and UNEP in 1994 and by 2015 they had been established in 58 countries (UNIDO, 2015b). The program aims at improving the resource productivity and environmental performance of businesses and other organizations in developing and transition countries (KNCPC, 2014). The roles of NCPCs are: technical and financial assistance, raising awareness in CP, training local experts and building local capacity for CP, providing policy advice to national and local governments, technology transfer and helping in preparation for project proposals for CP investments (UNIDO-UNEP, 2010).

Policies and regulations have been found to play a critical role in implementation of CP. UNEP has since 2011 partnered with the European Union (EU) to prioritize regional approach on mainstreaming Sustainable Consumption and Production (SCP) and resource

efficiency to enable countries to make shift and decouple environmental degradation from economic growth (UNEP, 2015). In Kenya, the government compliance and enforcement regime that encourages Pollution Prevention is the Environmental Management and Coordination (Amendment) Act (2015), an amendment of EMCA, 1999 which is the National Environmental Policy. The policy emphasizes the 'Polluter Pays Principle' and the 'Precautionary Principle'. Legal articles within the Act that are used for CP implementation are Environmental Audits (EAs), Environmental Impact Assessment (EIA), Environmental Quality, Environmental Monitoring and the various licenses for waste handling (KNCPC, 2004).

According to KNCPC, enterprises are required to quantify and characterize their wastes and understand their production processes and services, ultimately developing their environmental policies. Kenya, however, lacks a national cleaner production policy. Some policy statements on CP and environmental conservation addressed in the national industrialization policy framework draft are: promotion of investment in local manufacturing of CP equipment along with other emerging technology, mainstreaming operation of KNCPC into the ministry responsible for industrialization and development of a national CP policy (GoK, 2010). A public policy is needed in order to scale up efforts to green the manufacturing sector in terms of eco-labeling, recycling and re-use, production of eco-friendly materials and support of RECP processes (UNEP, 2014).

The activities of NCPCs have clearly proven the economic and environmental benefits of applying CP in businesses and in some areas have facilitated the integration of CP in national policy frameworks (UNIDO-UNEP, 2010). The potential for CP to benefit businesses is well demonstrated, but it's not yet as widely adopted as might be expected. According to Schaltegger *et al.* (2008), this could be because of lack of adequate information, the notion that CP is only relevant to manufacturing, institutional frameworks which don't encourage the adoption of CP and lack of a one-to-one relationship between organizational change (such as CP adoption) and acting change. Babilas *et al.* (2007) attributed successful application of CP in companies to technological, training, institutional and government capacities. These capacities are lacking especially in developing countries and efforts still need to be done to encourage

CP adoption. This study was necessary as it investigated into the most influential factors that determine the adoption and implementation of CP in manufacturing industries in Kenya, a topic that has not received much attention from many researchers. Another area addressed by this study is the policy arena in that the study suggests the importance of the country to adopt a cleaner production policy which is not yet there currently.

1.2 Statement of the Research Problem

Globally, economic development has been accompanied by a wide array of negative environmental and social impacts like environmental degradation in terms of natural resource constraints, climate change, waste management problems, food shortages and reduction in population life's quality. This is particularly worse in case of weak policy regulation and (or) enforcement (UNEP, 2012a). In Kenya, industrial development is identified as key driving force that puts pressure on environment (GoK, 2013); besides contributing to economic growth and job opportunities, it contributes significant environmental degradation and pollution due to factors such as type and age of technology in use, shop-floor practices and other specific industrial characteristics. Ways must therefore be found to achieve sustainable industrial development; one of them being Cleaner Production.

Empirical evidence shows that very few studies on determinants on CP adoption have been documented in Kenya as opposed to those that have been done elsewhere. Frondel *et al.* (2009), Kesidou and Demirel (2010), Horbach *et al.* (2011), Belin *et al.* (2011), Pereira and Xavier (2012) and Pablo (2013) all conducted studies on determinants of eco-innovation in countries such as UK, France, Germany and other OECD countries which are all developed countries and whose economic conditions cannot be compared with a country like Kenya. These studies yielded factors such as regulation and policy, cost savings and consumer preferences for environmentally friendly products as some of the determinants. However, eco-innovation entails both cleaner production and end-of-pipe approaches, two terms that the studies did not distinguish. Luken and Lompaey (2007) assessed the adoption of Environmentally Sound Technology (EST) in developing countries industries in a UNIDO study and noted that little is actually known about factors that have motivated industries in developing countries to comply with

environmental standards and more particularly to adopt EST, especially under the specific conditions faced in those countries. It is therefore essential for developing countries to gain better understanding of determinants of improved industrial environmental behavior and what can be done to strengthen those determinants. In his study on hotels in Nairobi County, Ondieki (2013) had sought to determine the factors influencing CP adoption and implementation but his study wasn't conclusive on the main determinants but only pointed out the less significant factors like previous proven benefits, information sharing by industry players and community pressure.

In spite of the high level of environmental degradation and considering the importance of clean methods of production in sustaining resources, there seems to be less documented studies on determinants of adoption of CP in manufacturing industries. If the factors influencing CP adoption are identified and addressed positively, then more enterprises would take up the practice leading to resource conservation and ultimately enhancing sustainable development. The purpose of this study is to assess the determinants of adoption of cleaner production in manufacturing industries.

1.3 Research Questions

This study seeks to answer the following questions:

1. What type of cleaner production practices are adopted by the industries?
2. What are the impacts of CP in the industries?
3. What are the determinants for adoption of CP in manufacturing industries?
4. What challenges are faced in the effective CP implementation in the industries?

1.4 Research Objectives

The general objective of this study is to assess the determinants of adoption of cleaner production in manufacturing industries in Nairobi. The study will address the following specific objectives:

1. To examine the cleaner production practices that have been adopted by the industries
2. To discuss the impacts of CP implementation on the selected industries

3. To evaluate the challenges to effective CP adoption and implementation in the industries

1.5 Justification of the Study

Kenya has one of the largest manufacturing sectors in Sub-Saharan Africa; serving both local market and exports to East and Central African region (GoK, 2012). However, the contribution of the sector in GDP has stagnated at about 10% indicating that the rate of industrial growth has been slow (UNEP, 2014). Moreover, the industrial sector has for a long time been associated with pollution. According to IPCC (2014), the sector consumed about 19% of total societal energy and 30% of total global Green House Gas emissions in 2010. Manufacturing is responsible for about 98% of the total direct CO_2 emissions from the industrial sector. However, manufacturing holds the key to unlock the decoupling challenge by developing and delivering decoupled products and services, consumption patterns and lifestyles and driving decoupling through supply chains up to extractive industries. In addition, finding better ways to reduce energy consumption and waste emissions in manufacturing processes is critical to reduce emissions, save energy and other materials and also enhance sustainability (UNIDO, 2015b).

Over the past years, many manufacturing industries focused on end-of-pipe approaches, that is, treatment of pollution at the end of the production process rather than a pollution prevention approach (Dandira *et al.*, 2012). As SBA (2007: 1) puts it, *"CP is a mentality, a philosophy which pursues 'prevention' rather than 'remediation' in order to achieve sustainable growth."* Cleaner Production is an Industrial pollution prevention approach which can help decouple economic growth from environmental pollution (UNIDO-UNEP, 2010). It aims at a completely efficient production system where wastes would either not be created or would be converted into products with a market value (Schaltegger *et al.*, 2008). This study focuses on manufacturing industries because they are likely to contribute to higher pollution levels in form of end-of-pipe approaches compared to other categories of industries. Moreover, the researcher studies industries within Nairobi because this is the region with the highest concentration of manufacturing industries countrywide.

However, adoption of cleaner production remains a challenge for many enterprises. According to Dandira *et al.* (2012) there still remains great scope to improve the level of awareness and implementation of the concept. The fact that only a few industries in Kenya have incorporated the practice in their production processes shows that there are underlying determinants and challenges which need to be understood and measures taken by the appropriate institutions. This study aims at looking deeply into the application of various CP approaches into the production process in order to uncover the challenges met and more importantly the factors influencing CP adoption and implementation. Historically, the usual (and apparently reasonable) assumption amongst many managers has been that improving environmental performance represents only extra costs for a firm whereas the alternative hypothesis is that wastes and pollution are signs of low efficiency (Schaltegger *et al.*, 2008). Thus, this study will offer good understanding to manufacturers not to view cleaner production as just expenditure hence contributes to more adoption of the concept with one of the outcomes being improved economic performance of the manufacturing sector which is already declining. Also, similar industries which have not yet implemented CP may learn the methodologies that they can apply in their own industries. The study will also be of importance to the government in terms of formulation of laws and policies which will favor adoption of and long-term commitment to CP. Findings from the study will also be significant to the government and other stakeholders who will lay down necessary procedures in order to create a suitable environment for CP adoption by removing obstacles. Also, the study will also reach out to international funding agencies whose aid is necessary in supporting CP strategies implementation that is faced by severe financial constraints.

1.7 Scope and Limits of the Study

This study was conducted on industries within Nairobi except for two industries which were in Thika. All the manufacturing industries studied had worked with the Kenya National Cleaner Production Center (KNCPC) and had therefore incorporated some aspects of cleaner production in their production processes. The researcher sought to examine the extent to which each cleaner production practice was implemented. Impacts of CP implementation in the industries were also studied and aspects such as reduction of emission; energy and water conservation; training costs; increased profitability; and

increased costs of purchasing environmentally friendly materials were determined from the respondents' point of view but not from actual records from the industries. The researcher also sought to assess whether cost savings through water and energy conservation had influenced the industries to adopt cleaner production but actual figures of consumption were not put into account.

1.8 Operational Definitions

Clean technology: This refers to the installation or a part of installation that has been adapted in order to generate less or no pollution whereby the environmental equipment is integrated into the production process. This reduces resource consumption, wastes and hazards of the emissions generated and also risks of accidents or malfunction (OECD, 2014).

Cleaner production: It is the continuous application of an integrated preventive environmental strategy to processes, products and services to increase eco-efficiency and reduce risks for humans and the environment (UNEP, 2012).

Corporate Social Responsibility: This is the management concept whereby companies integrate social and environmental concerns in their business operations and interactions with their stakeholders (UNIDO, 2015a).

Eco-efficiency: This refers to the improvement in relationship between economic performance and environmental impacts; it's not about bridging a perceived gap between increasing competitive industrial production, but rather about increasing competitiveness through improved environmental performance (Schaltegger *et al.*, 2008).

Eco-innovation: This refers to any form of innovation aiming at significant and demonstrable progress towards the goal of Sustainable Development; achieved by either reducing environmental impact or achieving a more efficient and responsible use of resources (European Commission, 2015).

Eco-labeling: This refers to affixing labels to products that pass eco-friendly criteria laid down by governments, associations or standards certification bodies based on extensive research on product's life cycle impact (GDRC, 2015).

Environmental footprint: This is the area of productive land and aquatic ecosystems required to produce resources and assimilate waste at a specific material standard of living, wherever that land may be located (UNEP, 2014).

Environmental Management Systems(EMS): It is an aspect of an organization's overall management structure that addresses immediate and long-term impacts of its products, services and processes on the environment (UNIDO/UNEP, 2004).

Green Manufacturing: These are production processes which use inputs with relatively low environmental impacts, which are highly efficient, and which generate little or no waste or pollution (Ninlawan *et al.,* 2010).

Good housekeeping: This is a way of controlling hazards along the path between the source and the worker; removing all unnecessary items in the workplace and keeping all necessary items in their proper places (IAPA, 2007).

Occupational Health and Safety: In the context of CP, it's a case that aims at protecting the health and safety of workers and requires emissions reduction at source; in a more indirect way, efforts to make the working environment safer for workers result in better productivity (UNEP/UNIDO, 2004)

Product Redesign: This means changing the form of the consumer goods whereby the outcomes could be: reduction in toxicity of the materials in a product, packaging requirements or energy and water use; increased recyclability of the used components; or extension of the lifespan of manufactured goods (UNEP, 2012).

Source Reduction: This means reducing generation of wastes and contaminants at source, thereby reducing releases that could pose hazards to environment and public health (UNIDO/UNEP, 2004).

Sustainable Development: This refers to development that meets the needs of the present without compromising the ability of future generations to meet their own needs (WCED, 1987).

Triple Bottom Line: This refers to the methodology for measuring and reporting on financial, environmental and social performance (UNEP/UNIDO, 2004).

CHAPTER TWO
LITERATURE REVIEW

2.1 Introduction

This chapter is an analysis of previous research work relevant to the study. The themes of the literature are organized as follows: Concept of Cleaner Production, cleaner production practice, CP practices, determinants of adoption of CP, benefits of CP, challenges in CP implementation and policy and regulatory framework governing manufacturing industries. The theoretical framework related to CP based on which the researcher derives the conceptual framework is also discussed. The chapter also provides gaps in the literature that the current study intended to fill.

2.2 Concept of Cleaner Production

According to UNEP (2012), application of cleaner production in processes entails conserving raw materials and energy, eliminating toxic raw materials and reducing the quantity and toxicity of all emissions and wastes before they leave the production process. Application in products entails reducing negative environmental impacts along the life cycle of a product from cradle-to-grave by the use of an appropriate design; while application in services entails incorporating environmental concerns into designing and delivering of services.

Schaltegger *et al.* (2008), outlined the main objectives of CP as to minimise the use as well as optimize re-use and recycling of hazardous and non-hazardous materials; to use materials in the manufacturing process in a more efficient way reducing the amount of inputs needed and the amount of non-desired outputs; to minimize risks and improve human capital through workers' hygiene and safety programs; and to improve monetary returns by minimizing energy consumption and reducing material and handling costs. The last objective may often require capital investment.

There are some competing concepts to cleaner production. They include: cleaner technologies, eco-efficiency, waste prevention, pollution prevention (P2), waste minimization and green productivity but CP is a comprehensive approach that encompasses all these (SBA *et al.*, 2007). CP and sustainable technologies won't be

efficient without environmental management systems (EMS) (Babilas *et al.,* 2007). Conversely, CP may be used as a tool within EMS. Apart from EMS, implementation of cleaner production requires readiness to change established attitudes, implementation of technological change, collection and use of necessary information as well as a supportive institutional context (Schaltegger *et al.*, 2008).

CP is often misunderstood as being equivalent to cleaner or environmentally sound technology (EST). However, technology is just one element of CP. CP addresses human factors such as attitudinal change, methods, monitoring and management that ensure that technology is actually used in a manner that is environmentally sound while many definitions of EST include EOP technology which has no part in the meaning of CP (UNIDO/UNEP, 2004).

2.3 Cleaner Production at Global, Africa and Local Levels

2.3.1 Cleaner Production at Global Level

At the Earth Summit in Rio de Janeiro in 1992, CP became internationally recognized and was incorporated in Agenda 21 to help meet the goal of environmental protection and economic development. Since then, CP has been one of the main activity areas of UNEP's Division of Technology, Industry and Economics (DTIE). The Rio +20 Conference set out a basis for governments and industry to adopt green manufacturing with world leaders promoting sustainable patterns of consumption and production as one of the overarching objectives of SD (UNEP, 2013b).

Among the first countries to initiate NCPCs were China, Croatia, Czech Republic, Hungary, India, Mexico, Nicaragua, Slovakia, Tanzania, Tunisia and Zimbabwe. This is between 1995 and 1997. By mid-1990's, CP initiatives in developing and transition countries like China, India, Poland and Czechoslovakia had demonstrated that CP is equally applicable and beneficial as it had been in industrialized countries. Mexico undertook a demonstration project involving 7 foundries and identified 103 CP opportunities which resulted in savings in energy and material use (UNIDO, 2015b). Between 1998 and 2002, NCPCs were initiated in other countries such as Colombia, Costa Rica, Cuba, Ethiopia, Honduras, Kenya, Lebanon, Morocco, Mozambique, Peru, Republic of South Korea, Russian Federation, South Africa, Sri Lanka, Uganda and

Vietnam. During this period, there was transfer of Environmentally Sound Technology (EST) whereby experiences and lessons learnt from the first batch of NCPCs were transferred to new CPCs through study tours and engagement of lead experts as trainers and consultants in new countries. For example, Indian CPC provided extensive technical and related support in Asia-Pacific region while Czech and Slovak Centers supported expansion in Eastern Europe. The NCPC of Vietnam was the first among NCPCs to establish environmental and quality management systems which were certified on respectively ISO 14001 and ISO 9001 in 2002. This was as a result of the effort of UNIDO to combine CP assessments with Environmental Management Systems (EMS), Environmental Management Accounting (EMA) and EST assessment (UNIDO, 2015b).

Several current global trends are causing CP to grow in relevance and importance as more and more companies become aware of low inefficiency with which they use their material and energy resources (UNIDO/UNEP, 2004).CP received a market-orientation attitude between the years 2003 and 2007. This was a move to push for market-oriented service delivery on the side of NCPCs so that they can attain organizational independence and financial security. New NCPCs were opened up in Armenia, Bulgaria, Bolivia, Cambodia, and Egypt among other countries. European and Asian Roundtables enlarged the scope of CP to sustainable consumption and production (SCP). Between 2003 and 2006, UNEP implemented a GHGs emission reduction project from Asia and Pacific industries which included Bangladesh, China, India, Indonesia, Mongolia, Philippines, Sri Lanka, Thailand and Vietnam which demonstrated energy savings and GHG emission reduction through cleaner production and resource efficient methods and techniques (UNIDO, 2015b). These industries were in cement; chemicals; ceramics; iron and steel; and pulp and paper sectors.

Some countries undertook policy reforms and even established national CP policies (UNIDO/UNEP, 2004). The first generation of CP policy inputs were provided between the years 1998 and 2002 in China, Czech Republic, Guatemala and Nicaragua (UNIDO, 2015b). For example, Chinese government established the Cleaner Production Promotion Law which came into effect in 2003 and saw unprecedented comprehensive CP policy system starting to form. This was the first national law in the world to establish CP as a

national policy (Peng *et al.*, 2005). Some of the issues addressed by the policy include provision of economic incentives, establishing a CP fund, implementation of a time-limit to phase off obsolete technologies and integration of CP into the education system. Currently, China's environmental protection agency is converting from end-of-pipe pollution treatment to source control. The law provides environmental authorities with a mandate to instruct highly polluting enterprises to conduct CP audit and implement resulting opportunities. By the end of 2006, environmental authorities had mandated CP audits in 2710 enterprises and noted cumulative benefits which included water savings, electricity savings, reduction of wastes and waste water (UNIDO, 2015b).

Between the years 2008 and 2011, CP expanded to resource efficient and cleaner production (RECP). New NCPCs were opened up in Rwanda, Senegal, Albania, Cape Verde, Montenegro, Romania and the Republic of Moldova. Global evaluation of programs in 2008 confirmed that the NCPC program had resulted in substantial benefits at country and global levels but it had it had not yet achieved its full potential. This was attributed to lack of systematic follow-up to assessment findings and monitoring of actual benefits achieved by NCPC-assisted enterprises. The first RECP networking conference was held in Switzerland in 2009 where participating NCPCs agreed to establish global RECP network (RECPnet). This was formally established in 2010 and the first assembly of 41 founding members held in Nairobi in October 2011 where members adopted the Nairobi declaration.

In the Asia and Pacific region, the green growth initiative has been widely adopted as a way to reconcile tensions between poverty reduction and environmental sustainability. The European Commission-funded SWITCH Asia programme promotes sustainable consumption and production (SCP) among SMEs through green public procurement, cleaner production and eco-labeling and supports Asian policy makers in shifting towards SCP practices (UNEP, 2012b). SCP has its scope enlarged from CP. The period between 2012 and 2015 saw countries such as Ecuador, Ghana, Indonesia, and Mauritius among others initiating their CPCs. During this period, RECPnet grew from 41 to 71 members representing 56 developing and transition countries in 2015. In addition, UNEP started to champion the eco-innovation concept. Established NCPCs continue to diversify their

services to hospitality and health sectors; water supply and waste water treatment, agriculture; crafts; aquaculture and fisheries (UNIDO, 2015b). By the end of 2015, a total of 29 countries and 9 cities had adopted or started implementation of SCP and green economy policies (UNEP, 2016).

2.3.2 Cleaner Production in Africa

Zimbabwe, Tunisia and Tanzania were the first African countries to set up NCPC's. This was between 1994 and 1997. In Zimbabwe, the NCPC was initiated from late 1994 by the Environmental forum of Zimbabwe (EFZ). By 1998, 19 CP assessments had been completed characterized by demonstrations in both SMEs and large-scale operations. The assessments showed that the appreciation for CP was high for low- and no-cost options but there were no investments in high-cost CP options due to challenges like lack of technology, management commitment and access to/high cost of capital (UNIDO, 2015b). Ethiopia, Kenya, South Africa and Uganda initiated their NCPCs between the years 1998 and 2002. Egypt, Senegal, Rwanda, Ghana and Mauritius established their CPCs much later. NCPCs have been very active in Africa and they even supported the establishment of the African Roundtable on Sustainable Consumption and Production (SCP) in 2002 (UNEP, 2012b).

In November 2008, NCPC South Africa celebrated 6 years of achievement and conclusion of the period of direct donor support from Austria and Switzerland governments. Between the years 2003 and 2010, the CPC had implemented CP assessments and training to over 150 companies in chemicals; agro-processing; automotive and transport equipment; metals and allied processes; pulp and paper; clothing and textile; leather and footwear, tourism and hospitality; and commercial buildings sectors (UNIDO/UNEP, 2016b).Its CP strategy objectives were in 5 clusters namely: information and awareness; capacity building; technology development and cooperation; financial support; and policy and regulation. The centre involves itself in a variety of RECP services including energy efficiency, industrial symbiosis and waste recycling, Life Cycle Assessment (LCA), eco-labeling and environmental accounting.

UNIDO implemented transfer of environmentally sound technology projects between 2009 and 2012 in Egypt, Morocco and Tunisia whereby 43 enterprises received assistance through CP assessment, EMS implementation and EMA. As a result, companies involved achieved massive annual resource savings (UNIDO, 2015b).

The SWITCH-Africa Green is an EU-funded program launched in 2014 to assist six African countries to mainstream SCP policies into national governance. The countries are: Burkina Faso, Ghana, Kenya, Mauritius, South Africa and Uganda. The regional 10-year Framework of Programmes on Sustainable Consumption and Production (SCP) has spurred development and the implementation of a number of sub-regional, national and local SCP programmes. For example, pilot projects for mainstreaming SCP in national and city level development policies and action plans have been conducted in Tanzania and Cairo in Egypt (UNEP, 2012b).

2.3.3 Cleaner Production in Kenya

Kenya has been implementing sustainable development and eco-friendly technology like other countries in the world (NEMA, 2012). The Kenya National Cleaner Production Center (KNCPC) was founded by the Government of Kenya through the Kenya Industrial Research and Development Institute (KIRDI) and UNIDO in July 2000 under the country cooperation framework of 1999-2003 between the Kenyan government and UNDP. It assists the Kenyan industries to 'produce more with fewer resources and less pollution' (KNCPC, 2014).

A part of the Industry sector in Kenya has embraced CP technology through technical assistance by KNCPC in order to enhance efficiency in the use of natural resources and energy with the aim of reducing waste generation at source (NEMA, 2012). CP is seen as an important tool in promoting green economy in Kenya because it promotes activities that reduce carbon emissions, enhance efficient use of resources and improves industrial production while at the same time creating green jobs and alleviating poverty. KNCPC has been implementing programmes to promote Cleaner Production in industries since 2001.

An example of a KNCPC program that is ongoing is the Lake Victoria Environmental Management Programme (LVEMP II) which is designed to address pollution and inefficient resource utilisation through supporting the use of cleaner technologies by industries located in the Lake Victoria Basin. This is after NCPCs mapped industrial pollution sources in Kenya, Tanzania and Uganda and narrowed down to 88 polluting enterprises responsible for pollutant discharges into the basin. KNCPC is the regional coordinator of the program, which started in August 2010, and mainly works on sub-component 2.2 that is meant to address industrial pollution challenges and unsustainable resource consumption patterns within the lake basin through CP technologies. KNCPC works together with Uganda Cleaner Production Center, Tanzania Cleaner Production Center, Rwanda RECP Center and the Department of Industry of Burundi. The program involves 40 companies on the Kenyan side and has proved to be effective as the companies have managed to recycle their waste water reduce resource consumption-mainly raw materials, water and energy-by up to 50% (KNCPC, 2014). For example, Kitumbe tea factory implemented rainwater harvesting, solar drying and LED lighting and as a result achieved 60% reduction in water use and 20% reduction in energy consumption (UNIDO, 2015). In Nairobi, at least 20 companies have launched a program to curb pollution in Nairobi river basin. According to KNCPC (2014), the firms are working together with NEMA in collaboration with KNCPC with a hope that the companies will adopt CP strategies and hence reduce pollution in the river.

2.4 Cleaner Production Practices

According to UNEP (2014), greening the manufacturing sector would require approaches from two sides: supply side and demand side. Supply-side approaches include re-design of products and processes, substituting green inputs for conventional inputs, recycling and re-use of internal production processes, use of cleaner technologies and production processes with greater energy and water efficiency. Approaches on the demand side include production of manufactured goods to meet changing demand consumption, eco-labeling of manufactured products and mandatory energy-efficiency audits for large manufacturers. Another practice adopted is good housekeeping; a typically low cost option that provides low to moderate benefits (UNIDO/UNEP, 2004). 5S principles are used in the practice of good housekeeping. These principles are; Sort which involves

removal and disposal of unnecessary things; Systemize which is about arranging necessary items in good order for use; Sweep meaning cleaning the workplace completely; Sanitize/Standardize and Self-discipline which involves going to work early to check machines condition' and cleaning work area before and after work. 5S is among the first and fundamental steps implemented by an enterprise towards the path of implementing total quality management and continuous improvement at the operation level (ITC, 2012). Good housekeeping is meant to keep the workplace organized, clean, and with effective and standard conditions. The use of this tool was started in 1972 by Henry Ford in the United States but popularized as Japanese 5S in 1980 by Hiroyuki Hirano.

Table 1: 5S principles of good housekeeping

5S SUMMARY TABLE

5S PRINCIPLES	POOR		FAIR	EXCELLENT	
1.SORT (SEIRI) Take out necessary items & dispose.	1 A lot of unnecessary things are at the workplace.	3	Unnecessary items are disposed, but not right away.	5	Unnecessary things not found at any time.
2.SYSTEMATIZE/SET IN ORDER (SEITON) Arrange necessary items in good order for use	1 Employee often spend time looking for necessary things.	3	Necessary things are arranged but not in systematic order (not easy to retrieve and use).	5	Necessary things are always arranged in order for quick use.
3. SHINE/ SWEEP (SEISO) Clean your workplace completely.	1 Workplace as well as the machines are dirty and untidy. Many things are scattered around.	3	Workplace and machines are partially cleaned (Center and surface only)	5	Workplace and machines are completely cleaned. Area is free of dust.
4. SANITIZE/STANDARDIZE (SEIKETSU) Maintain high standard of housekeeping	1 No attention is given to keep workplace neat and tidy.	3	Workplace is tidy but not completely clean	5	Dust and dirt are completely shut out.
5. SELF-DISCIPLINE /SUSTAIN (SHITSUKE) Do things simultaneously without being told or ordered	1 No work discipline. People do what they like.	3	People follow rules. But just to start work on time, without enough preparation for the work	5	Prepares for work. Comes early to check machine condition. Cleans work area before and after work.

Source: ITC, 2012

Various studies have recommended CP practices in manufacturing/processing activities. Bach and Gheewala (2010), did a study at a coal preparation facility in Vietnam where they noted various problems like old technology, management of environmental issues, coal slurry (4.5 m ton/year), high amounts of solid waste (6 m ton per year) and fresh water consumption. They suggested CP options to address issues of run of mine coal

treatment, storm water, dust treatment and improving quality of fine coal product. CP techniques suggested were: improving process control, recycling, process modification, input substitution, redesigning technology and product modification but noted that not all techniques are applicable in every case. Mwithalii (2009) studied the role of cleaner production in enhancing water use efficiency of two manufacturing firms in Kasarani, Nairobi: Central Glass Industries and East African Breweries Ltd. He observed that annual water use declined in Central Glass Industries between 2004-2007 and noted practices such as re-using water at the cullet and sand plants and the use of closed system cooling as contributing factors. In EABL, he noted the re-use of hot condensed steam as one of the practices behind reduction in energy needs in the brewing process by 30%. In both industries, there was re-using and recycling thus saving the use of fresh natural resources.

2.5 Determinants of Adoption of Cleaner Production

Various empirical studies have come up with various determinants of adoption of CP in manufacturing industries. These determinants include: environmental regulation, cost savings, availability of technological resources, competition conditions, organizational innovations/internal innovation capabilities, consumer demand, international donors, availability of financial support from governments, voluntary codes/self-commitment, industrial agreements, involvement and cooperation in external knowledge flows and expected increase in market share/penetration of new market segments (Luken & Rompaey, 2008; Frondel *et al.*, 2009; Kesidou & Demirel, 2010; Belin *et al.*, 2011; Horbach *et al.*, 2011; Murovec *et al.*, 2012; Pablo, 2013; Ondieki, 2013). Of all these studies, only the one by Ondieki was conducted in Kenya and it was directed to the service sector; that is hotels in Nairobi County. Majority of the other studies were conducted in developed countries whose environmental and economic conditions are very different from those of developing countries.

Luken and Rompaey (2008) surveyed 105 plants in nine developing countries and across four manufacturing sub-sectors on factors affecting adoption of environmentally sound technologies (ESTs) as perceived by plant managers and key informants. They noted that environmental regulation and market pressure appear to exert more influence than

community pressure on EST adoption. However, ESTs are different from CP in that EST may include EOP approaches. Frondel *et al.* (2009) noted a positive correlation of environmental stringency with introduction of EOP technology but not with CP. They did an empirical comparison of environmental innovation decisions across OECD countries and noted that CP measures have been less subject to environmental regulations and hence tend to be stimulated by other factors.

In addition, Blackman & Arne (2010), studied Mexican leather tanning industry and noted that neither firm size nor regulatory pressure is positively correlated with adoption of clean technology. They concluded that the main driver is the firm's human capital. In Kenya, Mputhia *et al.* (2012) studied Micro and Small Enterprises (MSEs) in the manufacturing Sector in Nairobi but only considered awareness as a determinant of compliance with environmental regulations. The study established that awareness of environmental regulations influenced compliance and therefore recommended NEMA and other stakeholders to increase outreach to MSEs to make them aware of the benefits of environmental regulations compliance. They however noted awareness of EMCA and EIA/EA to be 79.4% and 88.2% respectively.

Horbach *et al.* (2011) studied the role of regulatory push/pull, technology push and market pull as determinants of eco-innovations by type of environmental impact. Using a dataset collected in the context of community innovation surveys of the European Commission in 2009, the researchers pointed out EMS as an important tool to trigger cost saving cleaner technologies because they help to overcome incomplete information within a firm. From the literature that they reviewed, they noted that environmental innovations are more or less regulation driven while many studies showed a positive role of cost savings as a motivation for CP technologies. The study grouped the factors that have been found as main determinants of eco-innovations into four: firm strategies, technology, market and regulation. Regulation pressure and corporate image were seen as the main drivers adopting CT in Spanish pulp and paper industry while data from US, Japan and Germany showed that innovation decisions of companies were mainly regulation driven. Customer pressure was not seen as a strong stimulus for environmental innovation as eco-friendly products are seen as still too expensive while supply factors

such as proximity to best infrastructure, improvement of technological capabilities, EMS, knowledge transfer mechanisms, senior management commitment, teamwork, empowerment of employees at all levels and environmental accounting were all found important as they enable a firm become aware of inefficiencies that weren't recognized previously.

Kesidou and Demirel (2010), did a study based on a dataset of 1566 UK firms that responded to government survey of environmental protection expenditure by industry in 2006 and noted that demand factors like customer and societal requirements on CSR affect the decision of the firm to undertake environmental innovations while they exhibit no impact upon the level of investments. They suggested that firms should initiate eco-innovations in order to satisfy minimum customer and societal requirements and yet increase investments in eco-innovations as stimulated by other factors such as cost savings, firm's organizational capabilities and stricter regulations.

On cost savings, a business is more likely to take on environmental management practices if they can see the benefits in the form of reduced costs and/or higher revenues and profits (Ondieki, 2013). In his study on hotels in Nairobi County, Ondieki was interested in determining the factors that influence adoption and implementation of CP. He however noted that previous proven benefits that accrue from CP implementation such as reduced expenditure on energy and water have less effect on encouraging CP adoption and attributed this to the possible fact that not many of the surveyed hotels have developed effective mechanisms for tracking the use of resources and the associated costs. However, his study was not conclusive in terms of the particular drivers to CP implementation in those hotels but went on to conclude how these other factors were less significant; improved employee morale, improved community relations and community pressure, good information sharing by industry players and support given by other stakeholders including local and international NGO's.

2.6 Benefits of Cleaner Production

Pollution can be considered as an indicator of inefficiency which is always characterized by resource wastage, poor working conditions, economic losses, environmental pollution, among other negative effects (Schaltegger *et al.*, 2008). In order to decouple growth from its environmental impact, manufacturing industries need to apply life cycle thinking; through adopting closed-cycle manufacturing process, extending the lifespan of manufactured goods, improving resource recovery and applying along product value chains (UNEP, 2012). CP is a sign of more efficient production; which in turn is more innovative and competitive, and in principle more economically superior (Schaltegger *et al.*, 2008). By implementing sustainability measures like CP, the manufacturing sector can boost economic and environmental performance through reduction of emissions, integration of by-products into the production value chain, substantial returns of investment and positive implications for jobs through opportunities in secondary production (UNEP, 2012). Implementation of CP strategies aim at increasing competitiveness and efficiency of firms as they assist in energy saving, water conservation, pollution control, safety of machines and workers and also enhances the image of the firm in both national and international arenas (GoK, 2010).

According to OECD (2012), Copenhagen is a leader among greening cities owing to its Clean-tech cluster. Companies in the region had a combined turnover of €30 billion in 2011 and at least 12 billion of this is directly related to clean-tech activities. The main sectors involved are energy efficiency, water and waste-water treatment as well as recycling. In Tunisia, a Lead Acid battery manufacturer saved over US$ 2.2m in two years from US$ 400000 investments through implementation of 19 pollution prevention options; the cost of treating chemicals reduced by 66% and that associated with future pollution prevention technology reduced by 33%, employees health was improved, energy and water consumption was reduced, less lead was required in the process and wastewater quality was improved (GDRC, 2015).

M'ribu (2006) studied waste management approaches in small-holder tea processing factories in Kenya and observed that although factories largely managed their wastes sustainably, there was no comprehensive and uniform approach to waste management.

He therefore recommended CP strategy adoption in waste management with a view to having tea processing procedures that are environmentally friendly. Ondieki (2013) assessed the adoption and level of implementation of CP by star-rated hotels in Nairobi County. He studied efforts to deal with energy conservation, solid waste management and OHS measures and noted that some of the leading benefits of CP to the hotel industry are: enhanced compliance to environmental safety, enhanced safety and health for staff, reduced operating, waste collection and disposal, energy, water and food preparation costs. Environmental programs have also proved to be an effective means of generating enthusiasm and motivating staff to work as a team. Ondieki noted that incorporation of CP practices leads to greater employee involvement in, and commitment to, the production process which often leads to higher quality products. UNEP established CP in order to promote changes that will help achieve sustainable development. Cleaner production in enterprises results in sustainable development by addressing three sustainability dimensions: Production efficiency through improved use of natural resources; Environmental Management through minimization of impacts on nature; and Human Development through reduction of risks to people and communities (UNIDO/UNEP, 2010)

2.7 Challenges in CP implementation

The challenges in CP implementation can be grouped into two broad categories: Internal and External challenges.

Internal Challenges: These are problems that emanate within the enterprise.

Some enterprises generally lack the knowledge about sources of pollution and waste flows that might be susceptible to CP solutions or generally about the economic and environmental potential of CP (Peng *et al.*, 2005; Schaltegger *et al.*, 2008). This means low awareness levels on environmental issues (UNEP, 2014). According to the China Coal Information Institute, CCII, (2014), some enterprises in the country just have insufficient understanding of the importance of cleaner production on sustainable development. There still remains great scope to improve the level of awareness, understanding and implementation of the concept in manufacturing industries (Dandira *et al.*, 2012).

Financial Constraints: Many enterprises have a difficulty in accessing cleaner technology due to lack of investment and financing (CCII, 2014; UNEP, 2014). An enterprise may not afford the cost of new technology. In many cases, EST requires high initial capital costs as compared to conventional technology and is also characterized by a high gestation period; this makes enterprises reluctant to invest in CP (Peng *et al.*, 2005). Green Credit Line (GCL) was first launched in 2003 in Colombia and later in Peru and Vietnam and it assists enterprises to finance profitable CP investments. Between 20003 and 2005, loans worth USD 12.4 million were made through GCL in Colombia. One of the beneficiaries was Aceros Industrialis; a steel wire company which invested USD 640000 to replace chemical with mechanical surface treatment thereby eliminating wastewater. As a result, the company avoided about 400 ton GHGs and realized annual benefits of up to USD 500000.

Lack of technical support: According to UNEP (2014), one of the challenges to CP among various sectors in Kenya is limited technical and professional management skills. Many enterprises have limited in-plant expertise/capability and lack access to external technical support.

Competing business Priorities: Some enterprises experience pressure for short-term profits hence fail to invest into practices that will cost them money without bringing returns immediately. They give higher priorities to production expansion/market share (Peng *et al.*, 2005). Most companies concentrate on running the industries without considering maintenance of equipment, which when poorly maintained, result in environmental pollution (Dandira *et al.*, 2012).

Lack of in-house monitoring and deficiency in maintenance: Some industries lack effective evaluation measures to quantify the financial performance of CP projects (Peng *et al.*, 2005). Others have inadequate industrial self-regulation; government initiatives fail to create self-regulation at factory level. Ondieki (2013) studied CP implementation challenges in the hotel industries in Nairobi and noted poor record keeping and weak accounting systems as some of the challenges facing the sector. Many of them lacked effective mechanisms for tracking the use of resources and the associated costs.

External Challenges: these are forces that affect CP adoption and implementation from outside the enterprise.

Failure of existing national policy and regulatory approaches: Many countries lack the necessary supporting policies and (or) their enforcement especially preferential policies that encourage enterprises to develop CP (CCII, 2014). A study done by Peng *et al.* (2005) on barriers for promotion of clean technology (CT) in Small and Medium-sized Enterprises (SMEs) of China revealed lax enforcement of environmental regulations; whereby weak enforcement of regulations doesn't make CP adoption an urgent task. They also noted absence of incentives on economic policies, for example, tax exemption and grant for installation of CT in SMEs. They recommended that the current governmental policy should give higher priority to lessening the external and financial barriers rather than internal and technical barriers. Although governments of different countries try to minimise pollution from manufacturing industries by imposing penalties, the issuance of disposal permits gives them room to continue polluting (Dandira *et al.*, 2012). Currently in Kenya, for example, there is no systematic monitoring of industrial effluents and emissions; although the legislative framework requires EIAs and annual EAs from large industries to be done (UNEP 2014). Institutional arrangements for both enforcing environmental regulations and providing support to prevent pollution in the country are weak. There are no government-led mechanisms and incentives to promote adoption and implementation of CP (Ondieki, 2013). Public policy will need to adapt to the changing situations in industries which may require assistance in the form of incentives and subsidies. KNCPC has conducted RECP assessments in various sectors and has found out that the major challenges to CP in Kenya are: lack of knowledge and awareness; limited technical and professional management skills; and high investment costs (UNEP, 2014)

2.8 Policy and Regulatory Framework Governing Manufacturing Industries

As of 1990, Kenya had no policy at all in the field of environmental protection and lacked a comprehensive environmental legislation (Orawo, 2016). According to Barczewski (2013) the current legislation is quite comprehensive although it lacks air quality regulations. It is also characterized by inadequate funding, lack of engagement

with important community stakeholders, duplication of regulations and lack of co-operation between ministries within the government.

2.8.1 Environmental Management and Coordination (Amendment) Act, 2015

This was assented to in May 2015 and commenced in June 2015 as an Act of Parliament to amend the Environmental Management and Coordination Act (EMCA) of 1999 in line with the current constitution of Kenya (GoK, 2015). In 1999, the Environmental Management and Coordination Act (EMCA) was assented to and it commenced in 2000. It is from this Act that Kenya's current environment regulatory regime originates. According to Barczewski, 2013, EMCA, 1999 is expansive and the most important contribution to governance of environmental regulations. The EMCA is an act of parliament to provide for the establishment of an appropriate legal and institutional framework for the management of environment. Institutions under EMCA include: NEMA whose role is to exercise general supervision and coordination over all matters relating to environment and to be the principal instrument of the government in implementation of all policies related to the environment, to enforce EMCA's provisions and subsidiary legislation (water quality, waste management, controlled substances, biodiversity, wetland, river and seashore, and EIA regulations) and to review and grant licenses to proponents that plan to change land-use; county environment committees which are responsible for proper management of environment within the counties and develop a County strategic environmental action plan every five years; and national environmental complaints committee which provides the administrative mechanism for addressing environmental harm (GoK, 2015)

2.8.2 Legal Notice 101 -EIA and EA Regulations

EMCA stipulates that any proponent of any project must submit a project report to NEMA before commencing financing or causing to commence or finance a project. If NEMA determines that the proposed project will have significant environment impacts, the proponent is mandated to complete an EIA at his or her own expense. The EIA is only conducted by NEMA licensed lead experts/licensed firm of experts.

2.8.3 Noise Regulations

These regulations prohibit the production of any loud, unreasonable, unnecessary or unusual noise which annoys, disturbs, injures, or endangers the comfort, repose, health or safety of others and the environment.

2.8.4 Water Quality Regulations, 2006

The need to formulate these regulations was necessitated by increasing environmental degradation especially pollution to water bodies (NEMA, 2010a). These regulations make it illegal to deposit anything into a water resource that will cause it to become pollution. They include; protection of sources of water for domestic uses, water for industrial use and effluent discharge and water for agricultural use. The regulations outline quality standards for sources of domestic water, quality monitoring for sources of domestic water, standards for effluent discharge into the environment, monitoring guide for discharge into the environment and standards for effluent discharge into public sewers (Kithika, 2016)

NEMA is tasked with licensing effluent and abstraction activities and monitoring sources of water at least twice every year. If someone pollutes water without a permit or license from NEMA, the Act makes it an offence punishable by jail time or hefty fines. The liable party is also responsible for cleaning up the pollution. During the licensing process NEMA charges a fee, engages local authorities, businesses, lead agencies and also examines environmental effects of the effluents/emissions.

According to NEMA (2010a), there has been increased compliance to prescribed environmental standards and efforts to embrace recycling and pre-treatment of wastewater by various facilities since the inception of these regulations. However, these regulations lack siltation standards when considering possible damage to a waterway when too much sediment is deposited in it (Barczewski, 2013)

2.8.5 Waste Management Regulations, 2006

Poor solid waste management has contributed to environmental pollution resulting in reduced environmental health quality, risks to human health, loss of aesthetic value and strained existing waste management infrastructure (NEMA, 2010b). Lack of waste

segregation has also worsened the situation and led to mixed wastes. The waste management regulations seek to stop and reverse environmental pollution resulting from solid waste by providing mechanisms for managing solid waste. These mechanisms include: promotion of CP technologies, segregation at sources, recycling and re-use. The regulations support the application of CP technologies in relevant facilities in order to minimize waste generation and maximize the use of raw materials through improvement of production processes, monitoring product cycle and incorporating environmental concerns in the design, process and disposal of a product.

These regulations apply to all categories of waste: industrial waste, hazardous and toxic wastes, pesticides and toxic substances, biomedical wastes and radioactive substances. The industrial sector is a major contributor of solid waste mainly in cities and other urban centers in the world (NEMA, 2010b). These regulations require the industrial sector to install pollution control technology for pre-treatment of the waste emanating from trade or industrial undertaking. They outline requirements for handling, storing, transporting and treatment/disposal of all waste categories. Disposal of waste, for example, should be done by a NEMA licensed company.

Stakeholders for these regulations are waste generators, transporters, recyclers, composters, incinerator operators and landfill/dumpsite operators. The regulations provide guidelines for licensing procedures, fees, offences and penalties.

2.8.6 Controlled Substances

These are basically ozone depleting substances. One needs a license to: produce controlled substances, import controlled substances, transport controlled substances through Kenya and export controlled substances

2.8.7 The EMCA (Conservation of Biological Diversity Resources, Access to Genetic Resources and Benefit Sharing) Regulations, 2006

An EIA license is required to engage in activities with an adverse impact on any ecosystem; lead to introduction of any exotic species or lead to unsustainable use of natural resources. Any person who intends to access genetic resources in Kenya needs an

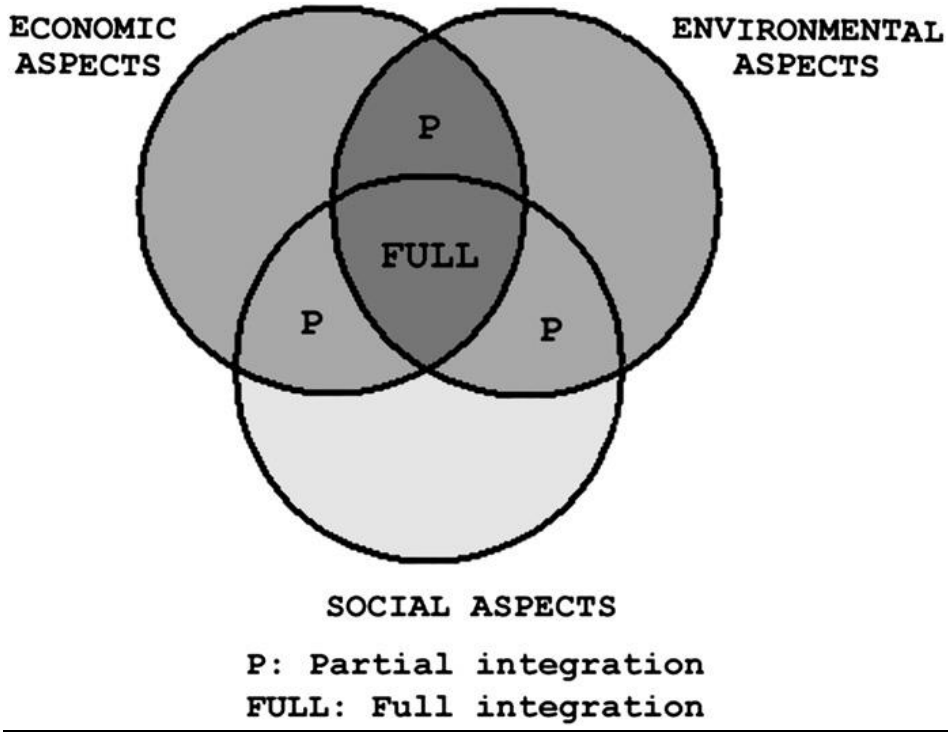
access permit for genetic resources in Kenya certificate from National Council for Science and Technology.

2.9 Theoretical Framework

2.9.1 The Three-Circles Model of Sustainability

This model was put forward in 2005 by the World Summit on social development which identified SD goals such as economic development, social development and environmental protection. This view has been expressed to explain the concept of sustainability which dates back to more than 30 years and was a key theme of the UN Conference on the Human Environment in Stockholm in 1972. The concept was coined to suggest that it was possible to achieve economic growth and industrialization without environmental damage (IUCN, 2006). The three dimensions have been represented as pillars, as concentric circles or as interlocking circles. An IUCN program in 2005 used interlocking circles model to demonstrate that the three objectives need to be better integrated. The model provides basic sustainability understanding especially of the interaction between the three aspects. According to Lozano (2008), sustainability is represented by the overlapping area of the three circles shown as 'Full' while areas outside of this are considered either as partial sustainability (P), the union of two circles, or not at all related to sustainability. This implies that sustainability is only those aspects where the three are united; which is a flaw as it disregards interconnectedness within and among the three aspects. Sustainability is however achieved by a condition of satisfying all the three aspects simultaneously (IUCN, 2006). However, the model lacks dynamics of process change over time and also considers human and environmental resources separately; while it's impossible to separate human development from environmental development (Lozano, 2008; Thatcher, 2014).

Figure 1: The Three Circles model of sustainability



Source: *Lozano, 2008*

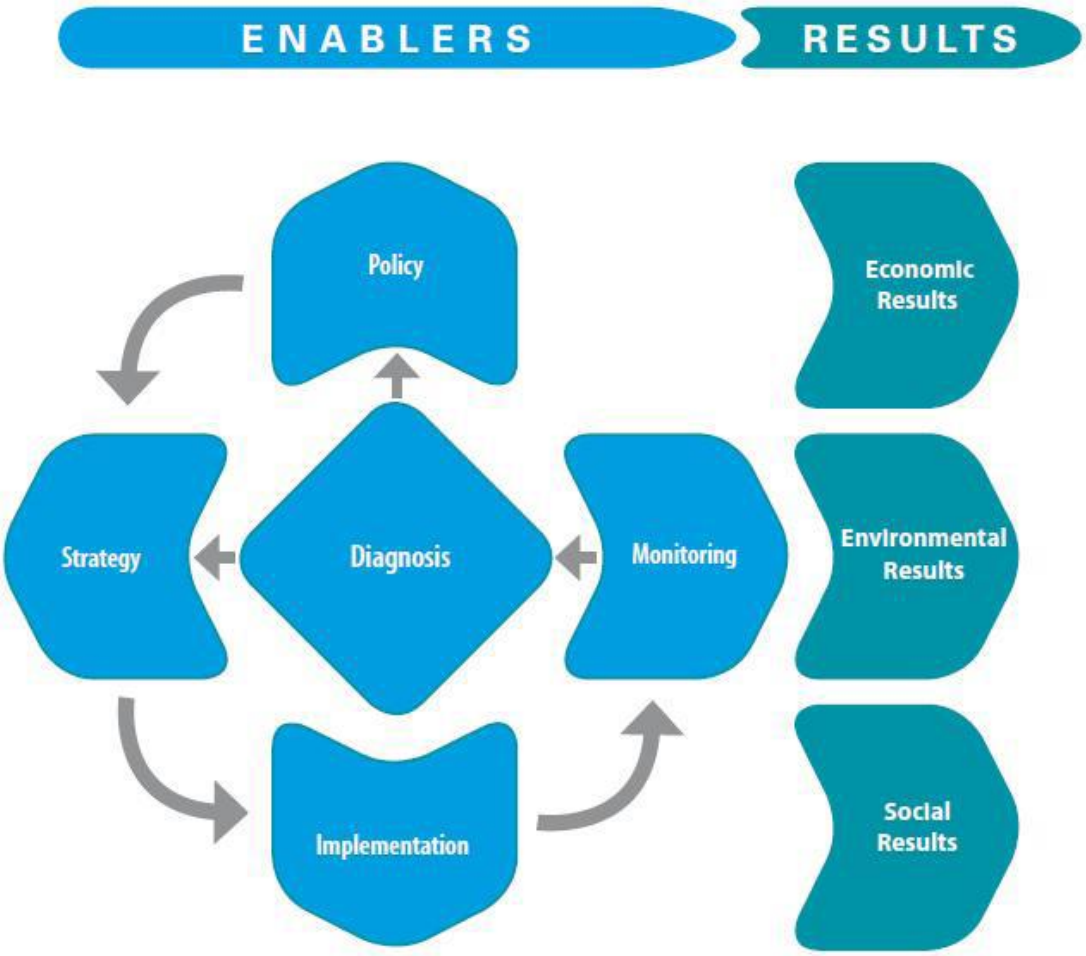
2.9.2 The Cleaner Production Excellence Model

The model was created and implemented in 2006 by Sustainable Business Associates (SBA), an international NGO, in collaboration with the University of Applied Sciences North Western Switzerland (FHNW) and the Royal Scientific Society (RSS) with financial support from the Swiss State Secretariat for Economic Affairs (SECO). It is seen as of great value especially to organizations in the Mediterranean region, in Europe and beyond. The CP Excellence Model was inspired from the European Foundation for Quality Management (EFQM) model, a non-prescriptive framework for business excellence which is the most widely used organizational framework in Europe and forms basis for majority of national and regional excellence awards. The model is applicable to all kinds of manufacturing organizations regardless of the industrial sector and size.

The model is built upon some fundamental concepts which impact among each other and are linked directly or indirectly with the model criteria. These concepts are: leadership and management commitment; employees' motivation; pollution prevention; recycling,

re-using and recuperation; energy efficiency; economic sustainability; social responsibility; and continuous improvement. The CP Excellence Model is a framework consisting of eight criteria: five 'enablers' and three 'results'. The enablers cover what an organization does and the results cover what an organization achieves. The enablers cause the results. In turn the enablers are improved using feedback from the results. The CP Excellence Model is based on the premise that, *"excellent and sustainable environmental, economic and social results are achieved by applying CP in a systematic mode which implies development and establishment of a diagnosis, a policy, a strategy, the implementation of CP options and monitoring of results"*(SECO/SBA *et al.*, 2007: 5).

Figure 2: The Cleaner Production Excellence Model



Source: SECO/SBA-RSS-FHNW, 2007

2.9.3 The Triple Bottom Line Model

The Triple Bottom Line concept, often abbreviated as TBL, was coined by John Elkington in 1994 when he wrote about "win-win-win" strategy but it was publicly articulated in 1997 after widespread recognition of his book, 'Cannibal with Forks: The Triple Bottom Line of 21st Century Business. TBL is an accounting framework that incorporates three dimensions of performance; social, environmental and financial (Furnish *et al.*, 2013). The concept originated from a business and corporate setting. Elkington felt that it had become increasingly clear that business must play a central role in achieving SD goals, that is, companies needed to become more responsive to what he saw as competitive and strategic challenges of growing concern over environmental and social justice by consumers. TBL concept of sustainability is a premise that growth and development should take economic, social and environmental impacts into consideration. TBL of sustainability calls for a balance between the three aspects (Thatcher, 2014). Its dimensions are also called the 3P's: People, Planet and Profits. It differs from traditional reporting frameworks, which measure profits; return on investment and shareholder value, in that it includes ecological and social measures. However, these measures can be difficult to assign appropriate means of measurement (Slaper & Hall, 2011). This means that measuring the degree to which an organisation is being sustainable or is pursuing sustainable growth can be difficult.

According to Furnish *et al.* (2013), prominence of the TBL concept of sustainability in international development efforts has been noted in the Brundtland Report of 1987, Our Common Future, as well as the UN's Agenda 21. The WCED Report strongly argued that a single focus on environmental issues would be a 'grave mistake' and that the environment does not exist separately from human actions and needs; its inseparable from development and poverty alleviation. The Agenda 21 is an international framework for SD that offers a practical approach for the three levels. The 27 principles underlying it promote the centrality of social equity and environmental protection to development for current and future generations.

TBL and its core value of sustainability have become compelling in the business world due to evidence of greater long-term profitability (Slaper & Hall, 2011). For example, reducing waste from packaging can reduce costs. In addition, the role of community involvement is a necessary component of TBL and SD strategies should favor shared responsibilities which involve bottom-up rather than top-down approaches (Furnish *et al.*, 2013). This is particularly important in implementation of CP which becomes successful when a committed top management of an organisation involves the workers in decision making. UNIDO based its CSR programme on the TBL approach which is used as framework for measuring and reporting corporate performance against economic, social and environmental performance. According to UNIDO (2015), TBL approach has proven to be as successful tool for SMEs in developing countries to assist them in meeting social and environmental standards without comprising their competitiveness. It's an attempt to align enterprises to the goal of sustainable global development by providing them with a more comprehensive set of working objectives than just profit alone.

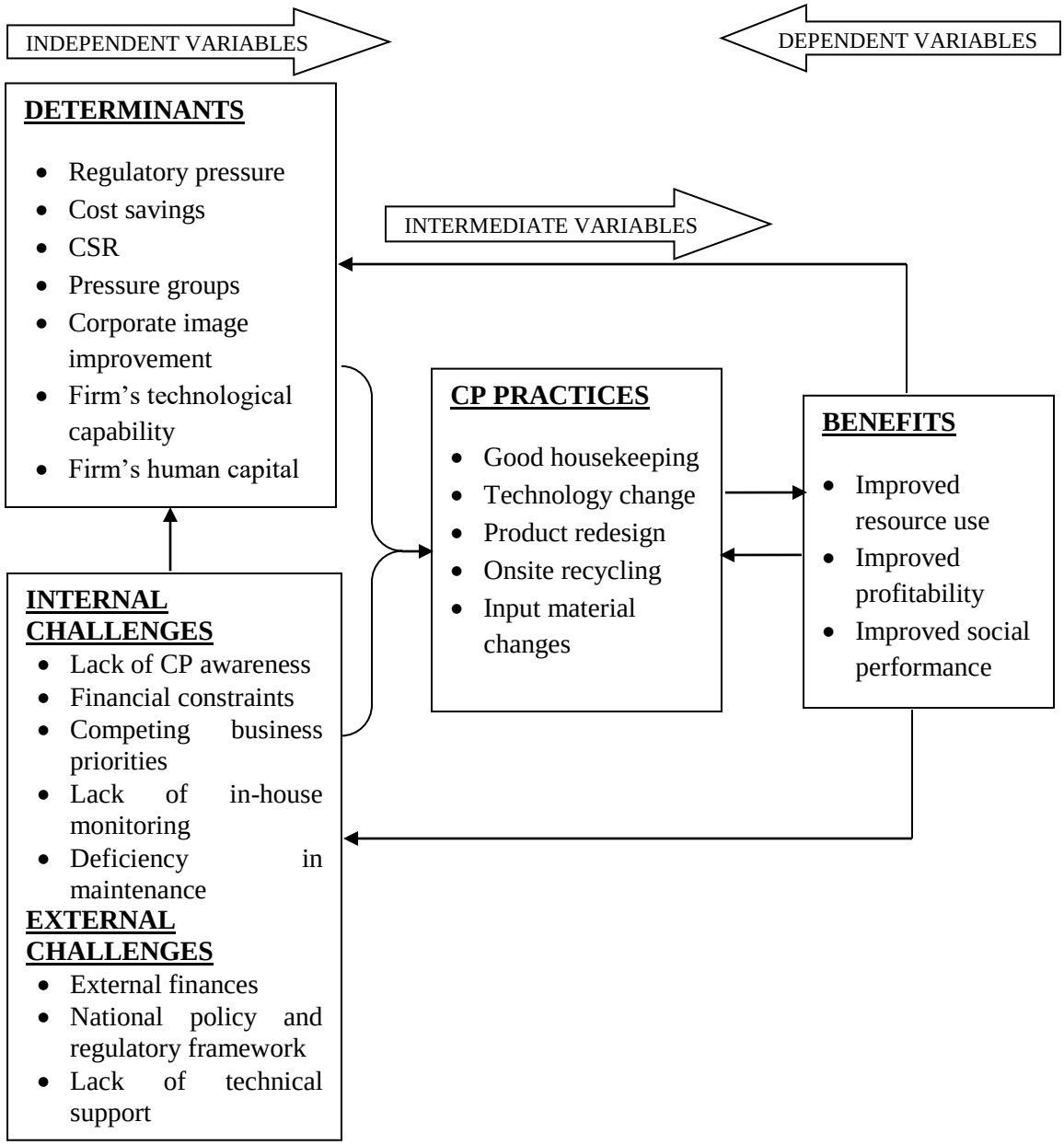
2.10 Conceptual Framework

The Cleaner Production Excellence Model formed the basis under which this study was laid. This is because the model encompasses specific CP aspects like energy efficiency, pollution prevention, recycling, reusing, social responsibility, leadership and management commitment, economic sustainability and continuous improvement; which this study is interested in; as opposed to the other models which generally address the issue of sustainable development. The researcher has modified it to suit it to the context of manufacturing industries. The conceptual framework of this study has three parts: CP determinants and challenges, CP implementation and CP benefits. The determinants are those drivers/ factors that influence the adoption of CP practices. The challenges are those factors that hinder adoption/implementation of CP in the manufacturing industries and they can be internal or external. After a manufacturing industry implements CP, the benefits that result are of three categories which match the three principles of sustainable development, that is, environmental, economic and social benefits and directly or indirectly impact on the challenges and also end up improving the practices. Benefits from CP implementation will also serve an indication of weak areas of influence that need to be acted upon while at the same time strengthening some drivers that will

improve adoption. For example, improved economic performance will lessen the problem of financial constraints. Aspects of improved social performance in most cases result automatically with implementation of Cleaner Production, particularly with good housekeeping.

Figure 3: Conceptual Framework

A CONCEPTUAL FRAMEWORK FOR CLEANER PRODUCTION IN MANUFACTURING INDUSTRIES



Source: Modified from SECO/SBA-RSS-FHNW, 2007; Ondieki, 2013

2.11 Research Gaps

Research into determinants of CP in manufacturing industries has not being given much attention. Studies by researchers such as Frondel *et al.* (2009), Horbach *et al.* (2011), Belin *et al*. (2011) looked at eco-innovation which involves end of pipe approaches which have no room in cleaner production. In Kenya, Mputhia *et al.* (2012) looked at awareness of environmental regulations and how it influences compliance to environmental regulations. Their study never took into account CP aspects. This study however looked into whether environmental regulations existence in Kenya influences the adoption on cleaner production. A study on cleaner production in Kenya conducted by Ondieki (2013) involved star rated hotels in Nairobi County. This study however dealt with manufacturing industries. Another study on manufacturing industries in Nairobi was conducted by Mwithalii (2009). However, it involved two related manufacturing industries and it was specifically investigating the role of cleaner production in enhancing water use efficiency without considering other benefits associated with cleaner production or even the factors influencing its adoption.

Kenya has not yet come up with a cleaner production policy. Industries are governed by environmental regulations which still give room for waste production and disposal into the environment. Cleaner production adoption, which encourages waste elimination, is a voluntary practice in the country. This is a gap in the policy framework. This study recommends that policy makers should see to it that the country gets a cleaner production policy governing all manufacturing industries.

CHAPTER THREE
RESEARCH METHODOLOGY

3.1 Introduction

This chapter describes the characteristics of the area in which the study was carried out. This includes geographical location, climate, population dynamics, drainage, industrial land use and major environmental issues. The methodology used in carrying out the study is also outlined. This includes: Research Design, Study population, Data collection methods, Data Analysis and Presentation methods. The researcher also highlights some of the limitations experienced during the study.

3.2 Study Area

3.2.1 Geographical location

Nairobi is located at the South-Eastern end of Kenya's agricultural heartland at approximately $1^0$9'S, $1^0$28'S and $36^0$4'E, $37^0$10'E with an area of about 700 km^2. It is Kenya's capital city and largest urban center. The county borders three others: Kiambu to the west and north, Machakos to the East and Kajiado to the south. The altitude is between 1600m and 1850m above sea level. The western part of Nairobi is rugged while the eastern part is lower and generally flat. It is a center of industry, education and culture and houses world headquarters of two UN agencies; UNEP and United Nations Centre for Human Settlements (UN- Habitat).

3.2.2 Climate

Usually referred to as the 'Green City in the Sun', Nairobi has a pleasant climate and weather conditions throughout the year (Omwenga, 2010). Nairobi has a temperate tropical climate with two rainy seasons. Heavy rains are experienced between March and April while short rains are experienced between November and December. The mean annual rainfall is between 850 mm and 1050 mm while the mean daily temperatures range between 12^0C and 26^0C (CCN, 2007). It's generally hot and dry in January and February and dry and cold between July and August.

3.2.3 Drainage

The main drainage follows the regional slope of volcanic rocks towards the east while a subsidiary internal drainage into the Rift region is confined to the western part (CCN, 2007). Water bodies and riverine areas cover 1.69% of the city's land area and usually face increasing pollution from municipal, industrial, mining and agricultural sources. The major rivers are Nairobi, Ngong and Mathare which traverse numerous neighborhoods (Tibaijuka, 2009).

3.2.4 Population Dynamics

The population of Nairobi represents about a quarter of Kenya's urban population and about 8% of the total population (Tibaijuka, 2009). According to 2009 Kenya Population and Housing Census, Nairobi had 3 million people but the projection for 2015 was 3.8 million with a population density of 3079/km^2 but varies significantly from extremely high to very low depending on economic status of residents (CCN, 2007). Nairobi represents a quarter of Kenya's urban population and has a population density of 3 079/KM^2 (Tibaijuka, 2009). Population is a major driver of environmental change and a determinant for issues such as solid waste generation, land-use patterns and settlement as well as resource consumption. High population growth rates have been attributed to high fertility rates and high influx of people to the city for purposes of higher wage employment, opportunity for higher education, better economic prospects and trade. The rapid population growth rate doesn't match the rate of economic growth and is associated with unemployment and urban poverty which have resulted to sprawling informal settlements that negatively affect the city's delivery of social services and quality of life (Omwenga, 2010)

3.2.5 Industrial Land Use

Nairobi is the most industrialized urban center in Kenya and East Africa in general. The main Industrial area is located to the east of the city. However, the area used for industrial purposes has grown phenomenally; some extensions have been uncoordinated leading to incompatible mixed land uses merged with or encroached into residential use (CCN, 2007). Nairobi town is one of the many cities and towns which have grown in population size and also expanded spatially to form huge metropolitan regions. The Nairobi

metropolitan region covers 32 000km^2. It covers areas such as Kiambu, Ruiru, Thika, Limuru, Mavoko, Machakos, Olkejuado, Masaku, Kikuyu, Kajiado and Kangundo and is both the largest and well established commercial and industrial region in East and Central Africa (Omwenga, 2010).

3.2.6 Major Environmental Issues

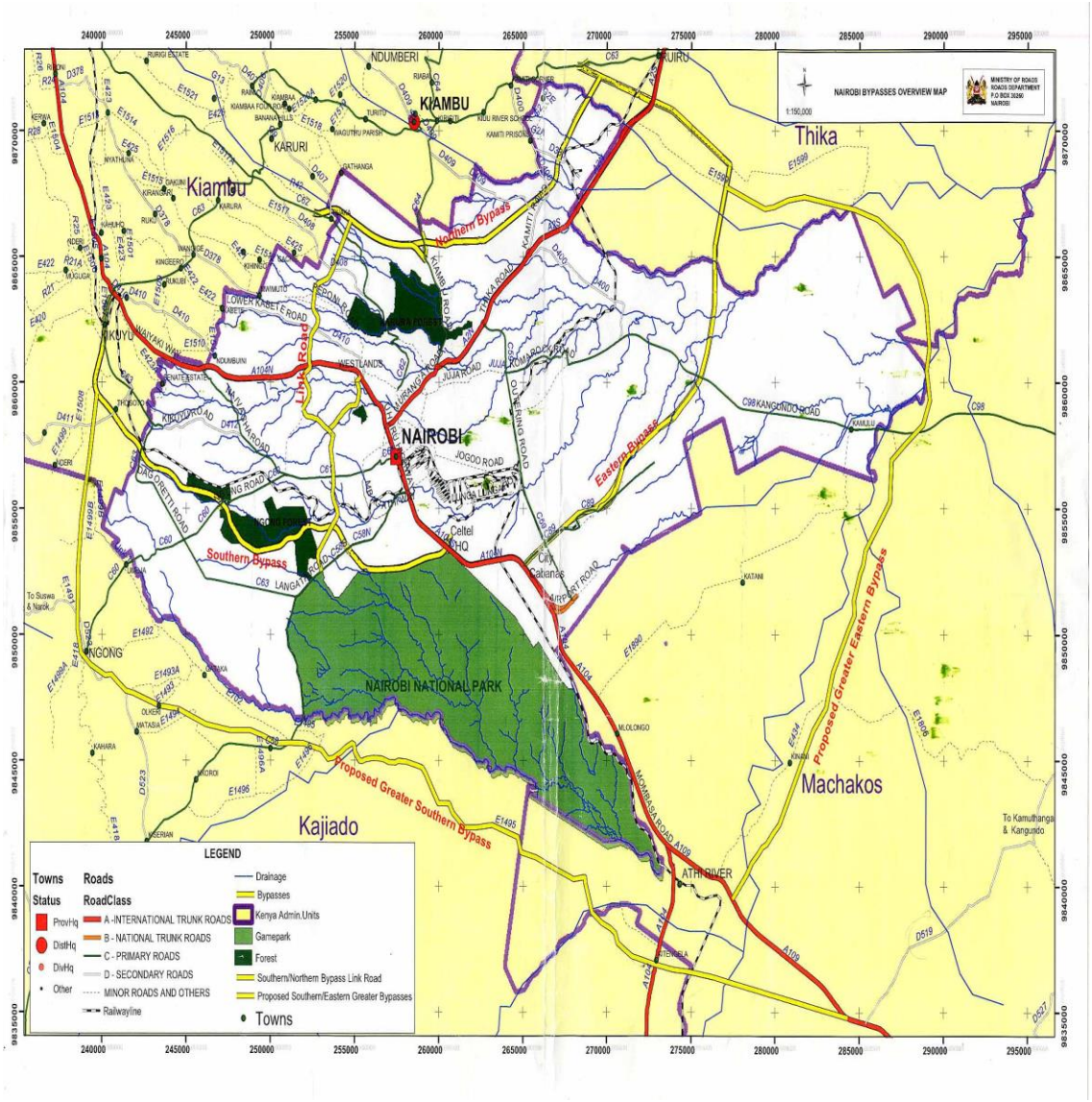
The city faces the challenge of planning for sustainable urban development that provides adequate housing and services. Major environmental issues include: rapid urbanization, informal settlements, air and water pollution, water supply and sanitation and solid waste management (Tibaijuka, 2009).

Nairobi's landscape was initially characterized by natural forests, riverine ecosystems and wetlands and abundant wildlife. However, physical expansion has come at the expense of the natural environment. Urban sprawl and construction of roads and other infrastructure has led to loss of forests and other natural areas such as mixed rangeland and bushland. The city's outskirts are threatened by urban growth.

Main sources of atmospheric pollution are vehicles, industries, emissions from charcoal and firewood burning and municipal sources such as burning of waste. The principal sources of water for Nairobi are Ndakaini, Ruiru and Sasumua dams. However, the city's waste water management has not kept up with increasing demands for the growing population and is inadequate to treat the amount of industrial and municipal effluent entering Nairobi River and other surface waters. A number of factories in Nairobi's Industrial Area discharge waste directly into Ngong river.

Increased urbanization, rural-urban migration, rising standards of living and reapid development associated with increased population growth have caused increased solid waste generation by industrial and domestic activities. In 1992, 800-1000 tonnes of waste were being generated; this amount shot to 1530 tonnes per day in 2002. Industrial wastes account for 14% of the total wastes (Tibaijuka, 2009).

Figure 4: Map of Nairobi County and Sorrounding Region



Source: Ministry of Roads, Roads Department, 2016

3.3 Methodology

3.3.1 Research Design

The study applied a descriptive survey research design as its purpose was to depict an accurate representation of individuals, event or situations (Robson, 2002). The researcher aimed to provide a description for issues in CP adoption, clarification of challenges and characteristics of particular industries, especially those related to production processes.

3.3.2 Study Population

The study population consisted of 15 manufacturing industries in the Nairobi Metropolitan Region that have already implemented CP and have been working with KNCPC. This is according to a list obtained from KNCPC in January 2015. KNCPC provided a list of all companies they have been working with countrywide whereby the researcher selected the manufacturing industries in Nairobi. The industries fall in processing, paper conversion, chemicals, tanning, plastics and rubber sub-sectors. The researcher conducted a census whereby the entire population was used for the study due to its small size hence no sampling was done.

Table 2: Industries Making Up the Population

Name of Industry	**Industrial Sub-sector**
Chandaria Industries	Paper Conversion
Unga Millers	Flour processing
BAT Kenya Limited	Tobacco processing
Kapa Oil Refineries	Edible Oil processing
Kapa Oil Refineries	Soap manufacture
HACO Industries	Plastics, cosmetics and detergents
Twiga Chemicals	Chemicals
East African Leather Factory	Leather tanning
Unilever Kenya Ltd	Manufacturing
Osho Chemicals	Chemicals
Superfoam Limited	Mattress manufacture
GlaxoSmithKline	Pharmaceuticals
Power Technics	Electricals
Geni Items Limited	Electroplating
Bidco Industries	Edible oil processing

3.3.3 Data Collection

3.3.3.1 Nature and Sources of Data

Data was collected from both primary and secondary sources. Primary data was obtained using questionnaires which were administered to respondents who had complete understanding of the industrial operations. Primary data collected included: size of the industry, major products and major raw materials used, major wastes generated, data on water and energy consumption, benefits and challenges to CP, determinants and impacts of CP. Secondary data was derived from published and unpublished literature from libraries and the internet. This data included various policies governing environmental protection, legal framework and CP practice throughout the world. The researcher also visited the websites of the industries surveyed, government bodies like NEMA and KNCPC, and of Organizations like UNEP and UNIDO which usually oversee implementation of CP. Relevant government policies and regulatory framework were also reviewed.

3.3.3.2 Research Tools

Questionnaires were used to extract information from technical officers, operations managers or HR representatives in the respective industries. Each industry to be studied had one questionnaire to fill; therefore, the researcher had fifteen questionnaires to be administered. The researcher liaised with HR representatives from each industry so as to get the right person to fill the questionnaire; majority of the industries required that the researcher goes through the HR manager office first and in many cases he/she determined who the respondent will be. Most of the questionnaires were dropped and then picked later as agreed upon with the respondent while others were administered through email. The questionnaire had five sections: Section one was used to gather general information about the industry; size of the industry, major products produced, raw materials used and wastes emitted. Section two gathered information on CP awareness and practice, Section three on benefits and challenges to CP, Section four on impacts and determinants and Section five on regulations governing the industries and compliance.

3.3.4 Data Analysis and Presentation

The data collected was entered in SPSS Version 20. The researcher organized the data into variables and then coded it. Descriptive statistics like percentages were used to analyze and make meaning out of the data. Frequency tables, bar graphs and pie-charts were then used to present the data. Bar graphs and pie-charts were generated using Microsoft Excel 2007.

3.3.5 Research Limitations

Some industries failed to respond by firmly stating that they do not allow academic research in their premises. This really affected the response rate. The researcher was able to convince some of them but this took a lot of time which was also limited for the researcher. For the ones that responded, the respondents were hesitant to disclose some of the information. They also restricted data collection to the questionnaire only and would not allow photographs. The researcher however assured them that the information will be used for academic purposes only.

The researcher also had a problem in acquiring expansive literature on the subject of CP especially here in Kenya. Not many empirical studies have been conducted in Kenya as majority of the referred studies are from elsewhere. Thus, the researcher made sure that the questionnaires were as detailed as possible in order to extract more information from the respondents.

Due to the slow nature of responsiveness on the side of the industries, the researcher incurred many costs in terms of calling and also travels expenses. At some point, the researcher engaged a research assistant to assist in data collection.

CHAPTER FOUR
RESULTS AND DISCUSSION

4.1 Introduction

This chapter summarises the results of this study. Areas covered include Response Rate, characteristics of the surveyed industries and CP practices, CP benefits, Challenges in CP adoption and implementation, Determinants of CP adoption and implementation, impacts from CP implementation, Compliance and Regulations and Hypotheses Testing.

4.2 Response Rate

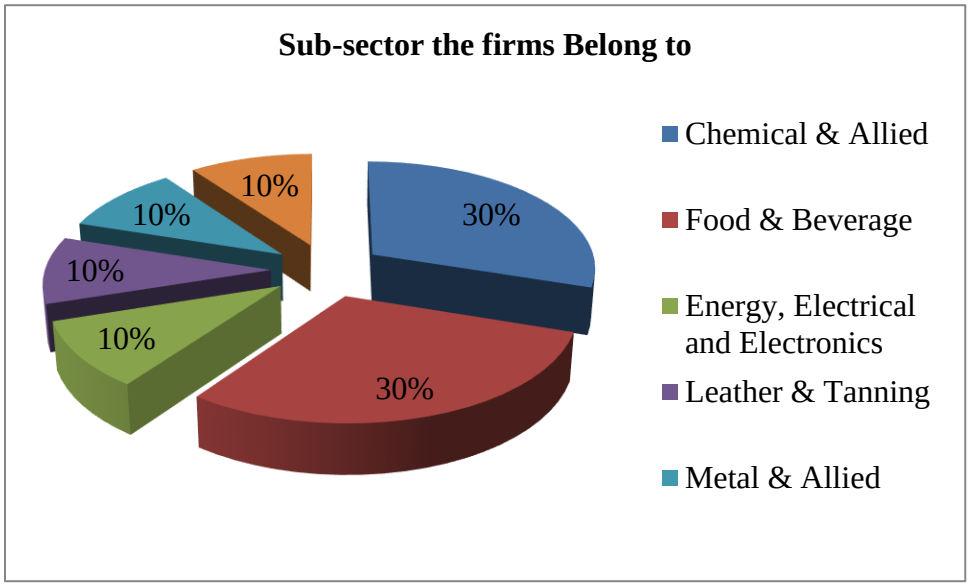
As illustrated in the previous chapter, the study involved a census on fifteen industries in the Nairobi Metropolitan Region which had already worked with the Kenya National Cleaner Production Center (KNCPC). Out of the 15 industries, 10 participated in the study making a response rate of 66.67%.

4.3 General Characteristics of Surveyed Industries

4.3.1 Subsector the firm Belongs to and Products Manufactured

Chemical and Allied subsector had 30% of the industries, 30% were from Food and Beverage, 10% from Energy, Electrical and Electronics, 10% from leather and tanning, 10% from metal and allied and 10% from pharmaceutical and medical equipment subsectors. Industries from the food and beverage subsector manufacture maize and wheat flour and also process edible oil which account for 10% and 20% of total products manufactured by industries under study respectively. 20% of the products manufactured are detergents while 10% are plants and animal chemicals. These products are from industries in the Chemical and Allied sector. Hides and skins, electrical products, electroplating and pharmaceuticals accounted for 10% of the total products manufactured each (Appendix 2).

Figure 5: Sub-sector the Firms Belong To



Source: Field data, 2016

4.3.2 Main Raw Materials Used by the Industries versus Major Waste Products

From the industries manufacturing detergents, chemicals and acid oil were the main raw materials while bleaching earth was the major waste product.40% of the industries reported to use chemicals and acid oil while bleaching earth accounted for 33.3% of total wastes generated. 20% of the raw materials were crude oil; namely palm/sunflower/corn oil. These were used in the industries manufacturing edible oils. Maize and wheat, metal anodes, hides and skins/hydroxides and electrical switches and cables accounted for 10% each of the raw materials used. Of the major waste products, waste water, scrap metal, bio-protein, organics, husks and Fatty Acid Distillate (FAD) accounted for 11.1% each (Appendix 2).

4.3.3 Year of CP Adoption

KNCPC started its operations in 2001. However, 30% of the industries reported to have adopted environmentally friendly practices before this time. This is the period between 1971 and 1997. 60% of the industries adopted CP between 2003 and 2009 while 10% reported to have adopted quite recently (2012). This is shown in table 3.

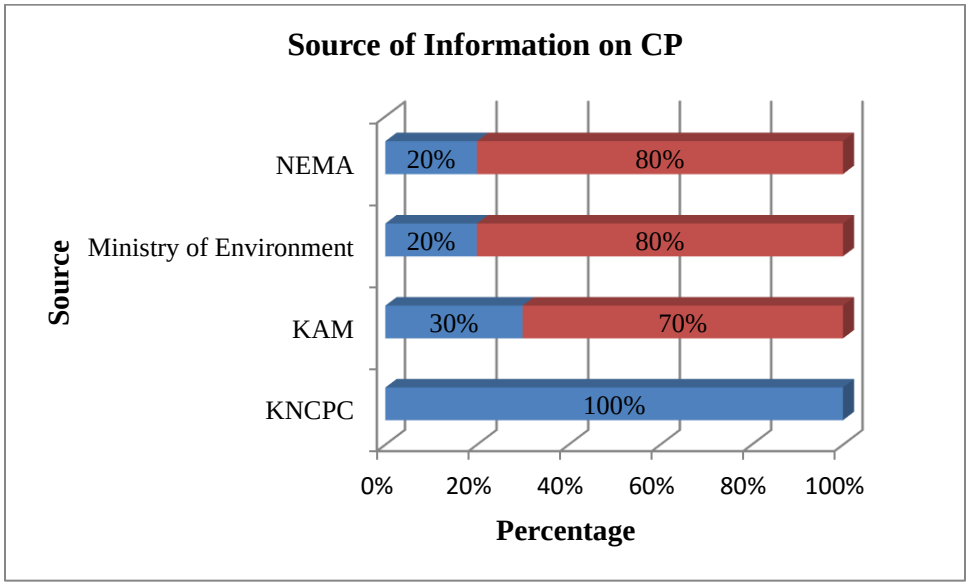
Table 3: Year the Industries adopted CP

Year of CP Adoption	Number of Industries
1971	1
1995	1
1997	1
2003	1
2004	3
2009	2
2012	1

4.3.4 Source of Information on Cleaner Production

All industries reported to have gotten information concerning cleaner production from KNCPC. This confirmed the fact that all industries under study had interacted with the government body. Of all industries under study, 30% had received information on CP from KAM, 20% from the Ministry of Environment and Natural Resources and another 20% from NEMA (Figure 6)

Figure 6: Source of Information on CP



Source: Field data, 2016

4.4 Cleaner Production Practices

Good Housekeeping: a small proportion of the industries reported the extent to which they have practiced good housekeeping as low (20%). Good housekeeping practices had been highly implemented in 60% of the industries while 20% had implemented the practice to a very high extent. This was done through proper arrangement of tools and materials and also through maintaining high standards in the chain of production. Others reported to have adopted 5S (Sort, Systematize/Set in Order, Shine/Sweep, Sanitize/Standardize, Self-discipline/Sustain) and also routine checks by checklist programs. Good housekeeping in many cases isn't associated with major cost implications for the industries. This explains the reason why it had been highly adopted.

Technology Change/Equipment Modification: a small percentage of the industries had not adopted new technology nor modified their equipment in attempts to adopt CP practices (10%). A slightly higher percentage reported the extent to which they have adopted new technology as low (30%) while other industries reported their attempts to be moderate, high or very high with 20% for each response. Those that had adopted this practice to a high extent reported that it was implemented through adoption of 4S and also introduction of new equipment through better and more efficient machines especially in terms of energy consumption. The industries that had adopted new technology to a low extent attributed this to the fact that change in technology is gradual in nature.

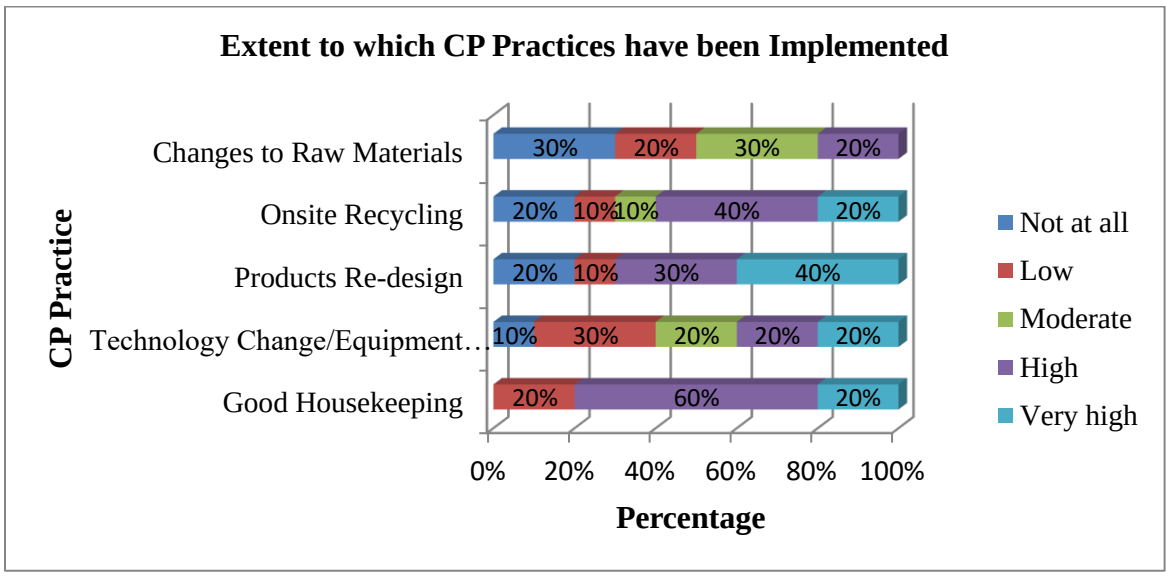
Products Re-design: there had not been any change of end products in 20% of the industries while 40% of the industries reported to have had very high attempts in re-designing their products. Other industries reported to have had low and high extent in the same with 10% and 30% respectively. Industries that had made attempts in redesigning products had achieved this through innovation and introduction of new brands. Main drivers in this CP practice were market changes, customer preferences and to enable optimum utilization of raw materials.

Onsite Recycling: a small proportion of the industries studied do not recycle materials onsite (20%). 20% of them practice onsite recycling to a very high extent. Other industries reported to have low, moderate and high extent of adopting recycling with 10%, 10% and 40% respectively. Recycling was mainly manifested in water use and the

putting up of Effluent Treatment Plants (ETPs). Major drivers for this CP practice were: reduction of wastage of raw materials, conservation of environment and reduction of costs.

Changes to Raw Materials: 30% of the industries had not changed their raw materials at all. 20%, 30% and 20% of the industries had had low, moderate and high attempts respectively in the manner they had carried out this practice. Industries that had not adopted this practice at all attributed this to the fact that they had no room for change and thus had used the same products. Others, due to their nature, lacked alternative raw materials for their products. Some had adopted this practice to a moderate extent through shifting to low sulphur oils, optimization and minimizing raw material wastage.

Figure 7: Extent to which CP Practices Have Been Implemented



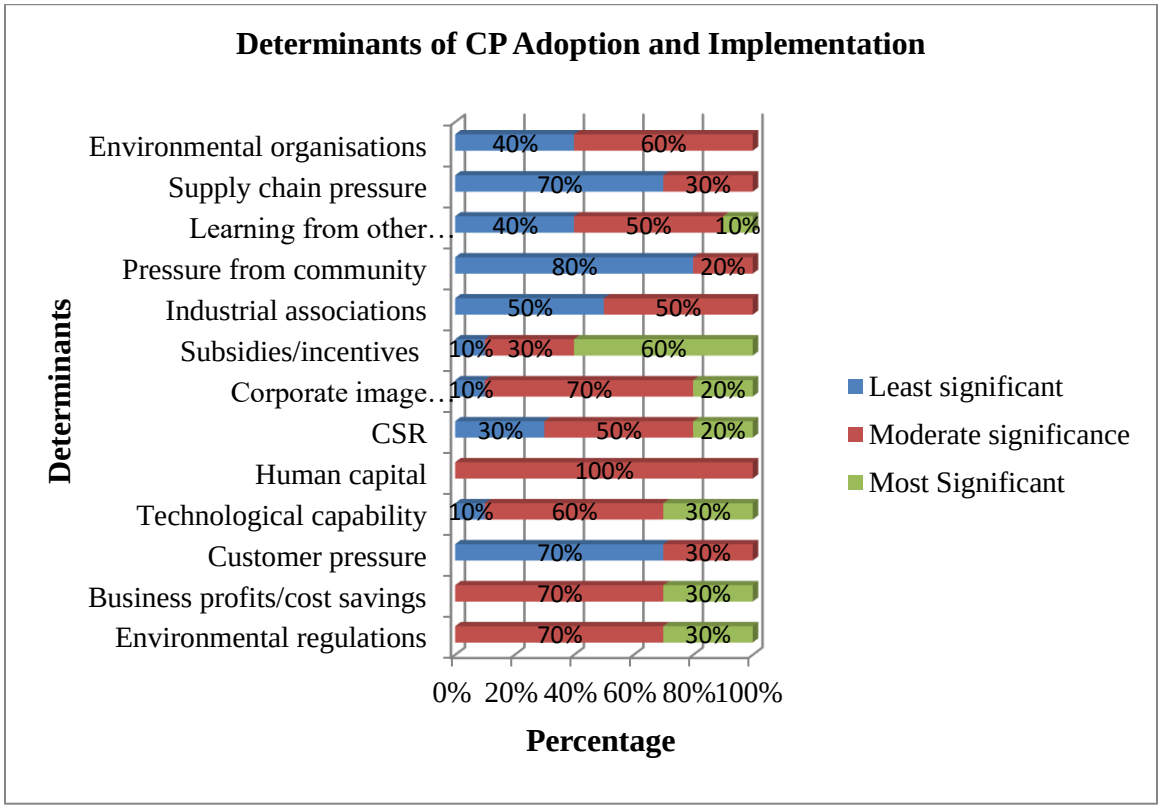
Source: Field data, 2016

4.5 Determinants of CP Adoption

Determinants such as customer pressure, pressure from industrial organizations, pressure from surrounding community to adopt environmentally friendly measures and supply chain pressure were reported to be the least significant of all determinants with more than 50% of industries each. Other determinants like pressure of environmental regulations, incentives/subsidies from government, expected business profits/cost savings and firm's

human capital had at least 30% of the industries considering them as the most significant (Figure 8).

Figure 8: Determinants of CP Adoption and Implementation



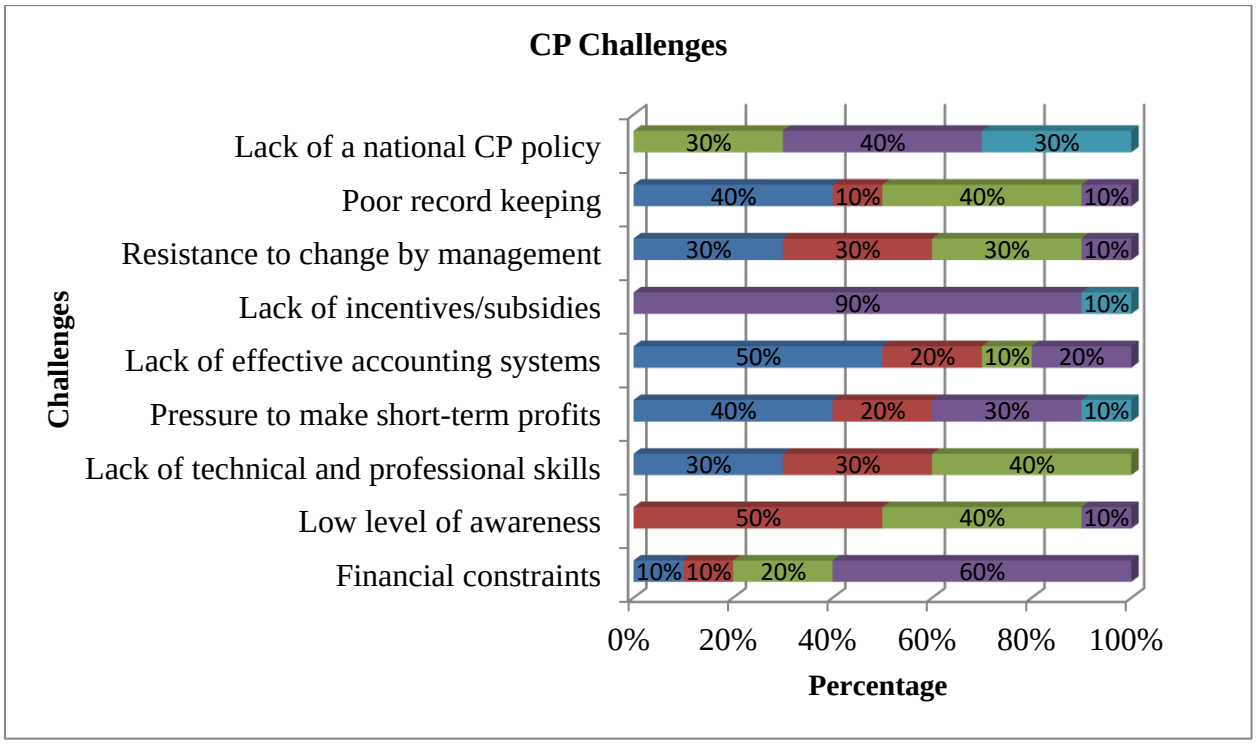
This concurs with the findings of a study by Luken and Rompaey (2008), which found out that environmental regulation and market pressure appear to exert more influence than community pressure on adoption of EST. similarly, a study by Kesidou & Demirel (2010) established that customer and societal requirements on CSR exhibit no impact upon investment level even if they may affect the firm's decision to undertake environmental innovation. Horbach *et al* (2011) noted that customer pressure was not seen as a strong stimulus for environmental innovation and that environmental regulations are more or less regulation driven in their studies on industries in Spain, US, Japan and Germany. They also noted the positive role played by cost savings as a motivation for CP technologies from the many studies in the literature they reviewed. Ondieki (2013) also noted that a business is more likely to take on environmental

management practices if they can see the benefits in form of reduced costs and/or higher revenues and profits.

4.6 Challenges Faced in Adoption and Implementation of Cleaner Production

Financial constraints had a strong impact on 60% of the industries, moderate impact on 20% and little impact on 10% of them. However, 10% of the industries never felt this challenge. Low level of Awareness on good environmental practices and benefits had a little impact on half of the industries, moderate impact on 40% of the industries and a strong impact on 10% of them. Lack of Professional and Technical Management skills had no impact on 30% of the industries, little impact on 30% and moderate impact on 40% of them. Pressure to make short-term profits did not have an impact on 40% of the industries; but had a little impact on 20%, a strong impact on 30% and a very strong impact on 10%. Lack of Effective Accounting Systems to quantify financial performance of CP projects had no impact on half of the industries; but had little impact on 20% of them, moderate impact on 10% and a strong impact on another 20%. All the industries reported that lack of incentives/ subsidies from the government to encourage CP adoption had had a strong impact in their efforts to adopt and implement CP. Resistance to change by Industry's top management and staff had no impact on 40% of the industries, little impact on 10%, moderate impact on 40% and strong impact on 10%. Poor Record keeping on water and energy Consumption as well as emissions had no impact on 40% of the industries; but had little impact on 10% of the industries, moderate impact on 40% of the industries and a strong impact on 10% of the industries. Lack of a National CP Policy in Kenya had a moderate impact on 30% of the industries, a strong impact on 40% of the industries and a very strong impact on 30% of them.

Figure 9: Challenges Faced in CP Adoption and Implementation



Source: Field data, 2016

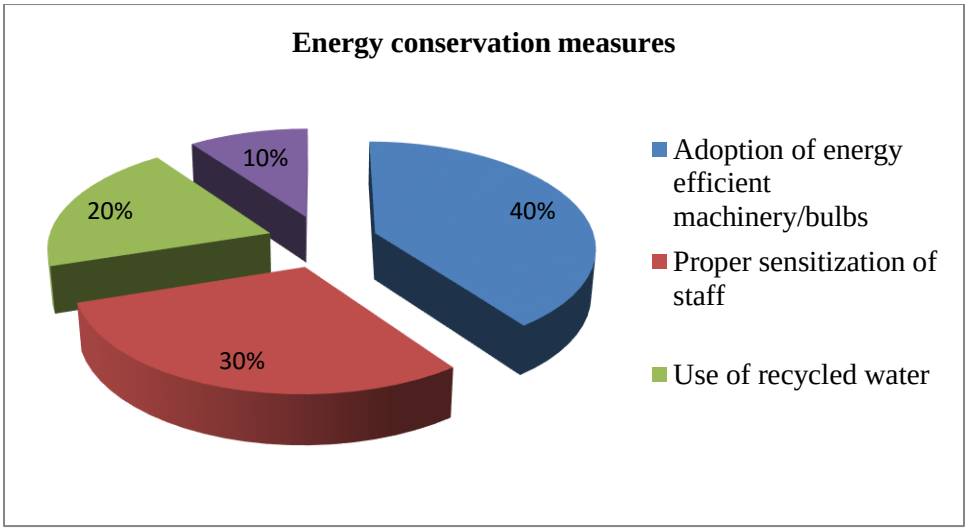
CCII (2014) in a study in China found out that the enterprises had difficulty in accessing CT due to investment and financing as they fail to afford the cost of new technology. Peng *et al* (2005) noted that enterprises become reluctant to invest in CP because EST requires high initial capital costs. Studies by CCII (2014) in China and Dandira *et al* (2012) noted that some enterprises lacked sufficient understanding on the importance of CP on SD and recommended that improving the level of awareness is paramount in the understanding and implementation of CP in manufacturing industries. In another study, Dandira et al (2012) found out that most companies concentrate most on running the industries without considering equipment maintenance. This is the pressure to make short-term profits. This worsens the situation because failure to keep the equipment in good condition results in environmental pollution. Ondieki (2013) noted in his study that hotels lacked effective accounting mechanisms to track the use of resources and the associated costs as they had poor record keeping and weak accounting systems. Other studies noted the lack of incentives and subsidies from government as having a strong impact on CP implementation. For example, Peng *et al* (2005) and Ondieki (2013) noted

lack of government-led mechanisms and incentives to promote adoption and implementation of CP. There is a dire need to have incentives on economic policies; for example, tax exemptions and grants for installation of CP technology.

4.7 Impacts from Implementation of Cleaner Production in Manufacturing Industries

CP implementation had had a very high impact on 70% on the industries as far as energy conservation is concerned; 10% had had a high impact while 20% had experienced a moderate impact on energy conservation. Regarding energy consumption, 100% of the industries are connected to the national Grid and utilize energy from KPLC; 90% of them also have diesel generators while only 20% utilized solar power as an energy source. However, 90% of the industries reported to have experienced considerable energy savings since CP adoption. Only 10% had realized increased energy consumption accompanied by increased costs. The industries had adopted various energy conservation measures: 20% of the industries use recycled water as a way of conserving energy; 30% of the industries ensure that their staff is well sensitized on proper usage of energy; 40% of the industries have adopted efficient energy conservation machinery and energy saving bulbs; while 10% have adopted metering of the energy flow system in order to track the production output (Figure 10).

Figure 10: Energy Conservation Measures Adopted by the Industries

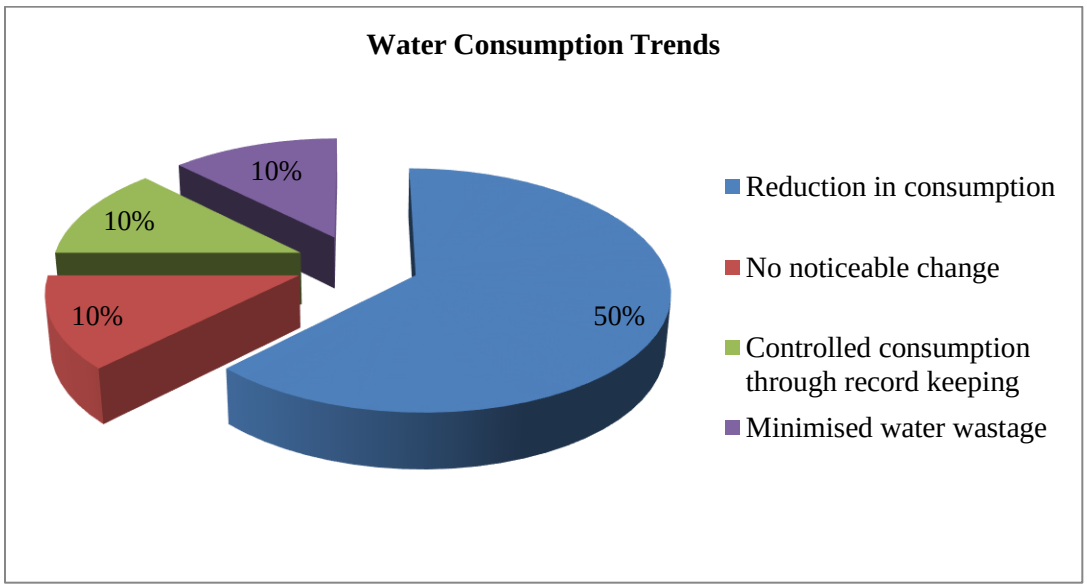


Source: Field data, 2016

The researcher sought to establish the extent to which cost savings through energy conservation influenced CP adoption. 20% of the industries reported that it had little influence, 20% moderate influence while 60% reported that energy cost savings had a strong influence on their decision to adopt CP.

CP had a very high impact on 60% of the industries, a high impact on 20% and a moderate impact on 20% of the industries in terms of water conservation. Regarding water consumption trends Since CP adoption, the researcher sought to find out about the water consumption trends since the Industry adopted CP. Regarding this, 30% of the industries had no noticeable change, 50% of the industries had noted a reduction in consumption, 10% of the industries had maintained controlled consumption through record keeping and another 10% had noted minimized water wastage (Figure 11 below).

Figure 11: Water Consumption Trends since CP Adoption

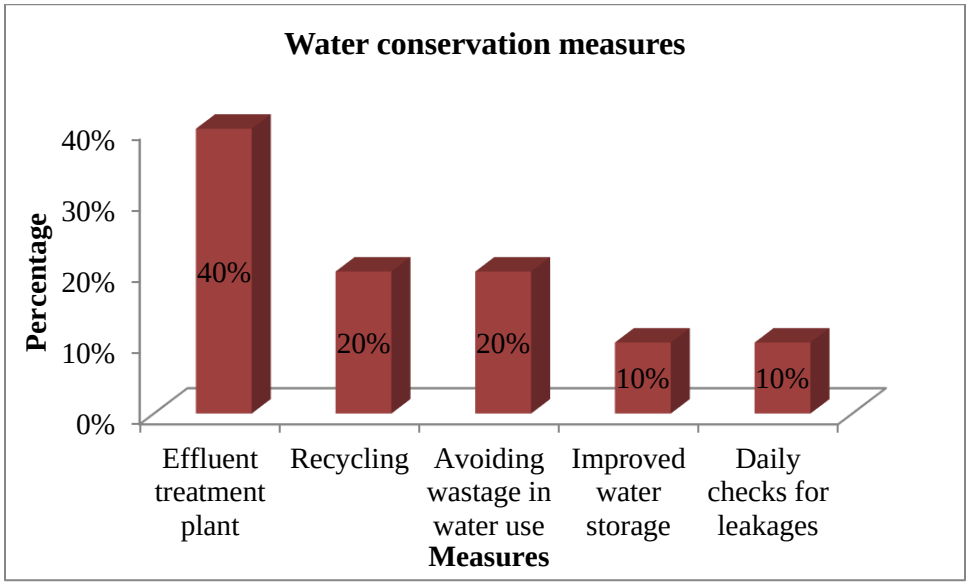


Source: Field data, 2016

Majority of the industries use piped water for their day to day industrial activities (90%); 70% of them reported to utilize borehole water while only 10% harvest rainwater for industrial use. However, the industries had adopted various water conservation measures; 40% of the industries treat their waste water through an effluent treatment plant, 20% recycled their waste water, 10% conducted daily checks for leakages, 20% have avoided

wastage in their usage of water while 10% reported to have improved on their water storage (Figure 12).

Figure 12: Water Conservation Measures Adopted by the Industries



Source: Field data, 2016

The researcher sought to establish the extent to which cost savings through water conservation measures had influenced their attempts to adopt CP. Majority of the industries (60%) reported that cost savings through water conservation had a strong influence in CP adoption while 30% and 10% reported that it had little and moderate influence respectively.

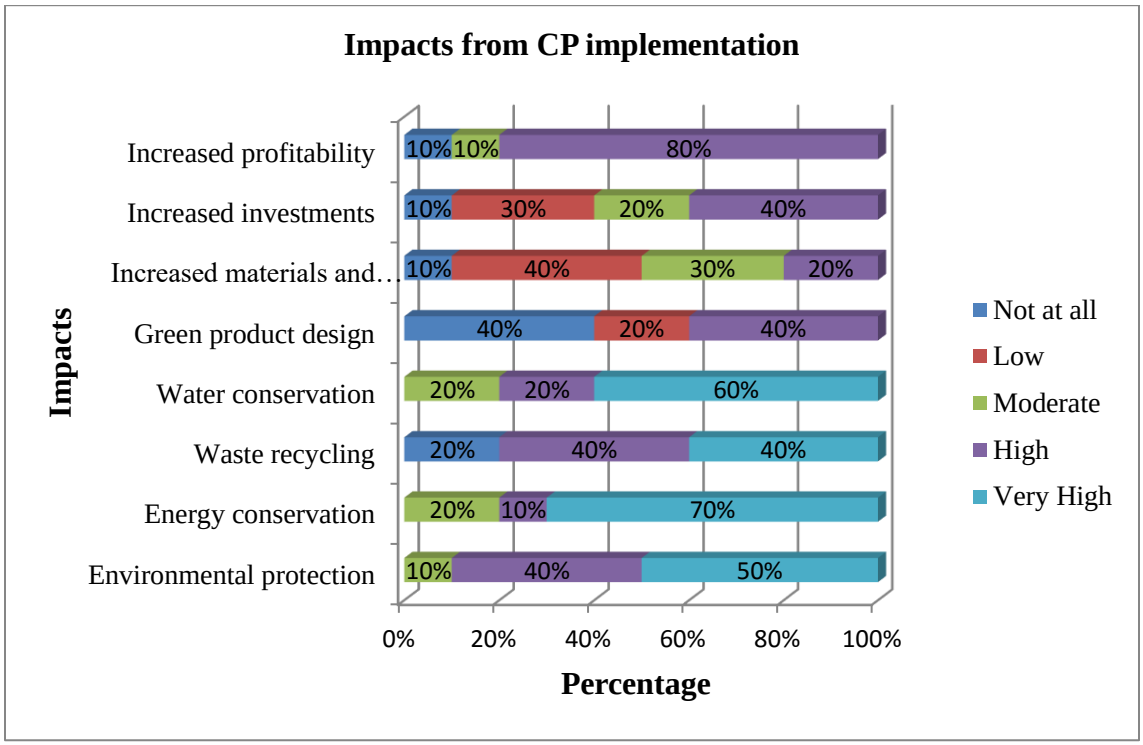
Green product design had not been adopted in 40% of the industries since CP adoption; it had a low impact on 20% of the industries and a high impact on 40% of them. A small proportion of the industries (10%) had not experienced increased costs of purchasing environmentally friendly materials and equipment; 40% felt a low impact while 30% and 20% felt moderate and high impacts respectively. Few of the industries (10%) had not experienced increased investments while 30%, 20% and 40% reported to have experienced low, moderate and high impacts on the same respectively. A big percentage (80%) of the industries studied had realized increased profitability in relation

to competitors to a high extent; but 10% of them had not experienced this at all while 10% had experienced a moderate impact.

Other impacts included: reduced cost of raw materials (30%), reduced Occupational Safety expenses (80%), improved corporate image (40%), reduced costs of waste discharge (60%), reduced environmental accidents (70%) and improved staff morale (50%). In addition, 40% of the industries had experienced improved external markets for products, 60% production efficiency gains and 30% improved quality of products. None of the industries surveyed reported to have experienced reduced penalty fee from NEMA; this might be attributed to the fact that cases of industries been subjected to penalties by the authority due to environmental pollution are rare and almost non-existent in the country.

Various studies have established the above impacts from CP implementation. For example, a study done by GDRC (2015) on a Lead Acid battery manufacturer in Tunisia who had implemented P2 options revealed benefits such as reduction of the costs of treating chemicals (by 33%), improved employee health, reduction in energy and water consumption, improvement of waste water quality and less lead was required in the process. Mwithalii (2009) in his study on EABL noted that the industry had experienced reduction in energy needs as a result of CP practices like recycling and reusing and process modification in terms of the use of hot condensed steam. Similar results on energy reduction were also noted by GDRC (2015) and Ondieki (2013). Bach and Gheewala (2010) in a study on a coal preparation facility in Vietnam noted problems in management of environmental issues and high amounts of solid waste and suggested CP practices as a solution. Thus, CP implementation is meant to be a solution to environmental problems and should result in reduction of pollution.

Figure 13: Impacts from CP implementation in the Surveyed Industries



Source: Field data, 2016

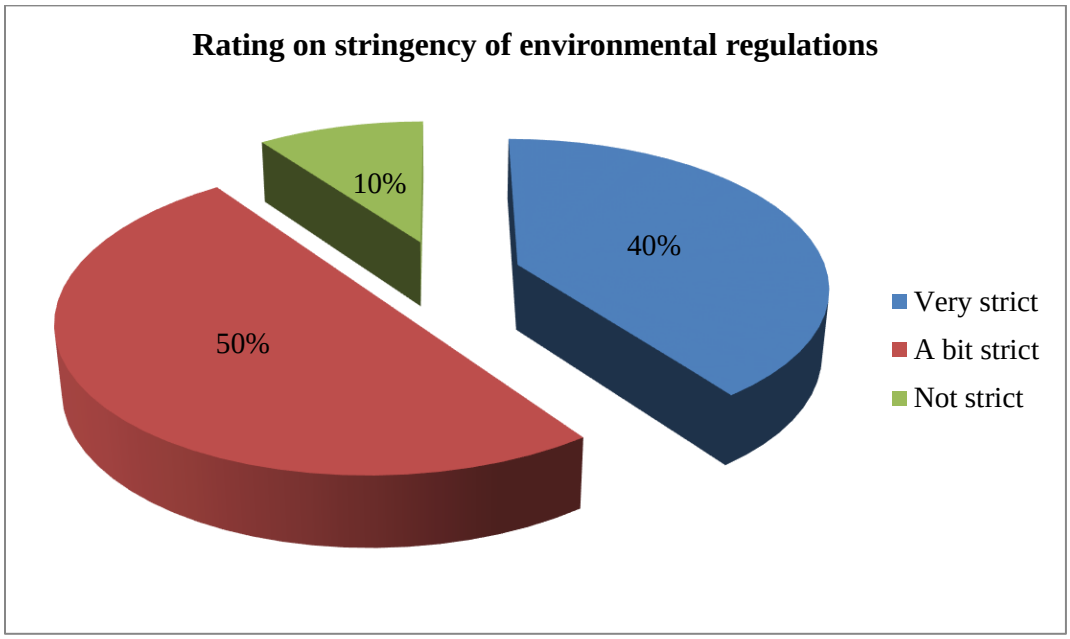
4.8 Compliance and Regulations

All the industries studied had a well-defined environmental policy and all employees were aware of the firm's environmental policy. A large proportion of the firms (80%) comply with certain environmental standards while 20% do not comply with any environmental standards. However, the researcher noted that many respondents were not fully aware of environmental standards like the ISO 14000 series. Therefore, majority responded to this matter with respect to environmental regulations in Kenya that they comply with; 42.9% comply with ISO 4001 standards, 14.3% with waste management regulations 2006, 14.3% with EIA regulations 2003, 14.3% with water quality regulations and 14.3% with environmental management policies. A small percentage of the industries had been able to comply with environmental standards for 12 years (10%), while 20% had been able to comply for four years and 10% for six years. The rest of the industries did not specify the period they had been able to comply with environmental standards.

International Organization for Standardization (ISO) standards provide practical tools for all three dimensions of SD; economic, environmental and societal. In the ISO 14000 series, there is ISO 14001 which is the world's most recognized framework for EMS and helps organs to manage better the impact of their activities on the environment and to demonstrate sound environmental management (ISO, 2016). Horbach *et al* (2011) noted that EMS is a very important tool to trigger cost saving clean technologies and also enables a firm to be aware of any existing inefficiencies. Other standards in the series according to ISO include: ISO 19011 which provides guidance on auditing standards (principles of auditing, managing audit programs and conduct of audits), ISO 14031 which provides guidance on evaluating environmental performance using suitable performance indicators based on internal and external reporting, ISO 14020 on eco-labels, ISO 14040 on Life-Cycle Assessment (LCA), ISO 14064 on GHGs accounting and verification and ISO 14063 on environmental communication guidelines helping companies make links to external stakeholders.

The researcher also sought to establish the times when the industries conducted the last environmental audit; 87.5% of them did their last audits in the year 2015 between April and December while 12.5% did the last audit in 2016.The respondents were also required to rate the stringency of environmental regulations on industries. Some industries felt that regulations are not strict (10%), others felt that regulations are a bit strict (50%) while 40% reported that environmental regulations are very strict (Figure 14).

Figure 14: Rating on Stringency of Environmental Regulations by Respondent Industries



Source: Field data, 2016

A large proportion of the industries reported that environmental regulations have influenced them in attempts to adopt CP (80%) while 20% reported that they had not been influenced by regulations. The 80% had been influenced in terms of adoption of environmentally friendly technology (37.5), noise control (12.5), and adoption of better production practices (25%), dust control (12.5%) and knowledge to reduce pollution (12.5%). The 20% who reported that they have not been influenced by environmental regulations referred their main drive to set targets by the firms.

CHAPTER FIVE
SUMMARY OF FINDINGS, CONCLUSIONS AND RECOMMENDATIONS

5.1 Introduction

This chapter gives a summary of research findings, conclusions and recommendations made to policy makers as well as for further research.

5.2 Summary of Findings

The industries studied were under the following sub-sectors: chemical and allied (30%), food and beverage (30%), energy electrical and electronics (10%), leather and tanning (10%), metal and allied (10%); and pharmaceutical and medical equipment (10%). 80% of the industries sell their products both locally and internationally. Chemicals and acid oil formed the major raw materials in the studied industries (40%), while bleaching earth and waste water were part of the major waste products (33.3% and 31% respectively).

30% of the industries had adopted environmentally friendly practices even before the KNCPC started its operations. 70% adopted CP after 2001. All industries had received information on CP from KNCPC. Good housekeeping as a CP practice had been implemented by all the industries surveyed though at varying extents. Some CP practices hadn't been incorporated at all in some of the industries: adoption of new technology in 10% of the industries, Re-design of products and onsite recycling in 20% of the industries. It was also noted that only 10% of the industries utilize rainwater in their day to day operations through harvesting. However, 70% of the industries had noted positive changes in water consumption trends since CP adoption. The major water conservation measures included ETPs (in 40% of the industries) and water recycling (20%). 60% of the industries reported that cost savings through water and energy consumption had had a strong influence on their attempts to adopt CP. As far as energy consumption was concerned, only 20% utilized solar energy. However, all industries had adopted various energy conservation measures.

CP benefits that were experienced by over 40% of the industries included: reduced costs of raw materials, occupational safety expenses, energy consumption and waste discharge; improved corporate image and staff morale; reduced environmental accidents; production

efficiency gains and improved quality of products. Significant challenges in adoption and implementation of CP included: financial constraints, lack of a national CP policy, lack of effective accounting systems to quantify financial performance of CP projects, low level of awareness on good environmental practices and their benefits and pressure to make short-term profits.

The most significant determinants of CP adoption among the industries were pressure of environmental regulations, expected business profits/ cost savings and human capital. High impacts of CP implementation on the industries studied were: environmental protection through reduction of emissions, energy and water conservation, waste recycling and increased profitability in relation to competitors.

5.3 Conclusions

On cleaner production adoption and implementation in industries, it's clear that the practice has not been widely implemented in the country. The industries that have incorporated some CP aspects in their operations have not fully implemented some practices like recycling; technology change and products redesign which are very relevant. Majority of industries also do no harvest rainwater nor utilize solar energy.

The lack of a national CP policy remains to be a big setback. Other challenges like lack of effective accounting systems and financial constraints were found to have a significant influence on CP practices such as onsite recycling, changes in raw materials, technology change and products re-design. This probably explains why these CP practices haven't been implemented at all in some of the industries.

The lack of awareness on environmental standards such as the ISO 14000 series was evident, which bear a major contribution to environmental and economic components of SD and TBL including benefits such as; reduced raw materials/resource use, reduced energy consumption, improved process efficiency, reduced waste generation and disposal costs and utilization of recoverable resources. Apart from the ISO standards discussed in the previous chapter, there are other upcoming standards such as ISO 14045 which will provide guidelines on eco-efficiency assessment principals and requirements, ISO 14051 on principals and framework for Material Flow Cost Accounting, ISO 14067 on carbon

footprint of products (quantification and communication of GHGs associated with products) and ISO 14006 which will provide guidelines on eco-design (ISO, 2016)

5.4 Recommendations

5.4.1 Policy Makers

The fact that there is no CP policy in Kenya is a matter of concern and is an issue of significance according to this study. CP need not be a voluntary procedure in the country for maximum realization of social, economic and environmental benefits. There needs to be some rule guiding all manufacturing industries regarding this issue as adopted in China in the year 2003.Policy makers also need to look into the regulatory framework governing industries as some regulations are in conflict. EMCA, for example, has some components that are in conflict with EIA regulations.

KNCPC should partner with organizations such as UNEP, ADB, World Bank, etc, to source funding, technology and human capital required so that their operations can reach out to a higher number of industries bearing the fact that the researcher only had 15 manufacturing industries only that have worked with KNCPC in the whole of Nairobi region.

The Ministry of Environment needs to work closely with the industries and provide more information on CP. Not many of the industries surveyed had received instructions from the ministry. The ministry together with bodies like NEMA need to work hand in hand to ensure that all environmental regulations are adhered to as some industries felt that the stringency is not strong. In addition to this, the government needs to see to it that industries have been provided with the right incentives they need in order to comfortably adopt and implement CP. Majority of the industries pointed out lack of government incentives as a major challenge.

The policy makers should collaborate with the Kenya Association of Manufacturers (KAM) because this body is in the best position to influence policy making on behalf of the industries. KAM should also find ways of influencing its members to adopt clean energy such as solar energy and also alternative sources of water like rainwater harvesting which this study found missing in most of the industries.

5.4.2 Further Research

There exists scarce empirical research on the aspect of CP; hence more studies are paramount. This study didn't consider aspects such as emissions and waste generation quantities. Thus, studies are necessary to establish the influence of CP on emission reduction and waste reduction. Moreover, studies need to be conducted on the role of CP in improving OHS in industries and also Economic Impacts of CP on industries; among others.

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APPENDIX 1: SURVEY QUESTIONNAIRE

The purpose of this questionnaire is to obtain information that is relevant to my research titled "Determinants of adoption of Cleaner Production in Manufacturing Industries: A study of selected Industries in Nairobi." Information collected will be used purely for academic research and will be treated with utmost confidentiality. I humbly request you to provide the information sought by this questionnaire as candidly as possible.

SECTION I: GENERAL INFORMATION

Name of industry: ……

Year of establishment: …….

Physical location of Industry: …….

Total number of staff: …….

Position of respondent in Industry: …….

1. Please select the sub-sector in which your firm belongs and the products you manufacture (Tick one)

Sub-sector	Tick	Major Products
Chemical and Allied		
Energy, Electrical and Electronics		
Food and Beverages		
Metal and Allied		
Paper and Board		
Pharmaceutical and Medical Equipment		
Plastics and Rubber		
Leather and Tanning		
Any other (please specify)		

2. Where are your target customers located? (please tick as appropriate)

Locally	( )
Internationally	( )
Both	( )

3. What are the main raw materials used by the industry for production?

……

……

……

4. What constitutes the major part of the wastes produced by the industry?

……

……

SECTION II: CLEANER PRODUCTION AWARENESS AND PRACTICE

1. In which year did the Industry adopt CP?

……

2. Where did the industry get information on Cleaner Production from? (please tick as appropriate; you can select more than one option)

i)	From the Kenya National Cleaner Production Center (KNCPC)	( )
ii)	From Kenya Association of Manufacturers (KAM)	( )
iii)	From National Environment Management Authority (NEMA)	( )
iv)	From Ministry of Environment and Natural Resources	( )
v)	From the internet	( )
vi)	From other enterprises	( )
vii)	From customers	( )
viii)	From environmental consultants	( )
ix)	Any other source (please specify)	

……

……

3. Please indicate the extent to which the following Cleaner Production practices are adopted in your industry:

(1) Not at all (2) Low (3) Moderate (4) High (5) Very High

CP Practice	1	2	3	4	5	Please explain briefly how
Good housekeeping						
Technology change/ Equipment modification						
Redesign of products						
Onsite recycling						
Changes to raw materials						
Any other (please specify)						

4. Which of the following water sources does your industry use? (Please tick as appropriate. You can select more than one option)

   i) Piped water supply ( )
   ii) Borehole ( )
   iii) Rainwater harvesting ( )
   iv) Nearby river/water body ( )
   v) Any other (please specify)

   ……
   ……

5. Please explain briefly water consumption trends in your industry since adoption of Cleaner Production……
   ……
   ……
   ……

6. Please outline the water conservation measures taken by your industry

   ……

   ……

   ……

   ……

7. To what extent did cost savings through water conservation influence adoption of Cleaner Production in your Industry? (Please tick one option)

   No influence ( ) Little Influence ( ) Moderate influence ( ) Strong influence ( )

8. Which of the following energy sources do you utilize in your industry? (please tick as appropriate. You can select more than one option)

   i) National Grid (KPLC) system ( )

   ii) Solar energy ( )

   iii) Diesel Generators ( )

   iv) Any other (Please specify)…….

   ……

   ……

9. Please describe briefly the trends in energy consumption since adoption of Cleaner Production in your Industry.

   ……

   ……

   ……

10. Please outline the energy conservation measures taken by your industry

    ……

    ……

    ……

    ……

11. To what extent did cost savings through energy conservation influence the adoption of Cleaner Production in your industry? (please tick one option)

    No Influence ( ) Little Influence ( ) Moderate Influence ( ) Strong Influence ( )

SECTION III: CLEANER PRODUCTION BENEFITS AND CHALLENGES

1. What benefits has the industry realised as a result of implementing Cleaner Production? (please tick as appropriate; you can select more than one option)

i)	Reduced costs of raw materials	( )
ii)	Reduced Occupational safety expenses	( )
iii)	Improved corporate image	( )
iv)	Reduced costs of energy consumption	( )
v)	Reduced costs of water consumption	( )
vi)	Reduced costs of waste discharge	( )
vii)	Reduced environmental accidents	( )
viii)	Improved staff morale	( )
ix)	Access to external markets for products	( )
x)	Production efficiency gains	( )
xi)	Reduced penalty fee from NEMA	( )
xii)	Improved quality of products	( )

2. The following table contains challenges faced in adoption and implementation of Cleaner Production in manufacturing industries. To what extent do they impact on your industry's operations in adopting CP? (please tick one option for each challenge)

   (1) No impact (2) Little Impact (3) Moderate impact (4) Strong Impact (5) Very strong Impact

Challenges to CP Implementation	**LEVEL OF IMPACT**				
	1	2	3	4	5
Financial Constraints					
Low level of awareness on good environmental practices and their benefits					
Lack of technical and professional management skills					
Pressure to make short-term profits					
Lack of effective accounting systems to quantify financial performance of CP projects					
Lack of incentives/subsidies from government to encourage CP adoption					
Resistance to change by Industry's top management and staff					
Poor record keeping on water and energy consumption as well as emissions					
Lack of a national CP policy in Kenya					

SECTION IV: DETERMINANTS AND IMPACTS OF ADOPTION OF CLEANER PRODUCTION

1. Below are determinants for adoption of Cleaner Production in manufacturing industries. Which ones apply for your industry? Please rate them on a scale of 1-5 (1 being the least significant and 5 the most significant)

DETERMINANTS	**LEVEL OF SIGNIFICANCE**				
	1	2	3	4	5
Pressure of Environmental regulations					
Expected business profits/cost savings					
Customer pressure					
Firm's technological capability					
Firm's human capital					
Corporate Social responsibility					
Expected corporate image improvement					
Subsidies/incentives from government					
Pressure from industrial associations					
Pressure from surrounding community to adopt environmentally friendly measures					
Learning from other enterprises					
Supply chain pressure					
Pressure from environmental organizations					

2. Below are some of the impacts from implementation of cleaner Production in manufacturing industries. Please indicate the impact in your industry as a result of adopting CP (please tick one for each impact)

   (1) Not at all (2) Low (3) Moderate (4) High (5) Very High

IMPACT	**LEVEL OF IMPACT**				
	1	2	3	4	5
Environmental protection through reduction of emissions					
Energy conservation					
Waste recycling					
Water conservation					
Green product design					
Increased training costs					
Increased costs of purchasing environmentally friendly materials and equipment					
Increased investments					
Increased profitability in relation to competitors					

SECTION V: COMPLIANCE AND REGULATIONS

1. Does your company have a well-defined environmental policy?

   Yes ( ) No ( )

2. If your answer to (1) above is Yes, is every employee aware about the firm's environmental policy?

   Yes ( ) No ( )

3. Does your industry comply with any environmental standards (e.g. ISO 14001)? If Yes, which ones and for how long have you been able to comply?

   ……

   ……

4. When was the last environmental audit done?

   ……

   ……

5. How can you rate the stringency of environmental regulations on industries? (please tick one)

   Not strict ( ) A bit strict ( ) Very strict ( )

6. Have the environmental regulations influenced your industry in attempts to adopt Cleaner Production? If so, how?

   ……

   ……

   ……

THANKS FOR YOUR PARTICIPATION

APPENDIX 2: FREQUENCY TABLES

products the company manufactures

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	detergents	2	20.0	20.0	20.0
	edible oils	2	20.0	20.0	40.0
	maize and wheat flour	1	10.0	10.0	50.0
	hides and skins	1	10.0	10.0	60.0
	electrical products	1	10.0	10.0	70.0
	electroplating	1	10.0	10.0	80.0
	pharmaceuticals	1	10.0	10.0	90.0
	plants and animal chemicals	1	10.0	10.0	100.0
	Total	10	100.0	100.0	

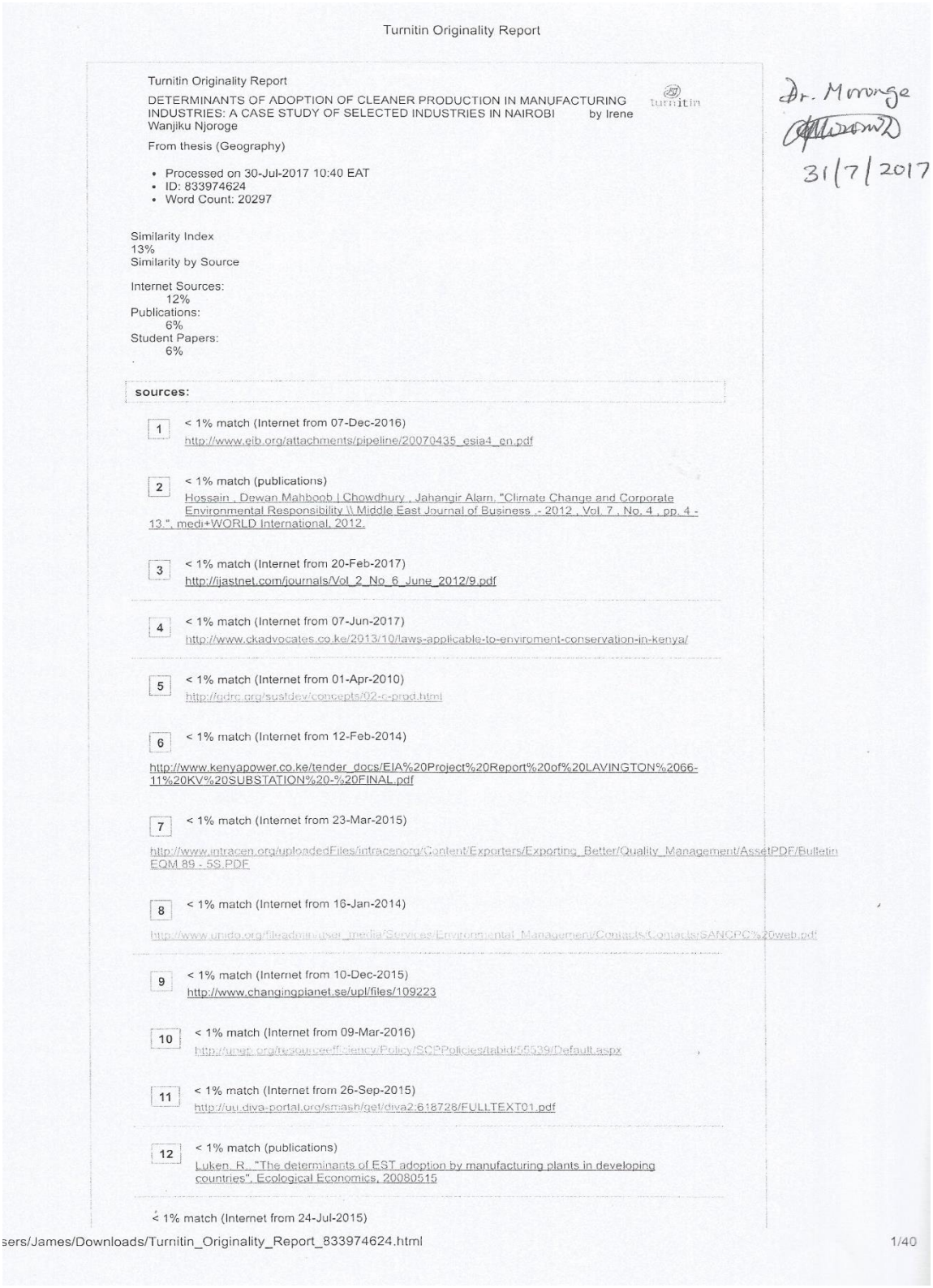
main raw materials used by the industry

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	chemicals and acid oil crude	4	40.0	40.0	40.0
	palm/corn/sunflower oil	2	20.0	20.0	60.0
	maize and wheat	1	10.0	10.0	70.0
	metal anodes	1	10.0	10.0	80.0
	hides and skins and hydroxides	1	10.0	10.0	90.0
	electrical switches and cables	1	10.0	10.0	100.0
	Total	10	100.0	100.0	

major waste products in the industry

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	bleaching earth	3	30.0	33.3	33.3
	waste water	1	10.0	11.1	44.4
	scrap metal	1	10.0	11.1	55.6
	bio protein	1	10.0	11.1	66.7
	organics	1	10.0	11.1	77.8
	husks	1	10.0	11.1	88.9
	poly ethene and fatty acid distillate	1	10.0	11.1	100.0
	Total	9	90.0	100.0	
Missing	System	1	10.0		
Total		10	100.0		

Appendix 3: Plagiarism Report



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Appendix 4: Declaration of Originality Form

Declaration Form for Students

UNIVERSITY OF NAIROBI

Declaration of Originality Form

This form must be completed and signed for all works submitted to the University for examination.

Name of Student: IRENE WANJIKU NJOROGE

Registration No: C50/71744/2014

College: HUMANITIES

Faculty/School/Institute: ARTS

Department: GEOGRAPHY AND ENVIRONMENTAL STUDIES

Course Name: M.A. ENVIRONMENTAL PLANNING AND MANAGEMENT

Title of the work: DETERMINANTS OF ADOPTION OF CLEANER PRODUCTION IN MANUFACTURING INDUSTRIES IN NAIROBI

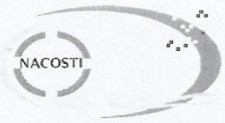
DECLARATION

1. I understand what Plagiarism is and I am aware of the University's policy in this regard.
2. I declare that this project (Thesis , project, essay, assignment, paper, report etc) is my original work and has not been submitted elsewhere for examination, award of a degree or publication. Where other people's work, or my own work has been used, this has properly been acknowledged and referenced in accordance with the University of Nairobi's requirements.
3. I have not sought or used the services of any professional agencies to produce this work.
4. I have not allowed, and shall not allow anyone to copy my work with the intention of passing it off as his/her own.
5. I understand that any false claim in respect of this work shall result in disciplinary action in accordance with University Plagiarism Policy.

Signature: .....

Date: 7/9/2017

Appendix 5: Research Permit



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Date: **27th July, 2017**

Irene Wanjiku Njoroge
University of Nairobi
P.O. Box 30197-00100
NAIROBI.

RE: RESEARCH AUTHORIZATION

Following your application for authority to carry out research on ***"Determinants of adoption of cleaner production in manufacturing industries: A study on selected industries in Nairobi,"*** I am pleased to inform you that you have been authorized to undertake research in **Nairobi County** for the period ending **25th July, 2018.**

You are advised to report to **the County Commissioner and the County Director of Education, Nairobi County** before embarking on the research project.

Kindly note that, as an applicant who has been licensed under the Science, Technology and Innovation Act, 2013 to conduct research in Kenya, you shall deposit **a copy** of the final research report to the Commission within **one year** of completion. The soft copy of the same should be submitted through the Online Research Information System.

GODFREY P. KALERWA MSc., MBA, MKIM
FOR: DIRECTOR-GENERAL/CEO

Copy to:

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Nairobi County.

The County Director of Education
Nairobi County.

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REPUBLIC OF KENYA

National Commission for Science, Technology and Innovation

RESEARCH CLEARANCE PERMIT

Serial No.A 15158

CONDITIONS: see back page

THIS IS TO CERTIFY THAT:
MS. IRENE WANJIKU NJOROGE
of UNIVERSITY OF NAIROBI, 0-200
Nairobi,has been permitted to conduct research in *Nairobi County*

on the topic: *DETERMINANTS OF ADOPTION OF CLEANER PRODUCTION IN MANUFACTURING INDUSTRIES: A STUDY ON SELECTED INDUSTRIES IN NAIROBI*

for the period ending:
25th July,2018

Permit No : NACOSTI/P/17/63066/18138
Date Of Issue : 27th July,2017
Fee Recieved :Ksh 1000

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Applicant's Signature

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Director General
National Commission for Science, Technology & Innovation