Integration of an Eco-Ethical Strategy into Product Life Cycle in Nairobi

A thesis submitted in fulfilment for the degree of doctor of philosophy (PhD) in the

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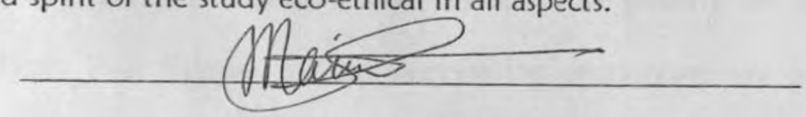
November, 2011

Declaration

I hereby declare that this thesis is my own work and that, to the best of my knowledge and belief, it contains no material previously published or written by another person, nor material which to a substantial extent has been accepted for the award of any other degree or diploma of the university or other institute of higher learning, except where due acknowledgment has been made in the text.

Eco-declaration

Apart from the ink used to print this monograph which this researcher had no control over, the materials on which this thesis is presented are 100% recyclable. This makes the letter and spirit of the study eco-ethical in all aspects.



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First and foremost to God for His uncountable blessings. I also wish to express my profuse gratitude first to my erudite supervisors, Dr. Tom Anyamba, Professor W.H.A. Olima and Dr Walter H. Ọnyango for believing in me and for indefatigable thorough supervision. To my family, wife Nyokabi and two sons Kiragu and Mburu, for their patience and understanding as I diverted much needed cash to my "selfish" needs. To the Department of Architecture and Building Science, for agreeing to host my academic ambitions when my 'home' department placed insurmountable impediments on my way. Special gratitude to the chairman Mr. Kigara Kamweru for his understanding and for unselfishly expediting the protocol of registration. The following, some of whom are my colleagues also had some bearing on my research. They include the late Dr. S. J. M. Maina who, before passing on, was my erudite supervisor, Prof. Paul Syagga for his unrelenting encouragement and advise, Dr. Robert Rukwaro, Dr. Zachary Gichunge, Dr. Njeri Wachira who thoroughly perused through the monograph for any possible inconsistencies, Lilac Osanjo, Romanus opiyo, Lorain Amollo, Kakumu, Lily Kimaru, Laban Shihembetsa, Isaac Adejumo, Isaac Chege, J. L. Mukira, Beatrice Khaemba, Tabitha Kiarii, Jain Abonyo, Michael Munene, Ben Kitolo, Charles Ouma, Millicent Otina and last but not least Joyce Akatch, for their moral support. To you all my Mashujaas (Heroes/Heroines), Asante (Thank you).

Dedication

To my late mother, Loise Wanjiku wa Maina, Who could have been elated.

Abstract

The thesis advanced in this study is the current local and global environmental ethics issue in product development policies within the framework of the ever growing customer demands. The study explores the current urgent need for appropriate product design structures, practical tools and eco-awareness among stakeholders in the product design process and throughout the entire product life cycle.

Existing literature decries the current deplorable state of global environment and its myriad effects on health, habitat and future generations. It also points to the great global concern for the environment and efforts by individuals, government and international agencies to mitigate these adverse effects. The literature further apportions currently available methods of assimilating environmental aspects into product design and the product life cycle. On the Kenyan situation, available literature decries the incapacity and apathy in dealing with environmental issues and documents the growing crisis of haphazard heaps of solid waste.

The study highlights these growing haphazard heaps of illegally dumped waste and its ecological effects on the living environment in Nairobi city. It hypothesised that incorporating eco-aspects in the product design and product life cycle would mitigate this problem. The objective was to evaluate the design process with the aim of investigating the level of incorporation of eco-ethical consideration in design. The study further sought to determine the effects of an eco-ethical consideration in the product design process so as to come up with other design models that could mitigate adverse effects on the environment.

Using a multiple case study approach, the study collected and analysed quantitative and qualitative data from primary and secondary sources. While quantitative data was collected using questionnaires, qualitative inquiry was through observation and focus group discussions. Analysis was done through varied method including statistical package for social sciences for windows while qualitative data was analysed through thematic analysis methods. Data obtained through observation was recorded in photographic format and analysed through classification method. The classifier algorithm took a set of parameters (or feature) that characterised the objects of study (or instance) and used them to determine the type (or class).

Findings revealed designer omission of eco-ethical strategies in the design process, a ruined environmental living dispensation and apathy and ignorance of eco-aspects. Based on these findings the study recommends integration of eco-aspects all along the product design process. Specific recommendation include; designer motivation (Moral obligation towards environment), where concern for the environment is ingrained in the total livelihood of the designer through formal and informal education by parents, peers, the education system (government) and society; competence (Designer awareness of eco-ethical aspects), where the designer understands enough eco-aspects as to have a wide enough arsenal to choose from while designing; product design and development (The product design process), where the designer actually integrates eco-aspects at all the known stages of the design process.

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Acronyms

UNEP	United Nations Environmental Program
WHO	World Health Program
IISD	International Institute for Sustainable Development (IISD)
JICA	Japan International Corporation Agency
ICSID	International Council of Industrial Design
ISO	International Organization for Standardization
WBCSD	World Business Council for Sustainable Development (WBCSD)
OECD	Organisation for Economic Co-operation and Development

CHAPTER ONE

INTRODUCTION

1.0 Introduction

In this chapter, the researcher has laid down a review of issues that inspired the entry into the study of application of eco-ethics in sustainable product design. The chapter also anchors the study on authorities and issues on the environment. It enumerates arguments advanced by national and global institutions on ecological sustainability and captures views on the state of the earth in terms of material capacity. The problem under review in this thesis is also outlined, justified, objectives identified and new terms defined in this chapter.

1.1Background to The Study

The state of the environment has lately become a big global issue, especially in this current age of climate change and global warming. Even from a locally based international environmentalist like Wangari Mathai, this issue has come home to Kenya. In her acceptance speech for the Nobel peace prize of 2004 delivered in the Oslo City Hall, Oslo, Norway, Wangari pointed out that currently, citizens of Africa are being mobilised to challenge widespread abuses of power, corruption and environmental mismanagement (Www.wangari maathai - Nobel lecture.htm, 2004)

Modern technology, or rather Western technology has failed us not because it has become economically counterproductive in the long run; and not because it has

become ecologically devastating, but mainly because it has ignored its basic function, namely that all its technics are, in the last resort, the tactics for living. Because modern technology has failed us as a set of the tactics for living, it has also proved in the process to be economically counter-productive and ecologically ruinous (Margolin, 1995).

On the environment front, Wangari (2004) said that people are exposed to many human activities that are devastating to the environment and societies. In her view, these include widespread destruction of ecosystems, especially through deforestation, climatic instability, and contamination of the soils and waters that all contribute to excruciating poverty. In Wangari's words

> "In the process, the people involved discover that they must be part of the solutions. They realise their hidden potential and are empowered to overcome inertia and take action. They must come to recognize that they are the primary custodians and beneficiaries of the environment that sustains them" (www: \wangari maathai - Nobel Lecture.htm, 2004).

According to Wangari, entire communities also come to understand that while it is necessary to hold their governments accountable, it is equally important that in their own relationships with each other and their environment, they exemplify the leadership values they wish to see in their own leaders, namely ethics, justice, integrity and trust. Wangari's points are given credence by ideas from the Brundtland report.

The report, Our Common Future, from the UN World Commission on Environment and Development (WCED) was published in 1987. Its targets were multilateralism and interdependence of nations in the search for a sustainable development path. The report sought to recapture the spirit of the United Nations Conference on the Human Environment - the Stockholm Conference of 1972-, which had introduced environmental concerns to the formal political development sphere. 'Our Common Future' placed environmental issues firmly on the political agenda; it aimed to discuss the environment and development as one single issue.

The publication of "Our Common Future" and the work of the World Commission on Environment and Development laid the groundwork for convening the 1992 Earth Summit and the adoption of Agenda 21, the Rio Declaration and to the establishment of the Commission on Sustainable Development. In that report, the view that society should adopt practices that enhance world peace through eco-cultural values as a matter of urgency was advanced.

Such practices are part of an extensive cultural heritage, which contributes both to the conservation of habitats and to cultures of peace. With the destruction of these cultures and the introduction of new values, local biodiversity is no longer valued or protected and as a result, it is quickly degraded and disappears.

> *"As we progressively understand the causes of environmental degradation", said Wangari, "We see the need for its conservation". Indeed, the state of any country's environment is a reflection of the kind of philosophy in place, and without such philosophy, there can be no peace. Many countries, which have poor environmental governance*

systems, are also likely to have conflicts and poor laws protecting the environment."

It is frequently argued that the move towards sustainable design needs to be built on three pillars: ecology, economy and society (Wilhide, 2002).

As shown in plate No. 1.1, on the red mandala, society cannot help being socially unconcerned, politically indifferent, and mute about individual responsibility, pursuing information, being environmentally oblivious, supporting material progress, oblivious of health and being hostile to transphysical phenomena. The green mandala demonstrates the ideal situation, as eco-philosophy. It shows eco-philosophy as objective, concerned, mindful and life oriented; points that starkly contrast with the red present philosophy. The present philosophy on sustainability is presented as inherently destructive to live on earth. It forms an observable opinion about contrasting situations that are under inquiry in this research. In addition, it continues to do exactly that now (Skolimonski; 1981:1).

On the other hand, eco philosophy as shown in the same plate, the second mandala offers irresistible options. These options offer a total solution to the problem of self-destruction that the current way of life is perpetuating (Loriot, 2003). The problem is that there is no evidence of its adoption anywhere on earth, and very probably not in Kenya.

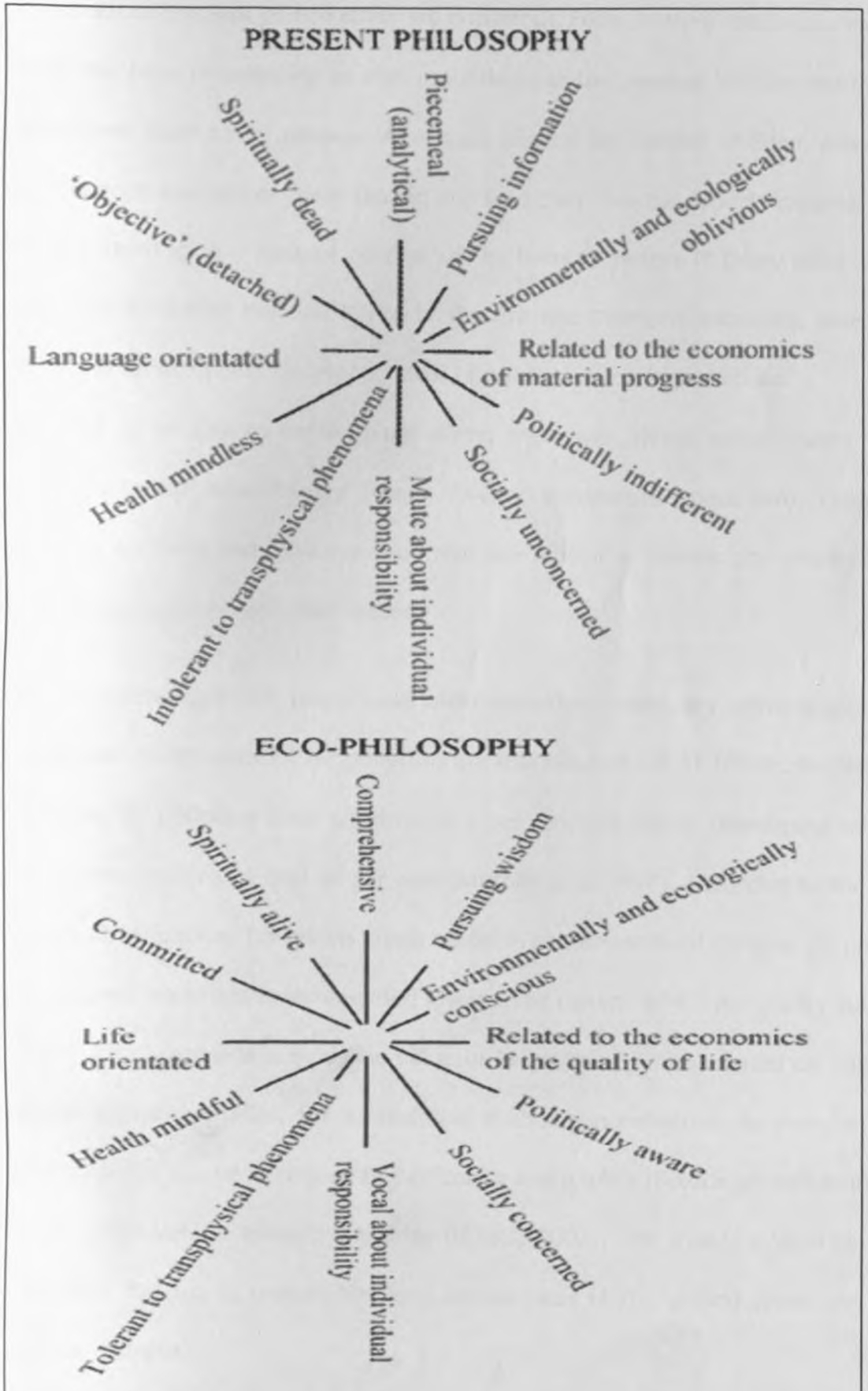


Plate No. 1.1: The mandala. Adopted from www.Simonthe scribe.co.uk/eco-philosphy.htm

The effects of this lack of eco-ethics are numerous. From its very cradle of evolution, nature has been propagating to man in subtle ways the message 'use but don't abuse'. The ancient Bible has a message: After God created the Garden of Eden, Adam, and Eve, He took the two of them around and told them 'See the world I created, it is all for you, don't spoil it because no one will be there to restore it' (Holy Bible. Genesis 2:15) This researcher believes this to be the first and strongest statement, based upon which Humankind later developed ideas of nature and ecological ethics.

We used to be able to throw things away. Moreover, things actually went "away. Where is "away" now? "Away" is here. "Away" is someone's back yard. There is no place to go from here. We now see that we inhabit a smaller and smaller planet. "Away" has become very close indeed.

Burning refuse, especially plastics and other hazardous waste, are affecting air quality. The global health costs of air pollution are estimated at US $1 billion. In developed countries, air pollution costs are close to 2 per cent of GDP; in developing countries, the figure is between 5 and 20 per cent (Mutuku et al, 1997). According to the World Health Organization, 1.5 billion urban residents endure levels of outdoor air pollution that exceed maximum recommended levels. "The current WHO Air quality guidelines (AQG) for O_3 provide a guideline value of 120$\mu g/m^3$ (60 ppb), based on controlled human exposure studies, for a maximum 8-hour concentration. As many as half a million deaths can be attributed to particulate and sulphur dioxide air pollution alone, mostly from vehicle exhaust emissions (WHO, 2007). The study by W.H.O. (2007) estimates that up to one in five lung cancer cases in the United States are due to vehicle emissions.

Power generation, industry and transport—currently mainly associated with towns and cities in the developed world—are responsible for the majority of emissions of carbon dioxide, the main greenhouse gas that is causing climate change. Over the next quarter-century, it is estimated that carbon dioxide emissions, mostly from cars, trucks and power stations, will rise by 60 per cent. More than two-thirds of the increase will come from developing countries because of fast economic growth and a significant increase in car ownership (Mutuku et al, 1997).

According to Enger & Smith (1995), lack of space for dumping solid waste has become a problem for many throughout the world. Communities are concerned about the increasing cost of waste disposal, possible hazards to ground water, and maintaining of air quality. Problems with solid waste have increased dramatically over the past several decades because of population increases and an attitude that convenience is a very important achievement.

Africa is quickly becoming a destination for information technology in the form of tons of used computers; fax machines, cell phones, and other gadgets. Although many of these machines can be repaired and resold, up to 75% of the electronics shipped to Africa is observably junk (Gov. of Kenya, 2003).

In spite of the rapid increase in urban population the International Institute for Sustainable Development (IISD, 2006) found out that expenditure by the City Council of Nairobi on infrastructure and services has been reducing progressively. The situation is no different in other Municipalities in Kenya as seen from the piles of garbage and broken down infrastructure. As would be expected, the IISD, (2006) points out that the low-income areas of the towns are most affected by the solid

waste. These areas are mainly dense unplanned settlements – often unrecognised by the local authority – and without basic services such as water, sewerage and roads. Unfortunately, these settlements are home to the majority of urban residents. For example, over 60% of the Nairobi population lives in these unplanned settlements. The above are some of the reasons that make solid waste such an important issue that it has aroused national concern. Even the President of Kenya is on record with pronouncements on effective solid waste reduction (JICA, 1998).

According to "The Interim Poverty Reduction Strategy Paper of 2000 – 2003" the problem has been aggravated by the presence of polythene (plastic carrier bags) in the environment. This 'plastic menace' as it is called, has become a symbol of what is wrong with the entire waste strategy in the country. As this thesis points out, light plastic waste is to be seen all over the country in both urban and rural areas, and because of their persistence in the environment, they may continue to be a nuisance over a long time.

The risks they pose to the environment (Govt. of Kenya, 2006) and to the residents have been voiced by environmentalists and recently even by the Minister for Labour in the Government of Kenya. This researcher feels that the problems identified above can be minimised at source. The study views the issue as a lack of ethics in the current human livelihoods evidenced in a survey by waste discarded haphazardly as the cause of the problems.

1.2 Problem Statement

In Kenya, the situation of solid waste throughout the country according to is a source of concern (Kirai, 1996). In Nairobi, for example, less than 20% of the waste

generated was collected in 1981 (Syagga 1996). General observations reveal a high level of solid waste accumulation around Nairobi. These wastes consist of haphazard heaps of uncollected garbage at the doorsteps of most homes and along the streets. Available literature also points to a limited collection capacity by the Nairobi city council (Mutuku et al, 1997, Syagga, 1996). The uncollected and illegally dumped wastes constitute a disaster for human health and causes environmental degradation (See plate 1.2).

Available literature and a reconnaissance survey conducted within Nairobi city council points towards carefree discard of waste by consumers and limited attempt at recycling. Academicians also cast little doubt that the environment and the ecological balance on earth are no longer sustainable. Papanek (2003) summarises this problem as a general lack of ecological-ethics (values) for humanity. He argues that it runs all along the design process and product life cycle. Thus this study attempts to investigate the values along the product life cycle of car seats, sofas and bags as contributors to the waste stream in Nairobi. The trio were selected after a reconnaissance within the larger Nairobi city.

Plate No.1.2: Problem of waste on the environment. Date: September 2008. Source, the researcher

1.3 Objectives

The overall goal of this study is to:

Evaluate the design process in respect to design and manufacture of car seats, sofas and bags so as to identify a design model ideal for enhancing the living environment.

The specific objectives:

The overall goal, for the purpose of this study, was achieved by undertaking the following specific tasks.

(i) Investigating the level of incorporation of eco- ethical considerations in design and manufacture of car seats, sofas and bags.

(ii) Determining the effects of an eco-ethical consideration in the product design process on levels of waste output.

(iii) Developing design models that would indicate better solutions for minimising waste accumulation in the environment.

1.4 Research Questions

The main research question and the subsequent questions seek to elucidate on what effects inclusion of eco-aspects in the product design process would have on the living environment. The main question is:

- Do product designers take eco-ethical considerations into account in the design process?

Others are:

- What are the levels of eco-ethical consideration in design of car seats, sofas and bags?
- What effects does omission of an eco-ethical consideration in the design process of car seats, sofas and bags have on the living environment?

1.5 Research Hypothesis

Null: Integrating eco-ethics in the product design process has no effect on living environments.

Alternative: Integrating eco-ethics in the product design process contributes to clean living environment.

1.6 Justification

This study has a practical environmental and ecological relevance. Papanek (2003), Tolba (1992) and Skolimonski (1974; 1981) argue that the current problem of ecological devastation emanates from human unethical associations with production, consumption and wastage. This study's advancement of their findings and argument could point towards intervention opportunities available to product designers, who may be considered the main source of waste.

Eco-Design can contribute significantly in achieving a more sustainable society as it provides reward through commitment (Stevels, 1999; Lofthouse et al, 2006). To the policy makers, understanding eco-product design would also bring substantial environmental benefits by saving resources and reducing the environmental impact of the production of raw materials. Because of their large volumes evidenced by data from this study, materials and short life cycle, car seats, sofa sets and bags are chosen for this research as representative of all waste generating products.

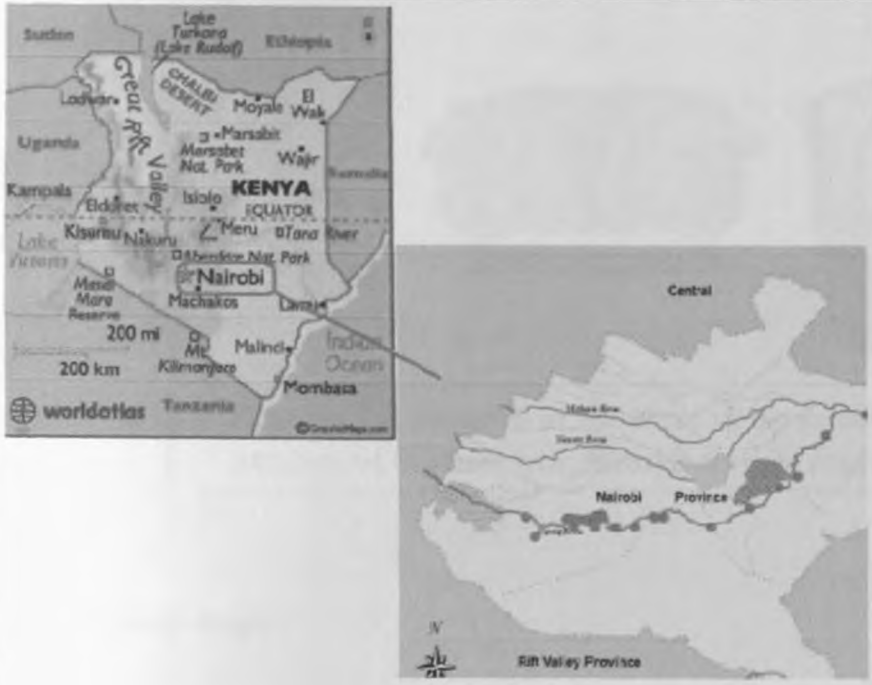
1.7 Contribution to knowledge

The society and commercial interests are taking design for sustainability seriously and designers will, as before, faithfully react to their needs. As its contribution to knowledge, the outcome of this study will present them a concrete model for arguing in favour of the environmental cause in their recommendations. This study's outcome offers designers the tools towards these ends. The evidence on eco-devastation and the current global concern for the environment calls for a new design paradigm. As a new design paradigm, the two outcomes of the new recommended design process and product life cycle will mitigate waste throughput in production. Such a paradigm

will not only save the world, but seems fundamental to save designers and the professional repute of design. The outcomes from application of the two processes will moreover open new opportunities to academia for teaching green design but also offer new opportunities for further research on their effects. Finally, it is expected that articulate execution of the recommendations will afford humanity a clean and sustainable living environment.

1.8 Scope And Limitations Of The Study

This study is limited to Nairobi, Kenya (See plate No. 1.3). Being the capital city, Nairobi has attracted the largest number of skilled labour than any other city or town in Kenya. It therefore has the highest concentration of the population targeted by this study. The study looked at eco-ethics of solid products and not directly at liquids unless they form an integral part of production process. A limitation of the research is that it does not focus on technical aspects but rather on strategic eco-ethical considerations and the content of product design and development processes. It also limited its scope to inclusion of and consideration for eco-ethical aspects by designers along the product design process of car seats, sofa sets and bags.



Nairobi's city limits have expanded multiple times since the early 1900s to accommodate its growth, not only of population, but infrastructure as well.
The city boundary was last expanded in 1963 shortly after independence to cover an area of about 266 square miles (680km^2).

From its earliest times, spatial development patterns have shown segregation between the central business district (CBD) and European, African, and Asian residential areas (JICA, 1998).

The central business district has been largely rebuilt since independence, with many of the old structures being torn down to make room for newer office buildings (JICA, 1998).

Plate No. 1.3. Map of Kenya showing location of Nairobi; source: www.worldatlas.com/webimage/countrys/africa/ke.htm

1.8.1 Thematic scope

This study seeks to promote and enhance harmonious relationships between human communities and their natural or environmental resources, building on the principle of sustainability. It confined itself to the product design profession to establish whether human communities value and are adequately informed about their actions to the natural environment. It sought to anchor on designers the ecological values so they can integrate eco-aspects in the design process. The study therefore confined itself to ethics specific to integration of eco-aspects in the product design and product life cycle by designers in Nairobi. The eco-ethic theme will be probed through the designers behaviour in design of car seats, sofa sets and bags an example of which are presented in plate no.1.4.

Plate no 1.4. Samples of the three items forming the case studies of this research; Source: study's reconnaissance

1.8.2 Physical scope

Within Nairobi city, the physical scope covers an area split into three locations as follows:

- Bags (Uhuru Market)
- Sofa sets (Park Road)
- Car seats (Park Road roundabout & Outering Road)

These four locations were selected after a census of the spread of the three cases was conducted in the larger Nairobi. The cases were found to be concentrated on the four areas as is explained further under methodology section of this study.

Bags: The study of bags was confined to Uhuru market located in the Eastland area of Nairobi shown on the map on plate No. 1.5

Plate No 1.5: Map of Uhuru market locality.

The red marked buildings comprise Uhuru Market

Sofa sets: The study of sofa sets concentrated along park road in Ngara area of Nairobi as shown on plate No.1.6.

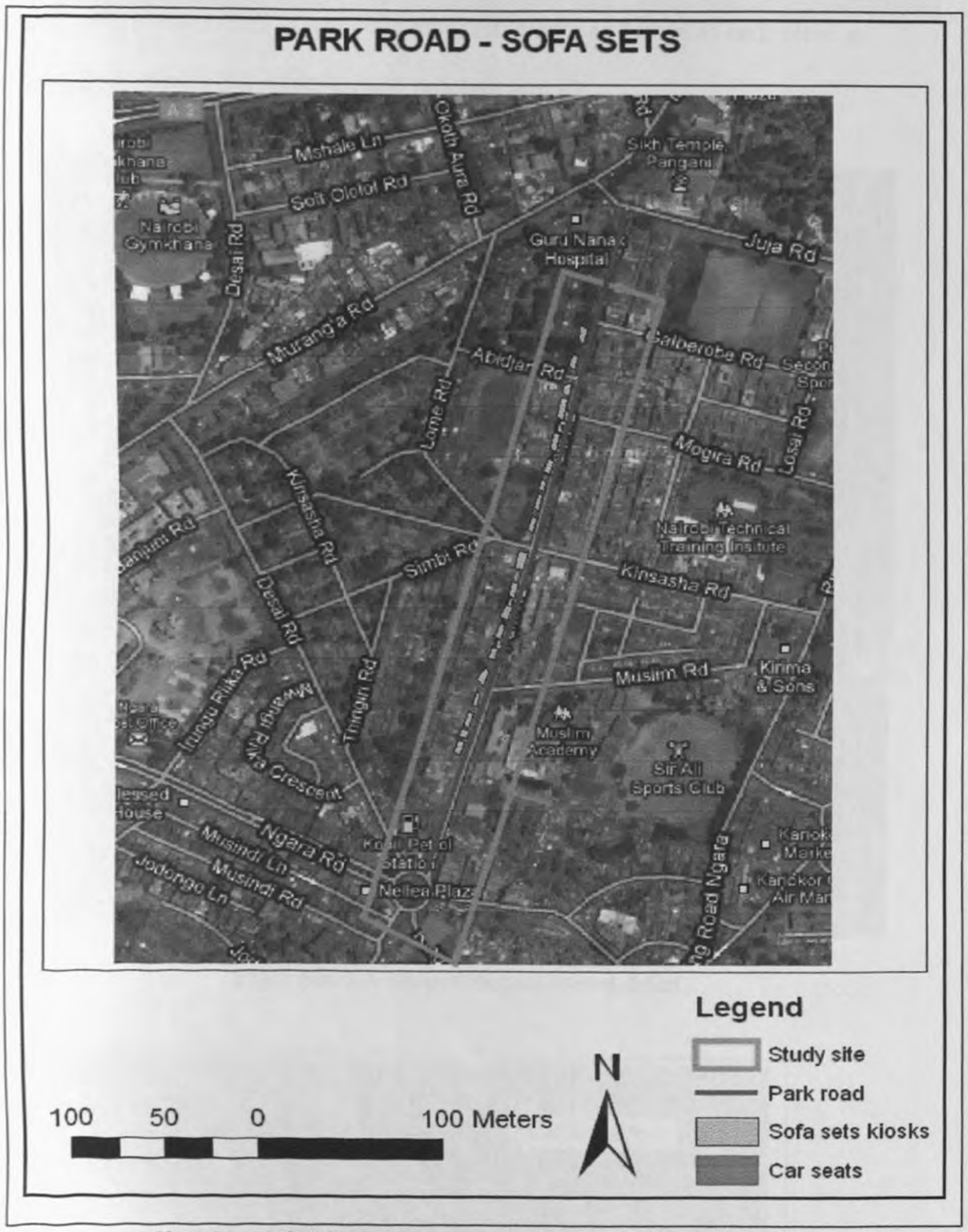


Plate No. 1.6: Map of Ngara area along Park Road, Nairobi

The park road site comprise of 13 different kiosks constructed on road reserve along park road (Marked Red). They are informal in nature and close to each other as shown in the following aerial picture on plate No. 1.7

Plate No. 1.7: Map of Ngara roundabout

Plate No. 1.8. Park Road Roundabout Car Seats Site

Car seats: the study of car seats was split into several sites due to the scattered nature of the designers. One site was in the park road roundabout (Plate No. 1.8) area while another was located in Umoja estate area along Outer Ring Road shown on map plate No. 1.8 and 1.9

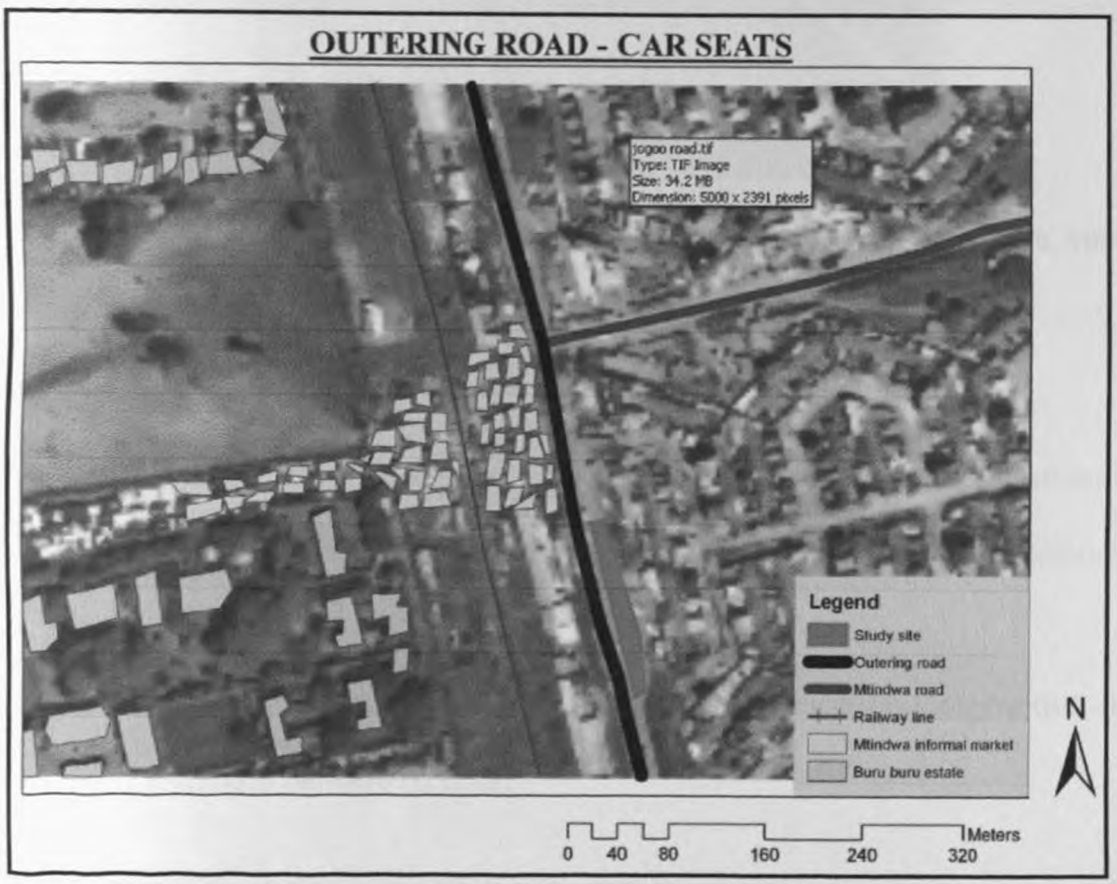


Plate No. 1.9: Car Seats Study Area

The designers are spread on open-air workshops along the Outer Ring Road as shown in plate No. 1.10.

Plate No. 1.10: Aerial view of Outer Ring Road. Source, Google earth, 2009

1.9 Assumptions

The thesis of this study emanates from the researchers philosophical assumptions that;

1. Eco-ethics is the central factor in all matters that concern environmental sustainability.
2. Designers currently lack a redeeming living ethical philosophy that should eliminate damage to Gaia.

On a practical level, this research assumes that;

3. Current unethical exclusion of eco-aspects in product design and development processes is the root cause of environmental damage that is threatening Gaias biodiversi1ty.

1.10 Definition Of Terms

After review of all possible meanings and their efficacy for its purpose, the study isolated and adopted the following technical terms:

Design: According to the ICSID (International Council of Industrial Design, 2006) design is a creative activity whose aim is to establish the multi-faceted qualities of objects, processes, services and their systems in whole life cycles. However, substantial disagreement exists concerning how designers in many fields, whether amateur or professional, alone or in teams, produce design. Dorst and Dijkhuis (1995) argued that "there are many ways of describing design processes" and discussed "two basic and fundamentally different ways". The prevailing view has been called "The Rational Model" The alternative view has been called "The Action-Centric Perspective".

The Rational Model

The Rational Model posits that:

1. designers attempt to optimize a design candidate for known constraints and objectives,
2. the design process is plan-driven,
3. the design process is understood in terms of a discrete sequence of stages.

Typical stages consistent with The Rational Model include the following.

- Pre-production design
    - Design brief or Parti – an early (often the beginning) statement of design goals
    - Analysis – analysis of current design goals

- Research – investigating similar design solutions in the field or related topics
- Specification – specifying requirements of a design solution for a product (product design specification) or service.
- Problem solving – conceptualizing and documenting design solutions
- Presentation – presenting design solutions

- Design during production
  - Development – continuation and improvement of a designed solution
  - Testing – in situ testing a designed solution
- Post-production design feedback for future designs
  - Implementation – introducing the designed solution into the environment
  - Evaluation and conclusion – summary of process and results, including constructive criticism and suggestions for future improvements
- Redesign – any or all stages in the design process repeated (with corrections made) at any time before, during, or after production.

Each stage has many associated best practices. This study adopted the rational model in identifying its subjects.

The Action-Centric Model

The Action-Centric Perspective is a label given to a collection of interrelated concepts, which are antithetical to The Rational Model. It posits that:

1. designers use creativity and emotion to generate design candidates,
2. the design process is improvised,

3. no universal sequence of stages is apparent – analysis, design and implementation are co-temporal and inextricably linked

Product design: Product design can be defined as the idea generation, concept development, testing and manufacturing or implementation of a physical object or service. Engineers define it as a logical representation of all product functions in sufficient detail to serve as product specifications. Product Designers conceptualise and evaluate ideas, making them tangible through products in a more systematic approach.

Eco design: design, which addresses all ecological impacts of a product throughout the complete lifecycle of the product, whilst aiming to enhance other criteria like function, quality, and appearance (Bras, 1997). Eco-design is related to the larger territory of 'sustainable design, which argues that needs can be fulfilled in ways that substantially reduce global pressures on finite resources and decrease levels of waste and pollution.

Eco-ethics: carrying the same meaning as environmental ethics, it is the part of environmental philosophy which considers extending the traditional boundaries of ethics from solely including humans to including the non-human world (Stevels, 2006).

Theory of human actions, as subjected to duty toward nature—to which humans belong and aiming at compatibility between nature and humanity, which provides

rules of conduct and behaviour for interacting with the natural environment (Lovelock, 2000).

Eco-product design: This is also referred to as Sustainable product development & design (SPDD). SPDD is concerned with balancing economic, environmental, ethical and social aspects in the creation of products and services.

Factor Four: It is a simple yet radical concept which, it has been suggested, holds the key to sustainable development. It refers to a hypothetical fourfold increase in 'resource productivity', brought about by simultaneously doubling wealth and halving resource consumption.

Its origins dates back to 1972, when a report by the Club of Rome called 'Limits to Growth' issued a stark warning that economic growth was using up resources at a rate that could not be sustained for much longer. Often mentioned in the same breath as Factor 4 is 'Factor 10' whose proponents argue that in the long term, resource use in developed countries needs to be slashed tenfold if we are to approach sustainability. The reasoning behind this is that globally, consumption needs to be halved, but that the greatest reduction should be borne by those countries that are currently the most profligate in their use of resources.

Sustainability: The ability to provide for the world's current population without damaging the ability of future generations to provide for themselves (www.sustainabletable.org) From the verb sustain, it means to hold up, to bear, to support, to provide for, to maintain, to sanction, to keep going, to keep up, to prolong, to support the life of (Www. encyclopaedia Britannica)

Eco-philosophy: is a rational restatement of the unitary view of a holistic approach of the globe in which all the living organisms (including plants, animals, environment and human race) belong to the same structure.

Mandala; "circle" – an idealized circular model of the cosmos, with the source of cosmic or temporal power located at the centre, and deities or beings representing lesser powers or energies radiating outward toward the periphery, the limits of the system. In Tantric practice, Mandalas are often employed as visual meditation support (Www.trimondi.de).

Tactics: branch of science dealing with detailed manoeuvres to achieve objectives set by strategy. A plan for attaining a particular goal. A design decision that is influential in the control of a quality attribute response. Variously though, tactics have been defined as specific techniques or actions developed by the stakeholders used to achieve a planned strategy (usually on a defined timeframe). Tactics are how the strategies are to be achieved (wordnet.princeton.edu)

Technics: the method of performance in any art, things pertaining to the practice of an art or science.

CHAPTER TWO

LITERATURE REVIEW

2.0 Introduction

This chapter reviews literature relevant to the objectives of the study. The objectives focused on investigating the level of incorporation of eco-ethical considerations in design and manufacture and determining the effects of an eco-ethical consideration in product design process. The literature review therefore focused on eco-ethics from three perspectives: namely the historical background of eco-design, eco-ethics laying down a basis for understanding the current status and developments and opinions on eco-ethics with focus on product design and finally, product development processes and product life cycle. Literature on sustainability of livelihoods and resources is reviewed from the perspective of formalised approaches to ecological innovativeness and environmental wellness.

2.1 History Of Eco-Design

Eco-design has a history dating from the 1960s. Since then, various organizations and governments have introduced principles, methodologies, programs, laws, and regulations related to eco-design and sustainable development. The declaration of the United Nations Conference on the Human Environment - the Stockholm conference- in 1972 also marked a milestone in eco-design history (UNEP, 1972).

Later in that decade, the three main concepts of eco-design, resource productivity, the natural step, and industrial ecology were introduced in Europe and North America (www.ricoh.com).

The concept, methodologies, and tools of eco-design can be divided into product-oriented and system-oriented approaches. In 1991, Professor Ryoichi Yamamoto and his colleagues introduced the eco-material concept as a proactive measure for eco-design and sustainable development in the field of material science and engineering. The World Business Council for Sustainable Development (WBCSD) in 1992 introduced the eco-efficiency concept (Tanaka et al, 1991). Ernst Ulrich von Weizsacker later introduced the factor 4 concept. In Europe Friedrich Schmidt-Bleek introduced the factor 10 concept (International Institute for Sustainable Development, 2006).

These two factors (4 and 10 concepts), have been widely used as indicators of sustainable development or of the benefits of eco-products (Chen et al, 2006). In the period from 1996 to 1999, various system-oriented concepts were proposed, including the ISO 14000 series, functional economy, product-service system, servicing, integrated product policy, sustainable service system, and triple bottom line (Netherlands Organization for Energy and Environment, 1997).

The trend in concept development since then has moved toward holistic management systems of products and services (Zerbock, 2003). In 2003, European scientists proposed the establishment of a new EU directive setting eco-design requirements for energy-using products. As a result, Eco-design development trends are shifting from products to services and from the old industrial economy to the new service

economy. Today, there are many approaches to eco-design including, eco-efficiency, eco-ethics, eco-services and best practice etcetera (Rolf, 2001).

2.2 Environmental Ethics: A Historical Overview

As a systematic and focused field of intellectual inquiry, environmental ethics was conceived after broad recognition in the 1960s of an impending "environmental crisis" (Callicott, 2007). Developing embryonically during the 1970s, environmental ethics came into being in 1979 with the publication of the *Environmental Ethics* journal.

According to Callicott (2007) the growth of environmental ethics, was heavily influenced by cultural factors. During the mid-twentieth century, environmental degradation reached crisis proportions after technologies, developed for war, became redirected to peaceful uses. *A Sand County Almanac*, written by Aldo Leopold (1949), had prophetically anticipated the emergence of an environmental crisis and proposed the evolution of a "land ethic" as the only appropriate remedy to these complex environmental problems (Aldo Leopold 1949).

In a widely reprinted and extremely influential article as quoted by Callicott (2007) and published in "*Science, the Historical Roots of Our Ecologic Crisis*" (1967), Lynn White, Jr. set the agenda for future environmental ethicists. White (1967) argued that to change what we collectively do depends on changing what we collectively think. White's specific analysis of the biblical roots of the environmental crisis was cavalier and simplistic at best, but his initial, more general intellectual analysis was compelling.

White (1967) believed that one had to identify and criticise the inherited attitudes and values regarding the characteristics of nature, human nature, and the relationship between humanity and nature that underlie and subtly shape our behaviour toward the natural world. Secondly, White believed that one needed to re-interpret or revise one's inherited attitudes and values regarding the traits of nature, human nature, and the human-nature relationship (White, 1967). Ecologically minded biblical scholars working with White's critiques, for example, later re-interpreted the human-nature relationships sketched in Genesis. Thirdly, one must develop and defend a new environmental ethic in order to guide and restrain anthropocentric environmental degradation.

As scholarly discussion in environmental ethics developed, a major theoretical cleft between anthropocentrism and non-anthropocentrism became apparent. Anthropocentrists upheld the conservative Western view that only human beings are morally significant (Hume 1951, Leopold 1949).

For anthropocentrists, polluting or destroying various aspects of the environment is morally wrong because human beings are adversely affected. Non-anthropocentrists countered that an anthropocentric environmental ethic is inadequate, because, in some cases, the extinction of some scientifically unremarkable and commercially worthless species that do not seem to be vital to any ecosystem processes would not materially harm human beings. Philosophers (Hume, 1951) committed to the Western tradition of moral philosophy have attempted to theoretically extend anthropocentric ethics in order to create a non-anthropocentric ethic. Not all human beings, however, are functionally rational. Thus, if anthropocentric ethical theory were applied even

handedly, infants, developmentally handicapped persons, and victims of Alzheimer's disease, would fall outside the moral pale. They would be no more morally considerable than non-human non-rational beings, and therefore would be treated with callous disregard. To include non-rational people within the pursuit of an anthropocentric ethic, we must lower the bar of moral considerability. It is, however, a way to begin extending moral consideration to the environment (Pauline 1997).

Biocentrism has become the end-point in this project of extending traditional Western ethics to wider and wider circles of entities. The main problem with including all living beings within the purview of ethics is not the plausibility of the theoretical project, but that most of our environmental problems remain unaddressed by this approach.

The individual welfare of each and every bug, shrub, and grub is just not very high on the list of environmental concerns. We are concerned, rather, about air and water pollution; soil erosion; global climate change; and, probably more than anything else, about species extinction or the catastrophic loss of biodiversity at every level of biological organization. If environmental ethics is to be connected with our perceived environmental concerns, thereby allowing constructive responses to the crisis that gave birth to environmental ethics, then we must work toward a more holistic environmental ethic.

Aldo Leopold's (1949) seminal "land ethic" has this crucial holistic quality. Leopold writes, "a land ethic changes the role of *Homo sapiens* from conqueror of the land-community to plain member and citizen of it. It implies respect for his fellow-members, and also respect for the community as such". Indeed, when Leopold states

the summary moral maxim, the golden rule of the land ethic, no mention whatever is made of "fellow-members"; only that the community as such is the beneficiary of environmental moral concern: "A thing is right when it tends to preserve the integrity, stability, and beauty of the biotic community".

A Western precedent for ethical holism can be found in Charles Darwin's account of the origin and evolution of ethics in the *Descent of Man*, from which Leopold seems to have borrowed heavily. According to Darwin (1871), ethics arose to foster the integrity of human societies (or communities), upon which human survival is utterly dependent. Darwin, in turn, borrowed heavily from David Hume's ethical philosophy in which there also runs a strong strain of holism. This holistic Leopold land ethic has a pedigree in Western moral philosophy traceable through Darwin back to Hume. The major theoretical problem with Leopold's land ethic is how to balance its holism with the individualism of our precious humanitarian ethics. Surely, we cannot agree that a thing is right only if it tends to preserve the integrity, stability, and beauty of the biotic community; and that it is wrong if it tends otherwise. What about basic human rights? What are we to do when respecting human rights conflicts with preserving the integrity, stability, and beauty of the biotic community? Leopold did not intend the holistic land ethic to replace individualistic human ethics, but rather he wanted it to supplement them (Skolimonski, 1981). However, he did not, as noted by this study, provide any guidelines for resolving conflicts between human rights and environmental integrity.

As environmental philosophy has matured (Murray, 1971), a number of green ideologies emerged that united environmental ethics with various political

movements. Eco-feminism, for example, unites environmental ethics with feminist politics. First, that the dominance of nature by "man" and the dominance of women by men are similar in form. Second, eco-feminists believe that in Western thought, all the way back to the ancient Greeks, women have been cognitively associated with nature. The Greeks identified material nature, which they regarded as chaotic, erotic, recalcitrant, and irrational, as a female cosmic principle while they identified immaterial form, which they regarded as disciplined, ordering, and rational, as a male cosmic principle. Similarly, social ecology unites environmental ethics with a more or less Marxist critique of capitalism, consumerism, and free-market economies (Murray, 1971). Here the key to solving our environmental problems is engaging in the dismantling of the capitalist economy through the disempowering of multinational corporations. Environmental justice focuses on the unequal distribution of environmental "bads," which are disproportionately visited on the poor and women and children of colour. It is therefore the view of this study that, environmental justice unites environmental ethics with political concerns about economic and racial inequities.

Among the various ideological schools of environmental philosophy (Viswanathan, 2005), deep ecology retains its own unique perspective. Deep ecologists hold that all of our environmental problems stem from our anthropocentrism. Furthermore, deep ecologists do not believe that resolutions to environmental problems can be completely fashioned from the field of ethics alone. Rather, if the deeper lesson of ecology—that all things are connected—is absorbed viscerally, the distinction between self and nature will be blurred and this ambiguity between self and nature will permit people to identify with nature, thereby allowing them to perceive the destruction of

nature as self-destruction..The most radical challenge to mainstream environmental ethics (Viswanathan, 2005) has emerged from a pragmatist perspective. Pragmatists claim that environmental philosophy has been too preoccupied with internecine disputes that are virtually unintelligible to non-philosophers.

According to pragmatists, the arcane philosophical debates about what set of entities have intrinsic value and thus moral consideration; the war of words and name-calling between deep ecologists and eco-feminists about whether the core problem is anthropocentrism or androcentrism; even the distinction between anthropocentric and non-anthropocentric environmental ethics—all are irrelevant to real-world environmental problem solving and policy making. Environmental ethicists, the pragmatist environmental philosophers argue, should not be in the business of generating a one-size-fits-all theory, but instead are engaged in casuistry. It rejects the binary notion that all environmental ethics should be one thing or the other—all theory or all pragmatic casuistry—and permits the complementary interaction of both top-down theory and bottom-up problem solving (Viswanathan, 2005).

In the span of scarcely a quarter of a century, from humble and scattered beginnings, environmental ethics has grown explosively into a multi-faceted and sometimes fractious field of inquiry. Indeed, it has overflowed the banks of ethics to constitute a more general field, "environmental philosophy."

First, far from being "solved," the environmental crisis is only getting worse, with the increasing rates of species extinction and the onslaught of global climate change. Second, despite the pragmatist's efforts to redirect it, environmental philosophy is more than an "applied ethics," it is a largely theoretical inquiry and thus subject to an

ever widening and deepening dialectical development of its theoretical foundations (Eco-ethics International Union, 2005).

2.3 Environmental Responsibilities

Any study about environmental responsibility ethics opens up a whole debate about how businesses can learn to be more environmentally aware and responsible. Many businesses are starting to realise that they have to do more to help the environment and cut down on the ways in which they affect the planet.

To this end, stakeholders must learn all about environmental responsibility ethics. The use of the word ethics in the phrase suggests that each individual may have a different set of values from which to work, but the important thing when dealing with a company or individual and their environmental responsibility is that a joined up approach is inevitable.

2.3.1 Environmentally Conscious Product Development

Sustainable development (Penev, Ron, 1996) is defined as the economical, social and environmental problematic synergy for meeting today's need and those of tomorrow's generations. In order to achieve such ambitious goals, the document Agenda 21 resulting from the Earth Summit held in Rio de Janeiro in 1992, addresses, in its chapters, one important issue: Sustainable Production and Consumption. The suggested principles promote the considerations of production processes and consumption patterns in order to develop less harmful methods of need fulfilment, while promoting a better quality of life for everybody. That document according to Penev and Ron, (1996) has received major support in many countries, but in reality and in practice, real solutions and results from these principles application are rare.

The reason being that absolute consumption is rising, and "total materials throughput and waste generation continue to grow".

These impacts negatively affect our societies' health and quality of life (Carlson et al, 2001). For a long time, the Western culture has been marked by a will to change its environment, to dominate nature and hope for a better future. Today, many have realised that this culture cannot be continued indefinitely.

Nature may be manipulated locally, but can hardly be dominated globally. What then, as posed by Porter (1995) would define sustainable consumption and production in our societies? The Wuppertal Institute proposed one definition, pointing at the important role of design in these life-cycle aspects:

> *"The use of services and related products which respond to basic needs and bring a better quality of life while minimizing the use of natural resources and toxic materials as well as the emissions of waste and pollutants over the life cycle of the service or product so as not to jeopardize the needs of future generations"* (Porter, 1995).

The goals are clear in this definition and ways to reach them consist of various instruments: imposition of production processes standards and environmental taxes, products redesign, and promotional educational campaigns for businesses, users and consumers. The most influential tools hence reside in the corporate sector initiatives (Porter, 1995).

There seems to be a shift in our economies. This shift leans towards more integrated measures that address products' whole life cycle, and that encompasses their design, production, consumption and end-of-life (Perry, 1995). According to the World

Business Council for Sustainable Development (WBCSD), many countries, including Kenya, have attained considerable growth while reducing material and energy use, therefore increasing industrial efficiency that in return increase competitiveness and reduce environmental liability.

These advantages of sustainability are seen by many businesses that chose to participate in sustainable development. However, many others are still not addressing environmental issues. Choosing sustainability (Perry, 1995) means firms address the environmental burden resulting from their growth and activities, while they acknowledge many opposing interests. This requires responsible leadership and vision, both very rare resources in the corporate sectors.

In North America, the U.S. Congress, in 1992, recognised product development as an essential and focal point for reducing environmental impacts of production (Salomon et al 1994). Design consists of decision-making that affects directly and indirectly levels of materials use, therefore natural resources extractions and composition, and quantities of eventual waste. The Congress hence supports designers in getting involved with environmental considerations when developing products. As embodied by the foregoing literature, the Kenyan situation is far from recognizing the product designer in the same light.

Such considerations (Piasecki, 1992) could result in competitive implications and new market opportunities. Unfortunately, the situation in Kenya is vague; environmental issues are still restricted to pollution prevention in the industry, and not tackled by product design.

Industrial designers with their knowledge of industry and consumers, their intimacy with products and their ability to create and to visualise ideas, can play an important

role (together with many other professionals engaged in the design process) in bringing about sustainable development. Conversely, it is shown in the labels for methods and tools for eco-design presented below what efforts have been put towards the same goal.

- EcoDesign Strategy Wheel
- Eco Indicators
- Factor X
- The Natural Step (TNS)
- Eco-labels
- Life Cycle Assessment (LCA)
- Design for Environment (DfE)
- Ecodesign
- Product Services Systems (PSS) and Alternative Function Fulfiller (AFF)
- Sustainable design

Many studies, for example Rembert, (1997) have shown that designers seldom have the opportunity to exploit their skills to their full capacity. The difficult challenge in eco-design is therefore to balance environmental qualities with usual products development criteria, such as costs, quality and functionality or performance.

In order to understand what eco-product design is and how it is accomplished, it is important to have an overview of the wide range of methods and tools available to the principal actors of eco-design, who are designers and engineers. Other important actors however, such as business leaders and marketing people, are the ones that possess the decision-making power over the realisation of product development. Rembert (1997) recommends that designers appreciate and systemise the relationships

between those participants. Besides, actors are subject to pressure from important players, such as consumers, shareholders and stakeholders and from spectators of this scene, such as governments, competitors, etc. This holistic view according to Piasecki, (1992) should allow researchers to have a better knowledge of drivers and barriers to the implementation of eco-design in the product development scene.

This study focuses on the ethics among product designers, production of goods and consumption in general, even though sustainable consumption constitutes a relatively new field, full of opportunities and challenges. This approach, though, has the goal of rethinking our current life styles in order to achieve eco-efficiency.

Figure 1 attempts to capture such eco-efficient process as a cycle.

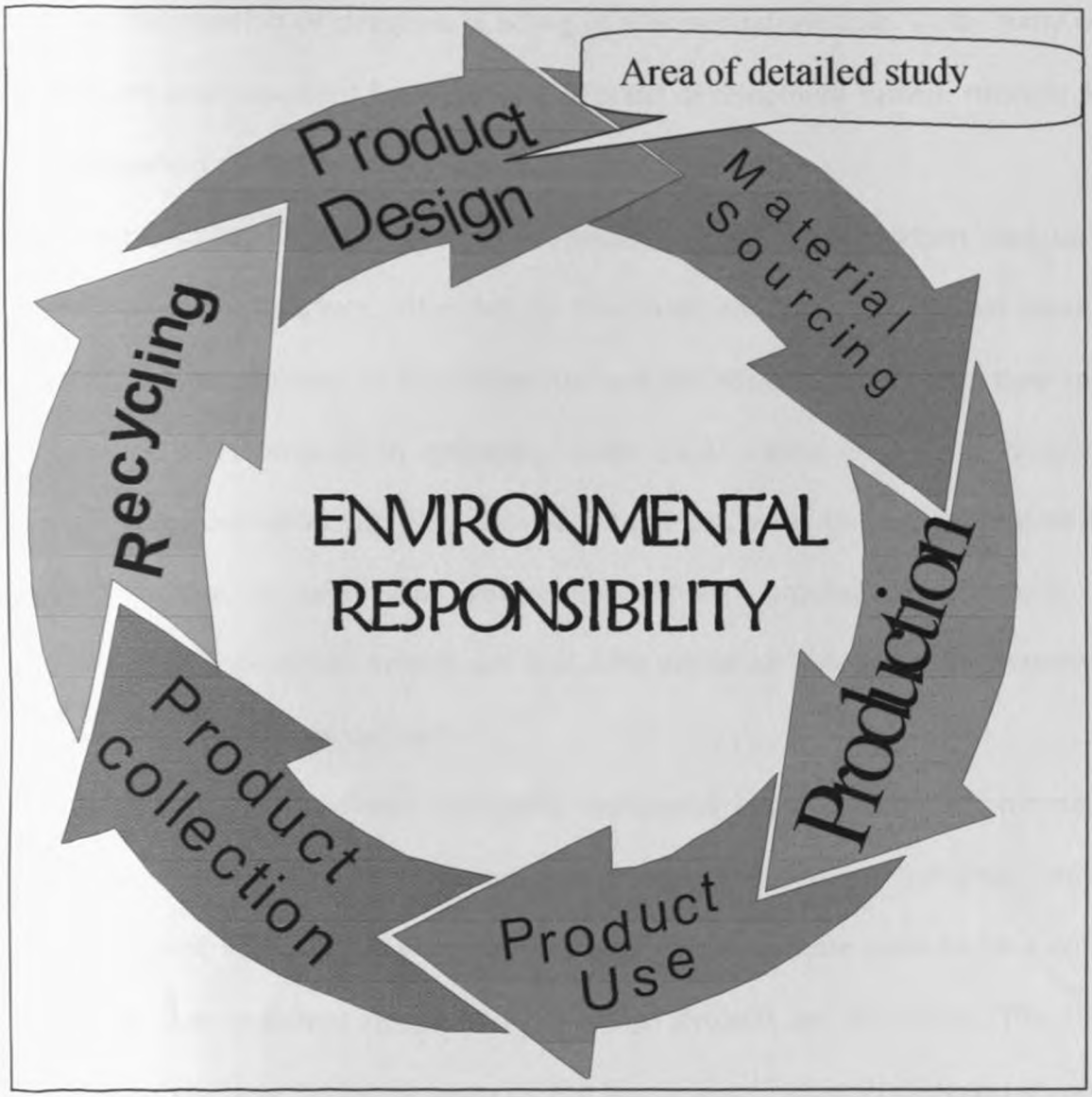


Plate No. 2.1: Product development process, Source: http://www.firstsolar.com/

2.3.2 Barriers and drivers of eco-design

The challenges of implementing eco-design in the traditional product development are numerous and surprisingly diverse. In theory, many barriers consist of the high risks associated with processes, the short-term vision of corporations, the lack of skilled resources on this subject, the lack of exterior incentives such as governmental programs, marketing studies that rarely assess or stimulate green demand and the

poor self-motivation of designers in acting in a more strategic role. While many other factors are also important for traditional product development success, stronger focus on motivation and competence is essential for eco-design.

The responsibilities in the poor environmental qualities of products and services provided on the markets rather fall on the social and national contexts shoulders. Surprisingly, the drivers of eco-design are not the removal of barriers; they mainly consist of wiser innovation strategies, which could consist of a good occasion to include environmental concerns. On the other hand, ways to stimulate eco-design is rather similar to ones that stimulate traditional product development: costs advantages, appropriate knowledge and skills within an industry, and pressure from consumers, suppliers and clients.

Environmentalists, engineers, designers, consumers even, should demonstrate costs savings and benefits that always occur with redesign of products with the environment in mind. However, as previously alluded, there seem to be a common thought that industrial design and eco-design projects are expensive. This thought might also explain, or be the cause of, the low level of industrial designers involved in the manufacturing sector.

There are some solutions to overcome barriers to traditional and eco-design in product development processes. The most important ones include multidisciplinary teams, best user's needs definitions, clear objectives and targets of products to develop, etc. Further, the motivation of players (internal or external), communication flows and quality amongst product development teams, life-cycle thinking of one product or service or system, chosen methods and tools of eco-design, and market

related effects of eco-design all have positive effect on product development and eco-design.

2.3.3 Problems Associated With Consumption And Production

Inefficient production processes, low durability of goods, and unsustainable consumption patterns lead to excessive waste generation that follows or exceeds trends in economic growth (Papanek, 2003). Around the world, costs of dealing with waste, energy inefficiencies and pollution effects on healthcare are fast increasing. It is known however that this fact has specific economic and geographical causes; for example, landfill costs. Waste is one problem, but resource depletion, high-energy consumption and pollution are other harmful environmental impacts of our lifestyles. The consumption of primary and secondary energy, consumed by final users, continues to rise, even if the part of energy efficiency, the amount of energy saved, is increasing since a decade. End-of-life measures, such as waste management, energy consumption reduction or pollution remediation is certainly the most studied and very successful ways to counter-balance unsustainable consumption patterns effects. Much effort according to Papanek (2003) has been made by governments, in partnerships with the private sector, in the promotion of the "3Rs": Reduction-Reuse-Recycle, to reduce quantity of residual matter, usually known as "waste". A very interesting write-up by Katranon (2006) chides the rich of this world for their eco-excesses. Katranon points out that undoubtedly; Americans in the United States lead an incredibly privileged lifestyle. He cites the sociology textbook, Society, the Basics, compiled and written by sociologist John J. Macionis, which defines capitalism as "an economic system in which natural resources and the means of producing goods and services are privately owned" (Macionis 2004; 306).

According to Macionis (2004), the earth in all her splendour has been transformed from natural habitat into natural capital. Naively, the west believed the world to be boundless in its natural resources. In his short, yet incredibly insightful book, aptly named A Short History of Progress, Wright (2005) reviews the human practice of creating civilizations that strip the land of its integrity. This causes not only ecological devastation, but the ruin of the civilization itself and the death of its people.

Katranon (2006) gives the ecological story of the Easter Islands. As with any civilization, the prosperity of the island had fostered the prosperity of its people. Accordingly, as the population continued to grow, the natural resources diminished. By blindly pursuing an inherently destructive ideology to the exclusion of all common sense, the Easter Islanders wrought utter and complete devastation upon the environment that sustained them, and their entire people.

Since that time, human civilization has evolved incredibly. With every day terms such as "global economy," "global marketing," "global communications" and "global warming," it is clear that we as humans, understand ourselves to be a true global village; a planetary island within the vast ocean of the universe. Alan Durning (2004) addresses the issue of living in a consumer society, and how this kind of society impacts the earth. Marking the rising increase of consumptive behaviour in America after World War II, Durning (2004) cites the sincere words of retail analyst Victor Lebow: "'Our enormously productive economy...demands that we make consumption our way of life, that we seek our spiritual satisfaction, our ego satisfaction, in consumption. In the book, Karl Marx, Selected Writings, the editor, David McLellan (2004, pg 474), includes Marx's views on this relationship between

people and every day objects or the "world of commodities with the products of men's hands". We identify with the product (DVD player, microwave oven, laptop, etc), as the absolute manifestation of said item- from thought of product to actual product, easy as you please. Commercially, in a capitalist society, the bottom line is "What sells?" Celebrities sell products (movies, cell phones, themselves), and even the newsbreaks for commercial sponsorship.

Wikipedia, the free online encyclopaedia, though not academically wholesome, notes the following: "Disney, Viacom (now known as CBS Corporation), Time Warner, Rupert Murdoch's News Corp, Bertelsmann, and General Electric together own more than 90% of the media market " (Wikipedia, 2006). Money, power, and status are the foundations of the American dream. Standing apart from society, ones loses a realistic definition of "self". Naturally, global ecological degradation is increasing accordingly.

As capitalism continues to demand more and more natural resources, the people that dwell on those lands have less and less choice but to adopt the American lifestyle (Packard, Vance 1960). The World Wildlife Fund, an environmental advocacy and restoration organization, reports that the American "ecological footprint" is far more devastating than most of our global neighbours: "To calculate the average size of each person's footprint, it [WWF] measures land use, pollution, energy consumption, and the level of carbon-dioxide emissions. As the global economy spreads the virus of capitalism, what then becomes of the planet when the rest of the world begins to emulate the way Americans consume?

Generally, corporations do not assess environmental damage when they go about burrowing into the planet for the resources they need to transform natural capital into economic capital. Costs placed on the corporation show up on the income statement, and diminish the bottom line. Environmental remediation is expensive" (Kelly 2001, pg 26). Returning to Donald Wright's A Short History of Progress, we find that this invention of human folly cropped up in societies long before greed was constructed into the institution of capitalism. Korten (1999) offers 9 design elements for a new way of life in his book, The Post-Corporate World. All packaging materials are reused. Products are designed to be repaired locally and ultimately recycled. Organic matter is composted in local vegetable gardens. Virtually no waste is dumped into the environment.

Expanding on this idea of recreating how societies interact with their ecological environment are architect William McDonough and chemist Michael Braungart, co-authors of the book, Cradle to Cradle. The actual physical book, Cradle to Cradle, is a prototype of possibilities to come. It is fully recyclable. Living in such a distinctively individualistic society, it becomes hard to imagine people willing to change and adapt to such a seemingly radical and different way of living.

If humans are capable of anything (McDonough et al, 2002), especially within the context of societal living, it is change. They also posses the capacity to legislate. Furthermore, the very function of legislation is to create laws that protect people and provide structures that promote well-being for all. Does anyone remember that crazy old axiom "By the people, for the people?" It is time to recreate our world, even if only a section at a time, into a true global village; a place where we are willing to act

within the genuine spirit of community, supporting each other and the planet we all share (Katranon, 2006).

2.3.4 Designers As Agents Of Change

Inter-generational debate around the globe would re-affirm a universally accepted observation that our (human) world is speeding up. For the last 200 years, design has been successfully converting financial, technical, human and natural capital into materialised and more recently de-materialised products and services. Design continues to enable the development of products and "development by design. Design is the key agent of change (Fuad, Alistair, 2002).

Fuad Alistair (2002) sees design as reactive; that is reactive to the needs of the latest economic models, to the needs of commerce, to the marketplace. He argues that design must become proactive and that design should embrace a new framework inspired by systems science, complexity theory and practical philosophy. He advocates for a design paradigm that will produce a vision of a sustainable twenty-first century and engage the professional design community.

Feud's arguments are also directed at the debate on design education. He argues that it will take a generation or two for emerging designers to shift the existing design paradigm. The design community has, largely, satiated its creative instincts within the boundaries of economic models, it has, largely, ignored its responsibilities to a world beyond economics. The wakeup call for designers is the challenge, and huge creative opportunity, presented by Design for Sustainability (Fuad, Alistair2002).

Design for sustainability has evolved from earlier debates on 'green' design, 'eco-design' and sustainable design. Despite differences of opinion, there is universal

agreement that design for sustainability is concerned with addressing the role of design in moving towards more sustainable development (Shidi and Kiminodu, 1999). The trinity of sustainable development is economic viability, environmental responsibility and social responsibility, or, in commercial language, the 'triple bottom line. Designers and manufacturers are much more focused on their immediate needs and the perceived needs of their new economic model.

Commercial. interests are taking design for sustainability seriously and governments and designers will, as before, faithfully respond to their needs.

Examination of statements from a cross-section of the design community, albeit entirely from the 'developed' world, simultaneously gives cause for celebration and concern. This is because the outcomes reveals how designers perceive design for sustainability As a possible new design paradigm, design for sustainability is constrained by the 'economy' in the trinity of economy, environment and society. If designers continue a 'business as usual approach', they will continue to serve interests, which control this economic model (Raven et al, 1993).

2.3.5 Well-Being and Human Needs

According to Raven at al (1993) a new design paradigm is not only needed to 'save our world' but seems essential to 'save designers' and the professional reputation of design. There is a very relevant need for cultural change within the design community. Designers are creative, emotional, and inspirational. Design is a creative process. To date most of the energy of designers has been applied to oiling the wheels of various economic models. Economies, markets, consumers (Martin et al, 2001) are the foci to which most designers are directed.

Designers frequently voice frustration over these constraints. They have also shown consistent concern for design which improves our lives and show continuing interest in experiential design, universal design, design and emotion, design to meet demographic changes and so on. To create new foci for design (Pronk 1998), it is necessary to initially remove the constraint of the economic marketplace, which tends to dominate all other foci, create several foci, which centre on the concept of 'well-being'.

These foci are environmental well being, socio-cultural well-being and the well-being of individuals. While the economic marketplace equates the concept of individual well being with material acquisition (Pronk, 1998), the new design paradigm can search much wider for its definitions of well being. The new design paradigm can represent the voices of all stakeholders. A core part of this new design paradigm is to re-examine the well being of individuals by embracing a methodology for understanding human needs in the context of sustainable development called Human Needs and Human-scale (Sisman, 2005).

2.3.6 Environmental Architecture

Environmental Architecture today (Auroville Building Center, 2008) is both too impersonal and dull to be called 'humane' architecture. This is because it is highly scientific in its approach or just calls itself 'green' but does not address the environmental requirements, as it ought to. The polarities of order and non-order as well as green vs. humane remains (Brian, 2001). Another issue to be resolved according to Brian (2001) is the common belief that environmental design curbs the creativity of a designer. This in turn brings into play consultants for environmental

design, which alienates it from the architects mind further. As a result, we get buildings designed by architects worked upon by consultants of environmental design, which promise to be 'green' but are not wholesomely so.

The vernacular approach to architecture (Hagan, 2001) in history has always been wholesome in its approach. Climate, form and function were never seen apart and were weaved into unison by the master builder/architect. According to Hagan (2001), the vernacular approach has also left behind a strong sense of identity and invokes highly stimulating behavioural patterns inside and outside the buildings.

It does not need to be an entire city to invoke such a feeling. It could be a single building or building complex. Such is where the house is essentially planned around the existing landscape and topography and where the users feel a strong love to their untampered surroundings beautified with minimum intervention. Such is the effect of this approach.

Hence, the new vernacular approach should consider the sense of the place, prosperity and people by relating the climatic considerations to both the physical and psychological responses. It is this researchers view that eco-ethics underlies all the above-mentioned considerations.

2.3.7 Bio-Climatic Building Design

The primary consideration in terms of sensitivity to local context would be the climate. By designing a climate responsive building, the architect also gives it a unique identity, which belongs exclusively to the site on which it's built. By designing for the sun and wind, the architect is also following pure logic and yet creating interestingly unrepetitive spaces (Viswanathan, 2005).

To achieve that, (Markus, Morris, 1980), the design of functional spaces should be conceived in parallel with climatic requirements so that the passive solar techniques adopted do not appear 'added-on'. Unfortunately, the 'finishing touch concept', where the design climatic requirements are addressed is only addressed by adding on a sunshade here and there.

This according to Markus and Morris (1980) is now very popular in eco-architecture where the architects advertise their buildings as green. For example, they clad the buildings with wood that is not local when the whole point is lost. In order to avoid such a circumstance the architect just requires common sense than to pick from "the magic eco- goodies bag". According to Skolimonski (1981), it is by now clear that no new technology can provide a solution by itself, that no new Culture can provide a solution by itself, that no new ideology can provide an answer by itself. However, each must become an aspect of a larger paradigm, an aspect, in other words, of a new set of tactics for living.

In their study on Eco- minimalism, Lidell and Grant (n.d) summarised it as follows:

> *"The advice therefore is simple. Trust your commonsense, do the straightforward thing first and be wary of strangers bearing gifts. Much of ecological design lies in the identification and revival of commonsense and good practice – albeit it often requires new knowledge and insight to underpin it. It also needs us to go back and question all the new man-made and often 'magical remedy' materials that have rushed into buildings over the past four decades."*

Hence simple solutions addressing both functional and climatic requirements are often more effective than prefabricated exhibitive add-ons. However, in reality, with certain exceptions, this is not the case today, as climatic considerations just remain mentioned in the brochures and articles but not entirely functional in the building itself.

This has to change if we need to build 'truly' bio-climatic buildings according to Viswanathan (2005). Each design has to be custom made for the context and maybe tested on common grounds for its performance and not vice versa. The consequences of Eco-ethical architecture on the practical level, Skolimsnki (1981), spell out a new kind of technology based on the idea of frugality, recycling, and the reverence for nature.; indeed a new economy, of which the reverence for nature is not a spurious ornament, but an intrinsic part of a new design.

2.3.8 The Ecological Crisis and the Human Condition

The global ecological crisis, which confronts humanity today, is one of the most critical turning points that human civilization has ever faced. He also opines that society has entered an unprecedented period in human history. By the vigour of our consumption and procreation, adds Leigh, the human species has modified our global environment at wide regional and global scales (Leigh 2005).

New ways to reconceptualise our unity with the biosphere, understand downstream impacts, and link social behaviour with environmental transformations, as Leigh notes, are increasing with corresponding intensity.

He notes that significant social change is needed for improving our collective relationship with the earth. He concludes that humans, with their unique capacity for self-reflection, are beginning to understand that the underpinnings to their current

ecological problems lie within their attitudes, values, ethics, perceptions, and behaviour. Leighs sentiments are also echoed by Wilson (1993) and Skolimonski (1974).

2.3.9 The Attitude of Product Users towards Environmental Concerns

Basing their analysis on socio-cultural factors, Shidi and Simizu (2007) focused their study on the present factors that blocked consumers from having more environmentally friendly lifestyles in order to achieve a sustainable society. Among the factors, they point, as hindering environmentally friendly lifestyle is the lack of acceptable products and services in the current system of production and consumption. They also point to the lack of environmental education and learning program for consumers to nurture their ability to take action toward environmental impact.

Shidi and Shimizu (2007) also posit that there is a need to implement strong efforts for education and learning on environmental aspects in the daily life of consumers. This researcher read this as a thesis to induce eco-ethics through the education system. Tolba (1992) and Unep (1972) propose such education to enable consumers to notice the environmental problems in their relationship with society and the economy, and to join forces with the efforts made by others to solve the problem.

2.3.10 The Politics Of The Artificial

In his paper, "Politics of the Artificial", Margolin (1995), argues that nature and the artificial must strike a balance. By trying to infuse the spiritual into design, Margolin sees a synthesis that must guide products and production in the spiritual sense. This

new essence, argues Margolin as does Papanek (2003) must exist beyond a socially constructed discourse. The two authors among others conclude that a new spirituality can address the increasing complex relations between the natural and the artificial and offers the basis for a new project for designers. This study identifies with the idea of "a new project" which construes a paradigm shift in livelihoods and adoption of eco-ethics.

2.3.11 A New Critique Of Design Issues

In a paper titled "Ecological Design: A new critique", Madge (1997) points to the transition from green to eco to sustainable in the design field. This in her view represents a steady broadening of scope in theory and practice, and to a certain extent, an increasingly critical perspective on design and ecology. She argues that design must go beyond the simplistic notion of design and the environment in the previous decade. Madge (1997) and Naes (1989) emphasises on the more radical theories emerging within both design and environmental thinking in order to demonstrate what this might imply for a new ecological criticism. In fact, Madge (1997) is only short of prescribing a new approach, which this researcher points to in the product life cycle. Such new ecological criticism could form the basis for eco-ethical livelihoods.

2.3.12 Sustainable Production

Quantities of products are not dependent on an industry's production capacity anymore. Cheap and disposable products (Ezio, 1989) are widely available in our societies. Even if we long thought the expansion of consumption would augment

chances to have a better quality of life around the globe, the results are however unequivocal: social instabilities, inequalities and environmental tribulations are direct consequences of this situation.

Products that possess good price for their quality fulfil basic needs, but the market of necessary products, products that fulfil primary needs, is saturated. Hence, competitiveness is now installed in what Ezio (1989) calls "replacement products" markets. Ezio Manzini, Italian designer and renowned eco-product design author, argues that these products are unnecessary. They are only fashionable and sold because of marketing efforts and publicity. It is also because the power of communication is increasing and able to greatly influence consumption. Production activities and market share competition is thus providing consumers with superfluous products that engender unsustainable consumption patterns, generate waste, and where products inherent qualities, such as aesthetic and design are no longer valued.

This has led designers to rethink their role in the market economy, where innovation quality constantly reduces, and is creating a constant technical, physical and aesthetic stress. Such stress (Leigh Peter (2005) puts a strain on companies without producing any substantial evolutionary refinement. Nowadays, many authors, scientific communities, businesses and consumers agree that these problems reside in what products are consumed, the quantity that is produced, and their qualities.

The shift that is remarked within the corporate sector, according to this study, from end-of-pipe solution toward prevention of environmental impacts, reflects the will of manufacturers to focus on the source of these impacts.

2.4 Assimilating "eco-logy" into product design

2.4.1 Eco-Materials, Eco-Components, Eco-Products, And Eco-Services

The prefix "eco", meaning habitat or environment, comes from "ecology", the branch of science concerned with the interrelationships between organisms and their environments. Eco has long been used in such compound forms as ecosystem and ecocide. More recently, (Yamamoto, 2007) this prefix has been used in combination with "materials ","products ", or "services" to indicate that they take into account environmental impacts through the entire life cycle.

2.4.2 Eco-Materials

Professor Ryoichi Yamamoto and colleagues at the University of Tokyo first introduced the term "eco-materials" in Japan in 1991 as a proactive measure in response to the sustainable development movement. Eco-materials (Kun-Mo Lee, 2005) are defined as those that can improve the environment throughout their life cycle, with accountable performance. Eco-materials encompass one or more of the following six factors:

1. Avoiding and/or reducing the use of non-renewable or scarce resources;
2. Enhancing the material closed loop by recycling and reusing waste;
3. Increasing resource efficiency including that of energy and materials;
4. Using more durable materials with fewer maintenance requirements
5. Promoting the use of renewable resources and energy; and
6. Minimizing adverse impacts on biodiversity and eco-systems.

In other words, eco-materials form a key concept in material science and technology to minimize environmental impacts, enhance the recyclability of materials, and increase energy and material efficiency. Eco-materials, according to Kun-Mo Lee (2005) also contribute to the development of eco-products and promote the green procurement movement in Japan and elsewhere. Eco-materials have relatively better ecological, economic, and efficiency features and are currently classified into groups based on similar proper ties, similar processing routes, and similar applications. The result is a data book that classifies them into seven categories: metals, polymers, natural materials, foams, ceramics and glass, composites, and others (Taylor & Francis, 2001).

2.4.3 Eco-Components

The term "eco-components" in this study refers to those used as components or parts of eco-products. Eco-components can be essential, functioning parts of a subsystem or equipment, or a combination of parts, assemblies, attachments, or accessories of an eco-product (Pil-ju 2005). They are sometimes called semi-products and used as inputs in eco-product manufacturing. Similar to eco-materials, eco-components are produced taking into account their environmental impacts through the entire life cycle. As a result, (Pil-Ju, 2005) the six factors involved in eco-materials can also be applied to eco-components. Eco-design or life cycle design concepts, methodologies, and tools are used in the production of eco-components. In addition, eco-components can contribute to the manufacture of eco-products through eco-design for disassembly, design for upgradeability, and design for waste prevention.

While eco-components are defined as components or parts of eco-products, (Kun, 2005) they are naturally related to the industrial sectors making them. Based on the major product categories, eco-components can be classified into seven groups: construction components, electrical and electronic components, semiconductor manufacturing devices, machine parts, automobile parts, packaging, and others (Tanaka et al, 1991).

2.4.4 Eco-Products

Eco-products are designed according to eco-design concepts and principles to have environmentally friendly features. Life cycle concepts and engineering play a very important role during the development phase of eco-products.

Eco-products are made from improved raw materials (Matias, 2005), including recycled or biomass materials. In addition, during the production process, minimal energy and water resources are used with less waste and fewer pollutants. In the consumption phase, the use of eco-products can lead to energy and water savings, minimal emissions, and reduced waste and subsequent need for waste treatment. Eco-products are also designed to ensure the ability to recycle and recover materials and components.

In Japan, (Yamamoto et al, 1991) eco-products generally bear eco-labels, which are type I, type II, or type III according to ISO 14020 standards. In addition, those products listed in the database of the Green Purchasing Network are also considered eco-products.

In this database, eco-products are classified into nine groups following the conventional industrial product categories. Among commercial products on the

Japanese market, these are home electric applications/lighting, carriers/automobiles, IT equipment, office furniture, apparel/fabric products, commodity/outdoor goods/housing kits, building and civil engineering equipment, machines and equipment, and some other eco-products not relevant to the above eight groups of eco-products (Yamamoto et. al, 1991).

2.4.5 Eco-Services

Eco-services are defined as those designed to shift traditional business from designing and selling products as physical objects into designing and selling product or service functions to meet the needs of customers (Charter, 2001). This new business is based on the life-cycle concept to ensure consideration of environmental issues. The use of eco-services (Shidi et al, 2007) can enhance the eco-efficiency of customer activities. A number of similar concepts have been proposed, such as Product Service Systems, Sustainable Service Systems, and eco-efficient services in Europe, and "servicising" in the USA (Charter, 2001). Although these concepts have their own distinguishing features, the main purpose of shifting traditional business to new, sustainable business in eco-services is common to all (Zerbock, 2003).

While the economy is shifting from goods production toward service provision, eco-products can be transformed into services to improve resource productivity and eco-efficiency. Eco-services have great potential to bring about huge changes in production and consumption patterns that will accelerate the shift toward a more sustainable society. Eco-services are generally classified based on actual business scenarios. The great diversity of eco-services has led to varying classifications

according to Charter (2002), and no single standard yet exists. Based on examples in the Japanese market, eco-services are classified into six categories:

1. Product-related services, including maintenance, upgrading, repair, reform, etc;
2. Reuse and recycling-related services;
3. User services, such as consumer leasing, rental, or product sharing
4. Outsourcing services, such as those provided by some professional companies in the form of pay- per-service waste treatment, hazard control, chemical handling, or facility management;
5. Management-related services, such as consulting, certification, diagnosis, assessment; and
6. Other services outside the above categories.

These six categories may cover most eco-services, from traditional industrial services to new services and businesses. According to literature review by this study, the classification of eco-services can be modified into four groups:

1) Product-related services,
2) Reuse and recycling-related services,
3) Management-related services,
4) Others.

This four categories capture what this study found to be universlly acceptable and practicable.

2.4.6 Conclusion

Literature has outlined a historical background of eco-ethics. It has also outlined methods and systems for environmental conscious product design. While clarifying eco- parameters and current eco-practices, the literature point to assimilation of the prefix "eco" to product design. As a systematic and focused field of intellectual inquiry, environmental ethics was conceived after broad recognition of an impending "environmental crisis". Its growth was heavily influenced by cultural factors. It sought to push society to work toward a more holistic environmental ethic.

As environmental ethics matured, a number of green ideologies emerged that united it with various political movements. Among them is eco-feminism which unites environmental ethics with feminist politics. Based on these arguments, it is therefore clear to this study that, environmental justice unites environmental ethics with political concerns about economic and racial inequities. The expected outcome is sustainable environment and livelihoods.

Unfortunately, the situation in Kenya is vague; environmental issues are still restricted to pollution prevention in industry and not tackled by product design. This is because designers are not challenged or identified as culprits in the problem. The difficult challenge in eco-design is therefore to balance environmental qualities with usual products development criteria, such as costs, quality and functionality or performance. Waste is one problem, but resource depletion, high-energy consumption and pollution are other harmful environmental impacts of our lifestyles today. As design continues to offer intervention opportunities in the development of products, there is a very relevant need for cultural change within the design community. This issue

among others gives impetus to the thesis of this study. Based on parameters/concepts recommended by global authorities, it seeks to encapsulate a theoretical grounding to understand and possibly solve these problems.

CHAPTER THREE

CONCEPTS FOR INTEGRATION OF ECO-ETHICS IN PRODUCT DESIGN

3.0 Introduction

In this chapter, the study enumerates the best practice eco-behaviour for industry. It apportions responsibilities to individuals within the production and decision making cycle. The chapter also examines strategies that offer maximum eco-returns in product design, the product and production process. Business strategies and ecological considerations in product production are reviewed with the aim to understanding the existing methods in the realisation of eco-ethical innovative products. The strategies enumerated for best practice behaviour in this chapter are globally recommended and universally accepted.

Environmental innovation

3.1 Business Strategies

As recently as a decade ago, many companies viewed business ethics only in terms of compliance with legal standards and adherence to internal rules and regulations(Piasecki, 1992). Today, driven by a range of new challenges and opportunities, the field of business ethics is fast breaking out of that compliance-based silo. Beyond legal compliance and government regulations, consumer, shareholder and stakeholder expectations also compel companies to address ethics effectively. This view is also supported by Steinhilper (2001), Raven et al, (1993) and Leopold (1949).

3.2 Corporate Leadership For Eco-Production

According to the Asian Productivity Organisation (2005), sound environmental management is an important contribution to ecological product development. It is increasingly seen as both a business responsibility and a business opportunity. Multinational enterprises have a role to play in both respects. This Asian productivity organisation (2005) recommends that managers of enterprises give appropriate attention to environmental issues in their business strategies and day-to-day operations as shown in the diagram adopted from Olundh.

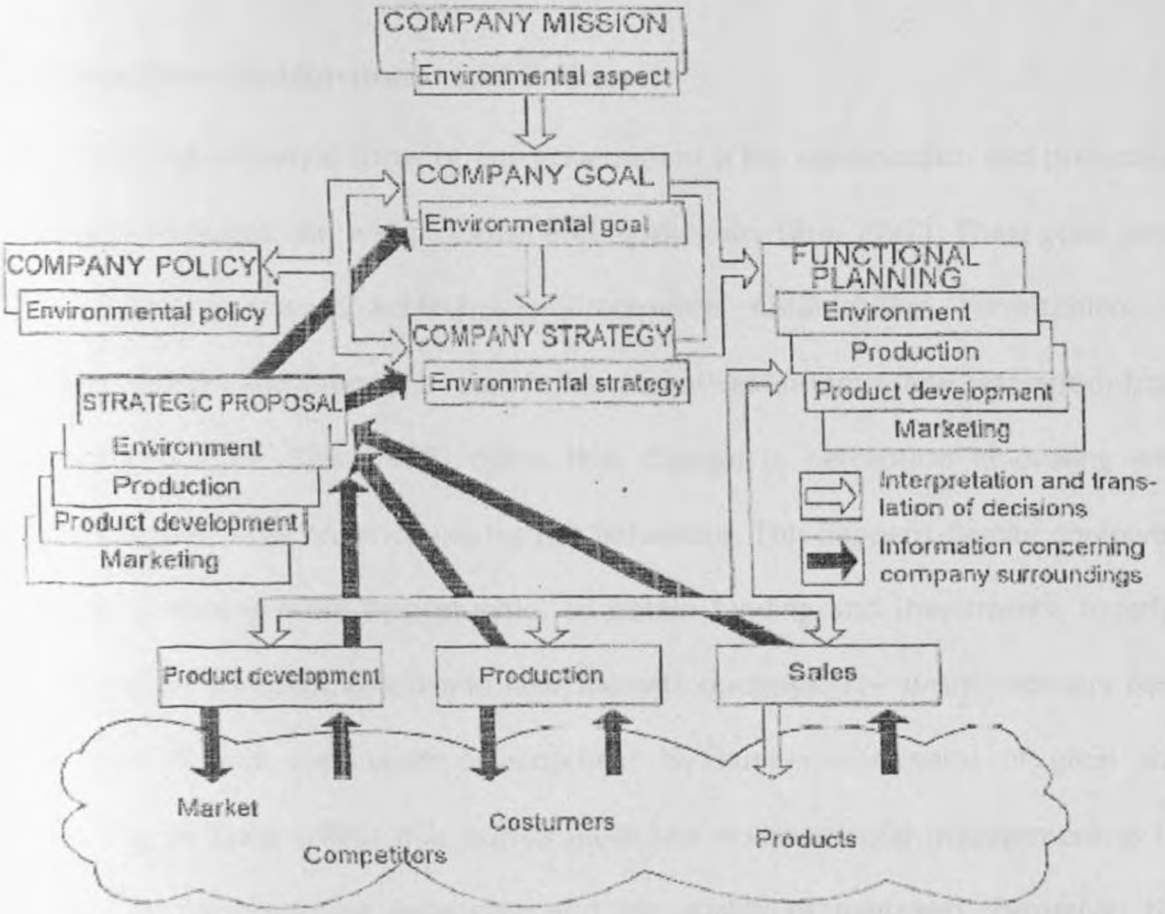


Plate No. 3.1: Product development in the planning structure with flows of information formalized by environmental systems. Adopted from Gunilla Olundh (2006)

Eco-production guidelines encourage multinational enterprises to raise their environmental performance by improving internal environmental management practices and seeking continuous environmental improvements. These can be achieved through a range of tools and approaches relating to environmental management as shown above by Olundh (2006). Such are engaging in public information and stakeholder consultation; assessing environmental impacts through the whole life cycle of processes; acting with precaution; providing for contingency planning; ensuring environmental training and contributing to the development of environmental policy.

3.3 Regulations And Environmental Policies

The main environmental focus of any government is the conservation and protection of natural resources: air, water, forests and biodiversity (Bras 1997). These goals seem very promising toward achieving environmental sustainability. Nevertheless, in practice, policies and programs result in few incentives and thus, few realisations from the private sector. Bras (1997) opine that changes in perception in dealing with environmental issues are encouraging this behaviour. This happens despite complying institutions having more opportunities to obtain funding and investments, together with superior competitiveness and new markets openings. The work necessary for a real shift toward sustainable development by businesses remains of great size. According to Karai (1996) it is not so much the environmental management as the search for manufacturing excellence and the quality of managers themselves that would appear to be at the origin of the win-win logic. Simply put, it is a personal imperative of the individual managers that would drive change. A tertiary sector

company (Ezio, 1989) doesn't feel the closeness to the environment as much as a primary or secondary sector company, whose first activities are to modify this environment.

3.4 Economical Considerations

Economical considerations that preoccupy business leaders when commercialising products are costs, prices, and performance. Although there are many authors and even corporations that denounce sustainable development benefits derived from corporate environmental engagement, such engagement remain mainly economical (Loriot, 2003). Not all businesses however have realised the economical benefits and potential of an increased environmental performance of their products. Further more, businesses tend to take strategic decision based on forecasting of sales rather than forecasting of demand changes. This prevents leaders from seeing long-term opportunities of environmental commitment. These sentiments are also supported by Markus & Morris (1980), Zerbok (2003), Tolba (1992) Margolin (1995) and Pronk (1998).

3.5 Allocation Of Resources

Lofthouse et al (2006), points that allocation of research funds and human resources, in terms of financial, political or time support originating from corporate leaders is a strong factor of success of the product development process. Corporate support also means the provision of strong environmental vision, and clear goals to the product orientation team (Markus, Morris, 1980). However it seems design resources are perceived as expensive: green projects are even more demanding in research time

than ordinary design projects. This is probably because rethinking of proposed materials choices and development processes need to be achieved to obtain performing environmental product (Www.ricoh.com2007).

On the other hand, designers are a relatively low-risk and inexpensive resource when considering that what they do has the potential to only add value and therefore improve market performance of one product, while reducing costs. In implementing Design for Environment (Papanek, 2003), time allocated is the most important factor in improvement of environmental qualities in new product development.

3.6 Extended Producer Responsibility (EPR)

Extended Producer Responsibility (EPR) is a strategy designed to promote the integration of environmental costs associated with products throughout their life cycles into the market price of the products (OECD, 1999).

Extended producer responsibility imposes accountability over the entire life cycle of products and packaging introduced on the market. This means that firms, which manufacture, import and/or sell products and packaging, are required to be financially or physically responsible for such products after their useful life. The OECD (1999) recommends that they must either take back spent products or manage them through reuse, recycling or in energy production, or delegate this responsibility to a third party, a so-called *producer responsibility organization* (PRO), which is paid by the producer for spent-product management. In this way, EPR shifts responsibility for waste from government to private industry, obliging producers, importers and/or sellers to internalise waste management costs in their product prices (Hanisch, 2000).

EPR has been implemented in many forms, which may be classified into three major approaches:

- Regulatory
- Negotiated
- Voluntary

It is perhaps because of the tendency of economic policy in market-driven economies not to interfere with consumers' preferences that the producer-centric representation is the dominant form of viewing the environmental impacts of industrial production. In statistics on energy, emissions, water etc, impacts are usually presented as attributes of industries ('on-site' or 'direct' allocation) rather than as attributes of the supply chains of products for consumers (OECD 1999). .

3.7 Market Research

Market research is the information collection and analysis, concerning consumers and markets (Carlson et al, 2001). It includes competitors, and marketing strategies effectiveness. Market sizes, buying decisions factors, consumer statistics, are all information collected by marketing people. In addition, they try to understand needs and desires of their customers, try to meet the latter, and promote, with appropriate material and strategies, their products to potential targeted customer. In the case of product development, marketing compares products with competitors' trends and products' stage of maturity, regulations, packaging, distribution, etc. Market innovation, defined by new markets identification and finding better ways to serve

them, is said to be the most successful strategy for profitability (Shindi, Shimizu, 2007).

Curiously, marketing research does not provide enough tools or methods to assess needs and potential markets (Lofthouse et al, 2006). The intuitive, naive and experimental approach to market analysis is frequent. Intuition methods are not undesirable or negative. However, they are based on the decision-maker's experiences and values, cultural and societal context. In addition, a bias, and / or omissions of the individual, according to this researcher, always permeates now. The method is hence risky and might explain the very large number of unsuccessful products (Pil-Ju, 2005).

The current trend in marketing is to move from cost-based strategies that forced marketers to propose always a higher consumption of mass produced products, toward a more consumer-directed approach. Pil-Ju (2005) opines that market research and consumption studies are greatly deficient, if existing at all, in the crucial understanding of what kind of consumption patterns would be suitable to achieve sustainability. Marketing people therefore have considerable power in determining and driving the necessity of eco-design within a corporate strategy of product development. One point this researcher supports is Loriot's (2003). It is that if clients' demand for environmentally conscious products, such demand doesn't seem to reach designers because of market personnel. The said personnel do not include such qualities in design briefs.

3.8 Marketing Strategies

Since the early 1990s (Hector 1999), a renewed interest of the marketplace on sustainability concerns surfaced. Not only is the relationship between humans,

organizations, and the natural environment being redefined as a result, but also the implications thereof are being reinterpreted. Because of this, perceptions are either being formed or re-evaluated on issues such as the environmental friendliness of products, recyclability, waste reduction, the costs associated with pollution, and the price-value relationship of environmentalism Pressure from various stakeholders - government, special interest groups, and consumers - is placed on businesses, which in turn keeps them under constant and unrelenting watch in their daily operations.

A direct result can be seen in the stricter regulations imposed by governments. Additionally (Stevels 2006), consumers are also becoming more outspoken regarding their needs for environmentally friendly products, even though questions remain on their willingness to pay a higher premium for such products. However, environmentalism poses many challenges to businesses and presents opportunities to capitalise on the demand for greener (Matias 2005).

3.9 Green marketing

Olundh (2006) refers to typical marketing for the environment as "green" marketing. Green marketing encompasses all efforts aiming at selling or commercialising ideas, services or products. Such products and services contain environmental qualities that would represent interest for buyer, user or a customer. Communication plan is part of a marketing strategy and it consists of publicity preparation, promotional activities, public relations, labelling and distribution. The latter serves the purpose of seducing consumers. Nevertheless, it could also be an information source about the utilisation of the product and its environmental impacts and performance. Marketing strategies (Papanek 2003) are increasingly aware and subject to a growing conscience from

customers who want greener, cleaner and more durable products but they are restrained to fulfil it.

Many businesses are known to refrain from promoting their efforts toward the environment, arguing their image, or especially their product's image, is diminished in the eyes of their customers. The extensive literature on green marketing by Loriot (2003) provides answers to why green marketing is present or increasing in our societies. Some answers relate to the fact that green marketing has been largely untested and restricted to purchasing.

3.10 Publicity, Demand Manipulation

Marketers state that, contrary to common thoughts, they do not "create" the demand. Some essential needs are present in all societies and marketing serves the purpose to find, tackle and fulfil them with products. Many authors (Papanek, 2003, Callicot, 2000, Tolba, 1992, Steinhilper, 2001) denounced the demand manipulation and creation that play an extremely important role in the consumption patterns present today, arguing that demand theory are completely and unfortunately avoiding understanding needs fulfilment and psychology of satisfaction. The above authors denounce that advertisement; the public opinion and the consuming routine, have replaced consumers' judgment by the pressure to consume.

Papanek (2003) maintains that the actual production system is creating wants in order to sustain its own "raison d'être". Society as a result becomes increasingly affluent, "wants are increasingly created by the process by which they are satisfied". Many studies have been carried out on this issue and an analysis of this subject would exceed the scope of this thesis. However, from them we can see there are reinforcing

causalities that are encouraged by the way new products are brought to markets and the image, fashion and pressure on consumers to buy them. Even the fact of introducing a new product renders obsolete the one already on the markets (Margolin, 1995).

3.11 Product Development

Numbers speak by themselves in the field of commercialisation of new products. Only 10% of product concepts produced by one company are developed, and from these, 25 % are commercialised. Finally, only 67% of commercialised products survive on markets (Achankeng, 2003).

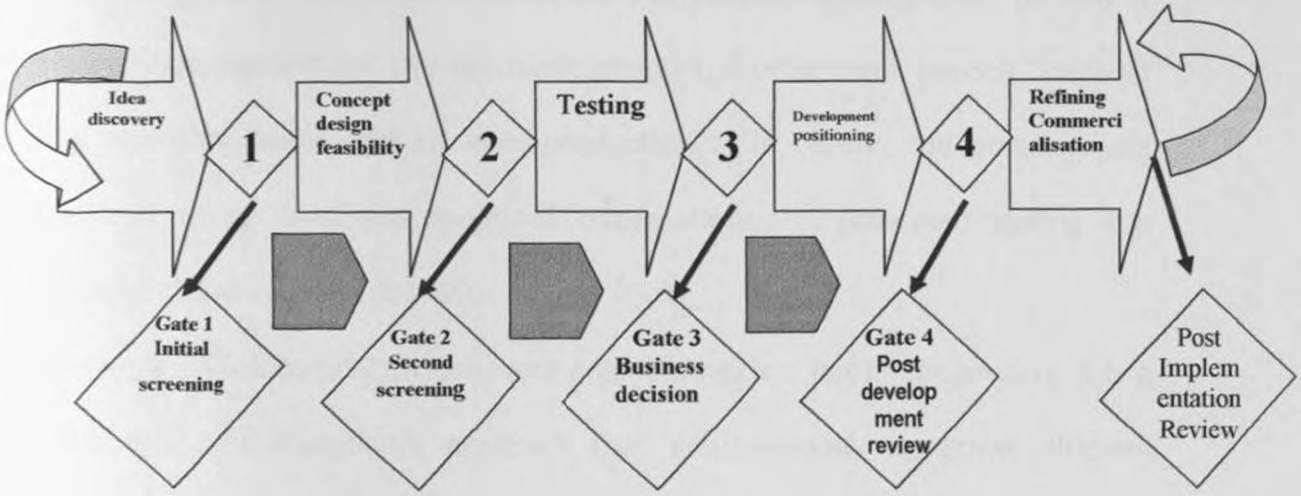


Plate No. 3.2: Design and product commercialization process: Source: Carlson et al, 2001

These facts suggest great resources, ideas and energy losses. Development of products is defined by the "creation of new products and the adaptation or redesign of existing products for new or existing markets" (Ezio 1989, Bert 1997, Tolba 1992).

Today, more than 50% of products sold on the market are new products younger than five years of existence (Carlson et al, 2001). Obviously, to sustain such product

as 75%. Competition is more aggressive than ever and consumers have plenty of choices on their markets. It is often said that 5% of total product development costs only are spent on the conceptual phase, while this phase, as we have seen before, results in more than 80% of total products costs (Achankeng, 2003).

Tolba (1992) advances that the process makes great emphasis on the necessity to cross certain gates (plate 3.2) before addressing the next phase, in order to save resources and time if the outcome of one phase is not sufficiently convincing to go further. However, because the "purpose of product development is to transform a product definition into a product specification" the models presented to illustrate product development processes, are very linear. Conception processes should move away from these mechanical, one-dimensional models of product development. Its flaw is that it exaggeratedly imitates the economic product development process "derived from the assembly line model of mass production". In reality, the processes are iterative and many feedback loops of information are generated during the development (Edison & Tadao, 1999).

Another process (Tolba, 1992), concurrent engineering, is a less-linear process. It is a systematic and cross-disciplinary approach that simultaneously integrates different phases of product development management and process, rather than considers the traditional sequential process separating disciplines and functions. It includes usually all phases of a product life cycle, from conception to its disposal. This approach permits useful time gains for commercialisation, of approximately 40%, result in costs reduction and resources optimisation, and permits to bring profits faster. Concurrent engineering teams require that many disciplines and designers manage such multidisciplinary teams (Kirai, 1996; Syagga 1996).

3.12 Industrial Design

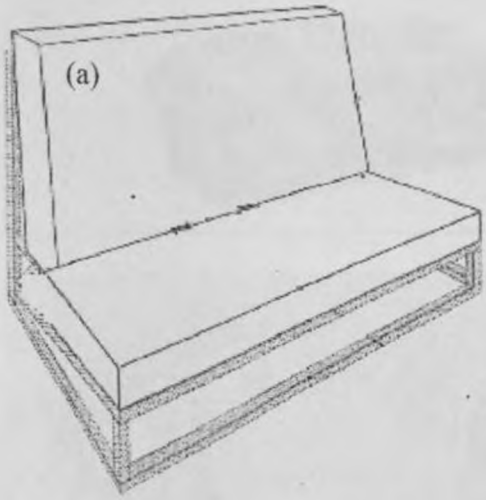
Design knows best about the artificial environment. The International Council of Societies of Industrial Design (ICSID) gives the official international definition of industrial design:

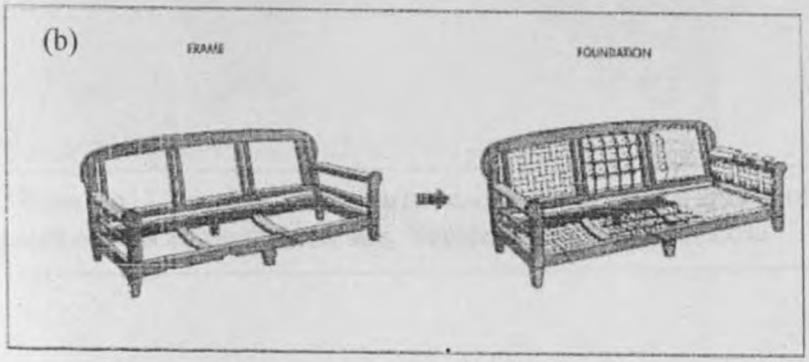
> *"Industrial Design is a creative activity whose aim is to establish the multi-faceted qualities of objects, processes, services and their systems in whole life-cycles. Therefore, industrial design is the central factor of innovative humanisation of technologies and the crucial factor of cultural and economic exchange."*

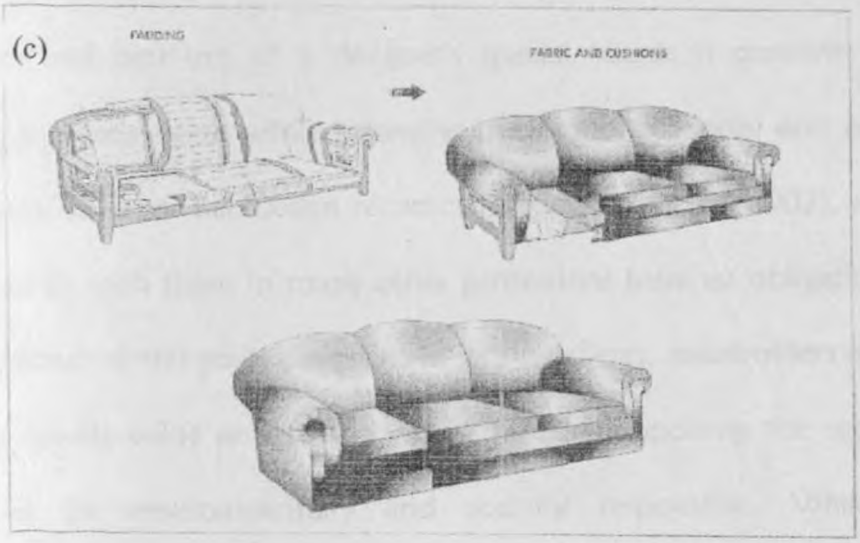
The ICSID emphasises that; designers' tasks must include sustainability as one of their practice principles. Industrial design was previously defined, by the ICSID, as a purely "creative activity the aim of which is to determine the formal qualities of objects produced by industry..." This shift might illustrate the new sustainable mandate designers should accept when practicing (Chen, Cho, Chang, 2006). Through the application of sound design practices, design practitioners are able to increase the value of products, services, communications and physical spaces, while at the same time reducing costs, improving efficiency and increasing productivity (ABC, 2008).

Papanek (2003) calls for the integration of the industrial design process in the Total Quality Management (TQM) process, to incorporate important use value of design, such as ergonomics, emotional value, etc. Design inclusion at the earliest possible stage of product development results in products that are less expensive and easier to produce, assemble, inspect and service (See plate no. 3.3). The consequence of good

design is therefore a lower cost of production, an increased demand for a good product and higher sales (Nelson, 2007). Subsequently, these higher sales turn to more environmental degradation at their end of life, a point that these study concur with.







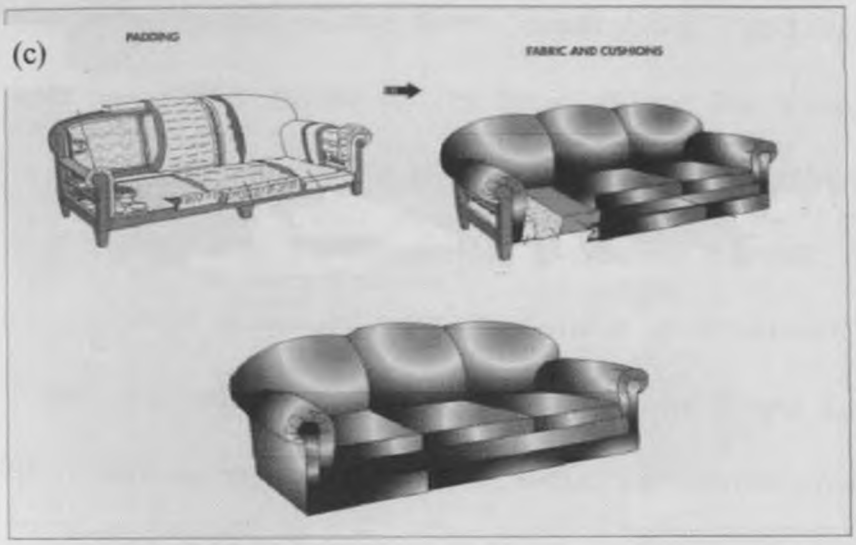


Plate No. 3.3 (a, b, c & d): Early design & production stages of sofa set, ideal for intervention. Source: http://leesminis.com

3.13 Industrial Design And The Environment

The highest and best use of a designer's special talents is creativity and skill in addressing a client's needs while balancing the economic, social and environmental consequences of his or her design recommendations. Charter (2002), advances that designers along with those in many other professions have an obligation to "do no harm" In pursuit of this goal, designers, in serving clients, stakeholders and the public can create special value and play a crucial role in supporting the requirements of business to be environmentally and socially responsible. While there are

There are many interpretations of the term "sustainability," and its definition continues to evolve as global debate on the topic widens. For some, it means maintaining the status quo. For others it is equated with notions of responsibility, conservation and stewardship. However, for a growing number of people, sustainability is a concept associated with "sustainable development," the first definition of which was articulated in the United Nations World Conservation Strategy of 1980. "Development" in this context includes economic growth, human rights and the satisfaction of basic human needs. For product design to be sustainable, it must take account of social and ecological factors, as well as economic ones; of the living and non-living resource base; and of the long-term as well as the short-term advantages and disadvantages of alternative action (Fox, 1986).

3.14 Designers' Legal And Ethical Responsibilities

Multinational enterprises are continually adapting themselves to a changing socio-economic environment. This applies to all corporate activities and related environmental management tools. For example (Yamamoto 2007), in a departure from previous "end-of-pipe" approaches to limiting pollution, argues that companies have implemented more efficient preventive environmental techniques, affecting the different stages of their value chains. (www.wordnet.priceton.edu)

Improved brand and corporate reputation, risk reduction, improved access to finance and value creation (i.e. development of "green products" for which a price premium can be obtained) are among the key considerations that motivate businesses in their efforts to improve environmental performance. As quoted by Pil-Ju, the Organisation for Economic Co-operation and Development (OECD, 1999) guidelines address four

categories of environmental improvements: process-related improvements, product-related improvements, consumer awareness, and research and development. (Pil-Ju, 2005)

3.15 Designers' Social Responsibilities

Designers need to change their attitude in product development if environment qualities are to be incorporated in the process (Loriot, 2003, Porter & Linde, 1995, Lofthouse et al, 2006). They should approach product design through a stewardship approach. This attitude would make designers responsible with the whole life cycle, and therefore the environmental impacts of a products' life cycle phases, as opposed to simply intervene in a process already in place. This concept is a logical extension of the notion of designer's responsibility in front of users, about health and safety of design products.

Design (Loriot, 2003) has gone excessively far in giving form to products for mass production; it has been firmly embedded in consumer culture. In getting so good "designing", designers have created reasons for users to become consumers, and placed their research to have a place in the economy, in an industrially based manufacturing culture.

3.16 Designers' Designs

Thinking ecologically about design is certainly not a "new" idea. Since ancient times, "designers" looked to nature for "solutions" to their common problems (Bras 1997). They saw nature as the perfect model to follow. More recently, designers such as Le Corbusier and Frank Lloyd Wright, among many others, have attempted, with some

degree of success, to address ecological issues through their designs. "Green Architecture," "Alternative Architecture," "Sustainable Design," and "Ecological Design," are some of the terms commonly used today to describe a special expression of design that takes as its primary driving force nature's processes. Van Der Ryn and Cowan (1996) defined this form of expression as "any form of design that minimizes environmentally destructive impacts by integrating itself with living processes." A new movement among design professionals has been developing for some time now with many of its principles synthesised by the current "green" movement in design.

Achankeng (2003) points out that even though, in recent times, an increase in ecological education and environmental awareness is apparent among design professionals, there is still the need to better understand the expression of ecology through design. A deeper examination (Steinhilper, 2001) of the current paradigm(s) driving the ecological design movement will show that it addresses issues in a reactionary and remediative fashion, only scratching the surface without really considering deeper questions. This "green" design movement is shaped by the dominant worldview, a highly Westernised and human-centred view that in the end lack ecological consciousness (Callicott, 2000).

It's Callicotts (2000) view that deep ecology presents itself as a possible alternative to the common dominant worldview of technocratic-industrial societies that regards humans as isolated and fundamentally separated from the rest of nature, as superior to, and in charge of, the rest of creation. Deep ecology involves cultivating ecological consciousness, the understanding that everything is interconnected. It involves learning how to be more receptive and trusting, more holistic in perception, and is

grounded in a vision of non-exploitative science and technology. Deep ecology as expressed by philosopher Arne Naess is "simple in means, rich in ends (Drengson and Inoue, 1995; Devall, Sessions, 1985)".

Due to the ever-increasing reach of technology, many of the proposed solutions to the problems humanity faces today are based on the concept of the "global society." Problems are no longer studied within their own context, but general, prescription-like solutions are the norm in dealing with them. Unfortunately, design is no exception. The current eco-design movement has many times approached environmental issues in this fashion. An example is the common and repetitive scenario in which "expert" designers based in other cities, states, or even countries are called upon to intervene on a site without really knowing the relevant socio-economic, cultural-historical and biophysical processes associated with that specific area. These outsiders (Skolimowski, 1981) in some cases do not even care to try to understand local cultures and their relationship to their surrounding environment. They simply refer to their own past experience and the application of a design "recipe" that might be thought of as the best fit for a particular project.

Ecological design (Raven et al, 1993) should be sensitive to local environments and cultures and respond accordingly, taking into account a bioregional approach. Bioregionalism predicates giving importance to natural boundaries between ecosystems instead of artificially made boundaries, and it implies self-regulation, a more sustainable way of life and work (Solomon et al, 1994).

3.17 Product Development Systems

According to Loriot (2003) the system is composed of four actors that have large responsibilities in product development.

- The corporate level or business strategies (see plate no. 3.3)
- The marketing level which includes market research, the product development team comprising process developers, such as the engineering department,
- The design of products as such, usually performed by industrial designers
- And Finally, the consumers or users of the product.

Innovation is what drives change in a company, and it can be initiated by different factors which include renewal of product line, regulations changes, stakeholders' pressure, processes improvements, competitiveness, growth or reduced sales. Loriot (2003) opines that it is initiated mainly by business strategies, marketing research, and a little less by product development or Research and Development (R&D) teams directly (See plate no. 3.3).

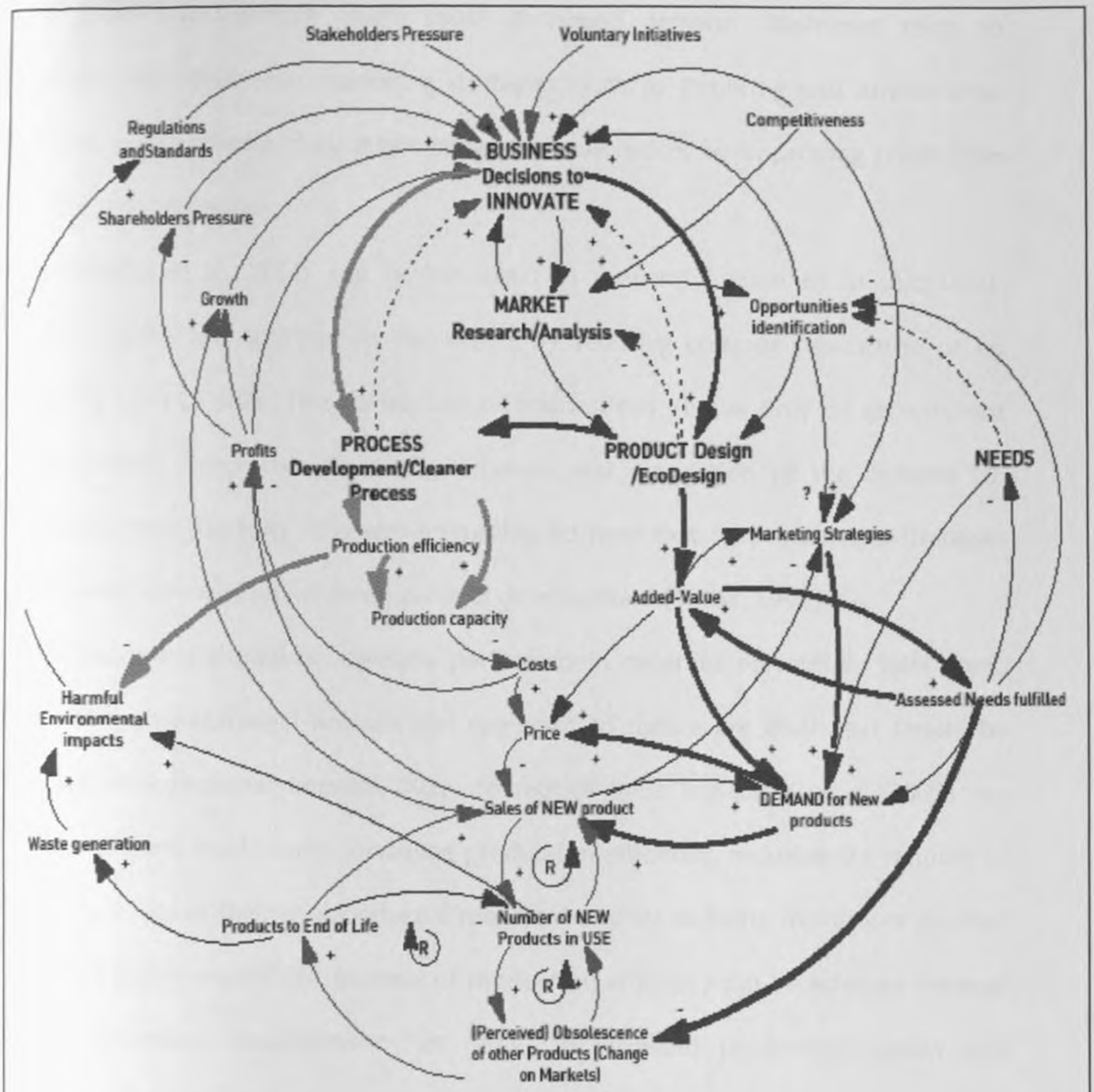


Plate No. 3.4: Model of product development system. Adopted from: Catherine Loriot; Lund University international Masters program in Environmental Science, the Netherlands.

Nevertheless, innovation affects the latter considerably as product development teams perform it. It results in lower costs of production (in the case of production efficiency improvements or capacity), or added-value products in the case of products' improvement (Knopf et al, 1932). Conversely, added value results in higher

price goods and therefore might cause decreased demand. Businesses seem to overcome this effect with marketing strategies, such as publicity and promotional activities, but in general, they might prefer to lower prices by improving production capacity and efficiency.

Sales (Martin et al, 2001) can be measured in monetary value or in sold units' number. Profits are achieved in two ways: by reducing costs of production or by increasing sales of units. The actual state of business can survive only on growth, not on stagnation, hence the changes in products and stimulation of the demand for constantly new products. It is also interesting to note that only businesses strategies and market research can influence product development (Tolba, 1992).

Need assessment should be carefully performed in order to successfully fulfil user's need. The environmental impacts that we want to reduce are illustrated simply by harmful environmental impacts. Ways to reduce these impacts (Loriot, 2003) are straightforward and include; increasing production efficiency, reducing the number of products in use or their environmental magnitude, or by reducing quantity of product that users put to end-of-life. Increase of production efficiency can be achieved through cleaner processes development that results in increased production quality and capacity, thus lowering prices and increasing sales.

3.18 The Concept of 'Life Cycle Thinking' - Overview

A life cycle approach should be able to define the best design strategy in order to reduce the environmental life cycle impact of a product. This approach can affect the following life cycle stages of a product:

- Extraction of raw materials;

- Production of materials;
- Manufacturing of parts;
- Manufacturing of semi-finished products and components;
- Assembly of the end product;
- Distribution;
- Use and maintenance;
- End-of-life treatment (reuse, disassembly, material and chemical recycling, energy recovery, ultimate disposal).

Although it may be useful to define the relative importance of the different life cycle phases for a specific project (based on past studies or experience), it is advisable not to focus on a single phase beforehand in order to avoid an adverse shift in environmental impacts from one phase to another. Minor shifts, however, might even be a useful strategy if the environmental performance of the complete life cycle is improved (UNEP, 1972).

3.19 Adopting Life Cycle Thinking in Product Design

Leigh (2005), defines it by making the following statement: "It starts with resources taken from nature, goes on to the production of materials, product design and product/component manufacturing processes, the use and maintenance of a product, and concludes at the end-of-life stage ("cradle to grave" approach)". This view is collaborated by among others: Kun-Mo (2005), Naess (1989), Olundh (2006), UNEP (1972) and Yamamoto (2007). Life cycle thinking takes into account all the environmental aspects that occur in the complete life cycle of a product (Hector, 1999). These include energy consumption, materials application, chemical substances,

durability, reusability/recyclability, packaging, transport, etc. The complete life cycle includes mining and materials production, production of components and subassemblies, assembly of products, and the reuse and discarding of products. One way to achieve eco-efficient solutions is by the "producers' responsibility" principle, under which producers are made ethically responsible for parts of the life cycle outside their traditional domain of manufacturing; for instance packaging waste, and products discarded by consumers. Life cycle thinking takes a holistic view. It checks that design options do not have a reduced impact at one lifecycle stage at the expense of increasing the impact on the complete life cycle. Consideration of the entire life cycle can help ensure that (/www.iso.org 2008);

- All the environmental and economic characteristics of a product are taken into account;
- Consideration is given to impacts generated by intermediate products, for example, emissions in manufacturing, which are not part of the composition of the finished product;

Environmental impacts are not merely shifted from one life cycle phase to another or from one medium to another: for example by eliminating an air pollution problem a solid waste disposal problem may be created instead.

3.20 Trade-Off Considerations Through Life Cycle Thinking (Multi-Criteria Approach)

As much as possible the designer has to take into account the potential impacts in terms of the use of resources and discharge of pollutants in every part of the environment (water, air, and soil). Other criteria such as odours, land use and

damage, noise, radiation, etc. might also be considered. The complete range of different potential impacts has to be taken into consideration through a multi-criteria approach [ISO 2001].

This multi-criteria approach helps to avoid displacing one type of environmental impact by another. In this context, any arbitrary exclusion of an environmental criterion has to be justified. Some examples of "displaced impacts" are:

- A recycling process that consumes more energy, possibly in transport as well as in processing, than is saved by recovering material;
- A miniaturised product, using fewer resources than its precursor, that is impossible to deal with at its end-of-life stage because of its complex design and use of mixed materials;
- A car with a white aluminium body and with a low mileage during its use phase: it is lighter and therefore uses less fuel, but there may be more energy and emissions embodied in its manufacture than can be saved in the use phase;

A product whose lifetime is over-extended by being much more robust and consuming more materials. New technology would permit its replacement with a product having much less environmental impact in use through enhanced energy efficiency. It was explained earlier that shifts from one phase to another should be avoided. Minor shifts, however, might be a useful strategy if the environmental performance of the complete life cycle is improved.

3.21 Selection of Low-Impact Materials

Decreasing hazardousness in the resources used can minimise the environmental impact at the product disposal stage. Selection of low-impact materials can be done either for the product or for the packaging, or for both.

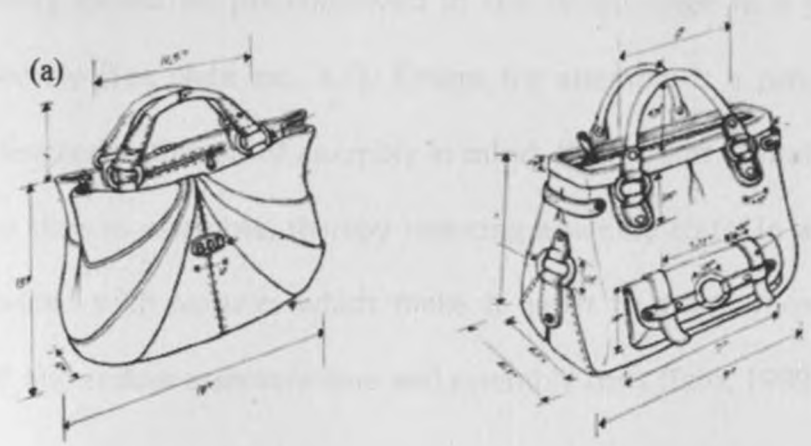
All technical or market developments should be taken into account, both upstream (e.g. the development of new materials) and downstream (e.g. the drawing up of new recovery processes) of the product's life cycle. Ideally, the information acquired from the different experiences should be organised to constantly feed into a knowledge base so that all data required for conducting an environmental assessment or set of design rules is gathered (Tolba, 1992).

3.22 Reduction In Materials Usage

Reduction of materials usage is based on a product's dimensions, weight and number of parts. It can also lead to the development of new techniques to avoid the use of some redundant components (ISO 2001).

3.23 Optimisation Of Production Techniques

The design and production processes should be investigated in order to improve environmental performance. Improvements can be obtained with material substitution, good check lists, on-site recycling and modification of technologies. An audit of the manufacturing plant can indicate where changes should be made in the production process (UNEP 1972).



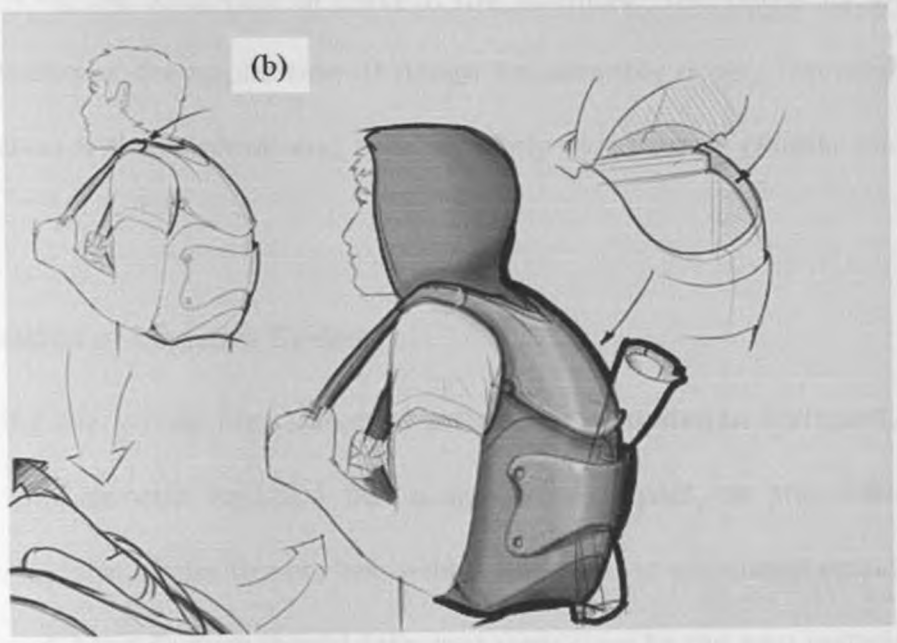


Plate No 3.5 (a, b & c): Bag design preconceived for minimal parts.
Source: www.selectism.com 2011

Product assembly should be pre-conceived in the design stage in a process called design for assembly (See plate no. 3.5). Design for assembly is a process by which products are designed with ease of assembly in mind. If a product contains fewer parts it will take less time to assemble, thereby reducing assembly costs. In addition, if the parts are provided with features which make it easier to grasp, move, orient and insert, this will also reduce assembly time and assembly costs (Ezio, 1989).

The reduction of the number of parts in an assembly has the added benefit of generally reducing the total cost of parts in the assembly. This is usually where the major cost benefits of the application of design for assembly occur. The other benefit of part reduction is the minimal end product likely to be waste (Kumar and Tanna, 2003).

3.24 Optimisation of Logistics System

Logistics during the whole life cycle of a product (raw materials transport, product distribution, and reverse logistics) has a significant impact on the environment. Companies should minimise the environmental impacts and associated economic costs of their logistics. Manufacture should take part very close to the raw materials source and the market (UNEP, 1972).

3.25 Reduction of Impact During Use

Substantial environmental gains can be made for many products by reducing the environmental impact during the use phase. Two key areas that should be addressed are product space and personal space. Products with massive components that serve little more than aesthetic value can be avoided, allowing for smaller and therefore

cosy buildings. Consumption of water and electricity during cleanup should be minimized through use of low maintenance materials (www.unep.org, 2008).

Appliances and other electrical equipment increasingly draw power when they are switched off or are not performing their primary function. Low usage of product due to low occupancy may also be avoided. Its impact is best explained by the following subliminal electricity use example. The "standby power" that provides remote control capability, network sensing, digital display and other features. Often, standby power is consumed simply because power supplies remain "on" while their appliances are switched off" (www.unep.org, 2008).

3.26 Optimisation of the Initial Life Stage - Design For Upgrade and Reuse

The objective here is to increase the initial lifetime of a product so that it can be used for a longer period before being replaced. The main issue in this field is to focus not only on products themselves, but also on the product within the system and the constraints in this system. Optimisation for upgrade and reuse can be reached by:

- Designing for easy maintenance by, for example, incorporating simple and quickly detachable parts;
- Designing for upgradeability, which is easier if the product is modular.

The extension of the original lifetime can lead to the establishment of a repair and maintenance service to supply spare parts and labour. A product can become obsolete for the user for many reasons;

- Technical: the product is worn out and no longer functions properly;
- Economic: new products have a lower level of 'costs of ownership' (maintenance, energy, etc.)

- Ecological: new products have less harmful impact in the use phase (maintenance, energy, etc.).
- Aesthetical: new products have a nicer look, a more fashionable design, and a better image.
- Functional: new products fulfil functions better.
- Psychological: old products have a negative emotional factor (unpleasant history); new products have a positive emotional factor.

Taking these into account, a design team can design a product that overcomes these obstacles. In particular, if one of the above reasons only concerns a part of the product, it can be designed to be easily upgraded, using modular design principles (Lofthouse et al, 2006).

3.27 Optimisation Of End-Of-Life System

This stage deals with reuse, remanufacturing, refurbishing, and recycling options. The reuse and recycling rate is enhanced by situations where the product remains in contact with the customer throughout the product Life Cycle. Examples of such customer relationships include the servicing and maintenance of equipment, and arrangements whereby the customer purchases a service rather than the equipment. Optimisation of the end-of-life system implies that the collected products are undamaged before reuse and are of a high standard. Product components must be available or remanufactured for a long time (Stevels, 2006).

3.28 New Concept Development

This eco-design strategy differs from the previous ones because it requires innovative thinking. A "Factor 4" or greater reduction in environmental impact is hard to achieve by modifications to existing products. The idea behind new concept development is to integrate and optimise product functions or to replace the product. This potentially leads to the development of new products with new functions to meet the same market needs. One example is the replacement of a seat rather than incremental repair that results eventually into consumption of more materials than the original. When the design team considers an eco-design strategy, "new concept development", promotes thinking towards a sustainable future beyond the existing product. It is inevitable that an eco phase is included in the design process (Bras Bert 1997).

3.29 Conclusion

The use of several different impact reduction strategies can produce better results than the application of a single one. In the process of product development, these strategies may include optimisation of the service provided by the product, conservation of resources, and reduction of pollution, waste and nuisances (Durning, Alan 2004).

In the foregoing discourse, the only thing lacking in the proposed concepts is the bold and forthright recommendation for incorporation of eco-ethical concepts in design. This study finds fault with this withholding or suppression of information while advancing eco-aspects in product design.

It appears that design choices should be determined by a combination of environmental strategies. The ecological aspects should also be included with other

design criteria, and "the choice of a specific design solution shall achieve a reasonable balance between environmental factors and other relevant considerations, such as safety and health, technical requirements for functionality, quality, and performance, and economic aspects, including manufacturing costs and marketability" (www.unep.org, 2008).

3.29.1 Life cycle thinking

It has been shown that a combination of eco-design strategies can be defined for a specific product or a company. Every stage in the product's life cycle has potential impacts on the environment. Life cycle thinking gives designers the ability to make informed decisions to reduce those impacts. This study relied on these recommendations to design eco-ethical gauging questions to capture eco-standing of designers in Nairobi.

The strategy or strategies chosen are mainly based on environmental criteria accepted universally and recommended globally by authorities like UNEP, Universities and the World Bank. The choice of an environmental impact reduction strategy should be based on internal environmental criteria weighting. However, it can also be based on "organisational/strategic" reasons: for example, in a small enterprise, there is less need for specific tools or for management of the eco-design process, as long as there is a product designer who is committed to eco-design and innovation, and who can see the strategic benefits and cost savings advanced by this study as eco-ethics.

3.29.2 Product design systems

While the practical application of ethics in design varies among designers, the foregoing literature expounds some common principles to be as follows:

- Low-impact materials: choose non-toxic, sustainably produced or recycled materials which require little energy to process
- Energy efficiency: use manufacturing processes and produce products which require less energy
- Quality and durability: longer-lasting and better-functioning products will have to be replaced less frequently, reducing the impacts of producing replacements
- Design for reuse and recycling: "Products, processes, and systems should be designed for performance in a commercial 'afterlife'."
- Renewability: materials should come from nearby (local or bioregional), sustainably managed renewable sources that can be composted when their usefulness has been exhausted.

New design principles necessary for sustainability are exemplified by this literature. While pointing that it is important for designers to recognize the impact made in every phase of a product's life cycle, the literature points the following ethical points as requisite for designers while integrating eco-ethics into product life cycle:

1. Insist on the right of humanity and nature to co-exist in a healthy, supportive, diverse, and sustainable condition.

2. Recognize Interdependence. The elements of human design interact with and depend on the natural world, with broad and diverse implications at every scale. Expand design considerations to recognizing even distant effects.
3. Accept responsibility for the consequences of design decisions upon human well-being, the viability of natural systems, and their right to co-exist.
4. Create safe objects of long-term value. Do not burden future generations with requirements for maintenance or vigilant administration of potential danger due to the careless creations of products, processes, or standards.
5. Eliminate the concept of waste. Evaluate and optimize the full life-cycle of products and processes, to approach the state of natural systems in which there is no waste.
6. Understand the limitations of design. No human creation lasts forever and design does not solve all problems. Those who create and plan should practice humility in the face of nature. Treat nature as a model and mentor, not an inconvenience to be evaded or controlled.

Eco-ethical parameters gathered from this chapter are enumerated in the methodology chapter of this study.

3.30 The variables

For the purpose of this study, the following parameters for integration of eco-ethics in product design and development formed the measurerable aspects supporting the main variable. Consideration or otherwise of each variable was the measure for an eco-aspect in the product design process. The parameters are divided into ethical

aspects using materials and product assembly. The following are the variables through materials:

- Reduction of materials
- Choice of material
- Use of plastics and polythene
- Recyclability
- Waste disposal methods and,
- Biodegradability

The following are the variable through product assembly methods:

- Detachability
- Product lifespan
- Volume/weight
- Number of parts
- Stackability
- Product disposal and,
- Concern for the environment.

3.31 Theoretical Framework

The theory guiding this study is eco-ethics. It emanates from the theory of ecological humanities. Eco-ethics theories are characterised by connectivity to specific knowledge domains and a commitment to two fundamental aims (Armstrong and Botzler, 2004). Both aims relate to the need to submit to ecological laws and to see humanity as part of a larger living system. This research adopts this notion as it applies to the product life cycle. It is this research's view that ethics is the central issue in eco-design. From

literature, this study expounds this understanding through a diagrammatical interrelatedness of design processes with eco-ethics as the central reference point (See plate 3.6). As Papanek (2003) illustrates, ethics, a major branch of philosophy, is the study of values and customs of a person or group.

It is divided into three primary areas: meta-ethics (the study of the concept of ethics), normative ethics (the study of how to determine ethical values), and applied ethics (the study of the use of ethical values).

Meta-ethics that is based on non-realism, points out that moral values are creations, dependent on people's feelings and goals regarding themselves and others (emotivism or prescriptivism) or on their belief systems (cultural or individual relativism). The local situation is that such wholesome values are lacking, leading to haphazard discard of waste.

Descriptive ethics is a value-free approach to ethics, which examines ethics not from a top-down perspective but rather observations of actual choices made by moral agents in practice (read designers). Some philosophers rely on descriptive ethics and choices made and unchallenged by a society or culture to derive categories, which typically vary by context. This can lead to situational ethics and situated ethics.

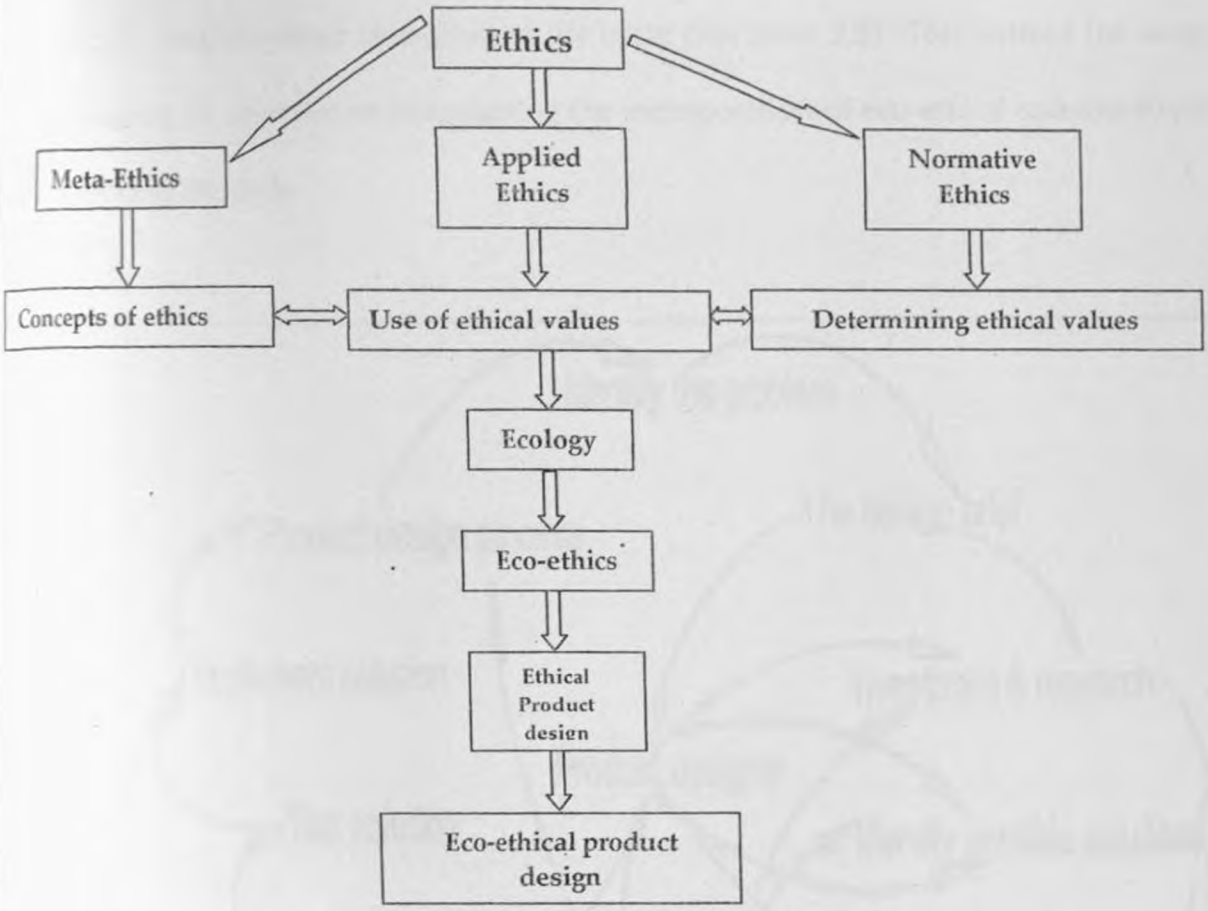


Plate No. 3.6: Theories of ethics: source; the author

Applied ethics is a discipline of philosophy that attempts to apply ethical theory to real-life situations. The lines of distinction between meta-ethics, normative ethics, and applied ethics are often blurry.

Gaia philosophy (named after Gaia, Greek goddess of the Earth) is a broadly inclusive term for related concepts that living organisms on a planet will affect the nature of their environment – to make it more suitable for life. The underlying message from these sustainability-based theories is that the current technics for living is detrimental to existence of life on Gaia. The call to acquire technologies that propagate sustainable living tactics is underscored.

This study adopts the idea advanced by applied ethics. Dealing with the application of ethical values in real life situations, it advances the cause of this study by informing the

need to integrate ethics into product life cycle (See plate 3.5). This assisted the study in meeting its objective of investigating the incorporation of eco-ethical considerations in product life cycle

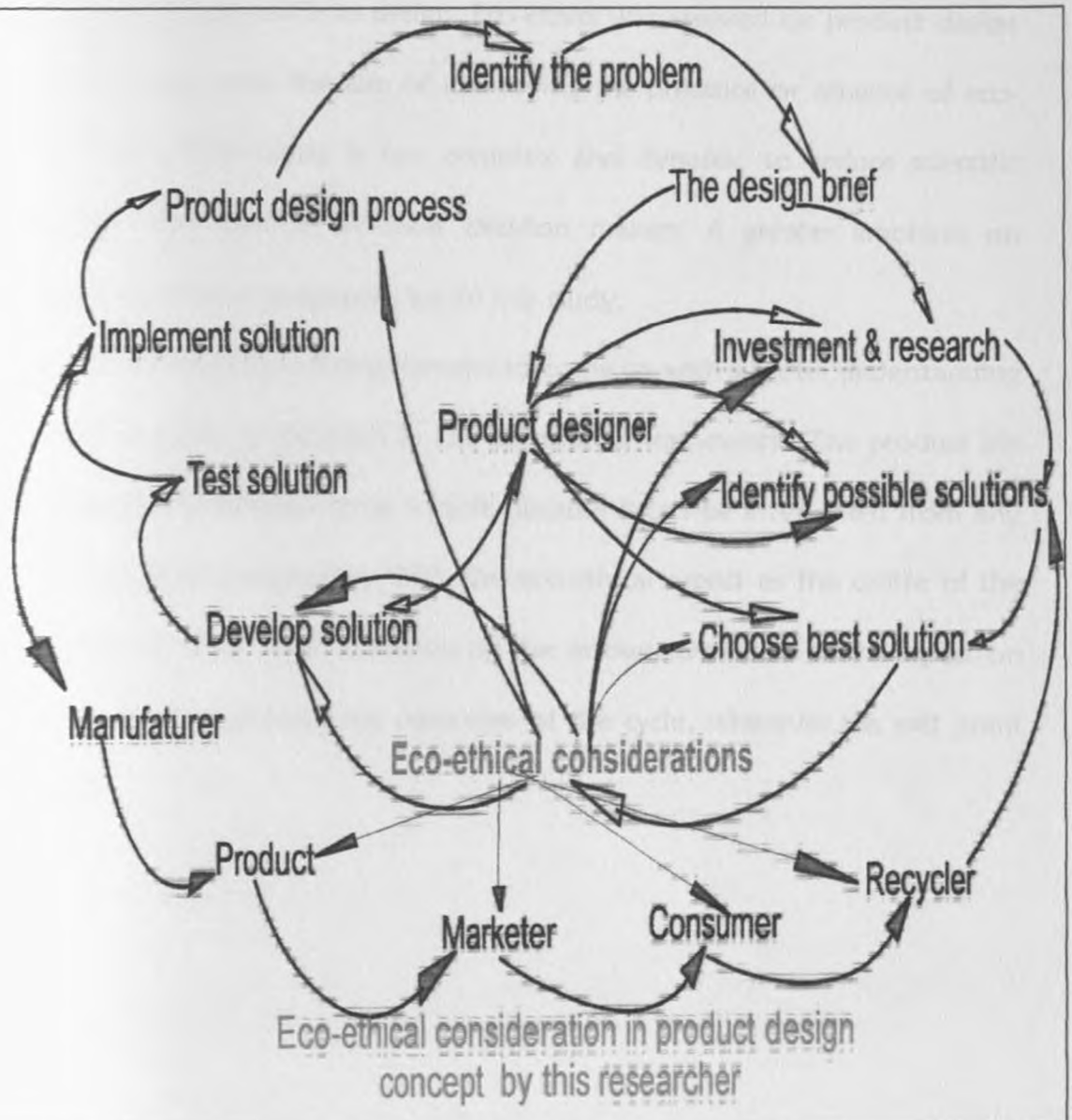


Plate No 3.7: Theoretical concept of eco-ethical product design. Source: Author

3.31 Conceptual Framework

Eco-product design and living tactics will require multiple sustainability strategies, which will range from the entire system, the entire Earth, to the local or regional.

Strategies starting at the highest system level are referred to as 'top-down,' and strategies designed for components, local or regional, are referred to as 'bottom-up.' The entry point for this research is at the product design on the conceptual figure 1.

This study uses a holistic approach of eco-ethics and eco-design to come up with a new eco-philosophical approach to design. Eco-ethics was assessed on product design process along the loop with the aim of identifying the presence or absence of eco-aspects. However, sustainability is too complex and dynamic to reduce scientific uncertainty to a level desired by most decision makers. A greater emphasis on sustainable-ethics and value judgments led to this study.

This study sought to build on existing theories to come up with a better understanding of the product life cycle as depicted in the conceptual framework. The product life cycle (See plate 3.6) is referred to as a cycle because it can be interpreted from any point on an ecological perspective. With the eco-ethical aspect as the centre of the cycle, it touches on every stage as shown by the arrows. Omission of the aspect on any stage may affect negatively the outcomes of the cycle, wherever the exit point along the cycle.

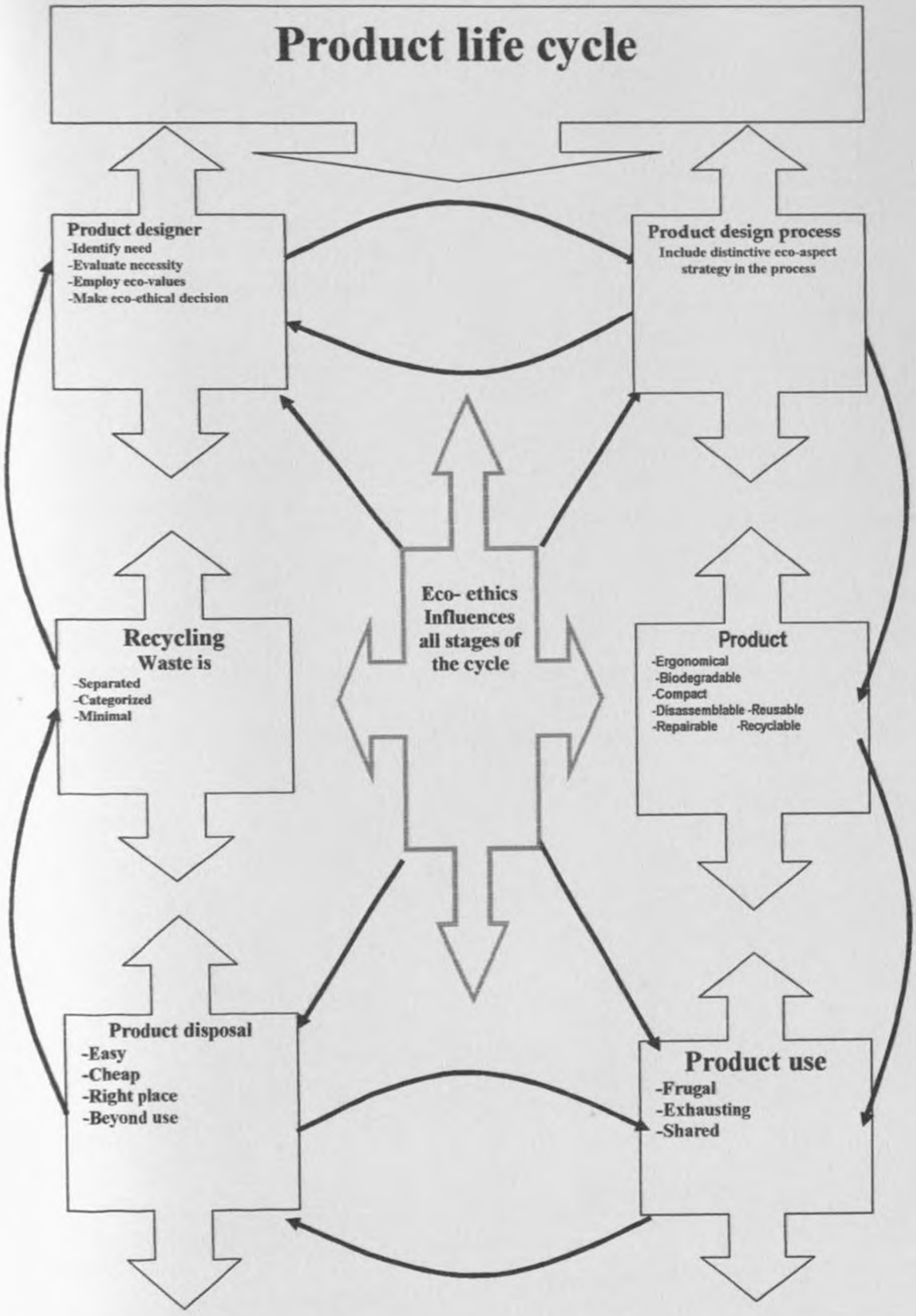


Plate No. 3.8: Eco-ethical product life cycle: Concept by Author

CHAPTER FOUR

RESEARCH METHODOLOGY

4.0 Introduction

This chapter presents in detail the methodology adopted in the study. There is also a justification for the choice of this kind of research. The population, sample and sampling techniques are outlined. Data collection, analysis and presentation methods are also explained. Finally, it outlines the variables controlling the hypothesis of the research. Figure 8 gives an overview of the study approach.

Overview of Research Method

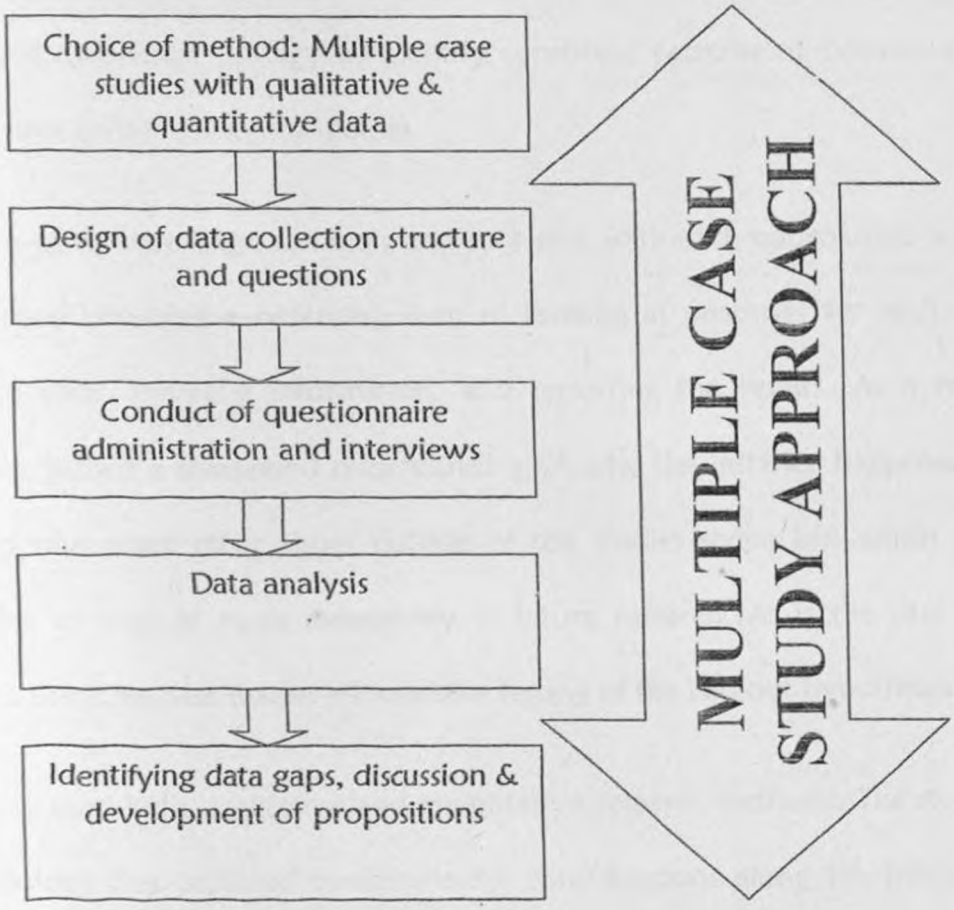


Plate No 4.1: Overview of Research Method

4.1 Research Design

This study adopted a case study approach, particularly a multiple case design. This design was chosen based on the understanding that a case study is one of several ways of carrying out social science research. Other ways include experiments, surveys, multiple histories, and analysis of archival information. Rather than following a rigid protocol to examine limited number of variables, case study methods involve an in-depth, longitudinal examination of a single instance or event: a case. The research took designer eco-ethics in Nairobi as its case study. It however had three items of interest through which the variables in question were probed. According to Yin (2003), multiple case design is often considered more compelling and robust. Multiple case studies use a factual and theoretical strategy to identify consistent patterns of behaviour and to uncover new and/or divergent themes.

The three cases were bags, car seats and sofa sets, with each approached separately. This method provided a systematic way of looking at processes for each of them, collecting data, analysing information, and reporting the results. As a result, the researcher gained a sharpened understanding of why the instance happened as they did, and unearthed other issues outside of the studies scope but which might be important to look at more extensively in future research. As is the case with this research, the three case studies allowed the testing of the laid out hypotheses.

The study used both qualitative and quantitative research methods. The study used a methodology that captured environmental considerations along the product design process. In the qualitative method a self-learning (*environmental influences and*

experiences for acquiring, enhancing, or making changes in one's knowledge, skills, values and views) method was used to capture inclusion of eco- aspects in manufacturing processes. This enabled the study to build up a comprehensive qualitative database of eco-ethical considerations. It involved selecting a sample and administering a questionnaire and interview guide on them.

The variables

The dependent variable in this study is eco-ethical aspects in design. The choice of this variable captures the study desire to establish inclusion or otherwise of eco-ethical aspects in design. It was based on the understanding that a dependent variable is what is to be measured or in other words what the investigator thinks will be affected during the experiment. An Independent variable is what is varied during the experiment; it is what the investigator thinks will affect the dependent variable (Mugenda and Mugenda, 2003).

To determine the values/level of integration of eco-ethics/aspects in design, the studies independent variable is inclusion of eco-aspects in the design process. This study used the following parameters to apply the independent variable:

Product materials; -reduction of materials

-inclusion of plastics

-recyclability of materials used

-waste disposal methods

-biodegradability

Product assembly; -weight

-disassembly

-stackability

-product lifespan

-number of components

4.2 Population, Sample and Sampling Technique

4.2.1 Population

The target population of this study was practising product designers and manufacturers. Among these are those who specialise in metal product, wood products, leather, fabric, clay, plastics etc. A reconnaissance survey in the larger Nairobi proved most of these to be thinly distributed all over the city. Except for designers of car seats, sofas and bags, the others were found unsuitable for this study due to their scattered nature and their intermittent nature of manufacture. To get a reliable sample of the population of these three, a reconnaissance survey targeting these three products was conducted around the city. They were found reliable for study due to their concentration and continuity in production. Where the items were manufactured in the same locality, observation was concurrent. In total, 196 designers/manufacturers were identified. The distribution was as presented in plate no. 4.2.

Plate No. 4.2: Total population of designers/manufacturers

Bags	92
Sofa sets	80
Car seats	24
Total	196

The reconnaissance survey was done as presented in plates 4.3, 4.4 and 4.5. As shown in plate 4.3, the population of bags is concentrated in Uhuru market.

As shown in plate 4.4, the total population for sofa set designers/manufacturers was 80. They are concentrated along Juja road (Huruma flats) and Park road area of Nairobi city.

Plate No. 4.3: Population distribution for bags

Date	Name of item	Name of market	Number of stalls	Number making bags	
7th Feb, 2009	Bags	Nyayo	192	Nil	
7th Feb, 2009	Bags	Kariokor	206	1 (one)	
9th Feb, 2009	Bags	Gikomba	150	3 (three)	
9th Feb, 2009	Bags	Gikomba open air	N/a	3 (three)	
10th Feb, 2009	Bags	Uhuru	400	85 (eighty five)	
10th Feb, 2009	Bags	Kenyatta	116	Nil	
11th Feb, 2009	Bags	Mathare north	86	1 (one)	
11th Feb, 2009	Bags	Umoja	112	Nil	
Total				92	

Plate No. 4.4: population distribution for sofa sets.

Date	Name of item	Name of location	Number of stalls	No. making sofa sets	Comments
24th January, 2009	Sofa sets	Park road	24	20	
24th January	Sofa sets	Juja road (Huruma flats)	25	11	
26th January, 2009	Sofa sets	Gikomba	Open air	32	They mostly make frames for sale.
27th January, 2009	Sofa sets	Dagoreti corner	Open air	3 (three)	
27th January, 2009	Sofa sets	Kawangware	Open air	10	
Various dates, 2009	Sofa sets	Thika road (Roysambu)	5	4	
Total				80	

Plate 4.5 shows the total population of car seats in Nairobi. There were a total of 24 designers/manufacturers, with concentrations at park road open-air garages at Ngara area of Nairobi city. Due to their small number, this study tried to reach as many as possible at random while concentrating the study at the Ngara site where the majority are located.

Plate No. 4.5: Population distribution for car seats

Date	Name of item	Name of location	Number of stalls	Number making car seats	Comments
24th January	Car seats	Park road	Open garage	13	
24th January	Car seats	Juja road (Huruma flats)	25	Nil	
26th January	Car seats	Gikomba	Open air	Nil	

27th January	Car seats	Dagoreti corner	Open air	3	
January	Car seats	Museum hill	Open air	5	
11th February	Car seats	Outer ring road (Umoja	Open air	3	
Total				24	

4.2.2 The Sample

This study used a census method to determine the right sample and its size. According to Israel (2006), using a census for small populations is one approach to determine an appropriate sample. This is done by using the entire population as the sample. Although cost considerations make this impossible for large populations, a census is attractive for small populations (e.g. 200 or less). Standing at 196, this study's sample fits this method very well. A census eliminates sampling error and provides data on all the individuals in the population. In addition, some costs such as questionnaire design and developing the sampling frame are "fixed," that is, they will be the same for samples of 50 or 200. Finally, virtually the entire population would have to be sampled in small populations to achieve a desirable level of precision (http://edis.ifas.ufl.edu/PD006).

This study's total population was 196, a small enough size to rely on the census method. The researcher therefore sought to reach all of them. For two items, i.e. bags and sofa sets, the population size at 92 and 80 respectively was big enough to allow for a reliable sample.

The last item car seats had a relatively small population. Standing at only 24, this study covered all of them. They however are still thought to hold a sizeable

contribution to the problem being studied that they could not be dismissed for any reason, not even number.

4.2.3 Sampling Technique

The study used stratified random sampling method. In this method subjects are selected in such a way that the existing subgroups in the population are more or less reproduced in the sample. According to Mugenda & Mugenda (2003), stratified random sampling involves first selecting by whatever method (Census for this study) and assigning to two or more groups and then using simple random sampling to pick the cases/units. In this study three groups were already evident as car seat, sofa set, and bag designers. Each of these products formed the strata in the sampling technique. They represented the wider population of product designers who include metal fabricators, carpenters etc.

4.2.4 Data Collection

This study is based on two types of data, namely: -

1. Secondary data

2. Primary data.

Secondary data was collected through review of relevant literature from manuals, books, journals available at the University of Nairobi library (See 4.2.9), UNEP library and through Google scholar dedicated internet journals (See 4.2.10) subscribed by the university of Nairobi library web services.

There are many methods of collecting primary data and the main methods include: questionnaires, interviews, focus group interviews, observation, case-studies, etc. The key point here is that the data one collects is unique to the researcher and his research and, until it is published, no one else has access to it (http://brent.tvu.ac.uk). Based on this understanding, the following diagram (Plate No. 4.6) summarises instruments used to capture primary data. Below it, the different methods are elucidated (See 4.2.5/6/7).

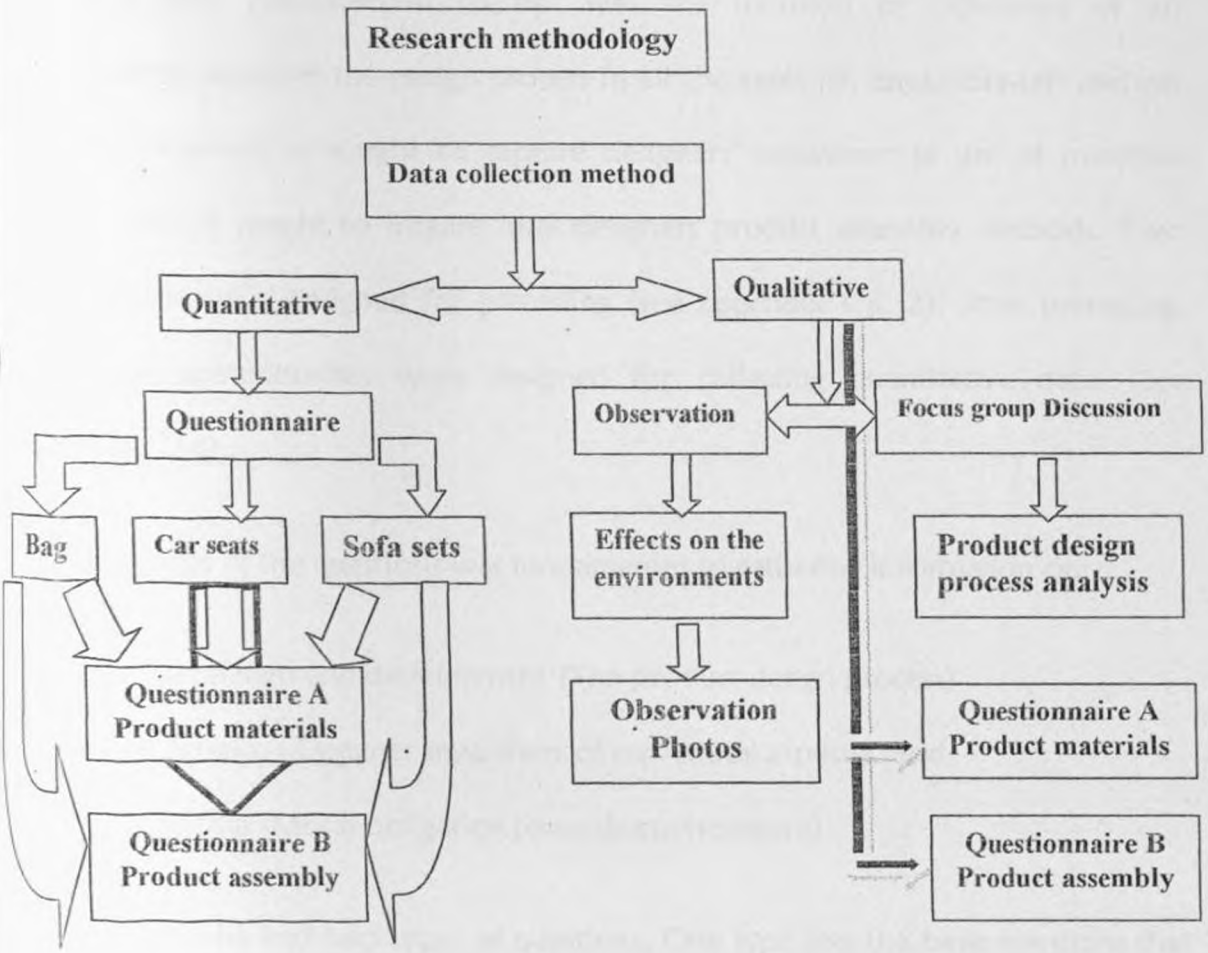


Plate No. 4.6: Overview of data collection process: Source; the author

To facilitate a smooth running data collection excersice, data collectors were issues with an introductory letter (see appendix 6). The introductory letter was used for

questionnaire administrators only. A research clearance permit was also acquired from the national council for science and technology, the body charged by law to control all research in Kenya (see appendix 7).

4.2.5 Questionnaires

There was one questionnaire for all the designers. The questionnaire covered the design process, which is largely the same for all this much-related fields of design of the three cases. Fundamental to this was the inclusion or otherwise of an environmental aspect in the design process in all the cases i.e. bags, sofa sets and car seats. Questionnaire A sought to capture designers' behaviour in use of material. Questionnaire B sought to inquire into designers product assembly methods. Two questionnaires were designed for pretesting (see appendix 1 & 2). After pretesting, two actual questionnaires were designed for collecting quantitative data. (See appendix 3 & 4).

Broad coverage of the questions was fundamental to gathering information on;

1. Product design and development (The product design process)
2. Competence (Designer awareness of eco-ethical aspects), and
3. Motivation (Moral obligation towards environment)

The questionnaire had two types of questions. One type was the basic questions that sought quantifiable answers. The other was a secondary support /follow-up question that sought qualitative/explanatory responses.

The first section of the questionnaire sought aspects on inclusion or otherwise of eco-ethical aspects using materials. The parameters used to capture requisite data were:

- Reduction of materials
- Choice of material
- Use of plastics and polythene
- Recyclability
- Waste disposal methods and,
- Biodegradability

The second section of the questionnaire sought for inclusion or otherwise of eco-ethical aspects using product assembly methods. The parameters used to capture requisite data were:

- Detachability
- Product lifespan
- Volume/weight
- Number of parts
- Stackability
- Product disposal and
- Concern for the environment

Follow-up questions were based on exhaustion and repetitive tendency to judge adequacy. This technique is supported by Douglas (2003); Goulding (2002) and Locke, (2001) who argue that the researcher continues expanding the sample size until data collection (e.g. interviews) reveals no new data. According to the trio, this may take 10 or 20 or 30 or even more questions. Thus, Strauss and Corbin (1998) recommend to either narrowing the focus of the research question at the beginning or

after three or four questions. By using the first few responses as guides to the essence of the phenomena a researcher can narrow the focus and reduce the number of interviews (Kwortnik, 2003, Strauss & Corbin, 1998).

4.2.6 Observation

The researcher also conducted a survey by being an observer. This inductive process emphasises that social life is not fixed, but dynamic and changing. Therefore, if people's social lives are constantly changing, researchers must participate in it, and record their experiences of those transformations, their effects on people, as well as their interpretations. As such, researchers must become part of that environment for only then can they understand the actions of people who occupy and produce cultures. This technique is least likely to lead researchers imposing their own reality on the social world they seek to understand (http://uk.geocities.com/).

Generally, there are three types of observational research:

- Covert observational research - The researchers do not identify themselves. Either they mix in with the subjects undetected, or they observe from a distance. The advantages of this approach are: (1) It is not necessary to get the subjects' cooperation, and (2) The subjects' behaviour will not be contaminated by the presence of the researcher. Some researchers have ethical misgivings with the deceit involved in this approach.
- Overt observational research - The researchers identify themselves as researchers and explain the purpose of their observations. The problem with this approach is subjects may modify their behaviour when they know they are

being watched. They portray their "ideal self" rather than their true self. The advantage that the overt approach has over the covert approach is that there is no deception (Holigrocki et al, 2006).

- Researcher Participation - The researcher participates in what they are observing so as to get a finer appreciation of the phenomena. Researchers that participate tend to lose their

For the purpose of this study covert observation was adopted. Because the study needed to record scenery, there was no need to involve the people in the locality. Data collected from this observation method was visual (photographic) in nature. Observation was random in nature but with prior definition of indicators of ecological damage through poor waste disposal techniques. Many haphazard heaps of wastes were documented along roadsides and in residential areas.

The observation was not confined to the case study geographical scope. Because the effects of eco-ethical neglect are in most cases not immediate, its results are spread as wide as the product is able to be placed. This study therefore confined its scope to the larger Nairobi, wherever the effect manifested itself.

4.2.7 Focus Group Discussion

Focus group discussion method was used to collect qualitative data. The purpose of focus group discussions is to gain knowledge about a particular topic or need by interviewing a group of people directly affected by the issue. Data collected through focus group discussion can be used to collect information for many purposes, such as

conducting a needs assessment, unearthing dynamics of opinion or evaluating a program (http://www.etr.org/).

For the purpose of this study, it was the study's plan that the selected members of the focus group would assist to:

1. Explore the depth and nuances of opinions regarding eco-ethics in product design
2. Understand differences in perspectives on eco-design
3. Understand what factors influence designer opinions or behaviour in environmental sustainability

The overall goal of the focus group discussion was *"To gain understanding whether designers in Nairobi are morally compelled to include an ecological-aspect in product life cycle.* The purpose was also to use the focus group data collection method to triangulate the other two methods used in the research namely: questionnaire and observation. The guiding principle of the discussion was the following.

Plate No 4.7: The Design Process: Source; Scott Wertel wertel.blogspot.com (2011)

1. Since there is no environmental consideration in the current typical design process (Plate No. 4.7), do designers include such a consideration while designing?
2. Due to the exclusion of an eco-ethical aspect mentioned above, is there a relationship between the product design process and waste levels in the environment?
3. Is eco-ethics a necessary attribute in design practice? Must it be incorporated?
4. Where in the design process shown above (Plate 4.7) eco-ethics be integrated?

To capture the necessary information during the discussion the researcher used a voice recorder. This would allow meticulous analysis of the contributions. Recording also allowed for repeated reference where any point needed further clarification/confirmation.

According to (http://wasis.ou.edu/2010) analysis of Focus Group data is best done using the following thematic coding factors:

1. Frequency – number of times something is mentioned
2. Specificity – details
3. Emotion – enthusiasm, passion, etc. in responses
4. Extensiveness – how many different people said something

(http://wasis.ou.edu/2010)

The study therefore utilized the four factors to identify and determine exhausting coverage and depth of data.

4.2.8 Interview

In the pre-test of questionnaire process, designers and manufacturers were interviewed to establish their understanding of pertinent design eco-ethical issues. This was peripheral to the actual research and was meant to only assist in design of the questions.

4.2.9 The Library

This research used resources in libraries at the University of Nairobi and UNEP offices in Nairobi to capture secondary data. The collected data was qualitative in nature.

4.2.10 The Internet

The Internet was a great resource in capturing secondary data in this research. Online, the researcher was able to access international refereed and peer reviewed journals subscribed to by the university of Nairobi web services. The Google scholar search engine was particularly invaluable because it provides only academic literature. Florida Centre for Instructional Technology, (2004) states that the Internet can be a researcher's dream come true. By browsing the Internet, much as one would browse the shelves of a library, one can access information on seemingly limitless topics. In addition, web-based catalogues are available in many libraries to assist researchers in locating printed books, journals, government documents, and other materials. The university of Nairobi web service provided this resource.

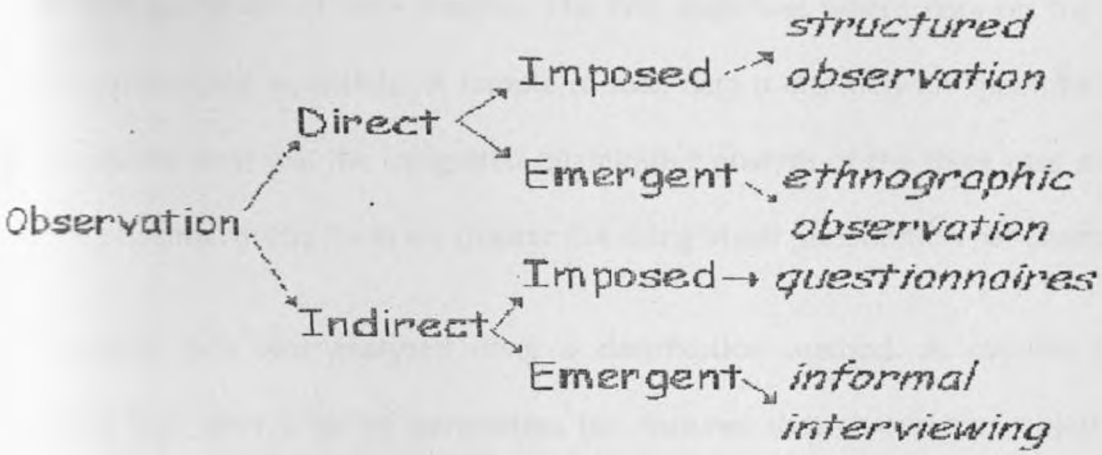


Plate No 4.8: The research structure; Adopted from www. Information. et/.../resmethods.net

The research focused on the population chosen on the product design process. The research structure shown on figure 11 by Professor Tom Wilson of the University of Sheffield was adopted as a guide for data collection in this research. Throughout the data collection period, data collectors were engaged to collect the necessary data. A letter was issued to introduce each research assistant and for explaining the research study.

4.3Data Analysis

The collected quantitative data was analysed using the statistical package for social sciences-SPSS for windows, while qualitative data was analysed through thematic analysis method. According to Tere (2008), thematic analysis is highly inductive, that is, the themes emerge from the data and are not imposed upon it by the researcher. In this type of analysis, the data collection and analysis take place simultaneously (Rudolph Tere, 2008)

There were two levels of data analysis. The first stage was where data on the case studies was analysed separately. A sample of such data is attached on appendix 8 to 16. The second level was the integrated quantitative analysis of the three case studies which is presented in the thesis on chapter five using visual presentation bar charts.

Photographic data was analysed using a classification method. A *classifier* is an algorithm that takes a set of parameters (or *features*) that characterize objects (or *instances*) and uses them to determine the type (or *class*) of each object (Zeisel, 1995). Waste was treated as the feature while the built environment represented the instance where the interaction between the two parameters determined the class (level) of degradation. For effective analysis, the study used a photo analysis worksheet (see appendix 5).

4.4 Data Presentation

Descriptive statistics enable us to understand data through summary values and graphical presentations. Summary values not only include the average, but also the spread, median, mode, range, and standard deviation. Descriptive statistics can be illustrated in an understandable fashion by presenting them graphically using statistical and data presentation tools (Shirley and Wearden 1991).

Several types of statistical/data presentation tools exist, including: (a) charts displaying frequencies (bar, pie, and Pareto charts, (b) charts displaying trends (run and control charts), (c) charts displaying distributions (histograms), and (d) charts displaying associations (scatter diagrams). For the purpose of data presentation in this study, only four data presentation tools were used. They are pie charts, bar charts, tables

and photographs. It will be noted that for quantitative data presentation both table and bar charts are utilised in presenting data. This is not without reason. Because this study falls under the two departments of architecture and design which use visual imagery for communication, the two tools compliment each other to target these two specific audiences while clearly laying out issues for the other disciplines.

4.5 Test of hypothesis

This study conducted a test of its hypothesis. A statistical hypothesis test is a method of making decisions using data, whether from a controlled experiment or an observational study (not controlled). This study used both these methods. In statistics, a result is called statistically significant if it is unlikely to have occurred by chance alone, according to a pre-determined threshold probability, the significance level. One use of hypothesis testing is deciding whether experimental results contain enough information to cast doubt on conventional wisdom. Any result found to be statistically significant is also called a positive result; conversely, a result that is not unlikely under the null hypothesis is called a negative result or a null result (Layman 1993, Mugenda and Mugenda 2003).

The critical region of a hypothesis test is the set of all outcomes which, if they occur, will lead us to decide that there is a difference. That is, cause the null hypothesis to be rejected in favor of the alternative hypothesis. Based on this understanding, this study conducted a test of hypothesis using correlation and chi-square techniques.

According to Layman (1993) and Israel (2006), the Chi-Square (X^2) test is undoubtedly the most important and most used member of the nonparametric family of statistical

tests. Chi-square is a statistical test commonly used to compare observed data with data we would expect to obtain according to a specific hypothesis. The chi-square test is used to determine whether there is a significant difference between the expected frequencies and the observed frequencies in one or more categories. Chi-Square Test Requirements are:

1. Quantitative data.
2. One or more categories.
3. Independent observations.
4. Adequate sample size (at least 10).
5. Simple random sample.
6. Data in frequency form.
7. All observations must be used (Dowdy and Wearden, 1991).

In this study, all the above requirements were available and subsequently used.

4.6 Unit of analysis

The study sought to capture data on levels of integration of eco-ethical aspects in product design by designers. Therefore the designer formed the unit of analysis. The variables through which the designer affects outcomes was analysed using several parameters including; designer choice to reduce materials, designer's choice to include plastics, recyclability of recommended materials and designer waste disposal methods. The main research question of the study namely: do product designers take eco-ethical considerations into account in the design process dictated that the designer be probed for the same, hence the choice. Whereas the designer is expected to implement the design process wholistically, s/he was probed for inclusion or otherwise of an eco-

check as illustrated in the diagram below. The eco-check was introduced based on the hypothesis of the study. Authorities, among them Lotiot (2003), Porter and Linde (1995) and Lofthouse (2006) pointed to the need for designers to approach design through stewardship where they are responsible for the whole product life cycle (Cradle to Cradle). This concept would logically extend the notion of designer's responsibility to that of the environment.

Plate No. 4.9: Cradle to cradle product life cycle
Eco-check proposed by the researcher

CHAPTER FIVE

ANALYSIS OF DATA AND RESULTS

5.0 Introduction

This chapter presents the analysis of data collected during the field study. Data that was collected using all the instruments such as the photography, questionnaires for case studies and focus group discussion are also analysed, tabulated and presented.

5.1 Case studies

Charts 5.1 to 5.32 present results for the three case studies. Case studies were used to capture two types of data namely qualitative and quantitative. The purpose was to fulfil the first objective of the study. The objective was *"to investigate the level of incorporation of eco-ethical aspect in design and manufacture of car seats, sofas and bags"*. The first section presents findings for inclusion or otherwise of eco-ethical aspects using materials. The parameters used to capture requisite data were:

- Reduction of materials (Charts 5.1 & 5.2)
- Choice of material (Chart 5.3)
- Use of plastics and polythene (Tables 5.4, 5.5, 5.6, 5.6, 5.7, 5.8)
- Recyclability (Table 5.9, 5.10, 5.11, 5.12, 5.15, 5.16)
- Waste disposal methods (Table 5.13 & 5.14) and,
- Biodegradability (Table 5.17 & 5.18)

The following bar chart presents the quantitative relationship. It will also be noted that for some questions there is a follow-up question whose resultant data is qualitative.

5.1.1 Questionnaire A (Eco Aspects Through Materials)

Chart 5.1: Reduction of materials in production

As shown on tables 5.1 & 5.2, the study found out that 53.8% of the respondents have tried to reduce materials in production of bags while 39.6% did not. 5.5% of the respondents gave the response "it depends" while 1.1% of the respondents gave the response "don't know". 41.7% of the respondents were recorded in the study to have tried to reduce materials in the production of car seats while 37.5% did not. 20.8 % of the respondents gave the response "don't know" to this question. On sofa sets, the study found out that 40.9% of the respondents had tried to reduce materials in production, while 43.3 % had not. The implication of these findings is that there is considerable effort in reduction of materials in production. The reason for this though cannot be conclusively attributed to eco-awareness since the data does not point to that.

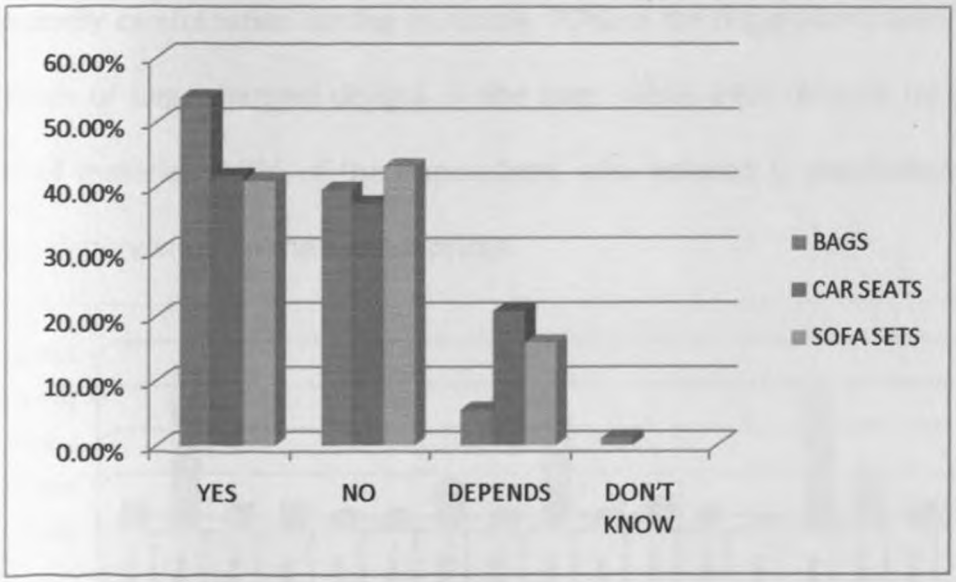


Chart 5.1: Reduction of materials in production

Chart 5.2: Material Reduction method

The study revealed that 9.1% of the respondents tried to reduce in production of car seats by squeezing to fit. 72.7% of the respondents reduced by leaving off unseen parts, while 9.1 % had their reduction based on the customers' pocket. It was found out in the study that 5.6% of the people who reduced in sofa set production did so by leaving some parts, while 5.6% reduced by making simple designs. 19.4% of the respondents who reduced in sofa set production did so by eliminating unnecessary details while 5.6% reduced by substituting materials used. About 47.2% of the respondents who reduced in sofa set production reduced the measurements of the sofa sets, while 11.1% reduced the sponge used, and 5.6% termed the methods they used "a business secret".

The study found out that 6.1% of the respondents who reduced materials in production of bags did so by avoiding buying branded materials, while 2% did so by being extremely careful when cutting materials. 59% of the respondents who reduced in production of bags changed designs of the bags, while 24.5 reduced by reducing allowance of material. 8.2% of the respondents who reduced in production of bags did so with dependence on the market prices.

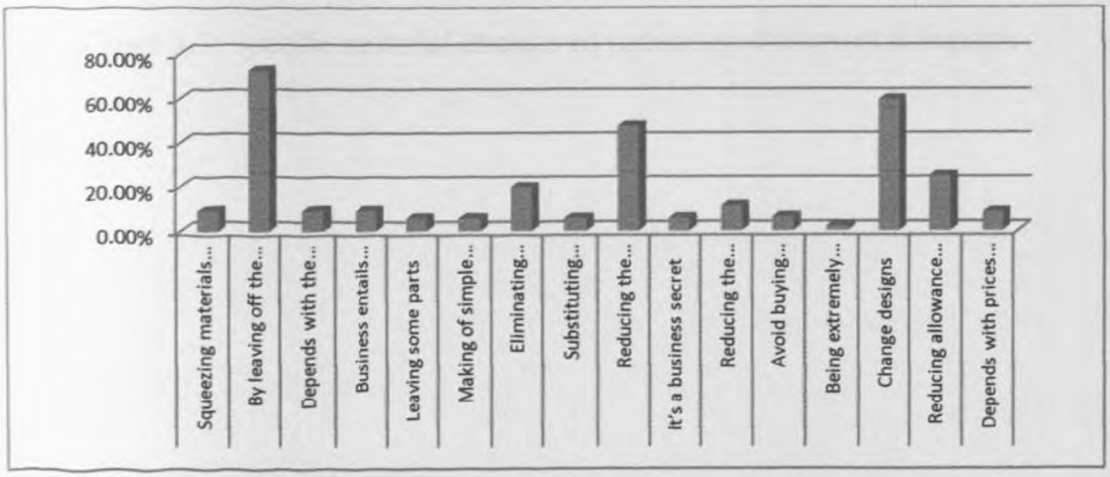


Chart 5.2: Material Reduction method

Chart 5.3: Specific material choices to reduce environmental impacts.

It was found out in the study that 12.5% of the respondents who produced car seats made specific materials choices to reduce environmental impacts, while 83.3% did not. It was found out that 25.9% of the respondents who produced sofa sets made specific materials choices to reduce environmental impacts, while 72.9% did not. 41% of the respondents who produced bags made specific materials choices to reduce environmental impacts, while 54.2% did not.

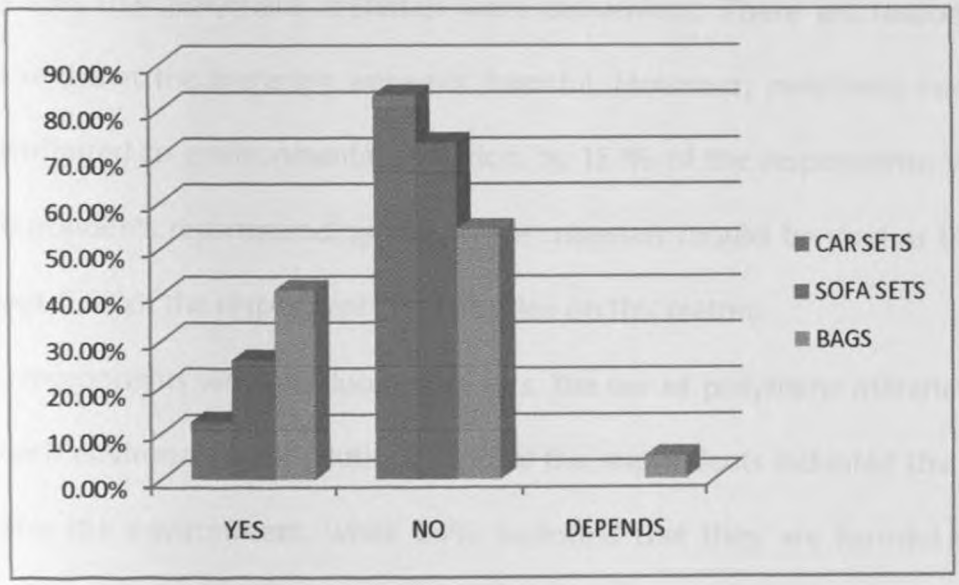


Chart 5.3: Specific material choices to reduce environmental impacts

Charts: 5.4, 5.5, 5.6, 5.7 and 5.8: Use of plastics and polythene

Chart 5.4: Designers view about the use of polythene materials.

In car seat production, about 15% of the respondents said polythene materials were easier to use and readily available. About 15% of the respondents indicated that polythene materials were economical and very useful in their work. The polythene materials were also attributed to reduction in pollution by about 15 % of the respondents but when they were to be used properly. About 10 % of the respondents said that these polythene materials were cheap and reliable, whereas 5 % of the respondents said that polythene materials were convenient. There are respondents (10%) who said that the materials were not harmful. However, polythene materials were also attributed to environmental pollution by 15 % of the respondents, with 5 % of the respondents recommending that, these materials should be used as the last option. About 5 % of the respondents had no idea on this matter.

Among the respondents who produced sofa sets, the use of polythene materials was associated with environmental pollution, 22% of the respondents indicated that these materials litter the environment, while 24% indicated that they are harmful to the environment, with others advocated for their ban (9.8%). On the other hand 30.5 % of the respondents indicated that they are good for use if disposed well. About 13.5% of the respondents said that polythene materials were convenient for use. Polythene materials were also viewed as affordable and easy to use by about 4.9% of the respondents, with 1.2 % arguing that they are readily available. Although they pollute the environment 6.1% of the respondents said that polythene materials are convenient, these was further elaborated by 1.2 % of the respondents who indicated that the smaller materials should be banned. About 1.2 % of the respondents

attributed to the prevalence of use due to lack of other options they can use. A large section of the respondents, 24 % said that polythene materials are harmful to the environment. About 3.7% of the respondents had no use to polythene materials, and 4.9% of the respondents said that they were not the best for use. About 1.2 % of the respondents failed to comment.

Among the respondents who produced bags, the largest section of the respondents, 24.1% said that polythene materials are very useful in daily life. Also 8.4 % of the respondents said that if well used and managed polythene materials are good. About 8.4 % attributed use to affordability and their being cheap. About 1.2% indicated that if they are used in small quantities, polythene materials have no significant negative effects. Their availability and easy use was the response from 1.2% of the respondents. However the significant percentage of respondents had negative comments on these materials; 12% said they are not good, 3.6% said they are not long lasting, and about 2.4 % attributed them to breeding of mosquitoes.

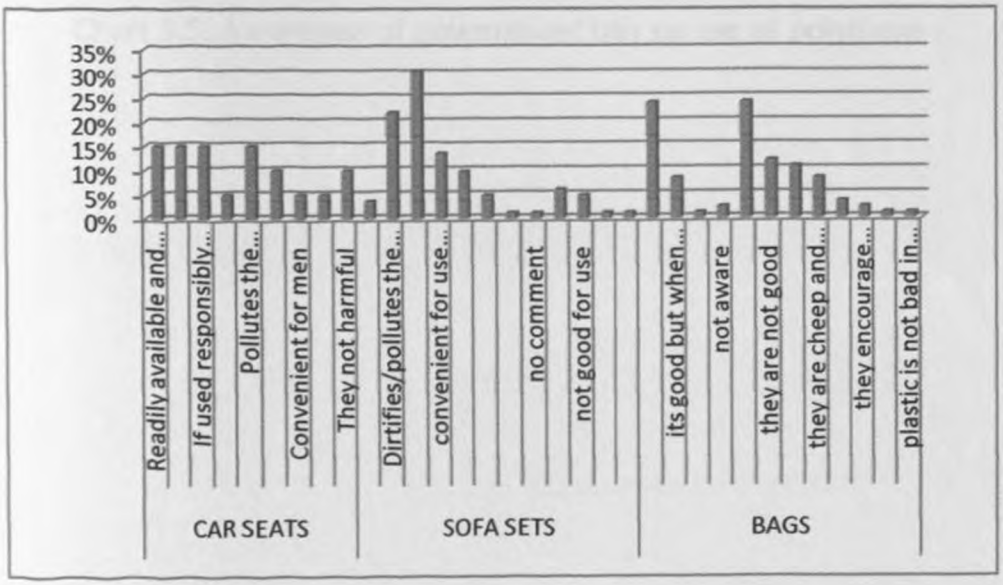


Chart 5.4: Designers view about the use of polythene materials

Chart 5.5: Awareness of government ban on use of polythene

Concerning government ban on polythene materials, 86.4 % of the respondents who produced sofa sets were aware of the ban while 12.5 % did not have knowledge of the ban. A significant percentage of the respondents, who produced bags, 91.1%, were familiar with the government ban, while only 7.8% had no knowledge of the ban. About 85.2 % of the respondents who produced car seats were aware of the ban while 8.8% of them did not have knowledge of the ban.

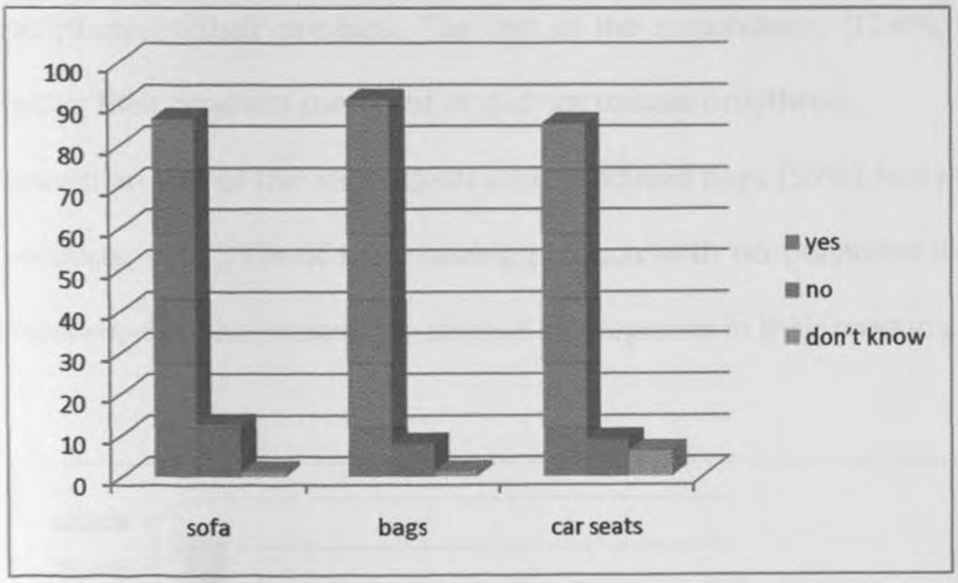


Chart 5.5: Awareness of government ban on use of polythene

Chart 5.6: Quantity of polythene included

The study found out that a large percentage (75%) of the products from respondents who produced car seats contained polythene. The percentage that indicated lack of polythene in their products was 12.5 % of the respondents, while the remaining 12.5% had no knowledge of their products having or not having polythene.

Among respondents who produced sofa sets, only a small section of the respondents (29.9%) indicated that their product contain polythene while the majority, 52.9% had no polythene in their products. The rest of the respondents, (12.6%) did not know whether their products contained or did not contain polythene.

Slightly more than half of the respondents who produced bags (56%) had polythene in their products, with 33% of them having products with no polythene while 11% had no knowledge on the presence or absence of polythene in their products.

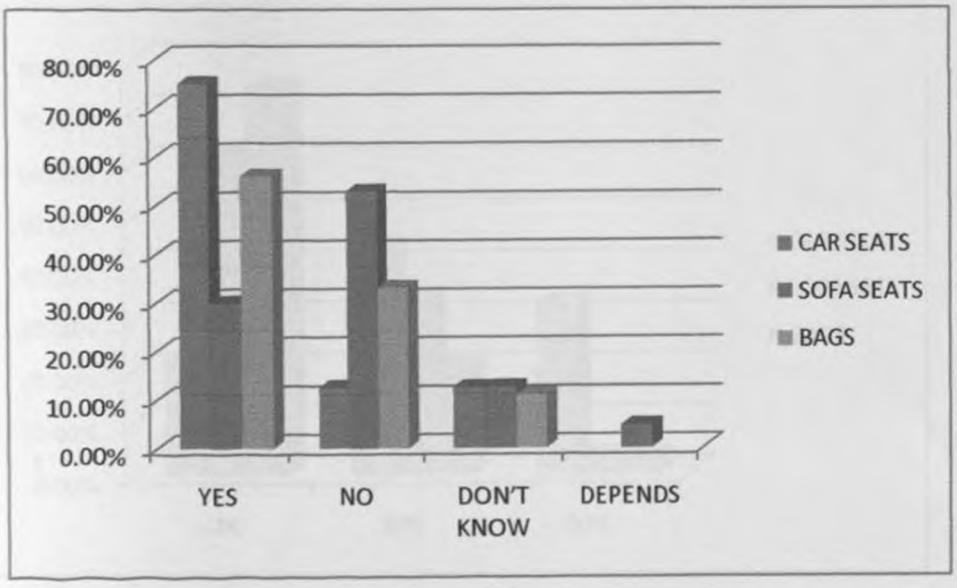


Chart 5.6: Quantity of polythene included in product

Chart 5.7: Inclusion of polythene in product.

The study found out that 22.2% of the respondents used 10% of the total materials as polythene in production of car seats, 44.4% of the respondents used of the total materials as 30% polythene, and 33.3% of the respondents used 50% of the total materials as polythene in their products.

It was also established that 61.5% of the respondents used 10% of the total materials as polythene in production of sofa sets, 34.6% of the respondents used 30% of the total materials as polythene while 3.8% of the respondents used 50% of the total materials as polythene.

The study found out that 75% of the respondents used 10% of the total materials as polythene, 20.8% of the respondents used 30.8% of the total materials as polythene, and 4.2% of the respondents used 50% of the total materials as polythene.

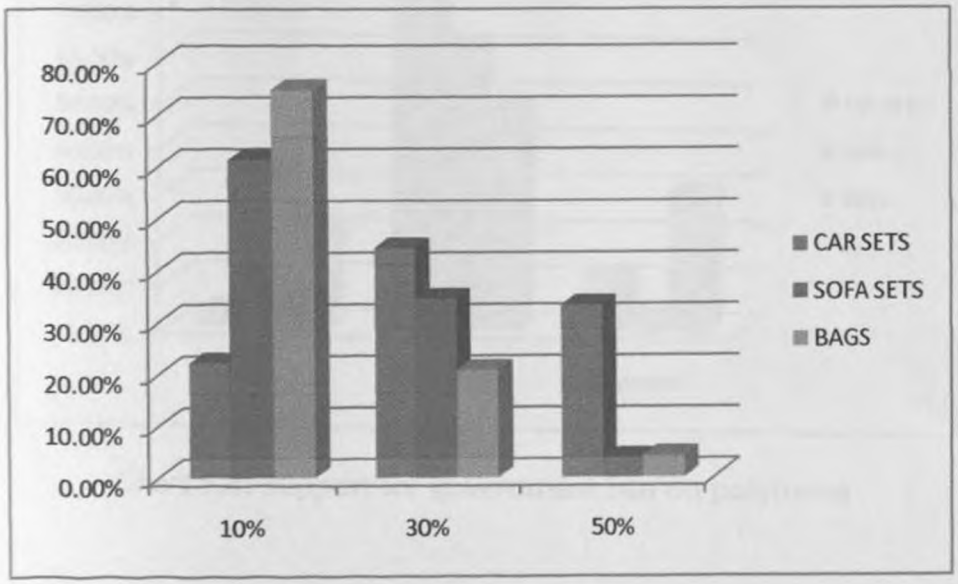


Chart 5.7: Inclusion of polythene in product

Chart 5.8: Support for government ban on polythene

The study revealed that the largest percentage of respondents who produced car seats (83.3%) were opposed to the ban of polythene materials, only 4.2 % supported the ban while 12.5% had no clear decision on whether for or against the ban.

A significant 34.1% of the respondents who produced sofa sets supported the government ban of polythene materials while the majority (62.5%) of the respondents were against the ban. The remaining 3.4% had no clear decision.

About 21.2% of the respondents who produced bags supported the ban, with a significant percentage, 48.3% being opposed to the ban. The rest of the respondents, 30.5 % considered that the ban ought to have been informed by various aspects.

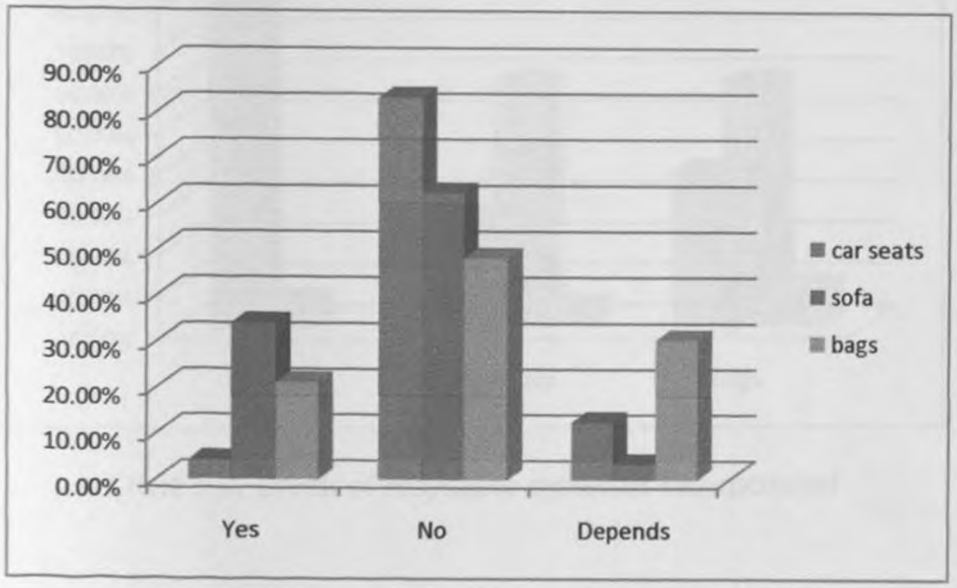


Chart 5.8: Support for government ban on polythene

Charts: 5.9, 5.10, 5.11, 5.12, 5.15, 5.16 Recyclability

Chart 5.9: Levels of recyclable materials incorporated.

On the levels of recyclability of materials incorporaated in design, the stydy found out that among car seat designers, 93.3% actualy do,while only 6.7% don't. Sofa set designers were, however, much lower in the same consideration standing at 27% who do, 60% who don't and 5% who don't know. The distribution in bag designers was a bit more evenly distributed. 38% of them incorporate recyclable materials, while 60% don't. those who had not thought about it stood at 10%.

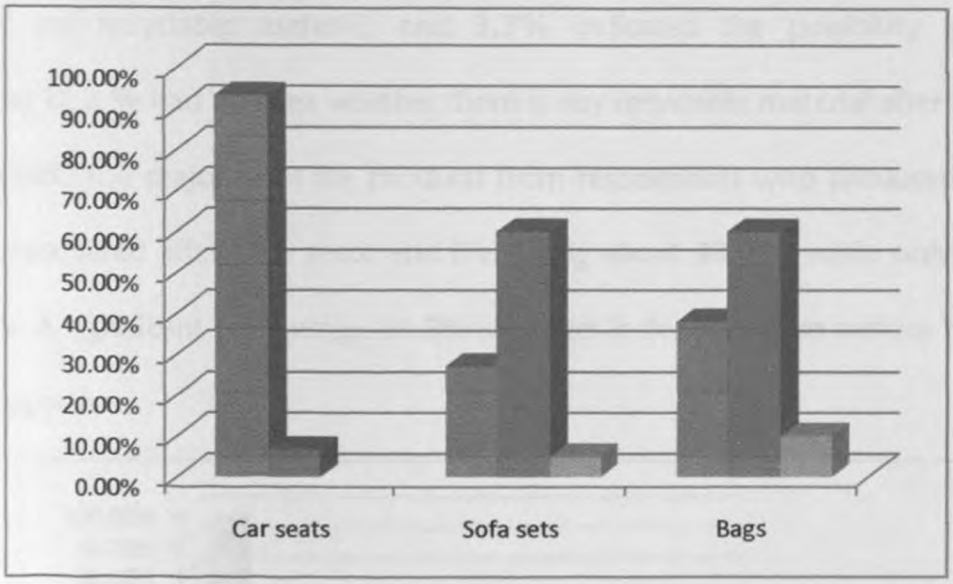


Chart 5.9: Levels of recyclable materials incorporated

Chart 5.10: Product take-back at end of their life

A very high percentage of the respondents who produced car seats (95.8%) utilised recyclable materials, while only 4.2% did not use any recyclable material in their products.

The largest section of the respondents who produced sofa sets (61.4%) indicated no recyclable material after the life of a product; only 29.5 % used such materials.

The use of these recyclable materials was subjective to various factors, according to 1.1 % of the respondents.

About 40% of the respondents who produced bags used recyclable material, 44.4% did not use recyclable material, and 3.3% indicated the possibility while the remaining 12.2 % had no idea whether there is any recyclable material after the life of the product. The majority of the products from respondents who produced sofa sets are not recovered after they reach end life, being about 48.9%, while only 19.3% is got back. A significant percentage; 31.8% said that it depended on various factors for this to happen.

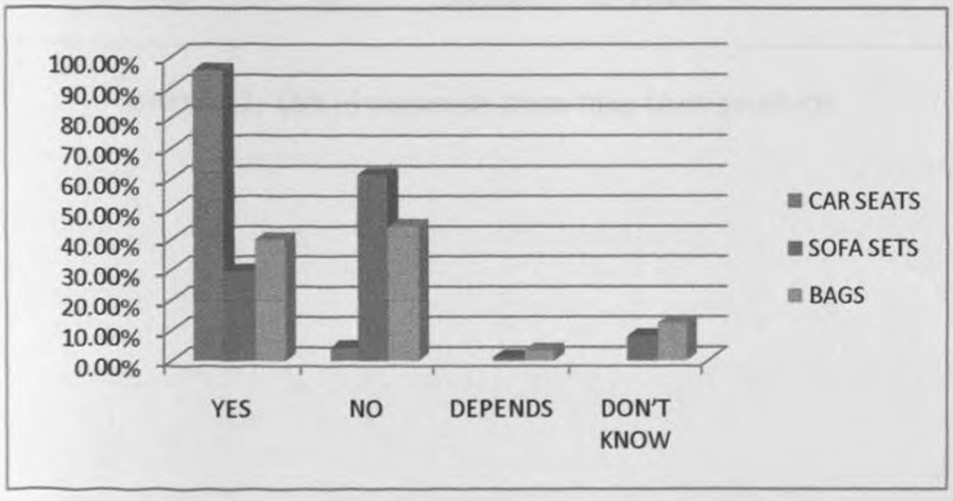


Chart 5.10: Product take-back at end of their life

Chart 5.11: Use of materials from take-back products

Only 22% of the respondents who produced bags indicated that they got back used products at the end of their time, while more than two thirds i.e. 78% did not get back these products. A small section of about 29.2% of the respondents who produced car seats got back the products at the end of their life. A relatively large section of about 41.7% did not recover the used products, while the 29.2%, said that this was subject to various factors.

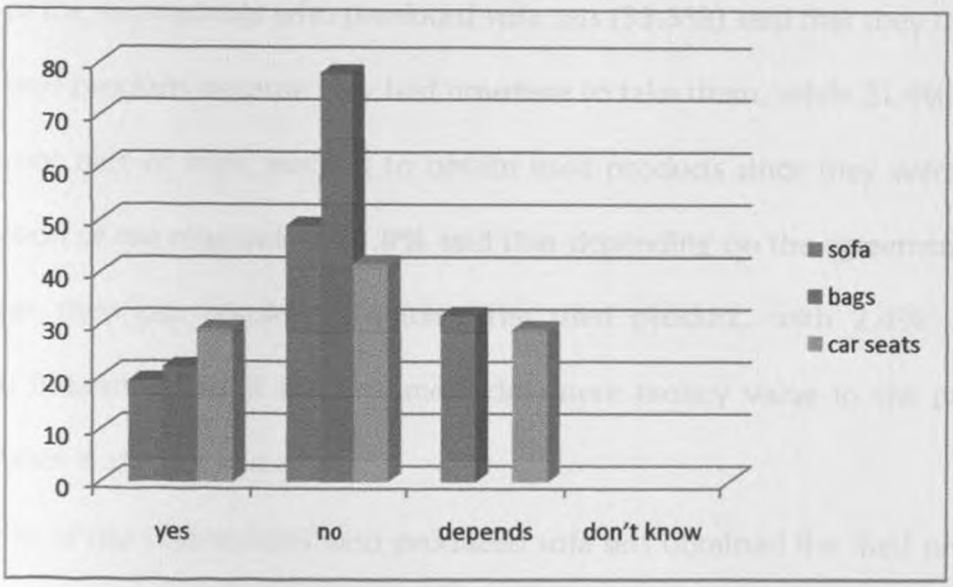


Chart 5.11: Use of materials from take-back products

Chart 5.12: Reasons for product take back

Among the respondents who produced car seats, the reason for obtaining the used product to the end of its life was significantly attributed to commercial purposes, 63.6% said that they obtained such products to sell them to recyclers. Those who did not obtain the used products gave various reasons; 18.2% indicated that they were not concerned about recycling, while 9.1% indicated that they were not useful in making new seats. The rest of the respondents obtained the used products for repair, this accounts for about 9.1% of the respondents.

A majority of the respondents who produced sofa sets (33.3%) said that they did not obtain the used products because they had nowhere to take them, while 21.4% argue that it was not part of their business to obtain used products since they were sold. Another section of the respondents, 4.8% said that depending on the agreement with the customer they can consider obtaining the used product, with 2.4% of the respondents indicating that if the customer adds more money value to the product they can obtain it after its end of life.

About 16.7% of the respondents who produced sofa sets obtained the used products for recycling, especially the frames. This was also similar with about 7.1% indicating that they can exchange the used products after an agreement, while 11.9% obtained the products for resell/auctioning or making new products.

A relatively large section of respondents who produced bags (26.2%) argued that they declined to obtain used products because the policy of their business is goods once sold are not returnable. About 21.5% obtained the products and bared the incurred costs, with about 1.5% obtaining them for resale. Lack of recycling technology made about 12.3% of the respondents not to obtain used products for

recycling, with about 1.5% of them claiming that they absolutely had no idea on how to treat used products. This was further emphasized by about 16.9% of the respondents who produced bags, who said that the used products were of no use to them, while 6.2% said that their business is restricted to selling and recycling is none of their business. About 9.2% of the respondents specialised in manufacturing and selling. An estimated 1.5% of the respondents failed to make a follow up on the disposal of used products, while only 1.5% made a follow but with conditions. A small section of the respondents, 1.5% obtained the products, repaired them and gave back to the customers.

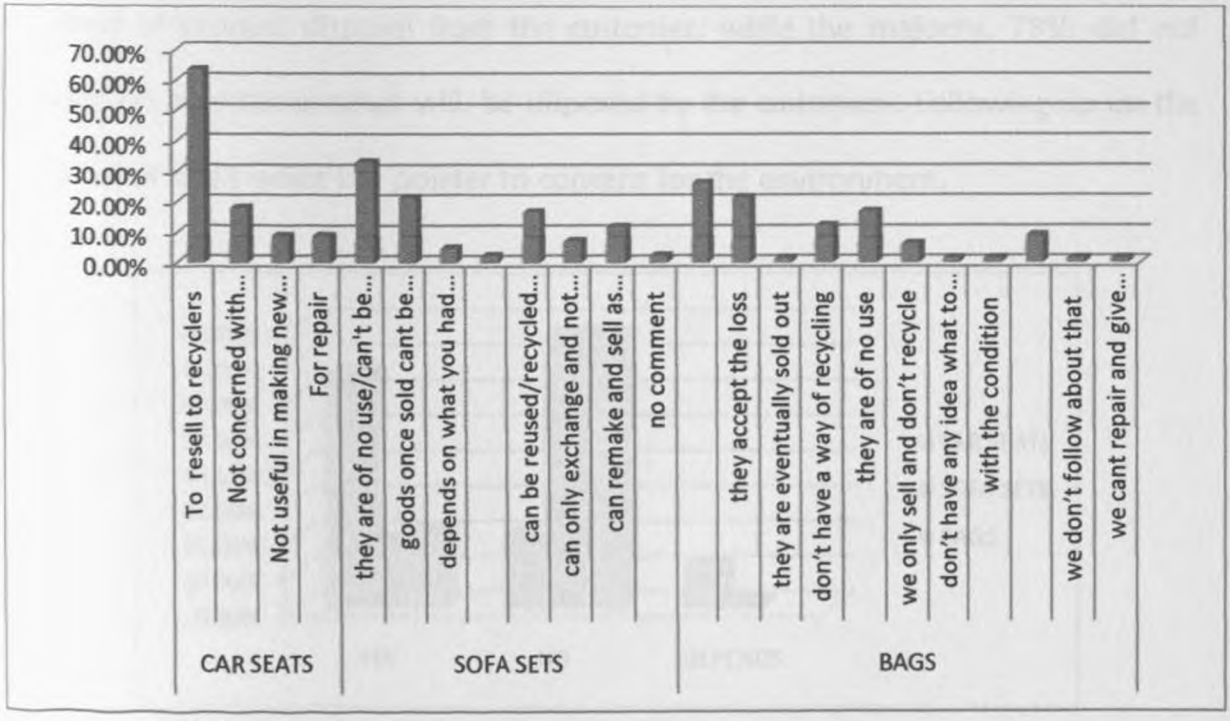


Chart 5.12: Reasons for product take back

Charts 5.13 & 5.14: Waste disposal methods

Chart 5.13: Waste materials disposal follow-up

A significant number of the respondents who produced car seats (66.70%) made an inquiry into the method of product disposal after its usage life has expired; 20.80% failed to do so while the rest, (12.50%) made such an inquiry depending on various conditions. The majority of the respondents who produced sofa sets (78%) did not inquire about the disposal of used products, with only 19.30% inquiring about disposal. About 2.30% did so but it was subject to various considerations

Only 22% of the respondents who produced bags were keen on knowing the method of product disposal from the customer, while the majority, 78% did not inquire on how the product will, be disposed by the customers. Following up on the disposal of one's waste is a pointer to concern for the environment.

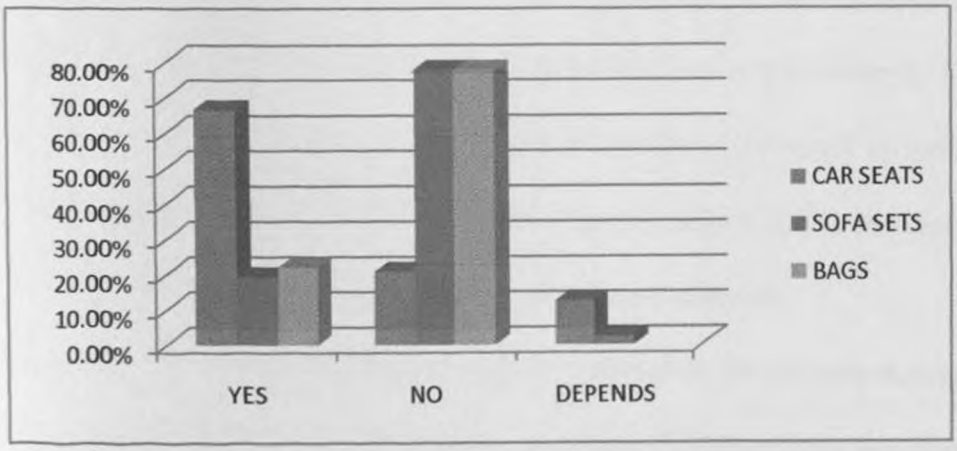


Chart 5.13: Waste materials disposal follow-up

Chart 5.14: Reasons for failure to follow-up

The main reason given by a significant percentage, of the respondents who produced car seats (42.90%) was that recycling was not part of what they do. About 28.60% of the respondents who produced car seats attached the issue of disposal entirely on the customer, with an additional 28.60% indicating that the customers can sell the product to recyclers.

It was evident that the customer was supposed to know how to dispose the product and not the sellers, as indicated by 73.70% of the respondents who produced sofa sets. About 3.50% of the respondents have never taken the idea about disposal into consideration, while 3.5% indicated that they were not directly involved in product disposal. The inquiring would negatively impact on the business; about 1.8% indicated that they failed to do so not to bother their customers, while 10.50% did not want the customers to doubt the quality of their product. It also emerged that such information is not useful and will not change anything that is according to 1.80% of the respondents. The responsibility of recycling was for the city council as indicated by 1.80% of the respondents. The rest of the respondents, about 3.5% indicate that they were business trading and not enquiring about product disposal.

Some of respondents who produced bags restricted themselves to manufacturing and selling and not touching on disposal. This makes up about 21.50% of the respondents. With about 4.60% of the respondents having no idea on product disposal inquiry, about 18.5% were not concerned about it. The customers were also blamed by about 6.20% of the respondents as not giving the sellers time to inquire about that. The city council was also charged with the responsibility of inquiring about product disposal by about 1.70% of the respondents.

There is a small section of the respondents, 4.6% who perceived the idea as of no benefit to them, while 1.50% of them argued that the process was cumbersome and hence ignored it. It was also perceived as a bother to the client, by about 4.60% of the respondents, this coupled with the fact that customers will doubt quality of the product according to 3.10% of the respondents. Lack of action was the reason for about 6.20% of the respondents for failing to inquire. The remaining 21.50% of the respondents did not bother since they consider sold products as the property of the customer.

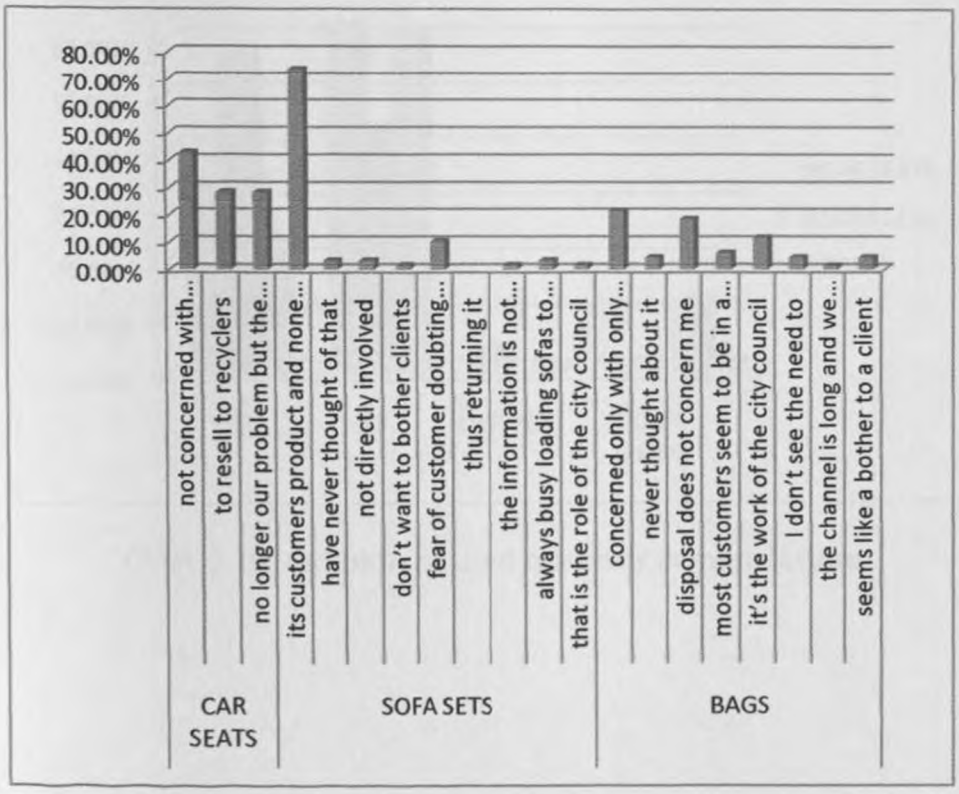


Chart 5.14: Reasons for failure to follow-up

Chart 5.15: Inclusion of used materials in manufacture.

More than half of the respondents who produced car seats, 62.5%, did not make use of used materials in their manufacture, only 33.3% used such materials, while 4.2% used them but this depended on various factors.

Among the respondents who produced sofa sets, the use of used materials was popular in the manufacture of new products, with about 56.8% of the respondents using such materials while about 43.2% did not use them.

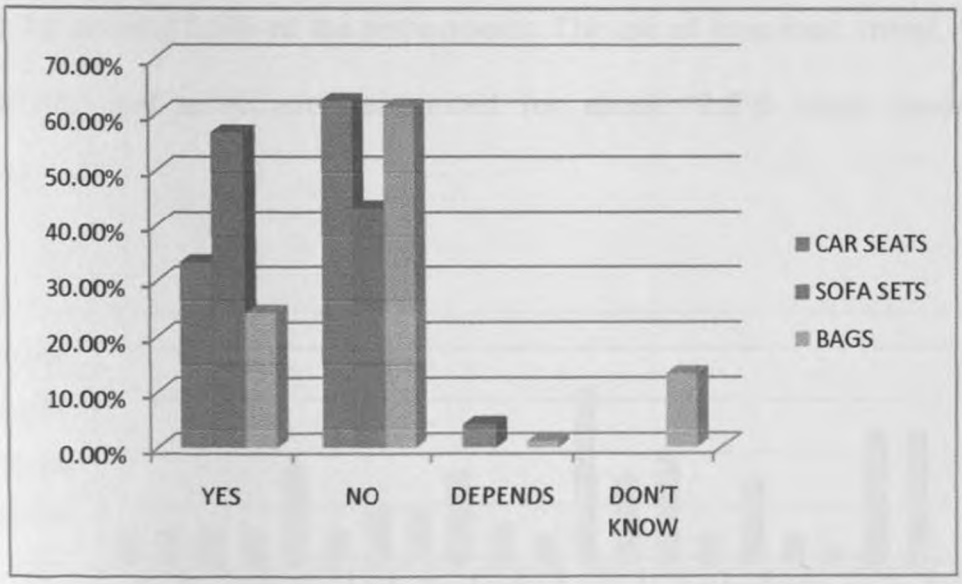


Chart 5.15: Inclusion of used materials in manufacture

Chart 5.16: Type of used materials included

A significant number of respondents (61.5%) who produced bags did not use the used materials in manufacture of new products. Only 24.2% had useful utilization of used, materials in the manufacture of new ones. About 1.1% used them but this was conditional. There were some respondents, about 13.2% who did not have knowledge on the use of used materials in manufacture.

The use of back foam was predominant among respondents who produced car seats, being used by about 37.5% of the respondents. The use of iron rods, metal, boded, lining material, and scrap each accounted for about 12.5% usage among the respondents.

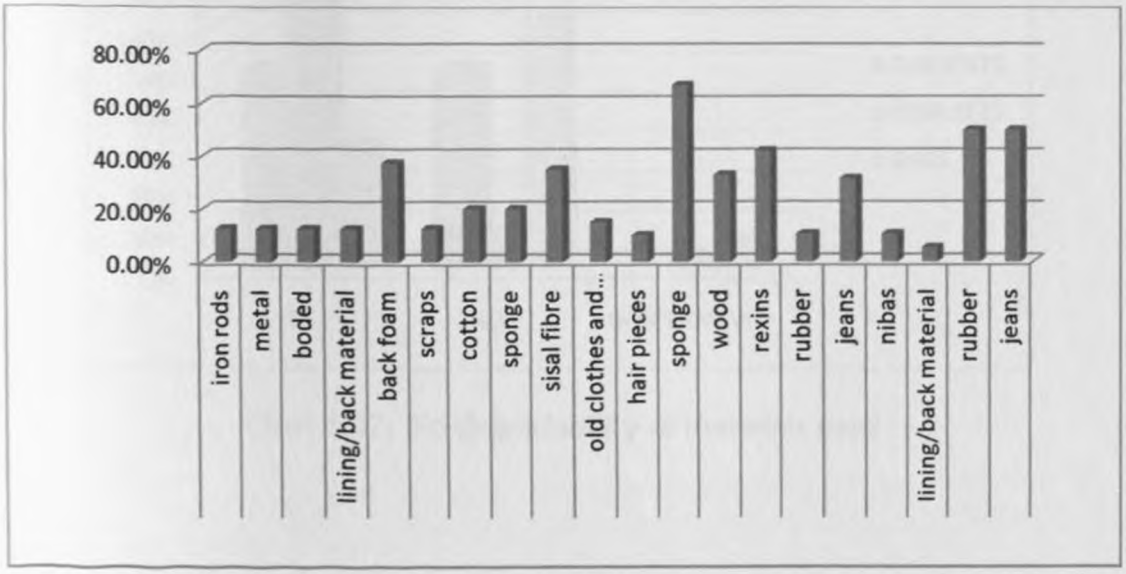


Chart 5.16: Type of used materials included

Charts 5.17 & 5.18: Bio-degradability of materials used

Industries that produce biodegradable waste are more environmental friendly. Of the three categories targeted, the car seat making business had 50% of the respondents producing degradable wastes and 50% producing non-degradable wastes are produced. 87% of sofa set makers believe that they produce degradable wastes while 9.1% produce non degradable waste, 3.4% did not know whether they produce biodegradable waste or not. 30.8% of bag makers use biodegradable materials while 62.6% use non biodegradable materials but 6.6% don't know whether the materials they use are biodegradable or not.

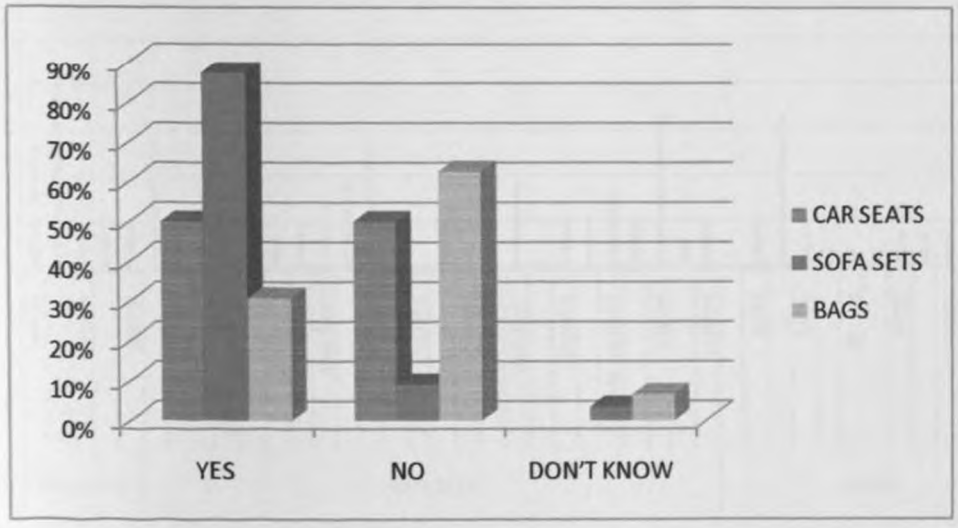


Chart 5.17: Bio-degradability of materials used

Chart 5.18: Type of biodegradable materials used

The study indicated clear ignorance on the biodegradability of materials among all respondents, where the respondents termed materials like sponge, plastic sacks, and jeans as biodegradable materials.

Among the respondents who produced car seats, 9.1% used cotton. Among those who produced sofa sets, 28.9% used wood, 9.2% used cotton, while 14.5% used sisal fibre. In respondents who produced bags, 3.7% used cotton, while 3.7% used steel section.

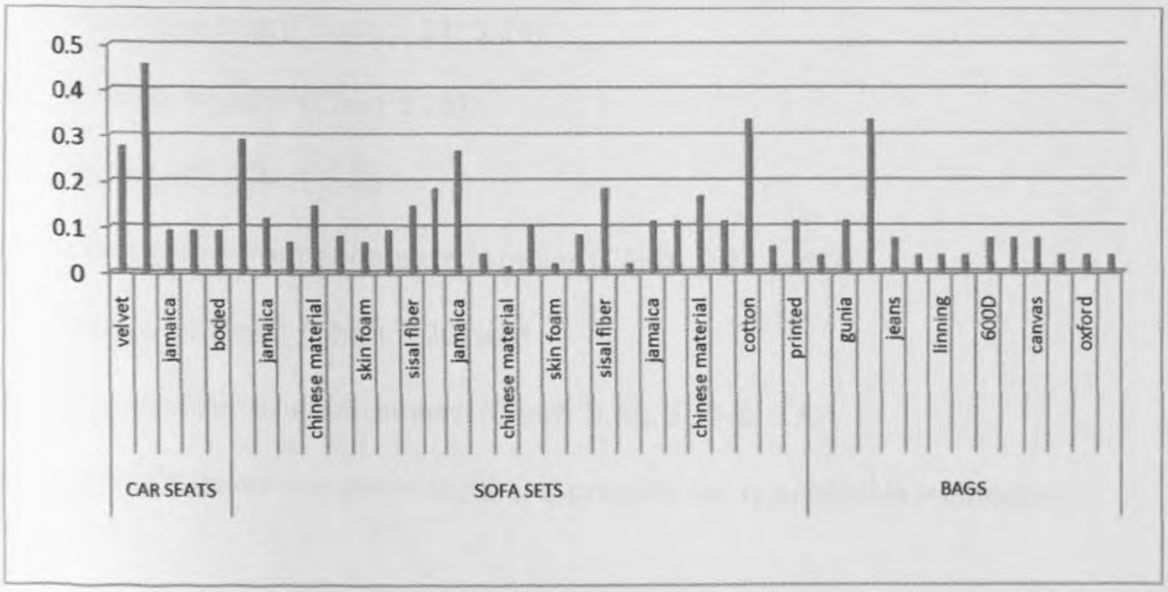


Chart 5.18: Type of biodegradable materials used

5.1.2 Questionnaire B, (Eco-aspects through Product Assembly)

Charts 5.19 to 5.32 are a continuation of results for the three case studies. The purpose of the charts was to follow-up on fulfilling the first objective of the study. The objective was *"to investigate the level of incorporation of eco-ethical considerations in design and manufacture of car seats, sofas and bags"*. The section presents findings for inclusion or otherwise of eco-ethical aspects using product assembly methods. The parameters used to capture requisite data were:

- Detachability (Charts 5.19, 5.20)
- Product lifespan (Charts 5.21, 5.22)
- Volume/weight (Charts 5.23, 5.24)
- Number of parts (Chart 5.25)
- Stackability (Chart 5.26)
- Component from endangered species (Charts 5.27 & 5.28)
- Product disposal (Chart 5.29) and
- Concern for the environment (Charts 5.30, 5.31 & 5.32)

The bar charts tabulate the percentages and presents the quantitative relationship.

5.1.3 Questionnaire B (Product Assembly)

Chart 5.19: Product joints fixation for detachability

For both car seats and sofa sets all the respondents admitted to have been fixing joints in a way that they can be detachable. This was slightly different from the case of bags where 96.7% admitted yes while 3.3% did not.

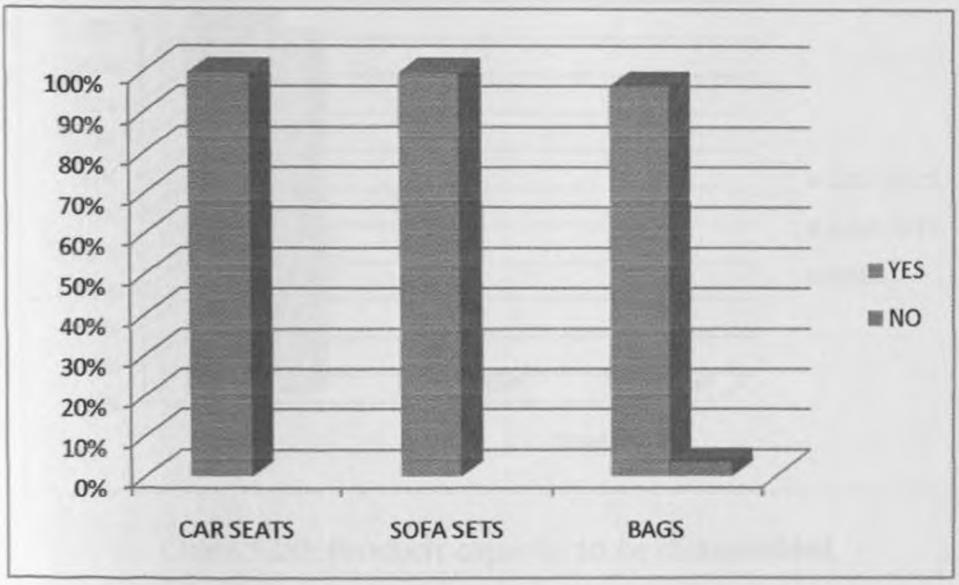


Chart 5.19: Product joints fixation for detachability

Chart 5.20: Products capacity to be disassembled

Again, all the respondents said that their car seats and sofa sets can be disassembled. For bags, 95.6 % of the respondents admitted that their bags can be disassembled, 3.3% said they cannot be disassembled while 1.1% said that their bags can only be assembled at sometimes."

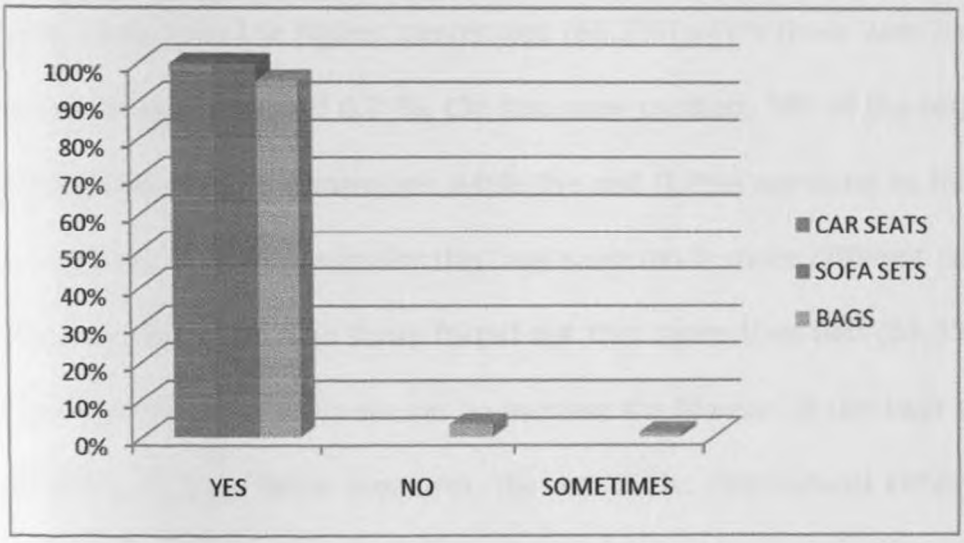


Chart 5.20: Products capacity to be disassembled

Chart 5.21: Measures taken to increase lifespan of product

The study obtained varied response regarding the taking of measures by the respondents to increase lifespan of their products. For car seats, 30.4 % of the respondents have ever taken measures while 30.4% have not. The highest percentage for car seats (30.8%) went for those who take the measures for sometimes while the rest went for those who take them on rare cases. For sofa sets, those who have ever taken the measures took the highest percentage (68.2%) while those who have never taken any measures constituted 6.8 %. On the same product, 9% of the respondents said they sometimes take the measures while the rest (1.1%) admitted to have rarely taken the measures. The responses for the bags were much more different from those of the other two products. The study found out that more than half (63.3%) of the respondents have never taken measures to increase the lifespan of the bags with only 31.1% admitting to have taken measures. the rest of the respondents either take the measures only at sometimes (2.2%) or on rare cases (3.3%).

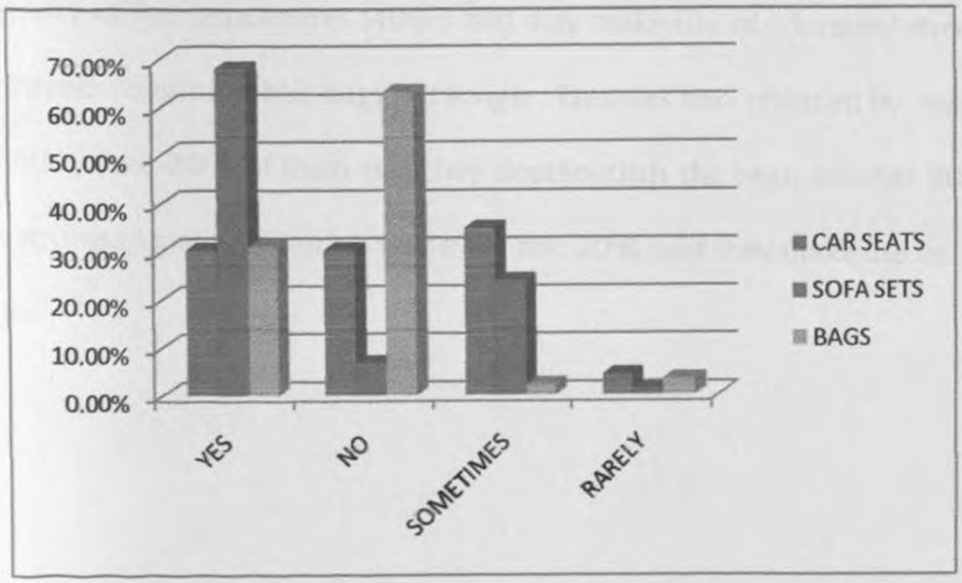


Chart 5.21: Measures taken to increase lifespan of product

Chart 5.22: Type of measure to ensure increased lifespan of product

For all the three products various measures that are taken to increase their lifespan were brought out. For car seats, majority of the respondents (57.1%) ensure they use strong material while the rest ensure there is proper welding of metal parts.

For sofa sets, majority of the respondents (48.2%) said they use strong materials or good materials which are of good qualities to ensure the sofa sets last longer. The use of hard woods rather than softwoods emerged as another popular measure for increasing the lifespan of sofa sets as reported by 28.6% of the respondents. Other measures which have also been applied to increase the sofa sets' lifespan, as given by the respondents, include: putting more nails during manufacturing phase (8.9%); getting strong joints for reinforcement (5%); proper selection of materials to be used (3.6%); and making use of sponge skin (2%). In some rare cases (1.8%), there were those respondents who said that they ensure they make the best as they can to please their customers.

For bags, majority of the respondents (40%) said they make use of durable/ strong/ appropriate threads to ensure their bags last longer. This was also reflected by rest of the respondents, where 20% of them said they double-stitch the bags, another 20% said they use stronger/quality materials while the rest 20% said they make use of smaller stitches.

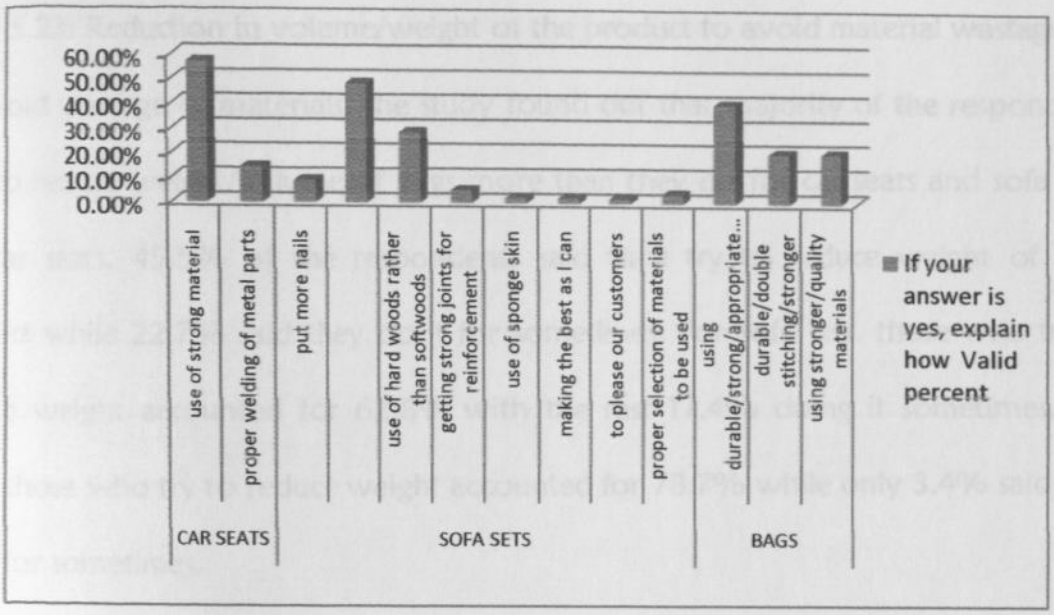


Chart 5.22: Type of measure to ensure increased lifespan of product

Chart 5.23: Reduction in volume/weight of the product to avoid material wastage

To avoid wastage of materials, the study found out that majority of the respondents tries to reduce weight/volume of bags more than they do for car seats and sofa sets. For car seats, 45.5% of the respondents said they try to reduce weight of their product while 22.7% said they do it for sometimes. For sofa sets, those who try to reduce weight accounted for 62.8% with the rest 17.4% doing it sometimes. For bags, those who try to reduce weight accounted for 78.7% while only 3.4% said they do it for sometimes.

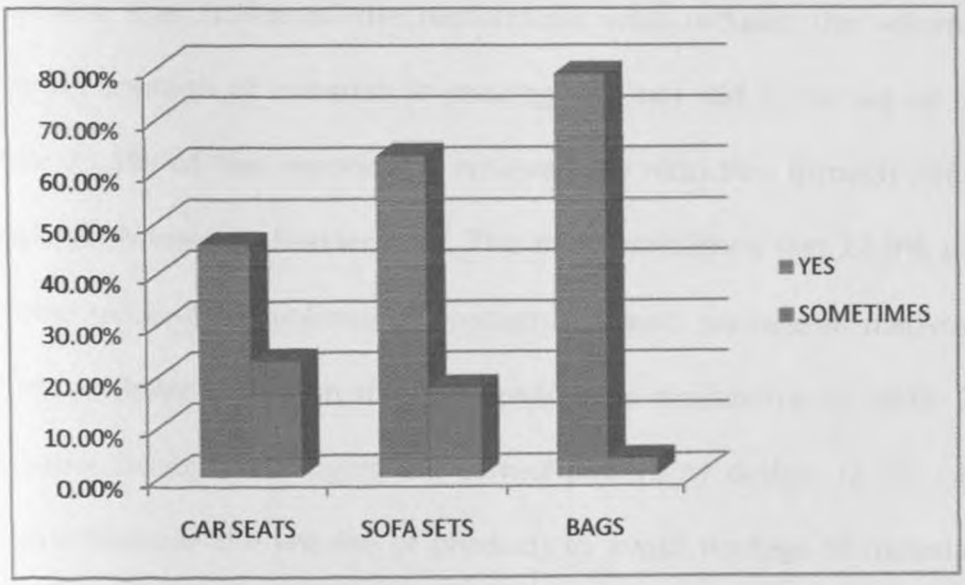


Chart 5.23: Reduction in volume/weight of the product to avoid material wastage

Chart 5.24: Method of reduction of product volume/weight.

The study found out that there are various ways by which the respondents ensure weight reduction for their products to avoid wastage of materials. It was revealed that 10 % of the respondents who reduced the volume of products to avoid wastage of materials in making car seats did so by using right proportions while 30% of the respondents achieved it by being careful in cutting the materials used. Data revealed that 50% of the respondents who reduced the volume of products to avoid wastage of materials in making car seats did so by careful measurements while 10% did so by buying accurate sizes.

The study revealed that 10.4% of the respondents who reduced the volume of products to avoid wastage of materials in making sofa sets did so by use of lesser materials, while 33.3% of the respondents achieved the reduction through selecting lighter materials as opposed to heavier ones. The study established that 22.9% of the respondents who reduced the volume of products to avoid wastage of materials in making sofa sets achieved reduction through precision in measurements, while 2.1% achieved the same through employing the correct pattern or design. 12.5% of the respondents who reduced the volume of products to avoid wastage of materials in making sofa sets did so by reducing frame sizes of their products. There were also those who did it by making use of woods and materials. These accounted for 2.1% of the respondents. Another 2.1% of the respondents said they squeeze the materials to fit. On the same purpose, 4.2% of the respondents said they do not make the cushions too spongy while another 4.2% said they use sponge instead of fibre. The rest of the respondents (2.1%) admitted to make use of small and cheap design.

In bag production, several ways are also used to reduce their volume in order to avoid wastage of materials. Among the respondents that were interviewed 9.4% were found to re-use the pieces that are normally cut out. 20.3% of the respondents indicated that they ensure volume reduction for bags through careful marking, measuring, cutting and usage of the materials. Those who reduce the volume by drawing and cutting precise patterns of the materials amounted to 20.3% of the total respondents interviewed. On the same purpose, 10.9% of the respondents ensure there is material reduction by eliminating unnecessary decorations/pockets/zips. Other ways of avoiding wastage of materials as stated by different respondents include: use of different seams (3.1%); making of light materials (6.3%); use of different patterns (changing of designs and patterns) 15.6%; squeezing the patterns (6.3%); buying exact measures of materials and patterns (3.1%). There are also other ways of reducing the volume of bags to avoid wastage of materials. There were those respondents who do this by inventing new patterns. These accounted for 1.6% of all the respondents. Others said they do it by cutting down costs. Further, 3.1% of the respondents said they cut enough patterns and materials to use while 4.7% said they ensure maximum use of materials to avoid wastage. The rest of the respondents (1.6%) gave out the use of specific materials as another way of reducing the weight of bags to avoid wastage of materials.

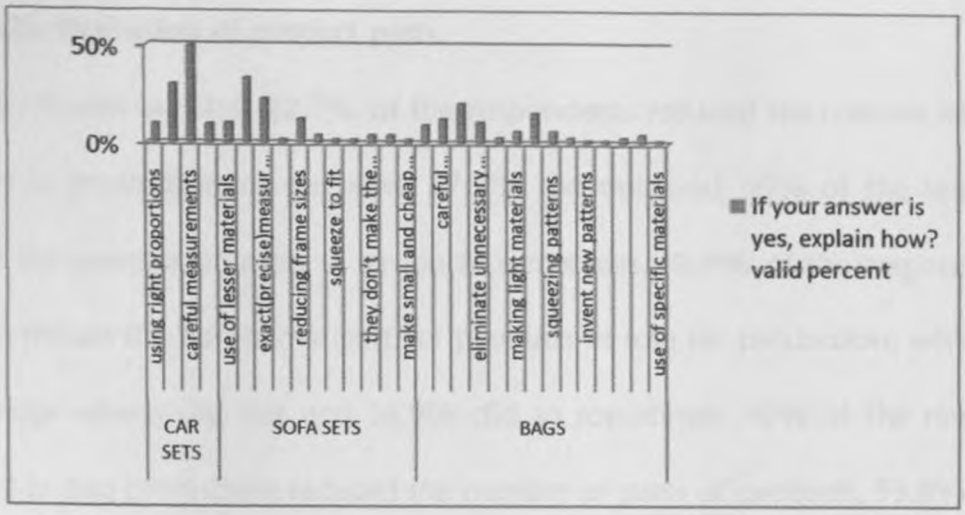


Chart 5.24: Method of reduction of product volume/weight

Chart 5.25: Reduction of product parts.

The study found out that 22.7% of the respondents reduced the number of parts of products in production of car seats, 27.3% did not, and 50% of the respondents reduced the number of parts of products sometimes. 18.4% of the respondents put effort to reduce the number of parts of products in sofa set production, while 64.4% of the respondents did not and 14.9% did so sometimes. 41% of the respondents involved in bag production reduced the number of parts of products, 53.8% did not, while 2.2 did so sometimes.

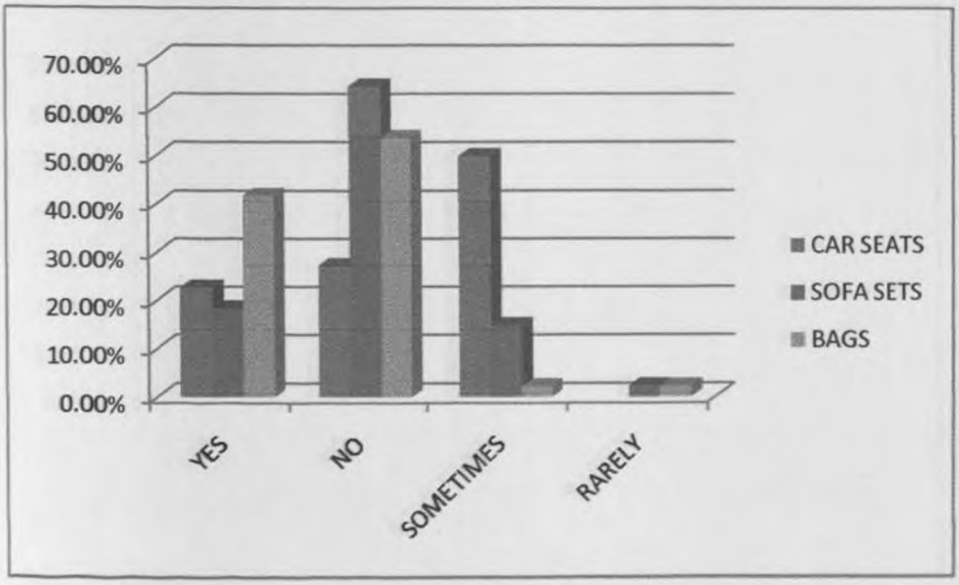


Chart 5.25: Reduction of product parts

Chart 5.26: Product stackability.

The study found out that all the respondents producing cars seats could stack their products one on top of the other. It was also found out that 37.5% of the respondents who produced sofa sets could stack one on top of the other, while 42% could not. 14.8% of the respondents who produced sofa sets stacked their products sometimes, while 5.7% stacked rarely. The study revealed that 76.9 of the respondents who produced bags stacked their products one on top of the other while 13.2% did not, and 9.9% did so sometimes.

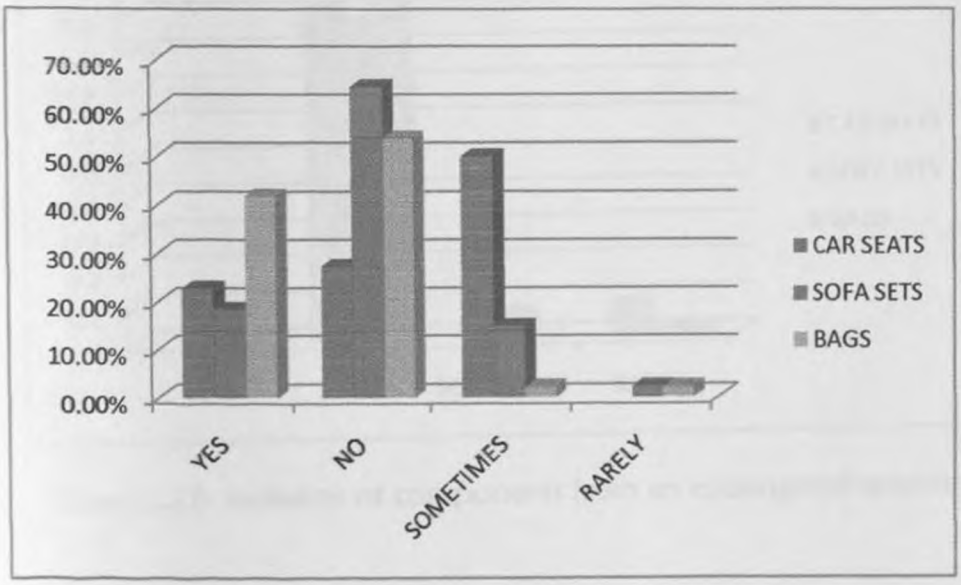


Chart 5.26: Product stackability

Chart 5.27: Inclusion of components from an endangered species

It was found out that 91.3% of the respondents who produced car seats did not have any components used from endangered species, while 8.7% rarely used products from endangered species. 3.4% of the respondents who produced sofa sets used components from endangered species while 87.4% did not. 6.9% of the respondents who produced sofa sets used products from endangered species sometimes while 2.35% of the respondents did not. A massive 97.8% of the respondents who produced bags did not use products from endangered species, while 1.1% used them.

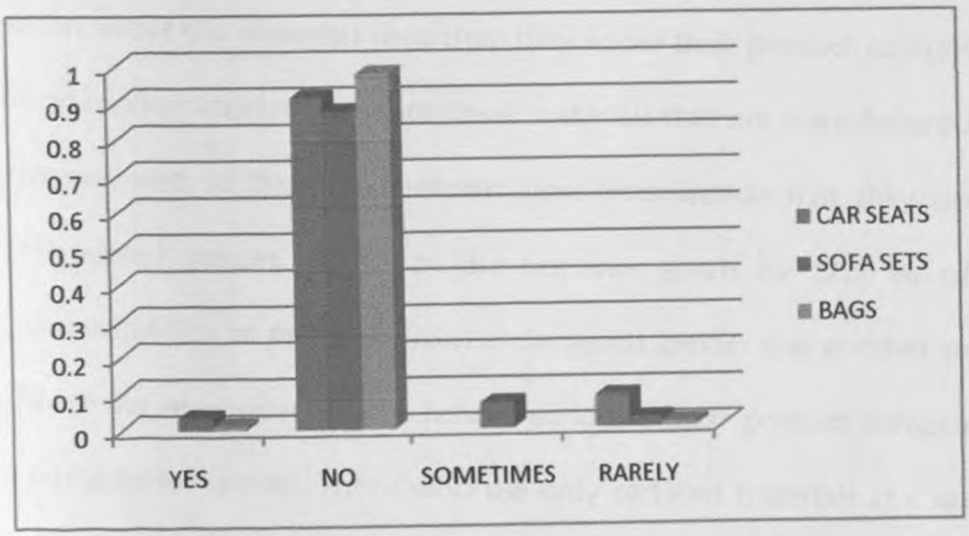


Chart 5.27: Inclusion of components from an endangered species

Chart 5.28: Capacity to identify materials from endangered species

The study also focused on finding out how the manufacturers get to know if some of their product components are/not from endangered species.

For car seats, it was found out that 12.5% of the interviewed respondents know their product components are not from endangered species since they are not from any animal. 6.3% of the respondents admitted their components are well known. The same percentage went for those respondents who said their product components can be distinguished from others. 12.5% of the respondents said that the facts that there are no complaints about the materials used then they know their product components are not from endangered species. Here are those materials that are manufactured and assured by factories and so the manufacturers have information that they do not belong to endangered species. This was the response given by 12.5 % of the respondents. Unavailability of materials from endangered species was another reason given by 6.5% of the respondents as to how they know their product components are/not from endangered species. Those who use only certified materials as a way of ensuring they are not from endangered species accounted for 18.8% of the respondents.

For sofa sets, the study found out that 17.9% of the respondents were sure of the information they gave due to unavailability of materials from endangered species. 41.1% of the same respondents said they knew it because those kinds of materials are identifiable through observation. About 3.6% of the respondents were not aware of any product components made from endangered species and so they were confident that theirs were also not from endangered species. For some respondents (about 5.4%) their product components cannot be from endangered species since there are

government regulations prohibiting the same. 1.8% of the respondents use velvet as materials for their products. About 3.6% of the respondents said they try to use alternative materials for making their sofa sets. On the same reason about 5.4% of the respondents said they use mahogany for making sofa sets to avoid using endangered species. Other materials that are used instead of those from endangered species are rexin, jeans, canvas and nibas as stated by 14.7% of the respondents.

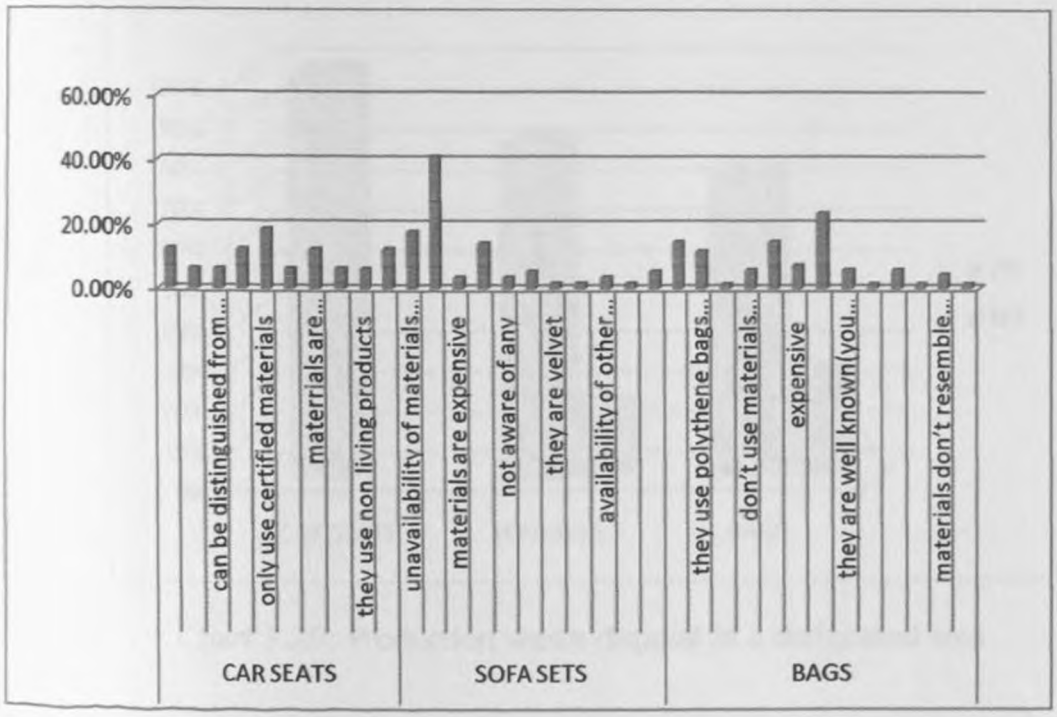


Chart 5.28: Capacity to identify materials from endangered species

Chart 5.29: Production waste disposal in a designated area

All the respondents who produced car seats disposed their waste in a designated area. 82.8% of the respondents who produced sofa sets disposed their waste in a designated area, while 17.2% did not. 74.4% of the respondents who produced bags disposed off waste from their products in designated areas, while 25.6% did not.

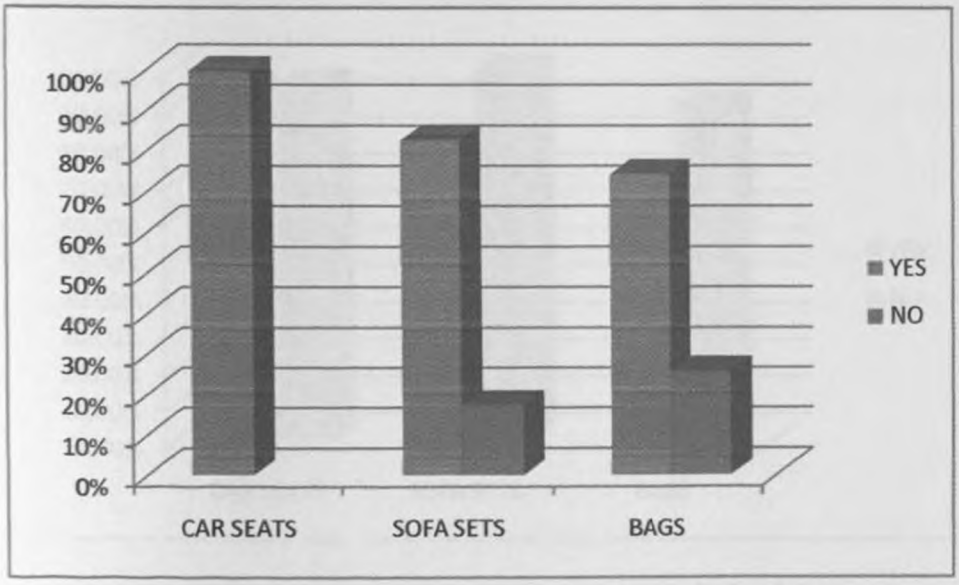


Chart 5.29: Production waste disposal in a designated area

Chart 5.30: Knowledge of environmental checklist.

All respondents who produced sofa sets were not aware of an environmental checklist. Only 4.3% of the respondents who produced car seats were aware of an environmental checklist. In comparison 9.9% of those sampled from bag making knew what an environmental checklist is. These figures clearly indicate that people in this sector are not privy to what an environmental checklist is.

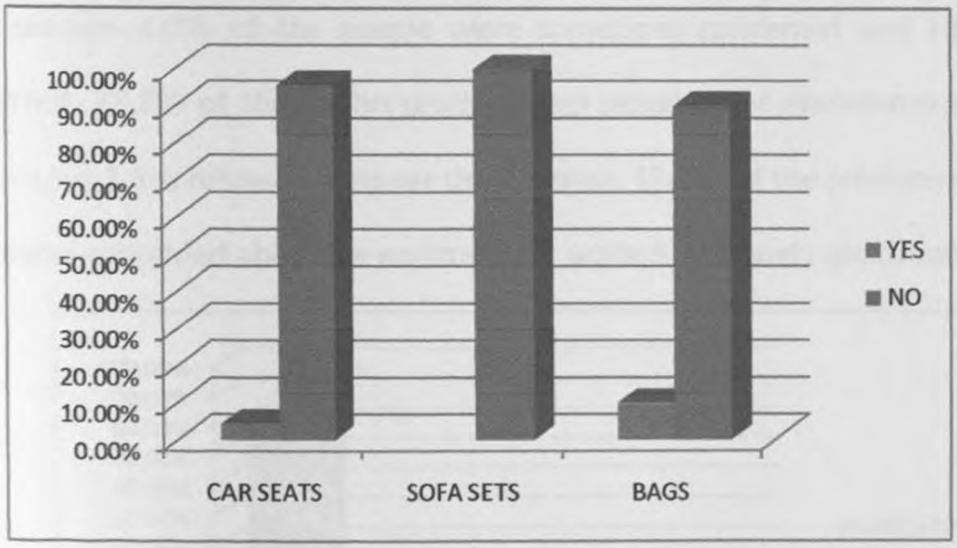


Chart 5.30: Knowledge of environmental checklist

Chart 5.31: Concern and involvement in management of environment

Asked whether the management of the environment was a matter of concern to people who make car seats, sofa sets and bags; 81.8% of those who make car seats were positive while 4.5% indicated it was not their concern and a similar percentage saying it is rarely their concern. But 9.1% said they sometimes get concerned about the environment. Sofa set makers have a relatively higher percentage of respondents concerned with the environment at 93.1% while 1.1% said the environment was not their concern 4.6% of the people were sometimes concerned and 1.1 rarely got concerned. 77.8% of those who produce bags perceive the environment to be their concern but 3.3% refused to answer the question. 12.2% of the producers of bags are sometimes concerned about the environment while 6.7% rarely get concerned.

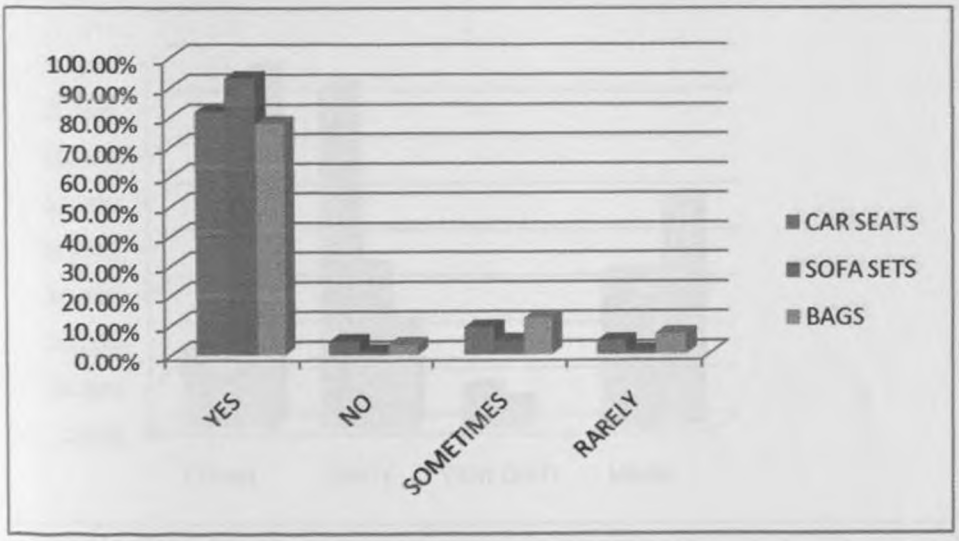


Chart 5.31: Concern and involvement in management of environment

Chart 5.32: State of designers working environment

The conditions of the working environment were varied between clean, dirty and very dirty. Only 17.4% of the car seat producers work in a clean environment compared to 59.3% sofa set makers and 77.5% bag makers. Of the three sectors the car seat industry is the dirtiest with 73.9% of the respondents working in a dirty environment and 8.7% working in a very dirty environment. 34.9% of sofa set makers work in a dirty environment and 59.3% of them work in a clean environment, making sofa set making cleaner than car seat making. The cleanest job of the three is making of bags. Of the respondents 77.5% work in a clean environment while 22.5% work in a dirty environment.

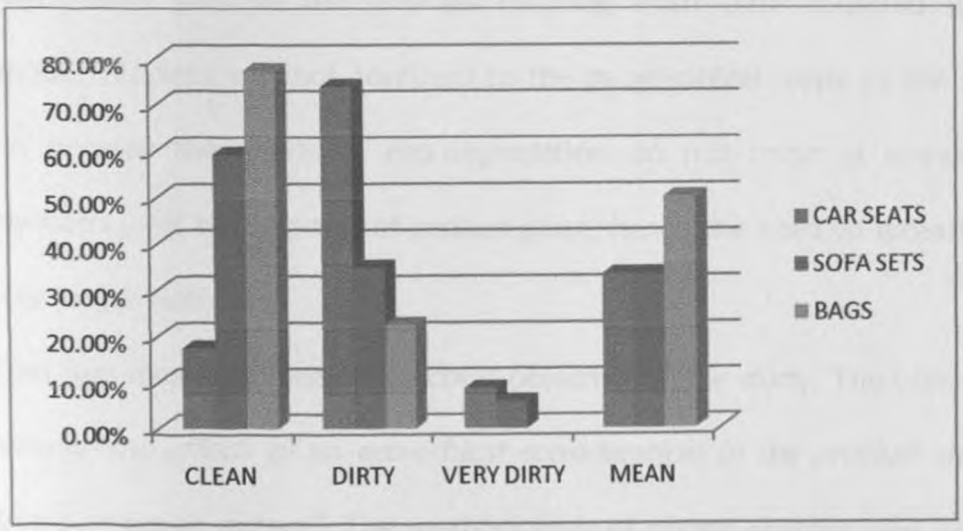


Chart 5.32: State of designers working environment

5.1.2 Summary of field study

The field study sought to capture requisite data on incorporation of eco-ethical aspects in product design. The sort of data captured was on designer's methods of reducing materials in the manufacture of products, choice of materials as way of avoiding non-biodegradable and banned materials and use of plastics that are already generally known to pollute the environment. Other eco-aspects sought through the field study were recycling efforts, waste disposal methods and product take-back programmes arrangements. The findings from the field study are enumerated in the chapter six on discussions and conclusions.

5.2 Observation

The photographs form part of the findings resulting from data collected using observer method. This data was not confined to the geographical scope of the case studies. This is because the effects of eco-degradation do not occur at source of product. It manifests itself at the point of consumption, hence the need to spread the study within the larger Nairobi.

The observation was meant to meet the second objective of the study. The objective was *"to determine the effects of an eco-ethical consideration in the product design process on levels of waste output"*. The methodology of photo analysis used in this study was proposed by Zeisel (1995; 102, 103 & 125) whereby the analyst relies on relationships between the observed phenomena and its/their environment to draw conclusions.

Poor handling of waste scatters it all over the route to the damp site, polluting the environment. This lorry was spotted at Kayole an estate in Eastlands of Nairobi city

where it goes to dispose illegally. The official disposal site is at Dandora approximately three kilometres from here.

Plate No. 5.1: Waste disposal, Date: 20th Sept, 2008, Source: the researcher,

Haphazard disposal of waste in the open spaces leaves it to be scattered by the wind. This waste in an estate in Kasarani in Nairobi city is an eyesore to residents and visitors alike. According to vegetable vendors adjacent to this site, the city council cleansing department has never collected garbage anywhere in this neighbourhood. It is usually washed away by storm water during the rainy seasons.

Plate no. 5.2: Solid waste in open yard, Date: 20th Sept, 2008, Source, the researcher

City streets are strewn with domestic waste posing health hazards as well as visual pollution to the city residents. This roadside dump at the former Muslim Girls high school at Ngara, Nairobi city is a permanent feature. Only the city street boy (scavenger) seems to appreciate its presence.

Plate no. 5.3: Solid waste disposed on roadside, Date: 20th Sept, 2008, Source: the researcher

Solid waste has encroached onto a major section of this road in Kangemi. Motorists and pedestrians are forced to use the remainder oblivious of possible risks, accidents and health effects.

Plate no. 5.4: Solid waste strewn on roadside, Kangemi, Date, 31st July 2009, source, the researcher

Old heaps of waste takes up open spaces in urban centres in Nairobi. Residents are forced to rest on them for lack of alternatives. They bury some buildings making them inhabitable due to leacheat leaking through the walls.

Plate no. 5.5: waste encroachment onto recreation spaces, Jogoo rd, residential, 28th July, 2009, Source, the researcher

In slum settings, with no access for waste collection trucks and narrow access paths, residents are forced to hop, step and jump through waste despite their tenderness.

Plate no. 5.6: Waste on slum footpaths. Kangemi residential area, 18th July, 2009: Source, the researcher

Life in this city estate has been factually on waste. Note the spread of waste on rooftops, paths and yards and the oblivious gait of the pedestrians. The researcher gathered from the residents that, they have no hope of the situation ever changing as it has been like this for as long as they can remember.

Plate 5.7: Kawangware Residential, July, 2009, *Source; Researcher*

Materials used in stuffing sofa sets constitute all sorts of waste, degradable and non-degradable. Its real hazard starts when the sofa reaches its end of life, the waste gust out and is strewn around the environment due to its light nature. This is at Gikomba in Nairobi city where most sofa sets frames in the city are made supplying at times the whole country. Finishing (stuffing) is however done at point of sale.

Plate no. 5.8. Gikomba riverside: Date: May 2007, Source: lilac osanjo, confirmed by the researcher

This designer and his handyman at the back, use waste to stuff sofas at Gikomba, Nairobi city. Their open-air workshop on the banks of Nairobi River is strewn with all sorts of waste. It pollutes the river, only two meters away, making the water unusable and causing death of aquatic creatures. By the close of the survey, the makers had been evicted in the new government clean the Nairobi river campaign.

Plate No. 5.9. Gikomba riverside, Date: May 2007, source: Lilac Osanjo, Confirmed by the researcher

One sofa set maker showing how he stuffs a sofa by concealing the waste with a nylon sack. His reason is not to recycle the waste but to evade the cost of new sponge. A thin ¼ inch sponge is used to cover the waste to make belief that all the materials are new sponge. The stuffed material remains a secret because the clients wouldn't accept the order if they knew the nature of the stuffing.

Plate 5.10: Ngara roadside kiosks. 1st August, 2009

Source: The researcher

The composition of waste always includes plastic bags and any other soft waste. According to the kiosk owner, the materials are neither sorted nor cleaned. He does not know whether they are disinfected either. He just stuffs the sofa sets with them. The danger of emission of poisonous fumes cannot be ignored nor ruled out.

Plate no.5.11: Ngara Roadside Kiosks. 1st August, 2009

Source: The Researcher

A haphazard waste heap behind one sofa set making workshop. Note the fabrics, the wood, metal and tyre among other materials. According to the workshop owner, the waste is home to rats and wild cats. Being a human habitat, the area and its environs stand the danger of human disease contagion not to mention the unsightly view and the foul smell.

Plate no. 5.12: Ngara roadside kiosks. 1st August, 2009,
Source: Researcher

A typical workspace for sofa set maker. It is not differentiated when heaps are waste or material in this workshop. It may end up in a sofa or get discarded depending on availability of better resources like money or materials.

Plate no. 5.13: Ngara roadside kiosks. 1st August, 2009
Source: The researcher

The city council has contracted private waste collectors to transport waste to the dumpsite. This picture captured along university way, Nairobi city, shows how poorly they do it. They spread it all along the route to the dumpsite, creating a bigger visual and environmental problem than the one they intended to solve in the first place.

Plate no. 5.14. Waste transportation, University way
Source: The researcher

Solid waste dug out of sewage along Temple Road near Kenya bus service station in Nairobi city, Kenya. Vehicular traffic in the background shows human habitation. The blockage leads to overflow of raw sewage along the city streets creating a health hazard. It also takes a lot of man-hours and money to unblock the sewers

Plate no. 5.15: Temple road near KBS station

Date; May 2009, Source: The researcher,

City council workers unblocking a city storm water drainage at temple road. In answer to the researchers inquiry from the duo on how often they de-block the sewer, they said once every rainy season, sometimes twice. This is due to solid waste, especially plastics getting washed into the sewer.

Plate no. 5.16: Temple road near KBS station,

Date, May 2009, Source: the researcher

Dumping into Nairobi River as shown on racecourse road is illegal and unethical. This makes the water unfit for consumption and uninhabitable by all biotic community. By close of this survey, ministry of environment workers were busy cleaning the river while watching out for illegal dumping.

Plate no. 5.17: Race course road Nairobi River Bridge

Date: September 2009, Source: The researcher

5.3 Summary of observation

The results of observation in this study clearly presented the current state of the environment in the study area. While manifesting the effects of deficient eco-ethical consideration in design, it presents the final stage of the product life cycle in Nairobi. The visual images depict polluted pavements, littered open spaces in some cases up to the entrance to habited buildings and on fences and shrubs. On the drainage system, the images depict clogged sewers, and murky waters possibly incapable of supporting

ny life. Manpower consumed on deblocking the drainage is also evident from the eaps of waste retrieved from the sewers. Observation also depicts conditions under hich the solid waste gets into the waste stream. The heaps of waste in the orkshops consist of all sorts of materials, including those that are non-biodegradable nd the manufacturers/designers in the process of initiating the waste stream.

4 Focus group discussion

his research used a focus group discussion data collection method. The goal of the ocus group discussion was *to evaluate the design process in respect of the three case tudies namely bags, sofa sets and car seats.* The aim was to gain understanding hether designers in Nairobi are morally compelled to include an ecological-aspect in roduct life cycle.

ccording to Mugenda and Mugenda (2003), a focus group is a form of qualitative esearch in which a group of people are asked about their attitude towards a product, ervice, concept, advertisement, idea, or packaging. Questions are asked in an nteractive group setting where participant are free to talk with other group members. Findings from this method were used to meet the three objectives of the study. The objective *"to investigate the level of incorporation of eco-ethical consideration in design and manufacture of car seats, sofas sets and bags"* was fulfilled as follows:

The case studies were not approached separately. Since the design process for the three of them is common, findings could be generalized collectively because they are qualitative in nature.

Out of an invitation list of 14 discussants, this study managed to get 10 respondents. This was a very good response standing above 70% of invited group. All the 10 had

at least a first degree. They therefore were qualified to discuss product design issues exhaustively.

According to (http://wasis.ou.edu/2010), analysis of Focus Group data is best done using the following thematic coding factors:

1. Frequency – number of times something is mentioned
2. Specificity – details
3. Emotion – enthusiasm, passion, etc. in responses
4. Extensiveness – how many different people said something.

For the purpose of this study, themes were isolated through specificity by insistence on more and more detail until repetitive commonality of information was detected.

On the issue of lack of eco-aspects in typical design process, the group concluded that the aspect must be incorporated at every stage of process. This is because it is possible that the designers input could be initiated and terminated at any of the eight stages. According to them, the designer input in Kenya is minimal and dwindling ranging between 20-30% of the design process. The reason for this is that most product machinery comes with embedded designs and moulds and that mostly, Kenyans import finished products. This denies the Kenyan designer the opportunity to intervene. Designers in the case studies of this research rarely suffer these problems.

On the second objective, *"to determine the effects of an eco-ethical consideration in the product design process on levels of waste output"* several issues emerged. Among them is the need for NEMA to enforce eco-ethics for lack of the same in society. Designers are known to be fully aware of the NEMA regulations. Despite this awareness, product design is driven by other factors than design. Among them are

profit, costs and time taken. Mitigation for waste prevention and reduction is totally ignored at the latter's expense. Designers in Nairobi therefore don't include it at all unless it is a regulation for conformity.

Thirdly, the objective *"to come up with other design models that would indicate a better solution for minimizing waste accumulation on the environment"* was discussed. The approach taken was to question whether designers incorporate eco-ethics and if the attribute is at all necessary in the product design process. The aim was to provide a basis for understanding other design models of the design process. It emerged that designers are interested in shape, beauty (appeal) and cost of the product above all else. It also emerged that designers are armed with knowledge of ethics in their training and that there are clear benchmarks from professional associations. Where they do therefore, it is mostly to comply with such rules that are mandatory rather than a personal choice. Designer encounter with eco-issues is mostly language oriented as business vocabulary of the time. It helps in technical sophistication to enhance the fees charged. It was agreed unanimously that eco-ethics is an extremely necessary aspect in the design process. With the current global climate change negotiation going on, the group was aware of the danger posed by the process. They therefore proposed that eco-ethics must be incorporated in the design process to mitigate such a problem.

To answer the same objective above, this study sought to specifically know where designers would fix eco-ethics in the design process. The objective as stated earlier was to come up with a design model that would indicate a better solution for minimizing waste accumulation on the environment. It emerged that it would be at every stage. But because the current typical design process is wholly assimilated in the designer

fraternity, the researcher sought to use his discretion to design a diagrammatical process without disrupting the current one. Based on this reckoning, the proposed eco-ethical product design process is appended on the recommendations section of this thesis (See table 7.3).

CHAPTER SIX

SYNTHESIS OF FINDINGS

6.0 Introduction

The overall goal of this study was to evaluate the design process with emphasis on eco-ethical product design. The objective was to investigate the level of incorporation of eco-ethical aspects in design and manufacture of car seats, sofa sets and bags. The first approach was on designer emphasis and recommendation for bio-degradability, volume, legal and recyclable materials. The second was on product assembly where the benefits are expected to be based on weight, disassembly, stackability, lifespan and number of components. In this chapter, these eco-ethical aspects are therefore discussed under two topics; product materials and product assembly.

6.1 Discussion

Three types of data have been analysed and results presented. The observation method presented data on the effects of waste emanating from the life cycle of the three cases on the living environment in the larger Nairobi. It is evident from this data that the effects of waste on the environment are visible and adverse. It also emerged from observation data that the waste is spread all over Nairobi. The heaps are an indication that there is little success in collection as alluded to by Syagga (1996) and Kirai (1996).

From the questionnaire, two types of data emerged. First, the quantitative data that was meant to measure eco-ethical aspect incorporation levels by designers in Nairobi. The other was qualitative data giving reasons and choices for designer decisions. These

two data sets clearly pointed to omission of eco-ethical aspects in the design and manufacturing processes.

Using the observation method, the study captured visual images to present its findings on the state of the environment in Nairobi. The objective of this study was *"to determine the effects of an eco-ethical consideration in the product design process on levels of waste output"*. For this purpose, the study used the findings to answer a question of the study. The findings were to determine what *the effects are of omission of an eco-ethical aspect in the design process on the environment.* As shown on the Charts no. 5.1 to 5.32, the effects include visual pollution, blocked sewers, wasted manpower through frequent deblocking of sewers, blocked roads, polluted rivers and unsanitary living conditions for citizens. The waste itself is solid. It includes materials that relate to the three case studies of this research and/or their related products. On analysis, evidence from the findings of this study proves that indeed there exists a relationship between eco-ethical consideration in the design process and levels of waste output.

It also pointed to non ethical decision in material choices and incorporation. This and other findings that proved the conjecture by this study were further reinforced by correlation of data and the chi-square analysis both of which proved it to be true that designers don't incorporate eco-ethical aspects in product design.

Data from focus group discussion was used to triangulate the methodology of the study. Using these multiple data sources, the study re-evaluated its objectives to achieve construct validity and to make conclusions. The issues and conclusions are outlined in chapter seven.

The case studies of this research, namely; bags, sofa sets and car seats were studied through parameters based on the materials used and assembly methods. These two variables accorded the study various insights into designer behaviour

6.1.1 Product Materials

The results from this analysis are useful in meeting one objective of this study namely; *"to investigate the levels of incorporation of eco-ethical considerations in design and manufacture of car seats, sofas and bags".* The parameters to gauge these lay emphasis on:

- Reduction of materials
- Choice of material
- Use of plastics and polythene
- Recyclability
- Waste disposal methods and
- Biodegradability

The study established that generally, less than 50% of designers tried to reduce materials in production. This is an indication that the chances of designing-in unnecessary materials are increased. Taken against the concept of life cycle thinking, a proposition which should reduce eco-life cycle impacts of a product, the findings indicate diminished chances of eco-production due to excessive materials. The findings also indicate that generally designers don't take eco-ethical considerations in design process and material usage.

Following up on the same issue of designer reduction of materials in production through design conceptualisation, the study found diverse methods of reducing unnecessary materials varying for each of the different items under investigation.

Major ones are 72.7% for car seats where they leave out unseen unnecessary parts, Sofa set designers where 47.2% reduce measurement of products while 59% of bag designers changed designs. These figures are encouraging though quite deceptive as further evidence proved.

With the total efforts still being below 50% of the possible solutions, with the other majority of methods being untried, the efforts afford little solution to the problem. Checked under the reduction in material usage concept, an ISO 2001 standardisation, these results shows little consideration of eco-aspects. Essentially, the unnecessary materials only contribute to excessive waste in the environment. It answers one fundamental question posed by this research on the relationship between product design process and waste levels.

Trade–off considerations through life-cycle thinking has potential impacts in terms of resource take-up and discharge of pollutants. Making specific material choices to reduce environmental impacts was found not to be one of the designers' considerations. The figures; 83.3%, 72.9% and 54% for car seats, sofa sets and bags respectively are a clear indicator of apathy for environmental issues in design considerations. ISO 2001 recommends a multi-criteria approach of an arbitrary inclusion or exclusion of eco-impacts as a trade-off in favour of the environment. This research sought to establish the effects of omission of an eco-ethical aspect in the design process. The findings are a clear indicator that the effects are un-mitigated in the designers' designs.

Trade off considerations also dictate that material choice is one of the stages where interventions are afforded the designer. Knowing the controversial issue that

polythene has become nationally and internationally lately, it is inevitable that any designer will think twice when recommending it.

By their nature, polythene materials are known to be non-biodegradable. Several governments have recently legislated against them to try to minimise their use if not outrightly banning them. As design materials, designers continue to recommend polythene in their propositions. Findings from this research indicate mixed feelings about their use and in most cases ignorance and care freedom. Among reasons given for their prevalence are: easy availability (15%), ease of use (15%), convenience and affordability (6.1%). Alternative reasons were ignorance and lack of other options.

The negative views above about the use of polythene materials are supported by the prevalence of the same as waste in the environment. The case studies and ethnographic survey indicate that polythene use and prevalence of solid waste in the environment are not unrelated. While a major reason is their failure to biodegrade, public apathy and ignorance of eco-issues of waste cannot also be ruled out. Designer incorporation is however the major route of entry into the waste stream since they are found in virtually all soft furnishing. Their level is therefore an indicator of designer lack of eco-ethical consideration as an important aspect in the product design process.

Concerted efforts by the government to control pollution by polythene and plastics conform to the current global trends in pro- environment tendencies. The research sought to know of what value could this drive have been were it aimed at and was embraced by designers. In one graphic example of low eco-ethics, this research found some interesting scenario. Among sofa set, bag and car seat designers, 86%, 91% and 85% respectively are aware of the government ban on their use. Yet, the knowledge

does not convert to action as shown in previous findings, indicating the outright disdain of eco-ethical issues. The recommended new concept development could have come handy here if designers proposed alternatives to replace the banned materials.

The quest by this study to establish designer inclusion of used material in the design process was based on worries by authorities and observation by this research. It sought to establish the types of materials used. The reason being that absolute consumption is rising, and total materials throughput and waste generation continue to grow.

Eco-materials (Kun-Mo Lee, 2005) are defined as those that can improve the environment throughout their life cycle, with accountable performance. Findings from secondary data of this research indicate that eco-materials encompass one or more of the following six factors:

1. Avoiding and/or reducing the use of non-renewable or scarce resources;
2. Enhancing the material closed loop by recycling and reusing waste;
3. Increasing resource efficiency including that of materials;
4. Using more durable materials with fewer maintenance requirements
5. Promoting the use of renewable resources and energy; and
6. Minimizing adverse impacts on biodiversity and eco-systems.

Generally though, this study established that none of the above has been fully integrated into product design process in Nairobi. In other words, eco-materials form a key concept in product design and technology to minimize environmental impacts, enhance the recyclability of materials, and increase energy and material efficiency.

Conscious designer reliance on any of the guidelines listed above was not evident. Findings from the research however indicated incorporation of used materials for stuffing but denial due to the insincerity of designers.

Where they told the truth, the materials they indicated to recycle most include iron rods, small metal parts, lining materials and other miscellaneous scrap items. Less than 30 percent of designers include any of them. As an eco-ethical aspect in design, recycling is therefore not embraced and is in fact treated as an embarrassment. No designer will boldly admit to incorporating used materials in their product lest they lose value and hence profits.

Selection of low impact materials is one strategy in decreasing hazardousness in the resources used. Through it a designer can minimise the environmental impact at the product disposal stage. Selection of low-impact materials can be done either for the product or for the packaging, or for both. Manufacturers' processes that use biodegradable waste are more environmentally friendly. Although about 50% of car seat designers, 87% of sofa set makers and 30.8% of bag designers incorporate non biodegradable materials, the picture is not very discouraging. But the effort does not seem to go far enough because the others who recommend non biodegradable materials are sizable enough to have adverse effects on the environment as shown by the ethnographic survey. The levels of inclusion of degradable materials are not sufficient to therefore conclude effective eco-ethical consideration in the product design process.

One other setback to eco-ethical decision making in design was found to be ignorance. The study indicated clear ignorance on the biodegradability of materials among all respondents, where they termed materials like sponge, plastic sacks and

jeans as biodegradable materials. The life cycle thinking also referred to as "cradle to cradle" concept is therefore omitted thus releasing the full pollutant capacity of materials on the environment. The issue on this problem was established not necessarily to be lack of eco-ethics but sadly, that of ignorance, an issue that was outside the scope of this research but which held incredible efficacy.

6.1.2 Product assembly

Method of product assembly can afford the designer many opportunities to prolong product life. The ecological benefit thereof would result from repair of degenerative parts rather than total replacement, a case that would release waste faster. Detachable product parts are useful in repair while saving the larger component of the product.

It emerged from the study that eco-benefits would be achieved by integrating the following propositions to the product design process:

- Environmental issues are integrated into the existing product development process
- Environmental issues are considered at the very beginning of the product development process
- Environmental checkpoints, reviews and environmental milestone questions are introduced into the product development process
- Company-specific environmental design principles, rules and standards are used
- Eco-design is performed in cross-functional teams
- Support tools are applied

Based on this framework, the study analysed product designer eco-trends captured through primary data. The objective was *"to investigate the level of incorporation of eco ethical considerations in design and manufacture of car seats, sofa sets and bags."*

To extrapolate appropriate meanings, the following parameters were used:

1. Weight
2. Disassembly
3. Stackability
4. Product lifespan and
5. Number of components

It emerged that, all the designers involved in assembly of car seats and sofa sets fixed joints in a way that they are detachable. This is a very positive note indicative of appreciation of eco ethics in product design. However, this was not entirely common among bag designers.

The study also sought to find out the eco-adaptability of design through possibility of detaching. It was found out that the production process for some bags assume a strict (sequential) open system which is not eco-friendly especially if the materials used are non-biodegradable. The possibility of detaching car seats and sofa sets enables replacement of broken/faulty parts. This concept of optimizing the initial life stage of a product helps to increase the product's life and reduces chances of its being disposed.

Along the same note, the ability to disassemble/detach products was wholly evident among car seat and sofa set designers. About 3 per cent of bag designers, however, did not have detachable bags, an omission which is against the concept of life cycle thinking. This is because it discourages extended productive use of materials.

6.1.3 Eco-assembly

The research had varied observations concerning design measures that are normally used during product assembly to increase the lifespan of a product. A significant number (30.4%) of designers involved in car seat assembly did not take any measures. Flexibility among the car seat designers was noted in this respect, where the greatest percentage (30.8%) took the measures sometimes. This leaves a lot to be desired in terms of life cycle impacts of products. It is a sign of the designers' ignorance on the importance of increasing the lifespan of products. The implication of this is negative impacts to the environment – perpetuated through waste dumping. More adverse impacts to the environment are realized when materials incorporated in the products are non-biodegradable.

As pointed out earlier, the aspect of taking design measures to increase lifespan of a product is considered a good eco-ethical design practice. Most of the sofa set designers fulfilled this aspect unlike most bag designers (63.3 %) who have not been taking any measures to increase the life cycle of their products.

The research has also highlighted the possibility of displaced impacts in the cycle of a product. For example, based on the response of the designers, various methods have been used to increase the lifespan of products. These include, for sofa set designers, use of hardwoods instead of softwoods as well as putting more nails and using strong materials. The use of hardwoods instead of softwoods has serious long-term ecological problem because, through cover depletion/deforestation, it leads to habitat change, ecological displacement and climate change. More so, use of nails and strong materials- which are not easily biodegradable- by car seat and bag designers leads to more problems in the bio-degradation process of the products.

The potential wastage of materials can be proportional to the volume and weight of the product. Effects on the environment are weighty and varied propositional to the volume. To mitigate this scenario at product design stage, various measures can be used. One of them is to reduce the volume of the product with the aim of reducing/avoiding wastage of materials. At design level, the designer with inherent eco-values can make informed choice not to include frolicsome materials. Generally, the research found out that all the designers tried to use some mitigating measures. Flexibility was however noted among car seat designers (22.7%) who did it only for sometimes.

About half (50%) of the cars seat designers did so by careful measurements. Sofa set designers also used the above method to reduce the size/volume of products. Most of the sofa set designers (32.3%) achieved reduction through selection of lighter materials as opposed to heavier ones (see example plate no. 6.1). While others did so by reducing the frame size of the products, bag designers mainly reduced the size or volume of products by accurate measurements, using pieces that are normally cut out, eliminating unnecessary decorations and using different designs and patterns. The latter concept of eliminating unnecessary decorations can be considered as an eco-friendly approach.

Car seat designed to minimize weight and parts. Source: www.kiel-sitze.de, 2011

The concept among other techniques cited above was however used by less than 50% of the designers. This indicates that eco-ethics has yet to catch up within this determining group.

Reduction in materials usage is a critical aspect of life cycle thinking in eco-design. This can be achieved by reduction in the number of parts of products. A large composition of car seat designers (50%) reduced the number of parts in products sometimes while 27% did not reduce. This, the study noted was due to poor sensitivity and consideration of eco-ethical innovations and improvements which could allow for reduction of parts. A large proportion of sofa set designers (64%) did not put efforts to reduce number of parts of products.

Environmentally conscious product development is highly based on the designer's initiative to put measures that consider reduction, conservation, preservation and optimal use. Product stacking is a concept that this study intended to use to observe the designers appreciation of space and the environment. All the car seat designers had products that could be stacked on top of the other. While most of the bag designers (76.9 %) had products that could be stalked on top of the other. However, the number of sofa set designers who assembled products that could be stalked on top of the other was much less with only 37%. The study found this to be due to volume, weight and fragility reasons. For example: sofas made from softwoods could easily break if stacked, while those made of hardwoods were too heavy.

Ecological rules are a possible corollary of design that is not eco-ethical in operation. Generally; most of the designers did not use components from endangered species in

their designs. Sofa set designers recorded the highest percentage that used components from endangered species with 6.9%. Use of products from endangered species is ecologically unfriendly and also reflects low eco-sensitive innovation amongst the designers.

However, the study found out that the designers have biased or semi-informed methods of determining whether materials are from endangered species. For instance, 18% of car seat designers believed they were not using materials from endangered species because they only used certified materials while 12.5% of the designers claimed they were not using components from endangered species because they did not use any animal product. The term 'endangered species' emerged to have different meanings to different designers. Most of the designers seemed to equalize endangered species only to an animal, thus excluding the plants from endangered species. This is evidence of ignorance and a lack of clear criteria for determining what constitutes endangered species. It may also be the basis on which some designers did not record any complaints or inquiry from clients about the components used and their source. While others said their products are well known, this claim was to dispel any suspicion on use of endangered species since the answer was unwarranted.

Most sofa set designers (41%) felt that they did not use materials from endangered species because such materials were identifiable just by looking at them. A further 17.9% reasoned that they did not use materials from endangered species because they were rare to find. The study finds this reasoning to be non eco-responsive because endangered species are a global phenomenon and local designers may not understand products from endangered species in other parts of the world, like the panda or alligator.

One of the signs of eco-ethical design is the eco-friendly interaction/associations with the environment or surroundings. The study looked at waste dumping to establish this. Generally, most designers disposed off their product waste in a designated area. This shows an aspect of ecological custodianship by the designers. However, some sofa set designers (12.2%) and bag designers (25.6%) did not dispose their production waste in a designated area, which shows lack of eco-ethical behaviour.

Knowledge and eco-ethical empowerment is vital for the idea of lifecycle thinking. While the designer literacy level was not within the scope of this study, the study found out that generally, the designers did not understand what an environmental checklist means. Such a checklist is basic and essential in design that involves eco-ethical insights. Tellingly, all the sofa set designers were not aware of environmental checklist while only 4.3% of car seat designers and 9.9% of bag designers understood what an environmental checklist means.

Management of the environment is an important component of life cycle thinking based design. Generally, most of the designers felt that management of the environment was a matter of concern to them. However, some designers are not concerned with environmental management; a fact which the study established to be a result of ignorance.

Eco-ethical relationship/associations constitute the pillar idea for the concept of life cycle thinking. The working environment affects the designer, just as the designer affects the working environment. The study found out that most car seat designers (73.9%) were generally working in dirty conditions. More than half of the sofas set designers (59.3%) were working in a clean environment while 77.9% of bag designers were working in a clean environment. The latter cannot attribute their clean

working environment to themselves; the cleaning business is done by the city council. But observation by this study as evidenced in photographic evidence elsewhere in this thesis proves the latter claim to be inexact. This is because a swept interior with the waste circumventing the structures exterior is not a convincing example of a clean environment. The trail will readily lead to the culprit.

6.1.4 Designer responsibility

The responsibility to the environment, according to the thesis of this study, lies squarely on the designer. As the originator of the design process, the designer input is fundamental to gaining understanding whether designers in Nairobi are morally compelled to include an ecological-aspect in product life cycle. Data on this issue was collected from a focus group discussion.

On the issue of lack of eco-aspect in typical design process, the group concluded that the aspect must be incorporated at every stage of process. According to them, the designer input in Kenya is minimal and dwindling raging between 20-30% of the design process. The reason for this is that most product machinery comes with embedded designs and moulds and that mostly, Kenyans import finished products. This denies the Kenyan designer the opportunity to intervene.

On the question of relationship between product design process and the environment, several issues emerged. Those issues included the fact that product design is driven by other factors than design. Among them are profit, costs and time taken. Mitigation for waste prevention and reduction is totally ignored at the latter's expense. It also emerged that designers are interested in shape, beauty (appeal) and cost of the product above all else. Designer encounter with eco-issues is mostly

language oriented as business vocabulary of the time. It was therefore unanimously agreed that eco-ethics is an extremely necessary aspect in the design process.

One method for change proposed is the adoption of true cost design. Due to the extensive behaviour and input change necessary, eco-design ends up not being affordable. It is neither optional. It is therefore very undesirable to all parties involved.

Findings also pointed to the need for a code of ethics, one in which the impact and importance of design is acknowledged, and the harm it does is reduced. Integrating eco-ethics at every stage of the design process would enable this to happen.

6.2 Test of hypothesis

6.2.1 Correlation of data

In correlating data, this study assumed that there is a relationship between the inclusion of eco-ethical aspect in product design and the environment. The hypothesis, "*integrating eco-ethics in product design process contributes to sustainable environment*" was tested for relationships between variable and the significance of such relationship. It used correlation coefficient to capture relationships between variables of the study. Correlation is one of the most common and most useful statistics. A correlation is a single number that describes the degree of relationship between two variables (http://www.socialresearchmethods.net/).

The formula for the correlation is:

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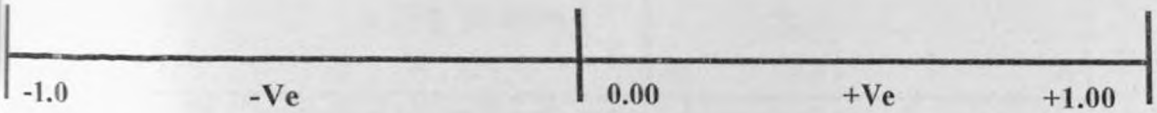
The formula for the correlation is:

$$r = \frac{N\Sigma xy - (\Sigma x)(\Sigma y)}{\sqrt{[N\Sigma x^2 - (\Sigma x)^2][N\Sigma y^2 - (\Sigma y)^2]}}$$

Where:

N	=	number of pairs of scores
Σxy	=	sum of the products of paired scores
Σx	=	sum of x scores
Σy	=	sum of y scores
Σx^2	=	sum of squared x scores
Σy^2	=	sum of squared y scores

Correlation uses the symbol r to stand for the co-relation. Through the magic of mathematics it turns out that r will always be between -1.0 and +1.0 (Dowdy & Wearden, 1991).The following diagram by the researcher illustrates this relationship.



Two tailed Pearson's correlation scale: Source; the author

If the correlation falls on the negative side of the scale, thus being less than zero, that is a negative relationship; if it's larger than 0.0 on the scale, the relationship is positive.

The study chose to use environmental impacts as the fundamental aspect to test relationships. On that basis, the study sought to test that against reduction of materials in production. The result is shown on the two tables below. Using the two tailed Pearson's correlation coefficient, the first table (table 6.1) returned results 0.000. Using the scale shown above, the result means that a reduction in production materials has no relationship to reduction in environmental impacts.

Table 6.1: Pearson's correlation on polythene ban v/s eco-impacts

Materials (bags)		Did you ever make specific materials choices to reduce environmental impacts?	Have you ever tried to reduce materials in production?
Did you ever make specific materials choices to reduce environmental impacts?	Pearson Correlation	1	.409(**)
	Sig. (2-tailed)		.000
	N	83	83
Have you ever tried to reduce materials in production?	Pearson Correlation	.409(**)	1
	Sig. (2-tailed)	.000	
	N	83	91

** Correlation is significant at the 0.01 level (2-tailed).

On the same note, table 6.2 returned significance at 0.001. This figure is on the positive side of the scale. It therefore means that support of a polythene ban is directly proportional to beneficial environmental impacts.

Table 6.2: Pearson's correlation on material choice v/s ban on polythene

Materials (bags		Did you ever make specific materials choices to reduce environmental impacts?	Do you support the idea of banning the use of polythene ?
Did you ever make specific materials choices to reduce	Pearson Correlation	1	.360(**)
	Sig. (2-tailed)		.001

environmental impacts?	N	83	83
Do you support the idea of banning the use of polythene?	Pearson Correlation	.360(**)	1
	Sig. (2-tailed)	.001	
	N	83	91

** Correlation is significant at the 0.01 level (2-tailed).

Following up on the same issue, the study used environmental management as the aspect to evaluate against disposal of residue production materials. The following two tables (table 6.3 & 6.4) illustrate the results of correlation to be significant at the 0.05 and 0.009 level respectively using the Pearson's two tailed method. The two figures are placed on the positive side towards 0.01 on the scale. This means that designer waste disposal methods are directly proportional to environmental impacts.

Table 6.3: Pearson's correlation on eco-concern v/s disposal area

Assembly sofa sets		Is the management of environment a matter of concern to you?	Do you dispose off waste from your product in a designated area?
Is the management of environment a matter of concern to you?	Pearson Correlation	1	.299(**)
	Sig. (2-tailed)		.005
	N	87	86
Do you dispose off waste from your product in a designated area?	Pearson Correlation	.299(**)	1
	Sig. (2-tailed)	.005	
	N	86	87

** Correlation is significant at the 0.01 level (2-tailed).

Table 6.4: Pearson's correlation on eco-concern v/s product lifespan

Assembly (sofa sets)		Is the management of environment a matter of concern to you?	Have you ever taken measures to increase life span of product?
Is the management of environment a matter of concern to you?	Pearson Correlation	1	.278(**)
	Sig. (2-tailed)		.009
	N	87	87
Have you ever taken measures to increase life span of product?	Pearson Correlation	.278(**)	1
	Sig. (2-tailed)	.009	
	N	87	88

** Correlation is significant at the 0.01 level (2-tailed).

6.2.2 Conclusion of correlation

In the words of Layman (1993), the significance level is usually denoted by the Greek symbol α (lowercase alpha). Popular levels of significance are 5% (0.05), 1% (0.01) and 0.1% (0.001). If a test of significance gives a p-value lower than the α-level, the null hypothesis is rejected. Such results are informally referred to as 'statistically significant'. At 0.001 level of statistical inference, significance is being implied. For the purpose of this study, a significance level of 0.1% (0.001) was taken. Except table 6.1, other tables' number 6.2-6.4 returned a correlation less than the P-value. Using Layman's (1993) inference, this study rejects the null hypothesis that *integrating eco-ethics in product design process does not contribute to sustainable environment.*

The rejection of the null hypothesis, qualitative data and this correlation of quantitative data support the hypothesis of the study. Furthermore, because Lymans views are supported by among others, Dowdy and Wearden (1991), Roberts and

Russo (2004) and Freedman et al (1997), it is this studies conclusion that indeed, integrating eco-ethics in the product design process contributes to sustainable living environment.

6.3 Chi-square test of hypothesis

The study hypothesises that integrating eco-ethics in product design processes contributes to sustainable living environments or in other words, that there is a significant relationship between eco-ethics in product design and environmental sustainability. For the purpose of testing the hypothesis and in order to clearly explain the process of testing the hypothesis, the study assumed there are two case scenarios;

Case I: That the already defined hypothesis is wrong and thus there is no relationship whatsoever between eco-ethics in product design and environmental sustainability. We will call this the Null hypothesis

Case II: That the study hypothesis is correct and there is a significant relationship between eco-ethics in product design and environmental sustainability.

The data collected during the study sought to achieve the study objectives and was in two sets;

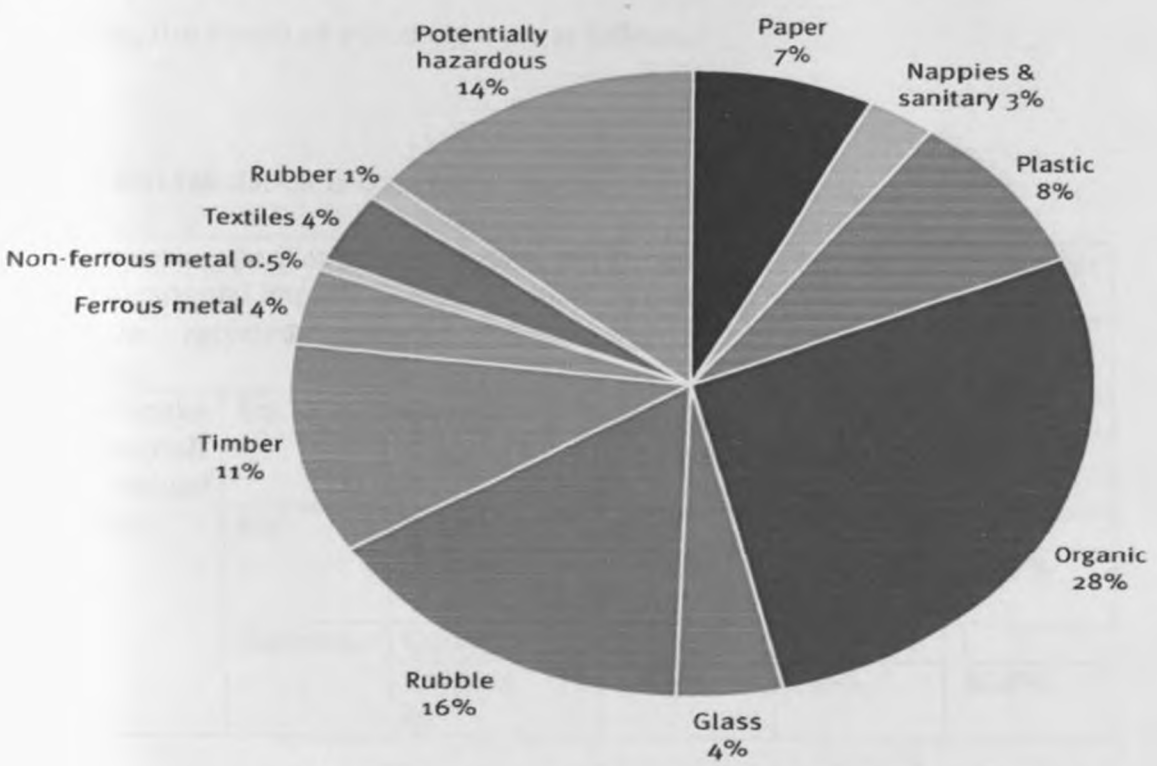
a) Data on the method of assembly of products during manufacture (Appendix 1)
b) Data on use of materials in the process of manufacture of products (Appendix 2)

6.3.1 The variables

To measure whether eco-ethics is related to environmental sustainability, two variables were selected from each data set, one addressing eco-ethics and the other

environmental sustainability. In the first data set (Table 6.5), respondents were asked to provide information as to whether they dispose off wastes from their products in the designated areas. They were also asked to provide information as to the cleanliness of their working environment. In testing the hypothesis, the former question sought to address eco-ethics while the latter sought to address environmental sustainability (the quality of the environment)

In the second data set (Table 6.6) respondents were asked to provide information as to whether they make specific material choices to reduce environmental impacts, constituting eco-ethics, and whether they include used materials in manufacturing, which in this case will constitute environmental sustainability through recycling. Although it was not within the scope of this study to quantify waste, literature pointed to the following to generally be the composition of solid waste.



Composition of typical disposable solid waste.
Source: www.mfe.govt.nz

6.3.2 The method

The study was interested in testing whether there is a relationship between use of eco-ethics in product design and environmental sustainability, the method used is the Pearson's chi-square test of independence. The test (Dowdy and Wearden 1991), often referred to as the chi-square test of independence is a technique used to determine whether there is a relationship between two categorical variables; which in this case are eco-ethics and environmental sustainability. This technique measures the significance of a relationship by use of numbers.

From the earlier defined variables, that is 1) whether respondents dispose off wastes from their products in the designated areas Versus the cleanliness of their working environment and 2) whether they make specific material choices to reduce environmental impacts Versus whether they include recycled materials during manufacturing, the results of correlation are as follows;

Table 6.5: Cross tabulation 1: Data from this study's analysis

Do designers make specific material choices to reduce environmental impacts Versus whether they include recycled materials during manufacturing,			Do designers include used materials in manufacturing?		
			Yes	No	Depends
Did you ever make specific materials choices to reduce environmental impacts?	Yes	Count	26	23	0
		Column N %	34.2%	22.8%	.0%
	No	Count	49	76	1
		Column N %	64.5%	75.2%	50.0%
	Depends	Count	1	2	1
		Column N %	1.3%	2.0%	50.0%

Table 6.6: Pearson Chi-Square Tests 1

whether they make specific material choices to reduce environmental impacts Versus whether they include recycled materials during manufacturing		Do you include used materials in manufacturing?
Did you ever make specific materials choices to reduce environmental impacts?	Chi-square	24.197
	df	4
	Sig.	.000(*,a,b)

* The Chi-square statistic is significant at the 0.05 level.

Table 6.7 Cross tabulation 2: data from this study's analysis

whether respondents dispose of wastes from their products in the designated areas Versus the cleanliness of their working environment			How is your working environment?		
			Clean	Dirty	Very dirty
Do you dispose of waste from your product in a designated area?	Yes	Count	106	50	3
		Column N %	86.2%	74.6%	42.9%
	No	Count	17	17	4
		Column N %	13.8%	25.4%	57.1%
	Some times	Count	0	0	0
		Column N %	.0%	.0%	.0%
	Rarely	Count	0	0	0
		Column N %	.0%	.0%	.0%

Table 6.8 Pearson Chi-Square Tests 2

whether respondents dispose of wastes from their products in the designated areas Versus the cleanliness of their working environment		How is your working environment?
Do you dispose of waste from your product in a designated area?	Chi-square	10.398
	df	2
	Sig.	.006(*,a)

* The Chi-square statistic is significant at the 0.05 level.

From the above tables (See 6.6-8), there are five (5) aspects that can clearly be identified

1. Count – This is the number of times cases were identified by respondents, for example in cross tabulation 2, the number of respondents who dispose off wastes from products in the designated areas and who at the same time have

clean working environment is 106

2. Column N percentage (%) – These are column proportions shown as the summary statistics. Column proportions are computed so that they sum to 100% down each column. This is used as a measure of independence of variables in that, if the variables being measured are unrelated then in each row the proportions should be similar across columns. Since there appears to be differences in the proportions across rows the two variables are related. The chi square figure though is meant to confirm this.
3. Chi Square – Since the test of independence hypothesises that there is no relationship between use of eco-ethics and environmental sustainability (as earlier defined in case I, Null hypothesis), the result in the column proportions should be the same across columns, and any observed discrepancies are due to chance variation. The chi-square statistic measures the overall discrepancy between the observed cell counts and the counts you would expect if the column proportions were the same across columns. A larger chi-square statistic indicates a greater discrepancy between the observed and expected cell counts – giving greater evidence that the column proportions are not equal and that the two variables being measured in both cases are related (Roberts and Russo, 2004).
4. Df (degrees of freedom) - This is used to identify the freedom of cases within the sample and will be understood better under item 5 below
5. Significance value - In cross tabulation 1, (Table 6.6) the computed chi-square statistic is 24.197. In order to determine whether it is enough evidence to support the hypothesis that the two variables being measured are related, the

significance value of the statistic is computed. The significance value is the probability that a random variate drawn from a chi-square distribution with 4 degrees of freedom (Refer to Pearson's chi-square tests 1, (Table 6.6) is greater than 24.197. Tabulation of data from this study with 4 degrees of freedom gave results of 0.000. Since this value is less than 0.05, the level at which the chi-square statistic is significant, the conclusion is that the two variables being measured are related.

According to Layman (1993), Chi-square measures the number of times where cases are not related to each other in a sample. The higher the significance value, the greater the independence of the variables and the less the value, the more closely variables are dependent or related to one another. The level at which the chi-square statistic is significant is at the 5% (0.05) mark. This means that if during a survey more than 5% of the cases taken are not related then the variables are independent of each other and thus the chi-square statistic is significant. On the other hand, if it becomes more difficult to find independence among the variables (that is if in a sample of 100 cases you cannot find 5 cases where the variables measured are not related) then there is a significant relationship between the two variables being measured (Freedman and Pisani, 1998).

6.3.3 Conclusion of Chi-square test of hypothesis

From the two variables used to test the hypothesis, the chi-square test significance is 0.000 and 0.006 for variables 1 and 2 respectively. Both relations are strong enough to support a relationship between the variables since they are both less than 5. It is

therefore evident that integrating eco-ethics in product design processes contributes to sustainable living environments. The validity of this conclusion is discussed further in section 7.5).

6.4 Conclusion

The three data sets have been discussed and synthesised in this chapter. Issues that pointed to designer unethical approach to the design process are cross-checked from the data sets and correlations established. Using correlation and chi-square methods, relationships are established between designer eco-ethical behaviour and the state of the environment (See section 7.5). Drawing from the same data sets, the conclusions and recommendations are presented in the next chapter.

CHAPTER SEVEN

CONCLUSIONS AND RECOMMENDATIONS

7.0 Introduction

In this chapter, the study lays out the contribution to knowledge as it emerged from the synthesis of the three data sets. It concludes the research by establishing validity of relationship between designer eco-ethics and the inclusion of eco-aspects in the design process. It finally presents the findings in proposition format and recommends diagrammatically an ideal eco-ethical product design process and a product life cycle.

7.1 Conclusions

The overall goal of this study is to evaluate the design process in respect to design and manufacture of car seats, sofas and bags so as to identify a design model ideal for enhancing the living environment. This goal was achieved by undertaking the following specific tasks.

(1) Investigating the level of incorporation of eco-ethical considerations in design and manufacture of car seats, sofas and bags.

(2) Determining the effects of an eco-ethical consideration in the product design process on levels of waste output.

(3) Developing two design models that indicate better solutions for minimising waste accumulation in the environment.

This was accomplished through three processes:

- Quantitative data collection through two questionnaires; one on materials usage and the other product assembly processes.
- Qualitative data collection as follow-up questions on the two questionnaires mentioned above and an ethnographic observer survey and,
- A focus group discussion that triangulated the data collection method.

From these three data sources, the power of the product designer is acknowledged to be of great significance for the success of an eco-product development project. This is due to the fact that such strong players are central in acquiring resources in terms of materials and budget for the project. A clear product designer's vision is also essential and refers, among other things, to the ability to put together the suitable competencies in order to develop a product that is appreciated and is wholesome in the market. This research sought to capture this essence in possibly, its entirety.

7.2 Incorporation of eco-aspects in design

These eco-aspects were brought to light by the study's attempt to fulfil its objective. The objective was "*to investigate the level of incorporation of eco- ethical considerations in design and manufacture of car seats, sofas and bags*". Several positive factors for integration of eco-ethics in product design and development emerged from this inquiry. Within the Eco-design literature, a number of factors have also, explicitly or implicitly, been presented as being essential when integrating Eco-ethics in product development. One frequently mentioned factor is designer commitment and support. An essential responsibility for the designer is to establish

clear environmental goals not only for the product development organisation as a whole, but for the individual product development projects as well.

This implies that environmental considerations should be addressed as a business issue, i.e. the environmental considerations must be balanced with commercial aspects. It also implies that Eco-design aspects should not only be integrated on an operational level, but also on a strategic level. The strategic level relates to how a designer or design team wants to position itself concerning environmental issues and includes, among other things, the establishment of an environmental product development process. This, as proved by data from this study should be different from the typical design process.

The need to balance environmental considerations and commercial aspects has been underscored by Bras (1997) and Callicot (2000), who argue that the route to long term integration of environmental considerations into the product design and development activities is to adopt strong environmental focus. Authorities have even gone one step further and argued that manufacturers should train all their staff in environmental issues. The reason is that environmental impact from different technologies varies. Hence, the choices made concerning which processes to use in a product is vital for the products environmental performance.

7.3 Effects of eco-ethics on the environment

A sub-objective of this research was *"to determine the effects of eco-ethical consideration in the product design process on the environment"*.

While fulfilling this objective, resultant data support the idea that ethical environmental issues should be included when establishing a product manufacture strategy. It is obvious that Eco-design does not only concern the product development phases following the establishment of the design specification, but also the phases prior to the design specification. This implies that environmental issues should be considered at the very beginning of the product development process.

Visual evidence presented elsewhere in this study is clear confirmation that there is indeed a relationship between eco-consideration in the product design process and the environment. The visual evidence is compelling in so far as it is not confined to one area, is not new waste, nor is it collected on time. Secondary data also pointed to the waste increasing over time and little effort anywhere to curb this trend.

7.4 Models for incorporating eco-aspects

Cognisant of the findings extrapolated above, the study found the other sub-objective valid to results of its inquiry. The objective was *"to examine other design models that would indicate a better solution for minimising waste accumulation on the environment"*. It emerged that an important resource is the environmental checklist when it comes to environmental alternatives of materials, components and processes. According to Carlson et al (2001), and results of this study, the expertise that the designer acquires from formal education in the specific issues related to their materials and components can be a valuable input when environmentally favourable product designs are sought. Hence, this implies that close designer/ manufacturer relationships is an important factor when developing environmentally conscious products.

A number of researchers have argued that for a prosperous integration of environmental issues in the product development process it is vital that an environmental champion exist in the design and development organisation, i.e. an enthusiastic person who can inspire the organisation to consider environmental issues. Porter and Linde (1995) actually argue that a person showing enthusiasm about environmental issues actually may be as effective in making environmental product improvements happen as an environmental subject specialist.

The eco-champion, the checklist, environmental education and acquired ethics propositioned above were also supported by the focus group data as integral to a sustainable living environment. These points, in conjunction with all other findings of this research are in total agreement with these sentiments and the hypothesis tested by the research.

7.5 Conclusion validity

In many ways, conclusion validity is very important because it is relevant whenever researchers try to decide if there is a relationship in their observations (and that's one of the most basic aspects of any analysis). Trochim (2006) defines conclusion validity as the degree to which conclusions reached about relationships in data are reasonable.

Using two methods, namely the Pearson's correlation coefficient and the chi-square techniques, this study sought to establish this validity by testing the research hypothesis. The research hypothesis *"Integrating eco-ethics in the product design process contributes to sustainable living environment"* was proved to be true through the three data sources and the correlation of studied variables.

In addition, in eco-ethical design literature, it has been stated by among others, Edilson et al (2007) and charter (2002) that environmental considerations should be integrated into the existing product development process. Data from this study suggests the same. This implies that the overall product design and development process should be kept intact. Some modifications might, however, be necessary, e.g. the use of various eco-ethical design methods and tools. To ensure that the environmental issues are considered, it emerged that environmental checkpoints, reviews and environmental milestone questions should be introduced into the product development process. The importance of implementing design-specific environmental guidelines, rules and standards has also been maintained.

7.6 Specific eco-ethical factors

In the following table, the factors that emerged from the study are structured as propositions according to three broad areas of concern (See 4.2.5). From these three broad areas, resultant data analysis presented six specific areas (See table 7.1) of concern for integration of eco-ethical strategies. The six are;

1. Environmental
2. Specific (defined) environmental aspects
3. Environmental checkpoints,
4. product-specific environmental design principles,
5. Eco-ethical product design
6. Support tools

It should be noted that the propositions are not presented in any order of priority and that it is not claimed that the table contains all the existing eco-ethical factors, because, as discussed in the methods section, it is impossible to cover all literature. Furthermore, as Eco-ethical product design research is a relatively new area of research it is not likely that all factors have yet been identified.

Table No. 7.1: *Propositions for new paradigm (eco-ethical mindset) for integration of eco-ethical aspects in product design. Source: Field study 2010.*

Eco-ethical factor	Eco-ethical proposition
Product design process	➢ Environmental issues are considered at the very beginning of the product development process
	➢ Specific (defined) environmental aspects are integrated along the existing product development process
Competence	➢ Environmental checkpoints, reviews and environmental milestone questions are understood and introduced into the product design and development process
	➢ product-specific environmental design principles, rules and standards are understood and utilised
Motivation	➢ Eco-ethical product design is performed and rewarded in all the product design process stages
	➢ Support tools like environmental checklists are supplied and applied

The discussion above shows that many of the proposed factors for integration of Eco-ethical product design aspects in product development relate to those factors which are generally seen as important in product development. However, some of the success factors are specific for integration of Eco-ethical aspects in design of the products under study in this research. These are the factors clustered within the areas of eco-competence and self motivation. However, as most of the factors for integration of Eco-ethics relate to the factors that are acknowledged to affect successful product design and development; this implies that if a

designer/manufacturer manages product development well, the likelihood increases that Eco-ethics can be successfully integrated into the product design process.

The research proposes the following specific design eco-aspects to integrate eco-ethics in the process.

Table 7.2: *Propositions for technical methods of integration of Eco-ethical aspects in product design. Source: Field study 2010*

Product materials	Proposition
	Eliminate unnecessary materials in production
	Make specific material choices aiming to reduce impacts on the environment
	Support government ban on non biodegradable plastics & polythene etc. by avoiding them in design propositions
	Use & reuse used materials
	Recommend only biodegradable materials in your design
	Specify correct disposal of residual waste
Product assembly	Fix joints so they can be disassembled and replaced saving the bigger part of the component
	Take measures to ensure increased life of product
	Reduce product components by avoiding unnecessary ones
	Reduce volume/weight of product to avoid wastage of space /materials
	Recommend stackable products to avoid excessive packaging & space
	Avoid components from known endangered species

Findings emanating from data of the focus group of this study were also conclusive. Since the findings indicate non integration of eco-aspect in design process, it was deduced from the data that morally, designers don't feel compelled to include such an aspect. Answers to the questions raised and discussed in the process can be summarized into the following eco-propositions/aspects.

- Integrate an eco-aspect at every stage of the product design process
- recommend every strategy as mandatory in the product design process

- Recognize the relationship between the product design process and the state of the environment
- Champion to other stakeholders (customers, manufacturers, marketers) the eco-benefits of integrating eco-ethics in all product development processes along the whole product life cycle.

As a rider to the recommendation to integrate eco-aspects in product design process, the following, from Kenya and comparative ones from the rest of the world are existing best practice examples of eco-ethical product design and development.

	
Sofa set made of recycled Standard Fabric In UK. Source: OfficeChairs.com2011)	Sofa set stuffed with waste fabric cut-offs In Kenya. Source: the study 2011

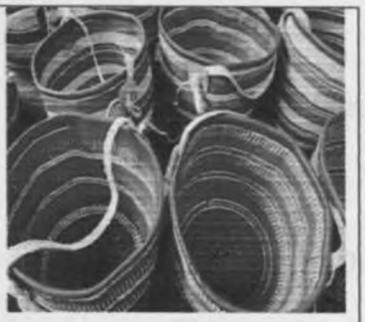
Table 7.3 a: comparative recycled sofa set from Kenya and elsewhere in the world

	
A Recycled Sofa Made of vintage refrigerators and salvaged car seats. (Source: ww.homefurnitureidea.com/fr2011)	A recycled sofa made of used wood and Stuffed with used fabric cut-offs. Source: the study 2011

Table 7.3 b: comparative recycled sofa set from Kenya and elsewhere in the world

Bag made of recycled film posters (USA) Source: www.wired .com2011

Bag made of recycled wrappers (India) (Source: ecostreet.com2011)



Bags made of waste Polythene bags (Kenya). Source: the study

Table 7.4: Comparative recycled bags from Kenya and elsewhere in the world

Car seats made of recycled foam and metal (Source: transportseating.com2011)

Car seats made of recycled foam and metal (Kenya). Source: the study 2011

Table 7.5: Comparative recycled car seats from Kenya and elsewhere in the world

7.7 Specific recommendations

The results pointed to overwhelming recommendation for integration of eco-ethical aspect at all stages in the product design process. Such aspects adopted and practiced in the following order should afford the designer/manufacturer requisite eco-competence.

1. *Awareness (Designer awareness of eco-ethical aspects)*

Where the designer has enough understanding of eco-aspects as to have a wide enough arsenal to choose from while designing.

2. Product design and development (The product design process).

Where the designer actually integrates eco-aspects at all the known stages of the design and production process.

On the latter, this study advances the following revised product design process. An eco-check should be conducted after every stage of the process. This model meets the third objective of the study which was to come up with other design models that would indicate a better solution for minimizing waste accumulation on the environment. As mentioned above, every aspect of the design process should be mandatory (see table 7.6).

The study also recommends inclusion of eco-checks at every stage of the product life cycle if and where a designer is involved (see table 7.7).

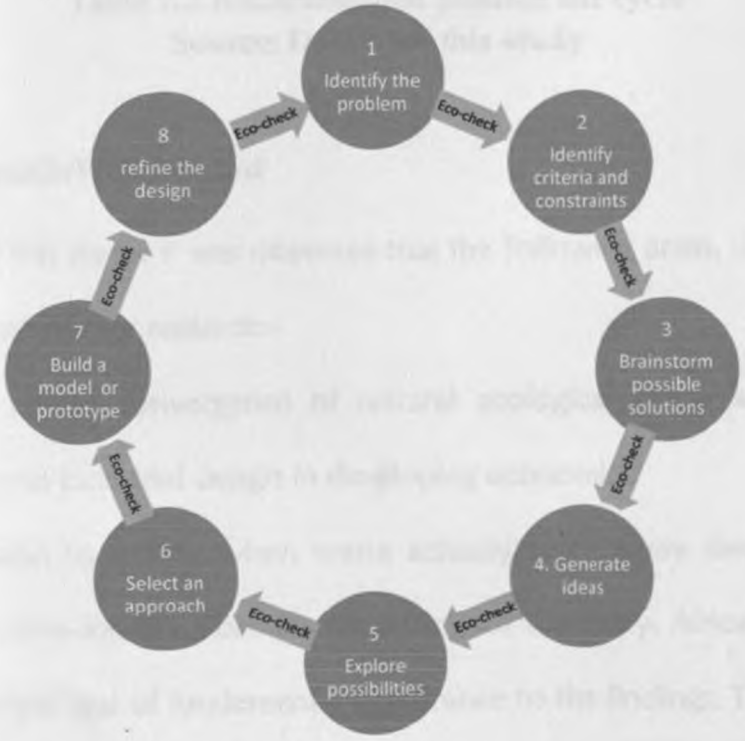


Table 7.6: **Recommended eco-ethical product design process. Source: The Author**

Table 7.7: Recommended product life cycle
Source: Data from this study

7.8 Further research/Way forward

In the course of this study, it was observed that the following areas, which are related to the study, need further research:-

1. Analysis of the convergence of cultural ecological values and the western influence on industrial design in developing economies.

The study alluded to a time when waste actually went away despite the African dwelling in the same locality. Forming the setting for this study, Africa and the cultural values of its people was of fundamental significance to the findings. The reason is that the moral obligation to the environment by the African individual underlies the

assion by even the noble, the Nobel laureate, Wangari Mathai, on whose ideals this udy anchored its thesis.

2. Investigation into local design education content on efficacy for imparting eco-ethical values to trainees.

ue to its limited scope, this study, in the course of data collection could not establish ie role education plays in imparting eco-values to the student. Such knowledge could oint to specific intercession opportunities to nurture future eco-ethical designers.

3. Establishment of all possible eco-ethical aspects in the product design and development process.

his could put down the best practice criteria for future designers to acquire the ecessary eco-values.

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2. Investigation into local design education content on efficacy for imparting eco-ethical values to trainees.

Due to its limited scope, this study, in the course of data collection could not establish the role education plays in imparting eco-values to the student. Such knowledge could point to specific intercession opportunities to nurture future eco-ethical designers.

3. Establishment of all possible eco-ethical aspects in the product design and development process.

This could put down the best practice criteria for future designers to acquire the necessary eco-values.

BIBLIOGRAPHY

Achankeng Eric (2003) *Globalization, Urbanization and Municipal Solid Waste Management in Africa*, University of Adelaide, U.S.A.

Aldo Leopold. (1949) *A Sand County Almanac and Sketches Here and There*, Oxford University Press, New York.

Amstrong Susan J, Botzler G Richard (2004) *Environmental Ethics, divergence and convergence*, Mcgraw Hill London

Asian productivity organization (2005) *Social capital and its impact on productivity*, Hirakawa-cho Dai-ichi Seimei Bldg. 2F 1-2-3 Hirakawacho, Chiyoda-ku, Tokyo 102-0093, Japan

ABC (Auroville Building Centre)(2008) *Towards sustainable architecture collected research.* Auroville: Centre for Scientific Research, New Delhi, India.

Bible, King James. Genesis: Electronic Text Center, University of Virginia Library

Bras Bert (1997), *Incorporating environment issues in product design and realisation*, UNEP, Nairobi, Kenya

Brian, E. Ed. (2001) *Green Building pays.* Spon press, London:

Callicott J. Baird. (2000) *Environmental Ethics: An Overview*, University of Texas, Texas, U.S.A.

Callicott J. Baird (2007) *Ethics & the Environment*, Pg. 119-120 Indiana University Press, Indiana, USA

Carlson et al, (2001) *A Holistic Approach to Materials Selection in Component Design*, Nordtest Report,

Centre for Environmental Studies (2008) *Sylvan's Critique of Deep Ecology*, University of Tasmania.

Charles Susanne (2006) *Eco-philosophy*, Free University Brussels, Pleinlaan 2, 1050 Brussels, Belgium)

Charter M. (2002) *integrated product policy and eco-product development*, Surrey inst. of Art & Design, Univ. College.

Chen, Cho, Yung Chang (2006), *A study of reverse design of eco-design and eco-manufacturing-using eco-efficiency indicators environmental protection and industrial safety*, hygiene department, Taiwan

David Hume, (1951) *An Inquiry Concerning the Principles of Morals (1871);* New York: Library of Liberal Arts, 47.

Devall, W. and G. Sessions. (1985), *Deep Ecology: Living As if Nature Mattered,* Gibbs M. Smith, Inc., Salt Lake City USA

Darwin Charles (1871), *Descent of Man,* bank of wisdom, Louisville KY 40201, London, UK

Dorst, K., and Dijkhuis, J (1995), *Comparing paradigms for describing design activity.* (16:2), pp 261-274, John Murray, London

Dowdy S. M. and Wearden, Stanley (1991) statistics for research, Wiley, (New York)

Drengson, A. and Y. Inoue. 1995. *The Deep Ecology Movement: An Introductory Anthology.* North Atlantic Books. Berkley, CA. U.S.A.

Durning, Alan (2004) *Consumption of Resources Outstripping Planet's Ability to Cope,* Associated Press.

Shindi Edilson, Tadao shimizu, (2007) *The Attitude of Product Users Towards Environmental Concern, -A Comparative Study of the Users Living in Chiba City and in Sao Paulo City,* Graduate School of Science and Technology, Chiba University Yayoi-cho 1-33 Inage-ku, Chiba 263-8522,Japan

Eco-ethics international union, (2005) *Research on Ethnic Eco-ethics and Eco-civilization's Construction in Chinese Ethnic Regions* (in journal of sustainable development vol. 2 No. 3, Jingfu Guo, Haijun Mao & Yuwen Yang, School of Economy & Management, Dalian Nationalities University, Dalian 116600, China

Edison Shindi, Tandao Kiminobu (1999), *The role of industrial designers in Japanese companies involved in eco-redesign process.* Graduate focal point for Europe, 53-70 Jinguame 5-chrome c/o Rudiger Kuhr Shibuya-ku Tokyo.

Enger, E. D. and Smith, B. F. 1995. *Environmental Science: A Study of Interrelationships.* Chicago: Wm. C. Brown, 431 p.

Ezio Manzini (1989) *The material invention: Materials and Design,* New Delhi Building Centre, India.

Fuad-Luke, Alastair (2002) *slow design: a paradigm shift in design philosophy?* Design by Development, *dyd02* conference, Bangalore, India, www.thinkcycle.com, July 2003

Florida Centre for Instructional Technology, (2004) *research tools,* Florida U.S.A

Freedman and Pisani (1997), *Statistical Methods for Psgchology*, 4th edn. Belmont, CA: Ouxbury Press. USA.

Freedman David, Robert Pisani, Roger Purves (1998) *Business Statistics*, 4th Edition Publisher: McGraw-Hill

Govt. of Kenya, (2006), *response to climate change and opportunities for sustainable development*, Nairobi, Kenya

Goulding, C. (2002). *Grounded Theory: A Practical Guide for Management, Business and Market Researchers.* London: Sage

Hagan, S. (2001) *Taking Shape: A New Contract between Architecture and Nature.* Architectural Press. Oxford:

Hanisch, C. (2000), Is Extended Producer Responsibility Effective? Environ Sci Technol, 34 (7), pp.170 A-175 A.

Hector R. Lozad (1999), *ecological sustainability and marketing strategy: review and implications*, Senton Hall University

Skolimowski Henryk (1981) *Ecophilosophy, Ideas in Progress Series*, Marion Boyers, Salem, N.H.

Holigrocki, R. J., Hudson Crain, R., Bohr, Y. & Young, K. (2006). *When direct observation assessment becomes treatment: Modifying the negative attributions of women victims of domestic violence.* Paper presented at the Society for Personality Assessment Annual Meeting in San Diego, CA.

Howard Liddell, Nick Grant, (nd), *Eco minimalism: getting the priorities right.* Gaia Architects - Elemental Solution

Hulme Karen (1996), *Armed conflict, wanton ecological devastation and scorched earth policies: how the 1990-91 gulf conflict revealed the inadequacies of the current laws to ensure effective protection and preservation of the natural environment*, University of Nottingham)

ICSID, International Council of Societies of Industrial Design (2006) *understanding sustainable design: quality of life and oppportunitites for design*, Charlton University, U.S.A

IISD (International Institute for Sustainable Development), (2006), *Green budget reform*, Michigan Technological University

Israel Glen D. (2006), *determining sample size*, university of Florida (http//edis.ifas.ufl.edu/pD006) USA.

Murray J., 1971) *Charles Darwins; the Descent of Man and Selection in Relation to Sex*, London.

Katranon (2006) capitalism-ecological-virus, (See Websites)

Kelly, Marjorie (2001). The Divine Right of Capital. San Francisco: Berrett- Koehler Publishers, Inc.

Kirai P. (1996), An evaluation of organic waste composting impact on SWM in Nairobi", Foundation for Sustainable Development, UNCHS (Habitat), 1996.

Knopf Alfred A., Spengler, Oswald (1932). Man and Technics. New York, The Journal for Historical Review, New York, U.S.A.

Korten, David C (1999), The Post-Corporate World, publisher unknown

Kumar K L, Tanna N., (2003), Industrial design scenario in southern Africa, international conference on industrial design engineering, UDSM, Dar Es Salaam & University of Botswana, Gaborone, Botswana

Kun-Mo Lee (2005) ecodesign, eco-product design institute (ERI) Ajou University, Korea

International council of societies of industrial design (2006) *eco-desig*n, Icograda Design Week in Hong Kong, China. (See http://www.icsid.org/)

ISO (2001) Guide for addressing environmental issues in product standards, http://www.iso.org/iso/home.htm

JICA (1998) An overview *of Solid Waste Management in Kenya*, Republic. of Kenya, *The study on solid waste management in Nairobi City in the Republic of Kenya, Kenya: Final Report Vol. 2.*

Kwortnik, RJ (2003). Clarifying "fuzzy" hospitality management problems with depth interviews and qualitative analysis. Cornell Hotel and Restaurant administrative quarterly vol. 44...

Layman ott (1993) *an introduction to statistical methods and data analysis*, PWS kent publishing co. London

Leigh Peter (2005), *The ecological crisis, the human condition, and community-based restoration as an instrument for its cure*, Silver Spring, Maryland 20910, USA

Locke, E. A. (2001), *Self-set goals and self-efficacy as mediators of incentives and personality.* Greenwich, CT: JAI Press.

Lofthouse, Vicky A. Tracy A. Bhamra, & Stephen Evans (2006) *Effective Ecodesign: finding a way forward for industry.* Cranfield University, School of Industrial & Manufacturing Science, Cranfield, Bedfordshire,

Loriot Catherine (2003). *Implementing environmentally conscious product development in the Canadian industries: an industrial design systemic perspective,* department of design Sciences, Lund University Sweden

Lovelock J (2000) *The ages of Gaia: a biography of our living earth,* 2nd edn. Oxford University Press, Oxford

Porter M, C. vander Linde, (1995).*Green and Competetive: Ending the Stalemates,* Hamard Business review,

Macionis, John J (2004), *Society, the Basics. Upper Saddle River*: Pearson Education, Inc.,

Madge Pauline (1997) *Ecological Design*: A New Critique, The MIT Press,U.S.A

Margolin Victor (1995) The politics of the artificial, Published by The MIT Press.

Markus, T. A. & Morris, E. N. (1980) *Buildings, Climate and Energy.* London: Pitman Publishing Ltd.

Martin Charter, Alex Young, Aleksandra Kielkiewicz-Young and Inga Belmane (2001) *Integrated product policy and eco-product development,* Greenleaf Publishing Ltd, The Centre for Sustainable Design, UK

Matias Lindahl (2005), *Engineering designers requirements on design for environment methods and tools,* royal institute of technology.

McDonough, William, Michael Braungart (2002), *Cradle to Cradle.* New York: North Point Press,

McLellan, David (2003), *Karl Marx, Selected Writings.* 2nd Edition Oxford: Oxford University Press,

Mugenda and Mugenda (2003), *research methods, qualitative and quantitative approaches,* Acts press, box 45917, Nairobi, Kenya

Mutuku A. Mwanthi Lambert O. Nyabola Ernest D. Tenambergen (1997) *The present and future status of municipal solid waste management in Nairobi,* International Journal of Environmental Health Research

Næss, Arne (1989). *Ecology, community and lifestyle.* Cambridge University Press. pp. 164-165

Nelson George (2007) *Defining design*, the humane village journal. webhome.idirect.com

Netherlands Organization for Energy and Environment (1997), *towards a sustainable future*, Dutch government

Zerbock Olar (2003) *Waste Reduction in Developing Nations*, School of Forest Resources & Environmental Science, Michigan Technological University, Rotterdam, The Netherlands.

OECD, (1999), *consumer responsibility*, (Organisation for Economic Co-operation and Development)

Ölundh Sändström Gunilla (2006) *Integrated Product Development*, Royal Institute of Technology / Dept. of SE-10044 Stockholm, Sweden.

Packard, Vance (1960). *The Waste Makers.* New York: David McKay, quoting Victor Lebow in Journal of Retailing.

Viswanathan (2005), *Neo-Vernacular Design and Eco-Psychology: A new approach to Environmental Architecture.* Mackintosh School of Architecture

Pil-Ju Park (2005), *eco-design, best practice of ISO/TR 14062*, research centre for Life cycle Assessment AIST, Japan

Madge Pauline (1997), *Ecological Design: A New Critique*, Design Issues, the MIT Press

Penev KD, Ron AJD. (1996) *Determination of a disassembly strategy.* International Journal of Production Research

Perry T. S. (1995) *Green refrigerators*, IEEE Spectrum.

Peters J. (Nd) Environmentally sound manufacturing. European Journal of Mechanical Engineering

Piasecki B. (1992) *Industrial ecology: an emerging management science.* Proceedings of the National Academy of sciences

Pronk J.T. (1998) *National environmental policy plan 3*, Ministry for development cooperation, the Netherlands

Raven H., Berg L., Johnson G, (1993) *Environment*, Sanders College publishing, Orlando, Florida, U.S.A

Rembert TC. (1997) *Package deal: the European war on waste.* The Environmental Magazine

Roberts G. Maxwel and Russo Riccardo (2004), *A students guide to analysis of variance*, routledge (Tailor and Francis group), London

Rolf Steinhilper (2001): *Environmental conscious design and inverse manufacturing. Recent Trends and Benefits of Remanufacturing:* University of Bayreuth

Rudolph (2008), *qualitative data analysis* (See Websites)

Salomon M, van der Laan EA, Dekker R., Thierry M, Ridder AAN (1994), *Product remanufacturing and its effects on production and inventory control.* ERASM Management Report Series 172, Erasmus University,

Shirley and Stanley Wearden (1991), *statistics for research*, A Wiley- Inderscience publication, john wiley and sons, New York.

Sisman Osman (2005), *ethics for industrial design, an ethical-political critique of sustainability in industrial design*, Middle east technical university.

Sisman osman (2005), *ethics for industrial design: an ethico-political critique of sustainability in industrial design.* Middle East technical university.

Skolimonski Henryk (1974), *Where Do We Go from Here*? Humanities Dept, College of Engineering, Ann Arbor, Michigan, U.S.A

Skolimonski Henryk (1981), *Eco-philosophy*, Marion Boyars publishers, Salem, N, H

Stevels, A. (2006) *Environmental Competence*, Philips Consumer Electron center, Eindhoven

Strauss Anselm and Corbin Juliet (1998) *Basics of Qualitative Research Techniques and Procedures for Developing Grounded Theory* (2nd edition), Sage Publications: London

Syagga, P.M. (1996), *Third World Cities in Africa in Urban Habitat: The Environment of Tomorrow*, Meulen G.G. and P.A. Erkelens (eds), Eindhoven University of Technology, pp 135-142

Tanaka Y, S. Matsuo, C. Takata, and R. Yamamoto (1991), *Thermal Conductivity of Environmentally Acceptable Alternatives to Fully Halogenated Chlorofluorocarbones,* Proc. China-Japan Chem. Eng. Conf., Tianjin, China.

Taylor and Francis (2001) The growing number; International Journal of Production Research Publisher: Volume 39.

Trochim William M.K. (2006), *Conclusion validity*, http://www.socialresearchmethods.net/kb/concval.php, 2010.

Tolba Mustafa K. (1992), *saving our planet*. Chapman & Hall, London

UNEP (1972) Report of the United Nations conference on the human environment

Van Der Ryn, S. and S. Cowan. (1996), *Ecological Design*. Island Press. Washington, D.C.

Papanek Victor (2003), *the Green Imperative; ecology and ethics in design and architecture*, Thames and Hudson

WCED (1987), *The Brundtland report, Our Common Future*, UN World Commission on Environment and Development.

W.H.O. (2007), *world health report 2000 and 2007 editions*. Geneva Switzerland.

Fox Warwick, (1986). *Approaching Deep Ecology:* A Response to Richard

Wangari 2004 In Www.wangari maathai - Nobel lecture.htm, 2004, accessed, 2010

Wetherill G berrie (1975) *elementary statistical methods*, Chapman hall, London

White Lynn Jnr. (1967), *'The Historical Roots of Our Ecological Crisis'*, reproduced in John Barr (ed), *The Environmental Handbook* (London

Wilhide Elizabeth (2002), *Eco, the essential sourcebook for environmentally friendly design and decoration*, Quadrille Publishing, London

Wilson Edward O (1993) *Is Humanity Suicidal?* New York Times Magazine May 30

Wright Ronald (2005). *A Short History of Progress*, Strategic foresight group

Yamamoto (1991) *Thermal conductivity of environmentally acceptable alternatives to fully halogenated chlorofluorocarbons*, proc. China-Japan chem. Eng conf. Tianjin, China.

Yamamoto Ryoichi (2007), *achieving a sustainable economy through eco-product design*, institute of industrial science, university of Tokyo.

Yin K. Roberts (2003), *case study research: Design and Method Applied Research Series*, Sage Publications, Beverly Hills

Zeisel John (1995) *Inquiry by design, tools for environmental behaviour research*, Cambridge university press

Websites

http://uk.geocities.com/balihar_sanghera/qrmparticipantobservation.html (Qualitative Research Methods: Participant Observation (Online 2009)

Wikipedia, the Free Encyclopedia. 2006. Concentration of Media Ownership. <http://en.wikipedia.org/wiki/Concentration_of_media_ownership>.
www.ricoh.com (Online 2009)

Www.wangari maathai - Nobel lecture.htm, 2004 (Online 2010)

www.sustainabletable.org (Online 2008)

Www. encyclopedia Britannica

www.trimondi.de

wordnet.princeton.edu

Katranon http://lunarshadepress.blogspot.com/2006/05/capitalsim-ecological-virus.html (Online 2010)

International organization for standards at www.iso.org 2008 (Online 2010)
Rudolph Tere (2008) Qualitative data analysis, http://e-articles.info/e/a/title/

(www.unep.org, 2008, (Online 2010).

www.rich.con2007 (Online 2010)

Scott Wertel (2011), The Design Process, (Online) wertel.blogspot.com/2010/07/turn-your-design
http://leesminis.com (2011) sofa set design

Appendix 1 Questionnaires designed for pre-testing. Assembly

This questionnaire deals with your method of assembly of your product during manufacture. Please select the most appropriate answer in the boxes adjacent to each question

	Name Contact	Car seats		Sofa sets	Bags
B		Yes	No	Some times	Rarely
1.	Do you fix joints in a way that they can be detachable?				
2	**Can your products be disassembled?**				
3	**Have you ever taken measures to increase life-span of product?**				
	If your answer is yes, explain how				
4	Do you try to reduce volume/weight of product to avoid wastage of materials/space				
	If your answer is yes, explain how.				
5	Do you put effort to reduce the number of parts of product?				
6	Can your products be stacked one on top of the other?				
7.	Is the material used from an endangered species?				
	If your answer is yes or no, how do you know?				
8	Do you dispose off waste from your product in a designated area?				
9	Ido you know what an environmental checklist is?				
10	Is the management of environment a matter of concern to you?				
	How is your working environment?. Clean		dirty		Very dirty

Appendix 2. Questionnaires designed for pre-testing. (Materials)

This questionnaire deals with your use of materials in the process of manufacture of your products. Please select the most appropriate answer from the boxes adjacent to each question

	Name Contact	Car seats	Sofa sets	Bags
A.	Please pick the answer that best answers each question	Yes / No	Depends	Don't know
1.	Have you ever tried to reduce materials in production?			
	If your answer is yes, explain how? _____			
2	Did you ever make specific materials choices to reduce environmental impacts?			
3	Are you aware of the gvernment ban on use of some type of plastics & polythene?			
4	Does your products contain polythene?			
	If your answer is yes. What percentage? 10_____	30_____	50_____	
5	If yes, do you feel like you are wrong in using polythene?			
6	Are any materials that you use re-usable after life of product?			
7.	Can any of the materials be put to any other use after life of product?			
	If yes, explain how and on what? _____			
8	Do you ever inquire where materials will be disposed after life of product?			
	If your answer is no, explain why not _____			
9	Do you incorporate any used materials?			
	If your answer is yes, explain which ones._____			
10	Are any of the materials you use biodegradable?			
	If yes, which?_____			

Appendix 3 Sample of actual Questionnaires (Product Materials)

This questionnaire deals with your use of materials in the process of manufacture of your products. Please select the most appropriate answer from the boxes adjacent to each question

	Name Contact	Car seats Sofa Sets Bags			Pls tick one of the options shown on the left as appropriate with the designers/manufacturer
A.	Please pick the answer that best answers each question	Yes	No	Depends	Don't know
1.	Have you ever tried to reduce materials in production?				
	If your answer is yes, explain how.				
2	Did you ever make specific materials choices to reduce environmental impacts?				
	What is your view about the use of polythene materials ?				
3	Are you aware of the gvernment ban on use of some type of plastics & polythene?				
4	Does your products contain polythene?				
	If your answer is yes, approximately what percentage? 10% 30% 50%				
5	Do you support the idea of banning the use of polythene?				
6	Are any materials that you use re-cyclable after life of product?				
7.	Do you take back products that reach end of their life?				
	If yes or no, explain why?				
8	Do you ever inquire where materials will be disposed after life of product?				
	If your answer is no, explain why not				
9	Do you include any used materials in manufacture?				
	If your answer is yes, explain which ones.				
10	Are any of the materials you use biodegradable?				
	If yes, which?				

Appendix 4 Sample of actual Questionnaire (Product assembly)

This questionnaire deals with your method of assembly of your product during manufacture. Please select the most appropriate answer in the boxes adjacent to each question

	Name Contact	**Car seats** **Sofa sets** **Bags**			Select the appropriate item on the left
B		Yes	No	Some times	Rarely
1.	Do you fix joints in a way that they can be detachable?				
2	**Can your products be disassembled?**				
3	**Have you ever taken measures to increase life-span of product?**				
	If your answer is yes, explain how _____				
4	**Do you try to reduce volume/weight of product to avoid wastage of materials/space**				
	If your answer is yes, explain how. _____				
5	Do you put effort to reduce the number of parts of product?				
6	Can your products be stacked one on top of the other?				
7.	Is any of the components used from an endangered species?				
	If your answer is yes or no, how do you know? _____				
8	Do you dispose off waste from your product in a designated area?				
9	Do you know what an environmental checklist is?				
10	Is the management of environment a matter of concern to you?				
	How is your working environment?. Clean _____ dirty _____ Very dirty				

Appendix 5. Photo Analysis Worksheet

Step 1. Observation

A By studying the photograph, form an overall impression of the photograph and then examine individual items. Next, to divide the photo into quadrants and study each section to see what new details become visible.

B. Use the chart below to list people, objects, and activities in the photograph.

People	Objects	Activities

Step 2. Inference

Based on what has been observed above, list inferences from the photograph.

Step 3. Questions

A What questions does this photograph raise in the mind?

_____

_____

_____

_____

B. Where could one find answers to them?

_____

_____

_____

_____

Source: Education Staff, National Archives and Records Administration, Washington, DC 20408. (http://www.archives.gov/education/lessons/worksheets/photo.html)

Appendix 6 Data collector's introductory letter

The bearer of this note is conducting a research on environmental ethics. The study is meant to be part fulfilment for the award of the degree of doctor of philosophy of the University of Nairobi. You have been selected for interview because by nature of work, you hold information and competencies that are valuable to this issue.

The information you will give will be held in confidence and will only be used for academic purposes only. We will highly appreciate your assistance in facilitating this research.

Yours faithfully

Samuel M. Maina

Appendix 7. Focus group discussion

Dear _____

Invitation to academic discussion

By: Samuel M. Maina (StAD) PhD candidate, Dept. of Architecture & Building Science, School of the Built Environment

Date: 11th December, 2009

Time: 10 am

Venue: Small seminar room, ADD level 3, Dept. of Architecture.

You are invited to a focus group discussion on my PhD research topic titled "Integration of an eco-ethical strategy into product life cycle in Nairobi".

For the purpose of my study, i hope that you will assist me to:

4. Explore the depth and nuances of opinions regarding eco-ethics in product design
5. Understand differences in perspectives on eco-design
6. Understand what factors influence designer opinions or behaviour in environmental sustainability

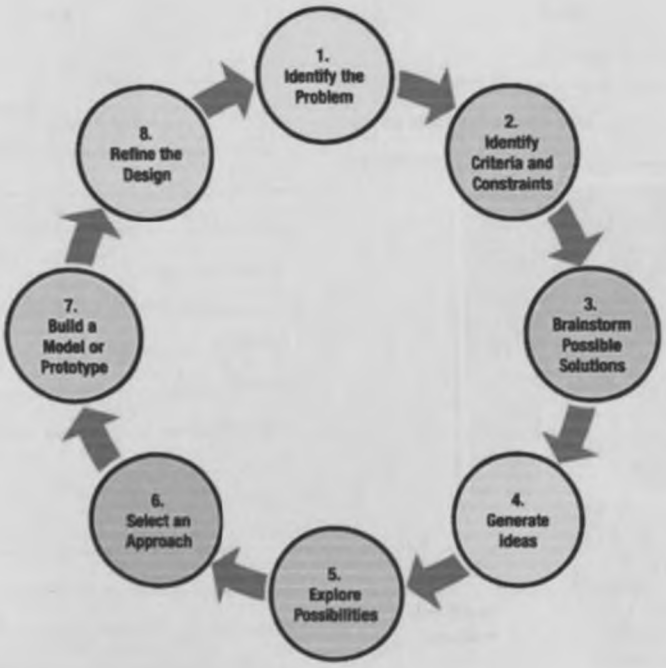
The overall goal of the focus group discussion will be *"To gain understanding whether designers in Nairobi feel morally compelled to include an eco-ethical-aspect in product life cycle."*

Members will address the following factors established by my research as data gaps in order to establish whether they/designers consider them.

1. Avoiding and/or reducing the use of non-renewable or scarce resources;
2. Enhancing the material closed loop by recycling and reusing waste;
3. Increasing resource efficiency including that of materials;
4. Using more durable materials with fewer maintenance requirements
5. Promoting the use of renewable resources and energy; and
6. Minimizing adverse impacts on biodiversity and eco-systems.

Therefore the focus group will seek to answer the following questions fundamental to unearthing the current eco-standing of designers in Nairobi;

1. Since there is no environmental consideration in the current typical design process shown in figure 12, do you think designers include such a strategy while designing.



1. Due to the exclusion of an eco-ethical consideration mentioned above, is there a relattionship between the product design process and waste levels in the environment?
2. Is eco-ethics a necessary attribute in design practice? Must it be incorporated?
3. Where in the design process shown above should it be integrated?

Your opinion and statements will be taken and used for academic purposes only. Your attendance and contribution will be highly appreciated.

Yours truly,

Samuel M. Maina
School of the arts and design
University of Nairobi

Appendix 8 Research permit

PAGE 2

THIS IS TO CERRTIFY THAT:

Prof./Dr./Mr./Mrs./Miss MWITURIA SAMUEL MAINA

of (Address) UNIVERSITY OF NAIROBI P.O.BOX 30197 NAIROBI

has been permitted to conduct research in

~~Location~~,

NAIROBI EAST District,

NAIROBI Province,

on the topic

DESIGNING NEW TACTICS FOR LIVING THROUGH ECO-PRODUCT DEVELOPMENT

for a period ending 30TH MARCH, 20 10

PAGE 3

Research Permit No. NCST/5/002/R/310

Date of issue 4.5.2009

Fee received SHS.2000.00

Applicant's Signature

Secretary National Council for Science and Technology

CONDITIONS

1. You must report to the District Commissioner and the District Education Officer of the area before embarking on your research. Failure to do that may lead to the cancellation of your permit.
2. Government Officers will not be interviewed without prior appointment.
3. No questionnaire will be used unless it has been approved.
4. Excavation, filming and collection of biological specimens are subject to further permission from the relevant Government Ministries.
5. You are required to submit at least two(2)/four(4) bound copies of your final report for Kenyans and non-Kenyans respectively.
6. The Government of Kenya reserves the right to modify the conditions of this permit including its cancellation without notice

REPUBLIC OF KENYA

RESEARCH CLEARANCE PERMIT

GPK 6055—3m—10/2009

(CONDITIONS—*see* back page)

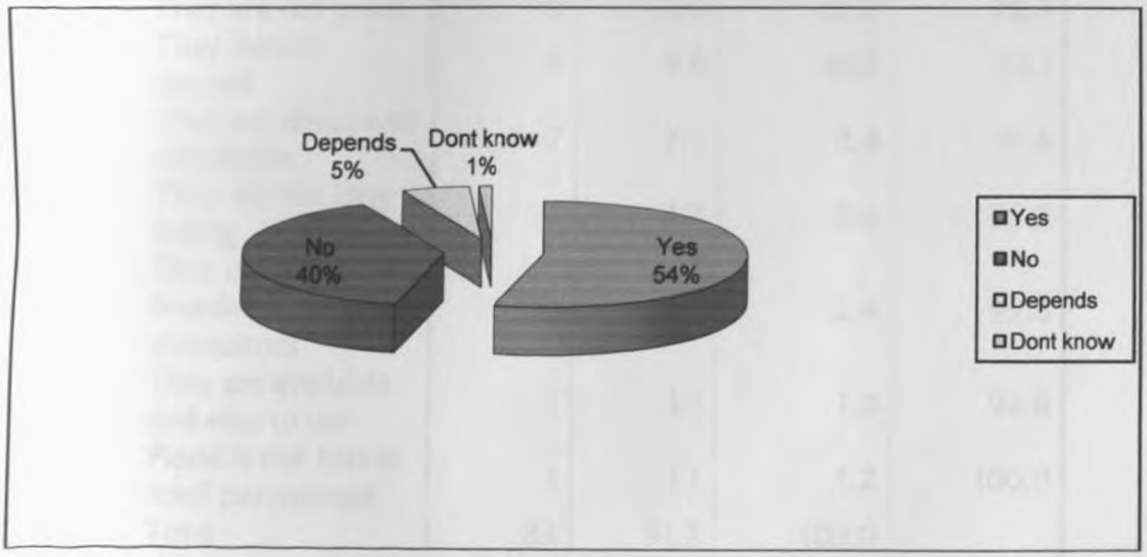
Appendix 9 Sample of data analysis and presentation level 2

Data analysis for bags

Questionnaire A

Have you ever tried to reduce materials in production?

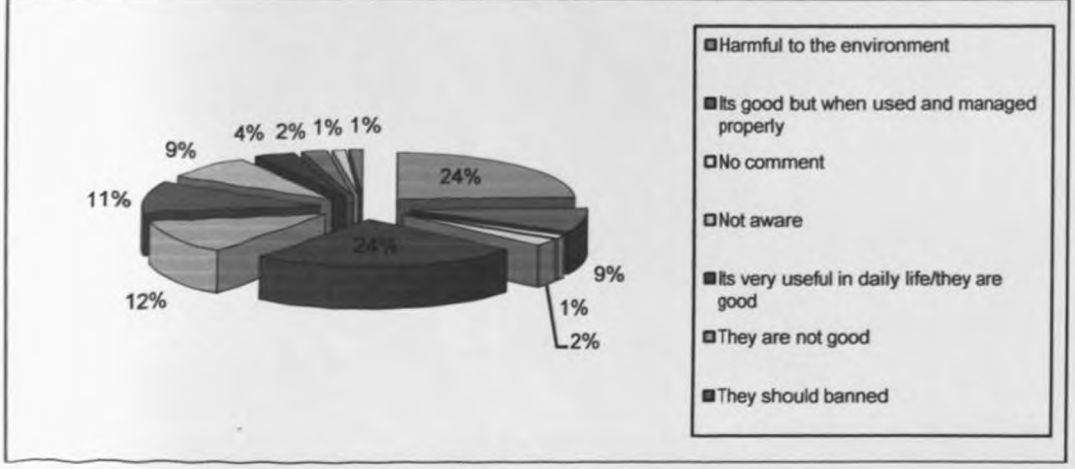
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Yes	49	53.8	53.8	53.8
	No	36	39.6	39.6	93.4
	Depends	5	5.5	5.5	98.9
	Dont know	1	1.1	1.1	100.0
	Total	91	100.0	100.0	



Appendix 10 Sample data analysis level 2

What is your view about the use of polythene materials?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Harmful to the environment	20	22.0	24.1	24.1
	Its good but when used and managed properly	7	7.7	8.4	32.5
	No comment	1	1.1	1.2	33.7
	Not aware	2	2.2	2.4	36.1
	Its very useful in daily life/they are good	20	22.0	24.1	60.2
	They are not good	10	11.0	12.0	72.3
	They should banned	9	9.9	10.8	83.1
	They are cheap and affordable	7	7.7	8.4	91.6
	They are not long lasting	3	3.3	3.6	95.2
	They encourage breeding of mosquitoes	2	2.2	2.4	97.6
	They are available and easy to use	1	1.1	1.2	98.8
	Plastic is not bad in small percentages	1	1.1	1.2	100.0
	Total	83	91.2	100.0	
Missing	No response	8	8.8		
Total		91	100.0		



Appendix 11 Sample of data entry and analysis at level 1

Entry for bags

1	Bags	No	No response	Its very useful in daily life/they are good
2	Bags	No	No	Its very useful in daily life/they are good
3	Bags	No	Depends	Its very useful in daily life/they are good
4	Bags	No	No	Its very useful in daily life/they are good
5	Bags	No	No	They are not long lasting

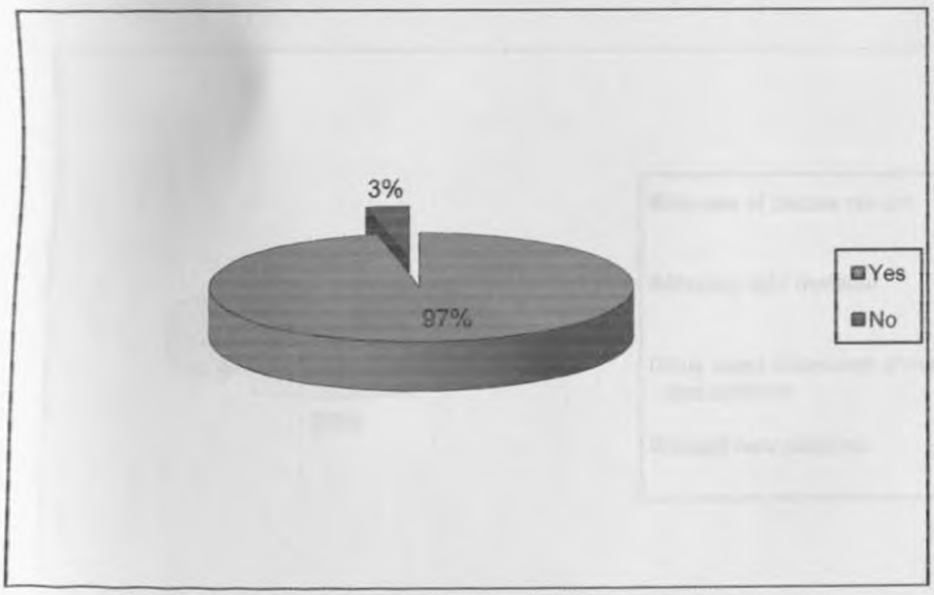
Appendix 12 Sample of data analysis and presentation level 2

Data analysis for bags

Questionnairre B

Do you fix joints in a way that they can be detached?

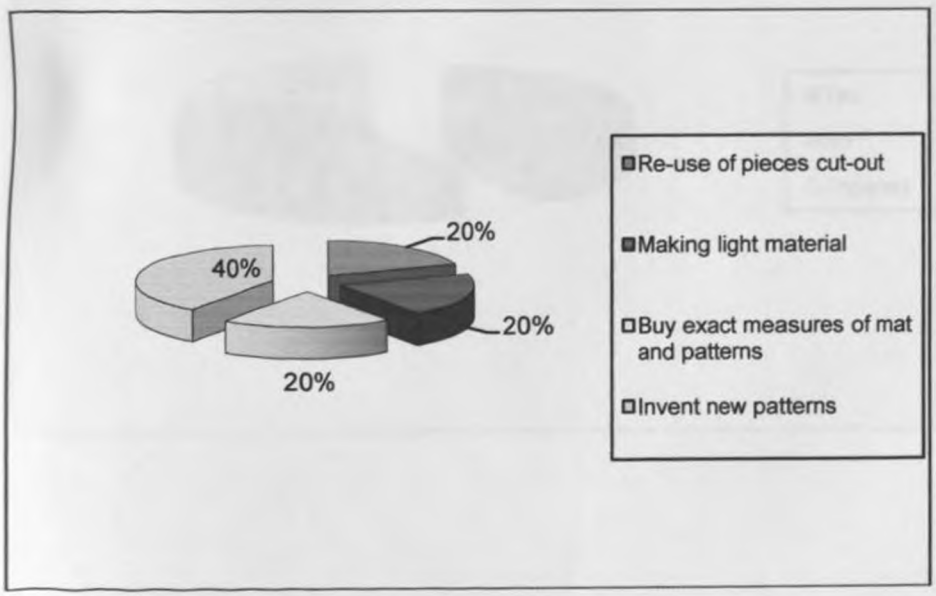
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Yes	88	96.7	96.7	96.7
	No	3	3.3	3.3	100.0
	Total	91	100.0	100.0	



Appendix 13 Sample data presentation (Qualitative)

If your answer is yes explain how

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Re-use of pieces cut-out	1	1.1	20.0	20.0
	Making light material	1	1.1	20.0	40.0
	Buy exact measures of mat and patterns	1	1.1	20.0	60.0
	Invent new patterns	2	2.2	40.0	100.0
	Total	5	5.5	100.0	
Missing	Not applicable	86	94.5		
Total		91	100.0		



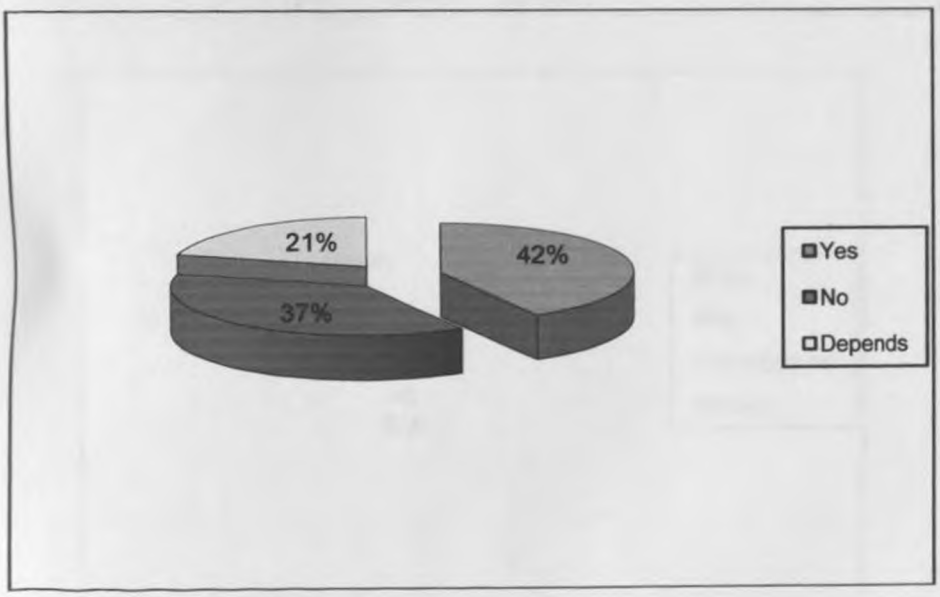
Appendix 14 Sample data analysis and presentation level 2

Car seat

Questionnaire A

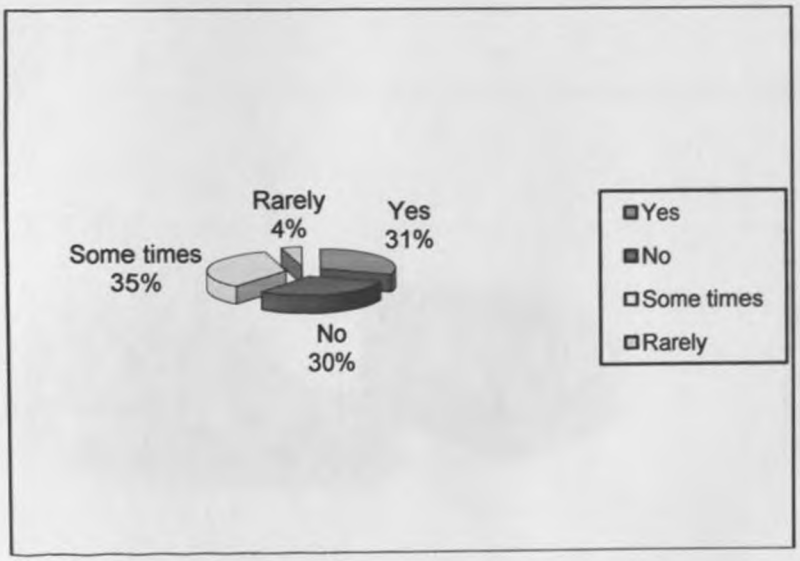
Have you ever tried to reduce materials in production?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Yes	10	41.7	41.7	41.7
	No	9	37.5	37.5	79.2
	Depends	5	20.8	20.8	100.0
	Total	24	100.0	100.0	



Appendix 15 Sample data analysis and presentation level 2
Car seats
Questionnaire B
Have you ever taken measures to increase life span of product?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Yes	7	29.2	30.4	30.4
	No	7	29.2	30.4	60.9
	Some times	8	33.3	34.8	95.7
	Rarely	1	4.2	4.3	100.0
	Total	23	95.8	100.0	
Missing	No response	1	4.2		
Total		24	100.0		



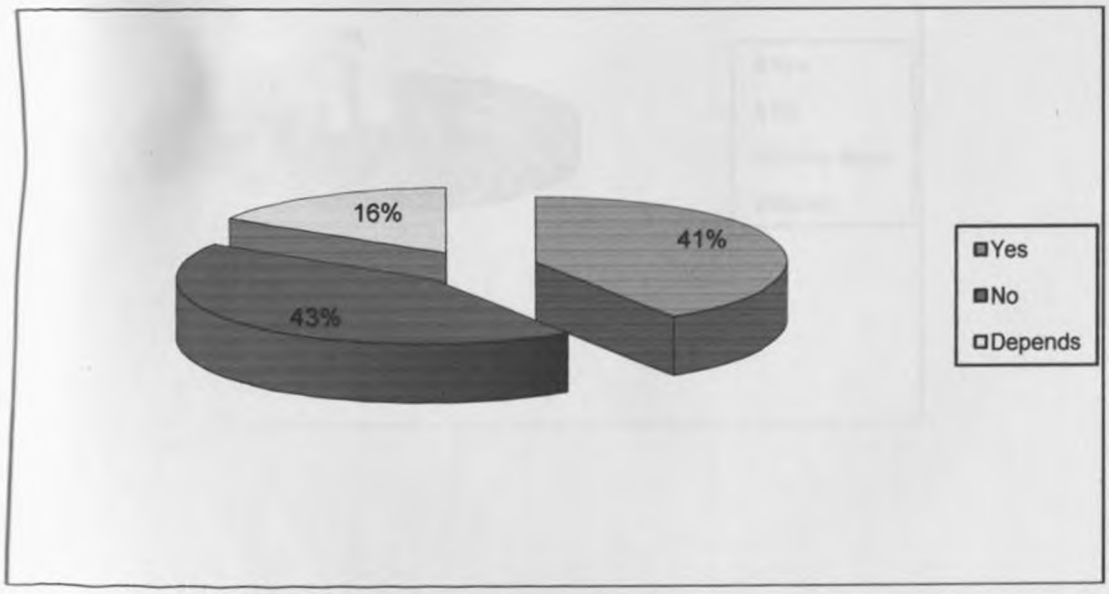
Appendix 16 Sample Data anlysis and presentation level 2

Sofa sets

Questionnaire A

Have you ever tried to reduce materials in production?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Yes	36	40.9	40.9	40.9
	No	38	43.2	43.2	84.1
	Depends	14	15.9	15.9	100.0
	Total	88	100.0	100.0	



Appendix 17 Sample Data anlysis and presentation level 2

Car seats

Questionnaire B

Have you ever taken measures to increase life span of product?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Yes	60	68.2	68.2	68.2
	No	6	6.8	6.8	75.0
	Some times	21	23.9	23.9	98.9
	Rarely	1	1.1	1.1	100.0
	Total	88	100.0	100.0