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## **Examining the Integration of Environmental Ethics in Product Design within Zambian Industries**

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### **Abstract**

This research critically examines the integration of environmental ethics in product design within Zambian industries. As environmental degradation, climate change, and unsustainable industrial practices intensify globally, design professionals and manufacturing industries are increasingly expected to adopt environmentally responsible approaches. The study explores how ethical considerations regarding the environment influence material selection, production methods, energy consumption, waste management, and end-of-life product disposal within selected Zambian industries.

The study adopts a qualitative research approach through literature review, case studies, and interviews with selected

industry practitioners. Findings reveal that while awareness of environmental sustainability is growing, the actual integration of environmental ethics into product design remains limited due to economic constraints, inadequate policy enforcement, limited access to eco-friendly materials, and insufficient professional training in sustainable design. The study concludes that strengthening environmental ethics in product design is essential for sustainable industrial development in Zambia. Recommendations are provided for policymakers, industry leaders, designers, and educational institutions to enhance environmentally responsible design practices.

**Keywords:** Environmental Ethics, Product Design, Sustainable Design, Zambian Industries, Eco-friendly Materials, Sustainable Manufacturing, Environmental Sustainability, Ethical Design, Waste Management

### **1. Introduction**

The contemporary global industrial environment is increasingly shaped by the urgent need for environmental sustainability. Industrial activities remain among the leading contributors to environmental degradation through excessive resource extraction, carbon emissions, solid waste generation, and pollution of air, water, and soil (UNEP, 2020) [6]. As a result, environmental ethics has emerged as a critical philosophical and practical framework guiding responsible human interaction with the natural environment.

Product design plays a central role in determining the environmental footprint of industrial production. Decisions made at the design stage—such as material selection, production processes, durability, reparability, and end-of-life management—significantly influence a product's overall environmental impact (Papanek, 2019) [4]. Consequently, integrating environmental ethics into product design is no longer optional but a moral and economic necessity.

In Zambia, industrial growth has accelerated in sectors such as mining, construction, agriculture, manufacturing, and consumer goods. However, this growth has not been matched with equally strong environmental safeguards in product design and manufacturing. Although environmental policies exist, their influence on everyday industrial design practices remains weak. This study therefore examines the extent to which environmental ethics is integrated into product design within Zambian industries and identifies key challenges and opportunities for sustainable transformation.

#### **1.1 Statement of the Problem**

Despite the growing global emphasis on environmentally responsible design, many products manufactured in Zambia continue to exhibit poor environmental performance. These products often rely on non-renewable materials, energy-intensive manufacturing processes, and generate excessive waste at disposal stages. Environmental degradation, including deforestation, pollution, and landfill congestion, continues to rise.

The problem lies in the weak integration of environmental ethics into the product design process. Many designers prioritize cost reduction, visual appeal, and rapid production without adequate consideration of long-term environmental consequences. Furthermore, enforcement of environmental regulations remains inconsistent, and designers receive limited training in sustainable and ethical design practices. As a result, the industrial sector contributes significantly to environmental challenges that threaten human health, biodiversity, and sustainable development.

### 1.2 Purpose of the Study

The purpose of this study is to examine how environmental ethics is integrated into product design practices within Zambian industries. The study seeks to assess the level of awareness among designers and industry managers, identify challenges affecting ethical design implementation, and propose strategies for strengthening sustainable product design.

### 1.3 Research Objectives

The objectives of the study are:

1. To examine the current level of integration of environmental ethics in product design within Zambian industries.
2. To identify the ethical, technical, and economic factors influencing sustainable product design.
3. To assess the challenges facing the adoption of environmentally responsible design practices.
4. To propose strategies for enhancing environmental ethics in industrial product design.

### 1.4 Research Questions

The study was guided by the following questions:

1. How is environmental ethics integrated into product design within Zambian industries?
2. What factors influence the adoption of sustainable and ethical design practices?
3. What challenges hinder the effective application of environmental ethics in product design?
4. What measures can enhance environmentally responsible product design in Zambia?

## 2. Literature Review

This chapter reviews key scholarly and policy-based literature relating to environmental ethics, sustainable development, product design, and environmental regulation, with particular reference to developing economies and the Zambian context. The review establishes the theoretical and empirical foundation for examining the integration of environmental ethics in product design within Zambian industries.

### 2.1 Environmental Ethics and Sustainable Development

Environmental ethics is a philosophical discipline that interrogates the moral obligations of human beings toward the natural environment. It emerged in response to the accelerated ecological degradation associated with industrialization, urbanization, and consumerism. According to DesJardins (2017) [2], environmental ethics expands traditional ethical thought beyond human-centered interests to incorporate the intrinsic value of non-human life and ecosystems. It emphasizes moral principles such as stewardship, intergenerational justice, ecological integrity,

and the precautionary principle.

In industrial and design contexts, environmental ethics requires that economic activities be guided not only by profitability and efficiency but also by moral responsibility for the protection of ecological systems. This means that manufacturers and product designers must evaluate the environmental consequences of their decisions across the entire life cycle of products—from raw material extraction to manufacturing, distribution, use, and end-of-life disposal (Bhamra & Lofthouse, 2016). Ethical design therefore involves minimizing resource depletion, reducing pollution, preventing toxic exposure, and ensuring safe post-consumer waste management.

The relationship between environmental ethics and sustainable development is deeply interconnected. The Brundtland Commission's definition of sustainable development as development that meets present needs without compromising future generations (Brundtland, 1987) [1] provides a normative ethical framework grounded in intergenerational responsibility. Environmental ethics strengthens this framework by emphasizing that future generations have moral rights to a healthy and productive environment. This ethical dimension transforms sustainability from a purely technical or economic concept into a moral obligation.

Furthermore, sustainable development is underpinned by the "triple bottom line" approach, which integrates environmental protection, social equity, and economic viability. Environmental ethics provides the moral justification for prioritizing environmental protection alongside economic growth and social development. In the absence of strong ethical foundations, sustainability risks being reduced to superficial "greenwashing" practices rather than genuine ecological responsibility (UNEP, 2020) [6]. In this sense, the integration of environmental ethics into product design is a critical pathway through which sustainable development objectives can be operationalized within industrial systems.

### 2.2 Product Design as a Determinant of Environmental Impact

Product design is widely recognized as the most influential stage in determining the environmental footprint of industrial production. The European Commission (2020) [3] estimates that over 80% of a product's total environmental impact is locked in at the design stage. This includes decisions regarding material selection, production methods, energy consumption, durability, maintainability, recyclability, packaging, and transportation.

Traditional product design has historically prioritized functionality, aesthetics, and market competitiveness with minimal consideration for environmental consequences. However, the rise of sustainable design and eco-design paradigms has redefined the role of the designer as an ethical agent responsible for shaping environmentally responsible consumption and production patterns (Papanek, 2019) [4]. Sustainable product design advocates for the use of renewable and biodegradable materials, low-energy manufacturing processes, non-toxic substances, and modular configurations that support repair, reuse, and recycling.

Life Cycle Assessment (LCA) has become a central tool in evaluating environmental impacts across the product life cycle. Through LCA, designers can quantitatively assess energy usage, greenhouse gas emissions, water

consumption, and waste generation at each stage of production and use. This enables informed decision-making that aligns with environmental ethics and sustainability goals. Circular economy principles further extend this approach by promoting closed-loop systems where waste is transformed into input for new production cycles (Ellen MacArthur Foundation, 2019).

In the absence of ethical design considerations, products often contribute to environmental degradation through planned obsolescence, excessive packaging, non-recyclable composites, and hazardous waste. Such practices not only strain ecosystems but also impose long-term economic and social costs on communities and governments. Therefore, embedding environmental ethics into product design serves both ecological and socio-economic interests by reducing pollution, conserving resources, and promoting sustainable industrial competitiveness.

### 2.3 Sustainable Design Practices in Developing Economies

The adoption of sustainable design practices in developing economies differs significantly from that of developed nations due to structural, economic, and institutional constraints. According to UNDP (2021) [5], developing countries face persistent challenges including limited access to green technologies, high costs of environmentally friendly materials, inadequate research and innovation infrastructure, and weak enforcement of environmental regulations.

Industries in developing economies often operate under intense pressure to minimize production costs in order to remain competitive in both domestic and international markets. This economic reality frequently leads to the prioritization of short-term financial gains over long-term environmental protection. As a result, industries continue to rely on cheap, non-renewable raw materials, energy-intensive production methods, and informal waste disposal systems (OECD, 2020).

Zambia mirrors many of these constraints. While the country has experienced industrial growth in sectors such as mining, agro-processing, construction, and consumer manufacturing, sustainable design practices remain at an early developmental stage. Many small and medium enterprises (SMEs), which form the backbone of Zambia's manufacturing sector, lack the technical knowledge and financial capacity to implement sustainable product design frameworks. In addition, limited training in eco-design within technical and higher education institutions further constrains the development of environmentally responsible design professionals.

However, developing economies also present unique opportunities for sustainable innovation. Context-specific solutions such as the use of locally available renewable materials (bamboo, timber by-products, and agricultural residues), low-energy manufacturing technologies, and repair-oriented design models offer viable pathways for integrating environmental ethics into product design. With appropriate policy support and investment in skills development, Zambia has significant potential to leapfrog towards greener and more sustainable industrial production systems.

### 2.4 Policy and Environmental Regulation in Zambia

Zambia has established a legal and institutional framework

aimed at safeguarding the environment and promoting sustainable development. The principal legislative instrument is the Environmental Management Act No. 12 of 2011. The Act provides for integrated environmental management, prevention and control of pollution, environmental impact assessment, and the sustainable management of natural resources.

The Zambia Environmental Management Agency (ZEMA) is the statutory body mandated to enforce this Act. Among its core responsibilities is the approval of Environmental Impact Assessments (EIAs) for proposed industrial projects and the monitoring of compliance with environmental standards. In principle, EIAs are intended to ensure that environmental considerations are integrated into all stages of industrial planning, including product design and manufacturing processes.

Despite this well-articulated legal framework, the practical enforcement of environmental regulations remains inconsistent. Several studies have identified capacity limitations within regulatory institutions, including inadequate staffing, limited technical expertise, and insufficient funding for routine inspections (Mukosha & Phiri, 2020). These constraints weaken ZEMA's ability to effectively regulate environmentally harmful industrial practices.

Moreover, public awareness of environmental rights and responsibilities remains relatively low. Many designers and manufacturers view environmental compliance as a bureaucratic obligation rather than an ethical duty. Consequently, environmental considerations are often treated as add-on requirements rather than as core design principles embedded within product development processes. This regulatory and ethical gap significantly undermines the effective integration of environmental ethics into product design within Zambian industries.

## 3. Methodology

### 3.1 Research Design

The study adopted a qualitative research design under a constructivist paradigm to understand lived experiences and perceptions of designers and industry managers on environmental ethics in product design.

### 3.2 Sampling and Participants

Purposive sampling was used to select participants from manufacturing industries in Lusaka, Ndola, and Kitwe. Participants included product designers, production managers, and environmental officers.

### 3.3 Data Collection Methods

Data were collected using:

1. Semi-structured interviews
2. Observations of manufacturing processes
3. Document analysis of product specifications and environmental policies

### 3.4 Data Analysis

Thematic analysis was used to identify patterns related to ethical awareness, material selection, waste handling, and regulatory compliance.

### 3.5 Ethical Considerations

Participants gave informed consent, anonymity was ensured, and data were used strictly for academic purposes.

#### 4. Results and Discussion

This section presents and critically discusses the major findings of the study on the integration of environmental ethics in product design within selected Zambian industries. The discussion is structured around four dominant themes that emerged from the data: limited awareness of environmental ethics, cost as a major barrier to ethical design, weak integration of end-of-life design, and weak policy enforcement.

##### 4.1 Limited Awareness of Environmental Ethics

Findings from interviews and observations revealed that most designers and production managers possess only a basic, surface-level understanding of environmental sustainability. Their knowledge is largely limited to general concepts such as pollution control, waste reduction, and compliance with environmental laws. However, the deeper philosophical and moral foundations of environmental ethics; such as intergenerational responsibility, intrinsic value of nature, stewardship, and ecological justice; were largely absent from their design thinking and decision-making processes.

For many participants, environmental ethics was narrowly interpreted as regulatory compliance rather than as a guiding moral framework for responsible product design. This means that environmental considerations were addressed only when required by law, inspection procedures, or certification demands. Few designers demonstrated proactive ethical commitment to minimizing environmental harm beyond legal obligations. As one participant noted, “As long as ZEMA approves our operations, we are okay. We just follow what is required on paper.” This reflects a compliance-driven rather than values-driven approach to environmental responsibility.

This limited ethical awareness has direct implications for product design outcomes. Without strong ethical grounding, designers tend to prioritize functionality, aesthetics, and cost over ecological impact. Decisions related to material selection, packaging, durability, and disposal are rarely subjected to ethical scrutiny regarding their long-term environmental consequences. This confirms earlier assertions by DesJardins (2017) <sup>[2]</sup> that without ethical consciousness, sustainability efforts remain technical and superficial.

The findings further suggest that gaps in professional training significantly contribute to this limitation. Most designers reported that they were not adequately exposed to environmental ethics during their training at technical colleges or universities. Sustainability was often treated as a minor topic rather than a core design principle. This educational gap perpetuates a generation of designers who are technically competent but ethically underprepared to confront environmental challenges.

##### 4.2 Cost as a Major Barrier to Ethical Design

Cost emerged as one of the most significant barriers to the adoption of environmentally ethical design practices. Participants consistently reported that eco-friendly materials, energy-efficient machinery, and clean production technologies are perceived as expensive and financially risky. As a result, industries prioritize short-term profitability and market competitiveness over long-term environmental sustainability.

Most manufacturers continue to rely heavily on cheap

plastics, synthetic composites, and non-recyclable materials because they are readily available and affordable. Although many respondents acknowledged the environmental harm associated with these materials, they emphasized that consumers in Zambia are highly price-sensitive, making it difficult to pass on the cost of sustainable materials to the market. One production manager stated, “If we use biodegradable packaging, the cost of the product goes up and customers will not buy.”

This economic tension reflects the broader dilemma faced by industries in developing economies, where survival and profit margins often take precedence over ecological responsibility. The absence of government subsidies, tax incentives, or affordable access to green technologies further worsens the situation. Consequently, industries remain trapped in unsustainable production cycles characterized by high energy consumption, excessive waste, and carbon-intensive processes.

From an ethical perspective, this finding highlights the conflict between economic ethics and environmental ethics. While businesses are expected to be economically viable, environmental ethics demands that profit should not come at the expense of environmental destruction and human well-being. The dominance of cost-driven decision-making undermines the moral responsibility of industries to protect ecosystems and future generations.

##### 4.3 Weak Integration of End-of-Life Design

The study further revealed that end-of-life considerations are weakly integrated into product design within Zambian industries. Most products are designed with a “use-and-dispose” philosophy rather than a “design-for-reuse, recycling, or recovery” approach. Designers rarely consider what happens to a product after it reaches the end of its functional life.

There was minimal evidence of design for disassembly, modularity, recyclability, or biodegradability. Many products, particularly packaging materials, household goods, and low-cost consumer items, are made from composite materials that are difficult or impossible to recycle. As a consequence, these products end up in landfills, open dumpsites, or drainage systems, contributing to soil, water, and air pollution.

Furthermore, the study found that take-back systems and circular production models are virtually non-existent in most industries. Manufacturers do not assume responsibility for post-consumer waste, shifting the burden entirely to individuals and local authorities. This violates a core principle of environmental ethics, which emphasizes extended producer responsibility and accountability across the entire product life cycle.

The lack of end-of-life design integration also undermines the goals of the circular economy, which seeks to minimize waste by keeping materials in continuous use. Instead, the prevailing linear model of production—take, make, use, dispose—continues to dominate Zambia’s industrial design landscape. This not only accelerates environmental degradation but also represents a lost economic opportunity to recover valuable materials through recycling and remanufacturing.

##### 4.4 Influence of Weak Policy Enforcement

Although Zambia has established environmental laws and regulatory institutions, the study revealed that weak

enforcement significantly undermines the integration of environmental ethics in product design. While the Environmental Management Act (2011) provides legal mechanisms for environmental protection and requires Environmental Impact Assessments (EIAs), actual compliance varies widely across industries.

Some industries were found to bypass environmental assessments entirely, especially smaller manufacturing enterprises operating informally. Others only comply when compelled by periodic inspections from ZEMA or when seeking approvals for large-scale projects. This reactive enforcement environment encourages minimal compliance rather than voluntary ethical responsibility.

Participants also pointed to limited monitoring capacity, inadequate staffing, and logistical constraints within regulatory institutions as major challenges. These weaknesses make it difficult for authorities to conduct regular inspections, enforce penalties, and provide guidance on sustainable design practices. As a result, environmentally harmful production methods often persist without accountability.

Additionally, the study found that penalties for non-compliance are often too weak to deter unethical environmental behavior. Some industries view fines as part of the cost of doing business rather than as moral or legal deterrents. This institutional weakness creates an environment in which environmental ethics is marginalized, and economic interests dominate.

From a policy perspective, these findings demonstrate that laws alone are insufficient without strong enforcement, education, and institutional capacity. Environmental ethics must be reinforced not only through regulation but also through continuous public sensitization, professional training, and institutional accountability mechanisms.

## 5. Conclusion and Recommendations

This study confirms that the integration of environmental ethics in product design within Zambian industries remains limited and inconsistent. While awareness of sustainability is increasing, practical application faces serious economic, institutional, and technical challenges. Without deliberate intervention, industrial growth will continue to compromise environmental integrity.

### 5.1 Recommendations

#### 5.1.1 For Industry and Designers

1. Integrate life-cycle thinking into all product design processes.
2. Adopt renewable, recyclable, and biodegradable materials.
3. Implement eco-design training for designers and engineers.

#### 5.2 For Government and Policymakers

1. Strengthen enforcement of environmental regulations.
2. Introduce incentives for industries practicing sustainable design.
3. Promote green technology transfer and innovation.

#### 5.2.1 For Education Institutions

1. Integrate environmental ethics and sustainable design into D&T and engineering curricula.
2. Promote research in sustainable manufacturing technologies.

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