A FRAMEWORK FOR ENVIRONMENTAL IMPACT ASSESSMENT OF PRODUCT PACKAGING

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by

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CERTIFICATE

This is to certify that the thesis titled *"**A framework for Environmental Impact Assessment of Product Packaging**"* submitted by **Mr. Sumer Singh** for the award of the degree of **Doctor of Philosophy** to the Indian Institute of Technology Delhi is a record of bonafide research work he has carried out under our supervision. The results contained in this thesis have not been submitted to any other university or institute for award of any other degree or diploma.

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Abstract

With the growing concern for environmental sustainability, it has become necessary to address the environmental damages caused by our present consumption approach. The packaging of products is one of the contributors to environmental damages, as often these product packages pose harm to the environment during production, use and when discarded after use. Most of the modern artefacts that are consumed, get delivered to us in some form of packaging and there is a need for environmental impact assessment of such packaging systems. However, the available environmental impact assessment tools are not comprehensive enough to facilitate the packaging designer and users to assess the environmental sustainability of a product package. Growing awareness amongst users of products and packaging across the globe has created a need for environmentally sustainable products. Due to user's awareness and subsequent demand, designers and manufacturers must cater to such needs to have a better acceptance of their products in the market. Therefore, there is a need for developing an assessment system that measures the environmental impact of product packaging. The present thesis addresses this urgent need.

In order to arrive at an assessment system to measure environmental impact, a comprehensive list of parameters was identified from multiple sources both by primary and secondary research. In the first phase, selection of parameters was not limited to packaging products but encompassed other domains as well. The process led to identification of many new parameters not reported earlier. A total of 27 impact assessment parameters were identified which pertain to four phases of product life-cycle namely preproduction, production, usage and end-of-life. This list of parameters was further filtered based on relevance to packaging

products and 16 important parameters were considered and proposed with their weights for the environmental impact assessment of product packaging.

The proposed research also establishes qualitative and quantitative metrics for measurement of these parameters. Based on parameters and metrics identified for environmental impact assessment, two frameworks for evaluation of packaging design alternatives have been proposed. First method is qualitative in nature and is based on Dominic method of evaluation which is often used at early stages of design. The second method is along the lines of Paul and Beitz which is a quantitative method often used during both early and later stages of design. The two methods proposed are adopted for evaluation of environmental impact assessment of packaging products.

After a rigorous collection of data, the proposed methods have been used to study evaluation of packaging options for two different cases from industry. Packaging of fruits and pen drive packaging as a part of supply chain has been studied in detail and effectiveness of proposed evaluation systems has been demonstrated. Overall, this work presents a comprehensive system to evaluate environmental impact of products/solutions which will help designers and users to make right choices and decisions.

Keywords: Environmental sustainability, Environmental impact assessment, Product packaging, Dominic method, Pahl & Beitz method

सार

पर्यावरणीय स्थिरता के लिए बढ़ती चिंता के साथ, हमारे वर्तमान उपभोग दृष्टिकोण के कारण होने वाले पर्यावरणीय नुकसान को संबोधित करना आवश्यक हो गया है। उत्पादों की पैकेजिंग पर्यावरणीय क्षति के योगदानकर्ताओं में से एक है, क्योंकि अक्सर ये उत्पाद पैकेज उत्पादन, उपयोग के दौरान पर्यावरण को नुकसान पहुंचाते हैं और उपयोग के बाद खारिज कर दिए जाते हैं। उपभोग किए जाने वाले अधिकांश आधुनिक कलाकृतियाँ हमें किसी न किसी रूप के पैकेजिंग में मिलती हैं और ऐसे पैकेजिंग सिस्टम के पर्यावरणीय प्रभाव के आकलन की आवश्यकता है। हालाँकि, उपलब्ध डिज़ाइनर प्रभाव आकलन उपकरण पैकेजिंग डिज़ाइनर और उपयोगकर्ताओं को उत्पाद पैकेज की पर्यावरणीय स्थिरता का आकलन करने की सुविधा के लिए पर्याप्त व्यापक नहीं हैं। दुनिया भर में उत्पादों और पैकेजिंग के उपयोगकर्ताओं के बीच बढ़ती जागरूकता ने पर्यावरण की दृष्टि से स्थायी उत्पादों की आवश्यकता पैदा की है। उपयोगकर्ता की जागरूकता और बाद की मांग के कारण, डिजाइनरों और निर्माताओं को बाजार में अपने उत्पादों की बेहतर स्वीकृति के लिए ऐसी आवश्यकताओं को पूरा करना चाहिए। इसलिए, एक मूल्यांकन प्रणाली विकसित करने की आवश्यकता है जो उत्पाद पैकेजिंग के पर्यावरणीय प्रभाव को मापती है। वर्तमान थीसिस इस तत्काल आवश्यकता को संबोधित करता है।

पर्यावरणीय प्रभाव को मापने के लिए एक मूल्यांकन प्रणाली पर पहुंचने हेतु, प्राथमिक और माध्यमिक अनुसंधान दोनों द्वारा कई स्रोतों से मापदंडों की एक व्यापक सूची की पहचान की गई। पहले चरण में, मापदंडों का चयन पैकेजिंग उत्पादों तक ही सीमित नहीं था, बल्कि अन्य डोमेन भी शामिल थे। इस प्रक्रिया के कारण कई नए मापदंडों की पहचान हुई जो पहले रिपोर्ट नहीं की गई थीं। कुल 27 प्रभाव मूल्यांकन मापदंडों की पहचान की गई, जो उत्पाद जीवन-चक्र के चार चरणों से संबंधित हैं, ये चरण पूर्व-उत्पादन, उत्पादन, उपयोग और जीवन का अंत है। पैकेजिंग उत्पादों की प्रासंगिकता के आधार पर

मापदंडों की इस सूची को और फ़िल्टर किया गया और उत्पाद पैकेजिंग के पर्यावरणीय प्रभाव मूल्यांकन के लिए 16 महत्वपूर्ण मापदंडों को प्रस्तावित किया गया।

प्रस्तावित शोध इन मापदंडों के मापन के लिए गुणात्मक और मात्रात्मक मैट्रिक्स भी स्थापित करता है। पर्यावरणीय प्रभाव मूल्यांकन के लिए पहचाने गए मापदंडों और मैट्रिक्स के आधार पर, पैकेजिंग डिजाइन विकल्पों के मूल्यांकन के लिए दो रूपरेखाएं प्रस्तावित की गई हैं। पहला तरीका प्रकृति में गुणात्मक है और मूल्यांकन के डोमिनिक विधि पर आधारित है जो अक्सर डिजाइन के शुरुआती चरणों में उपयोग किया जाता है। दूसरी विधि पॉल और बीट्ज की तर्ज पर है जो एक मात्रात्मक विधि है जिसका उपयोग अक्सर डिजाइन के शुरुआती और बाद के चरणों के दौरान किया जाता है। प्रस्तावित दो तरीके पैकेजिंग उत्पादों के पर्यावरणीय प्रभाव मूल्यांकन के लिए अपनाए गए हैं।

डेटा के कठोर संग्रह के बाद, उद्योग से दो अलग-अलग मामलों के लिए पैकेजिंग विकल्पों के मूल्यांकन का अध्ययन करने के लिए प्रस्तावित विधियों का उपयोग किया गया है। पूर्ति श्रृंखला के एक भाग के रूप में फलों और पेन ड्राइव की पैकेजिंग का विस्तार से अध्ययन किया गया है और प्रस्तावित मूल्यांकन प्रणालियों की प्रभावशीलता का प्रदर्शन किया गया है। कुल मिलाकर, यह काम उत्पादों / समाधानों के पर्यावरणीय प्रभाव का मूल्यांकन करने के लिए एक व्यापक प्रणाली प्रस्तुत करता है जो डिजाइनरों और उपयोगकर्ताओं को सही विकल्प और निर्णय लेने में मदद करेगा

कीवर्ड: पर्यावरणीय स्थिरता, पर्यावरण प्रभाव आकलन, उत्पाद पैकेजिंग, डोमिनिक विधि, पॉल और बीट्ज विधि

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