Management of the Plastic Product Life Cycle through QFDE

Z.Abdulah
Qassim University, Buraydah, Kingdom of Saudi Arabia

A.Elshamly
Taibah University, Medina, Kingdom of Saudi Arabia

R.Verschueren
University of Gloucestershire, United Kingdom

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Abstract

This developing paper summarises the treatment methods for solid waste, in particular packaging and plastics packaging waste. Through a descriptive study on the problem of solid waste treatment options. An integrated system The European Packing and Packing waste directory (CE/62/94) is developed to support the current treatment methods of solid waste. Through this research funded by SABIC1, the packing industry and the solid waste management methods could become more sustainable. It aims to examine the ability to use QFDE (Quality Function Deployment for Environment) to support plastics recycling and waste management, and how to improve the performance of the environment. This includes the measurement of achieving environmental standards in packing and packing waste as well as the possibility of supporting the recycling system through computer programs. It also focus on the ongoing losses of the current system for solid waste management. With this study, a framework is proposes which manages the whole plastics product cycle for production plants plastic, plastic recycling plants, and local authorities for solid waste management and treatment.

Keywords Reuse, incineration, landfilling, solid waste management, sustainable development, Quality Function Deployment

Introduction

The importance of waste plastic packaging stems from the increasing growth in usage of Packing and Packing waste, especially plastics materials included: "elastic, non-elastic and solid." The waste packaging and plastic packaging constitute a large percentage of solid waste. Plastics is cheap, lightweight, durable material, and is used in many products. Its wide are of application explains why demand for plastics products is growing dramatically, which led to the plastics waste disposal problem. In addition, development of plastic requires industrial processes with about 4% of the petroleum energy used in plastics, a non-renewable energy, as the plastics industry consumes 3.4% of the energy in manufacturing (Hopewell et al., 2009). It also causes air, soil, and groundwater pollution due to traditional treatment methods. This is why recycling is an important strategy for end-of-life waste management of plastic products. The Kingdom of Saudi Arabia (KSA) has competitive advantage in the plastics industry. The high availability of raw materials needed for this industry, 25% of the world's oil reserves, in addition to the gas.

High share of the global market in the petrochemical industry for up to 13%, 70% of the total packaging sector in the Gulf Cooperation Council (GCC). According to recent studies2, this sector recorded an annual growth rate of 15% in the KSA. Given the wide use of plastic as a raw material for packaging compared with glass and metal. The packaging industry as one of the most active industries in the KSA, where demand continues to rise on the packaging materials.

In KSA, the organisation 'SABIC' introduced advanced thermal plastics industry to the region for the first time. This will lead to the creation of new manufacturing industries in the near future. The kingdom's market presence holding first place in the Middle East, and sixteenth worldwide. Therefore they should aim to become the global centre for industrial packing. The KSA market is witnessing a trend towards the adoption of plastic as raw material in the packaging industry instead of metal and glass. There is a growing demand for flexible and solid packaging. Demand for safe and sustainable methods of packaging has seen remarkable growth in the KSA. At the same increased mobilization and food packaging requirements. This is due to the expected food consumption increase with annual growth rate of 4.6% between 2011 and 2015 to reach 51.1 million tons by the year 2015. The QFDE is a useful method to achieve environmental requirements. This method uses the benefits of the product life cycle analysis, and quality function deployment (QFD). By taking into account all of the quality requirements, and environmental requirements at the design of the product and translate it in the house of quality matrix (Masui et al.1 2003). QFDE is a method to support eco-design developed by incorporating environmental aspects into QFD (Akao, 1990), extending it so as to evaluate improvement concepts. The importance of this study is to improve the environmental performance of the packing and packaging waste sector, specifically plastics packaging in KSA. With the increasing share of global petrochemical market and increasing the size of the packaging industry. There is a growing requirement to improve and measure the performance of this sector. With international standards for sustainable development and environment protection, the need to recycle waste packaging is increasingly important.

Literature

The literature review found that product life cycle with regards to waste management is a prominent area of research. Forssberg; Pugh; Shen, (1999) presented a review of all plastics waste recycling phases, and the importance of plastic waste separation to develop recycling products. This study highlights the importance of plastic recycling to the plastic industry for saving energy and environmental requirement; it also shows that Flotation of plastics is the most flexible and useful technique among other techniques.

A case study presented by Wei Zhaoa et al., (2001) focus on municipal solid waste in Tianjin, China. This study found the need to reduce greenhouse gas emissions, and to save the waste of resources. The minimum requirement is to collect gas from landfill; the study confirmed the importance of reducing gases using recycling, and how applying the product life cycle analysis (LCA) supports the decision-making process. While Patel et al., (2000) presented the importance of using alternative methods for recycling, as a treatment that offer recovery of energy (burning and energy recovery) but not harming health.

A comprehensive study of all phases of solid waste management (Hopewell et al., 2009). This study focuses on the opportunities and challenges of recycling of waste packaging materials that are disposed of in a short period not to exceed one year, and this is what makes the current practices of disposal prevent environmental compatibility and sustainable development. The study provided an assessment of the different treatments of solid waste explained through harmful of landfill disposal. Because there are long-term risks of contamination of groundwater and soil, and the emission of harmful gases from the landfill. The study considered that pollution is the most important challenges facing the recycling and the technological, economic, and social challenges.

Through attention to these challenges, we will be able to convert from waste burial to the recovery of energy and materials safely. Al-Salem; Lettieri; Baeyens (2009) focused on the importance of energy

recovery from solid plastic. The study was presented four methods for the treatment of solid waste and feasibility of each plastic waste, and so, as the plastic is made from petroleum products so it contains energy must be recovered, the study highlighted that the most important of these methods is the recycling and incineration for energy recovery.

With the LCA of waste management becoming increasingly complex the research is looking at advanced management methods to improve control of the LCA. Kaebernick, Kara, Sun, (2003), presented a method for environmental design including quality, cost and environmental requirement. By using Environmental Conscious- QFD, the original matrix of QFD developed to include the LCA requirement. Around the same time Masui, et al., (2003) adopted QFDE to spread DFE (Design for Environment) on the whole company, environmental indicators as: "lower carbon dioxide emissions, and lower energy consumption." The results were that the further development of recycling and evaluation of the product life cycle analysis, lead to an improvement in environmental requirement.

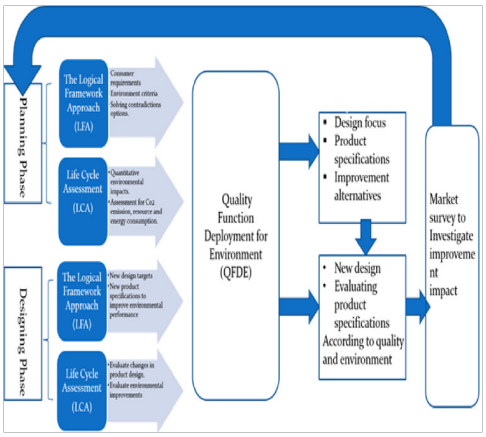
Additional studies were performed by Lei et al., 2007, who suggested a method to extend QFD to include The Life Cycle Design in designing phase. And, Sakao, 2007, who implemented eco-design by using three methods, they are LCA, QFD, and TRIZ. This presented a methodology for environmentally conscious product design. More recently Utne, Ingrid Bouwer, 2009, demonstrated how to improve environmental performance through the integration of Quality Function Deployment (QFD) and Life Cycle Analysis (LCA) of the fishing fleet.

Methods

The research is based on quantitative approach. Data collection will be performed through online questionnaires or relevant organisation in the plastics packaging industries. Once the date is collected, the following statistical tests will be applied. Once the statistical analysis is performed the relations ship strengths are used to populate the relationship matrix in the QDFE.

1. Alpha Factor method: to determine the degree of stability of the survey list.
2. The variance analysis: to determine the signif-icance of differences among the organisation.
3. The correlation test: to determine the degree of strength of the relation between environmental criteria and organisation performance.

The tool	The outputs
LFA	the goals of performance improvement according to requirement of the voice of costumer, and voice of the environment
LCA	Using quantitative data to evaluate all product life cycle stages. • A quantitative assessment for environmental impact in all life cycle stages.
QFDE	• Using weight of voice of costumer, and voice of environment to improvement options, and solve contradictions, and • New design to meet both requirements of environment and costumer.



This matrix consists of three steps: in the first step using LCA to evaluate environmental impacts by which we get the environmental profile. The second step using the QFDE to identify product specifications, by which we can identify design focus. The third step we take the results from phase1, 2 and we use QFDE in identifying the most important conflict between the environmental specifications, and technical specifications. Taking care of the negative or positive sign in the correlation matrix; VOE to

the 'contradiction matrix'/ Inputting contradicting VOC. The second phase: (Improvement Matrix) the out puts of the first phase are the inputs for this phase. It consists of four steps: first, the QFDE use outputs to identify. Improving options. Second: using LCA to evaluate Improving options according to environmental aspects. Third using QFDE to identify product concepts, regarding VOC and their weighting, and VOE and their weighting. Fourth: customer survey to evaluate customer requirement improvement.

Conclusion

Product design for recycling will assist and support all recycling efforts. In the UK, a study found that even a regular collect for packing shopping basket, the collected amount cannot recycle effectively (Local Government Association (UK) 2007). The suggested model is supporting the eco-design. Further, there is a need to raise environmental awareness among KSA, the economic benefits of recycle are encouraging the investment in this field, regarding the competitive advantage of KSA in plastic industry.

Wider implementation of policies to promote the use of environmental design principles by industry could have a large impact on recycling performance, increasing the proportion of packaging that can economically be collected and diverted from landfill (Shaxson et al. 2009). The second major challenge for the plastics recycling is the ability to recycle a larger proportion of the plastic mixed waste so that packaging should be collected and sorted to make recycled resins with minimal cross-contamination. With applying of durable consumer goods designing for disassembly, labels and adhesive materials should be selected to maximize recycling performance.

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