Decision making with the analytical hierarchy process (AHP) for materials and design selection in the POPE lawn mower manufacturing for minimizing environmental impacts

Mohammed Abbas1 and Sherif Mostafa2 1School of Engineering, University of South Australia, Mawson Lakes 5095, Australia

2School of Natural and Built Environments, University of South Australia, Adelaide 5000 Australia

Abstract

The POPE lawn mower has become one of the most important household machines. This is because many people are using lawn mowers every day to cut the grass in their home gardens, public parks or street verges to maintain a beautiful environment. However, this product has some negative impacts on the environment such as gases emissions and creation of solid or liquid waste. In addition, this product has some issues such as corrosion on the materials of some parts, and an inefficient and short life span. The impacts on the environment associated with POPE lawn mowers are a result of the materials and design used in the manufacturing process. Furthermore, the purpose of this chapter is to describe and analyses the POPE lawn mower components and propose how it can be improved by selection of new materials and designs used during the manufacturing process. The findings of this chapter project will propose some solutions to these issues by using the Analytic Hierarchy Process (AHP) to make decision which allows for a selection of new materials and designs for manufacturing the POPE lawn mower with less environmental impacts and greater efficiency. Finally, this research recommends that companies manufacturing the POPE lawn mower could improve the lawn mower by selecting new designs, materials and making changes to the energy consumption to make this product more efficient with less environmental impacts.

Keywords: AHP, material and design selection, POPE lawn mower manufacturing sustainability, green benefits

Introduction

In the recent years, the lawn mower has become one of the most important household products. This is because many people are using lawn mowers every day to cut the grass in home gardens and public parks or on street verges to maintain a beautiful environment. Moreover, this product has lower costs as compared with other lawn mower models and is much easier to use. However, this product has some negative environmental impacts including gas emissions and creation of solid waste. According to the Ministry of the Environment in Canada, during one season the POPE lawn mower emits nearly 48 Kilograms (106 IBS) of gas emissions (Clean Air Yard Care, 2015). Additionally, Boss (2005) highlighted that the POPE lawn mower includes many kinds of materials that have less recyclability at the end of their lifespan, such as rubber. These materials become scrap and solid waste for the environment. The effects of lawn mowers on the environment are a result of the materials and design used during the manufacturing process. According to Liu and Yu (2010), the common materials used in the manufacturing parts for lawn mowers are steel alloy, plastic, aluminium and rubber. These materials have many effects on environment, not only during manufacturing of the lawn mower, but also during the products' life cycle through to the end of its life. In addition, the designs decisions made for the lawn mower have several effects on the environment, such as methods of using fuel energy which produce a lot of emission gases (Andresen

2013). Moreover, this product has design problems such as corrosion of parts and inefficient energy consumption.

According to Saaty (2008), AHP is considered one of the techniques that regulate ideas for decision-makers and can facilitate in the organising the decision problem in a manner that is simple to follow and analyse. It has been used to help decision-makers select the best solution from many options and selection criteria. Also, AHP was used in many applications in operations research and design-for-six-sigma (DFSS) situations and quality engineering (Alexander, 2012). Moreover, the AHP can provide a means of reducing the problem into a hierarchy of sub problems which makes it easy to understand the problem and objectively evaluate (Kiong et al. 2013). Furthermore, AHP pairwise comparisons convert subjective evaluations into numerical values and be processed to rank each alternative on a numerical scale (Saaty Scale). Therefore, this chapter applies AHP to facilitate the selection of materials and design during the lawn mower manufacturing that will reduce the environmental impacts.

Current Gaps in Knowledge

Some research works have tried to improve the lawn mower manufacturing process by increasing the efficiency, lengthening the life span, making it more easy to use and reducing the environmental impact to make it more environmentally friendly (Clean Air Yard Care, 2015; Boss, 2005; Jeff et al., 2003). These researches tried to improve the lawn mower and reduce environmental impacts by substituting some materials with new materials in manufacturing or by selecting new designs. Despite these research attempts, the lawn mower still has negative impacts on the environment. Therefore, this research will focus in the minimizing environmental impacts for lawn mower by make decisions for selecting materials and designs which will be used in manufacturing this product.

Many experts have tried to decide on the selection of materials and design for the lawn mower manufacturing by study life cycles assessment (LCA) and analysing the components of this product. According to Liu and Yu (2010), trying to make a decision for improving lawn mower manufacturing through using life cycle thinking (LCT) in design chain and analyse all components for this product. Consequently, this chapter will utilise the AHP capabilities to facilitate the decisions making during the design and material selection.

Aim and objectives of the chapter

The aim of the project research is develop ab AHP model for material and design selection that will have less negative environment effects and improve efficiency. The Objectives of the chapter are:

• To analyse all components for the POPE lawn mower

• To study the lawn mower life cycles assessment

• To study the impacts that the lawn mower has on the environment

• To develop an AHP model for materials and design selection which can be used in the lawn mower manufacturing process

Research methodology

In order to achieve the aim and objectives of this research, the AHP is used as the methodology of this chapter. The methodology includes seven consecutive steps as following:

Step 1: Analyses all components for lawn mower

This research will start with a study of all components parts of the lawn mower and the materials which are used in manufacturing these parts. Also, will study how to manufacture these parts.

Step 2: Study the life cycle of materials constituent for a lawn mower

In this task, the research will create a flow chart for LCA of all materials used in manufacturing the lawn mower. This flowchart will start from choice of raw materials and continue to the end of materials life cycle.

Step 3: Study the current designs for lawn mower

After finishing the study of the material constituent for a lawn mower, further study will be made into the kinds of designs that are used in manufacturing this product

Step 4: Determine the effects of the Lawn mower on the environment

When finished analysis of all materials and current designs, this study will start to determine the impacts of this product on the environment by calculation of all gases emissions, solid waste, liquid waste, and other effects. After finishing the calculation all data will be recorded.

Step 5: Develop the AHP model

This will be done by breaking the problem into different parts like goal, criteria, sub-criteria and alternatives creates a hierarchy.

Step 6: Pairwise comparisons

The data for the AHP model will be collected from qualified experts, then qualitatively compare the different pairs of data.

Step 7: Sensitivity analysis and results

The end outcome of the research would project the overall analysis of the different pairs of data of the AHP model. It is envisaged that this analysis would assist researcher to make better decisions for selection materials and designs in manufacturing the lawn mower with minimizing environmental impacts.

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