Materials and Design 49 (2013) 525–535

Contents lists available at SciVerse ScienceDirect

Materials and Design

journal homepage: www.elsevier.com/locate/matdes

A quality function deployment-based model for materials selection

Kanika Prasad, Shankar Chakraborty *

Department of Production Engineering, Jadavpur University, Kolkata 700 032, West Bengal, India

ARTICLE INFO

Article history:
Received 7 December 2012
Accepted 20 January 2013
Available online 4 February 2013

Keywords:
Selection of materials (H)
Properties of materials (E)
Weighting and ranking factors (H)

ABSTRACT

Materials play a key role during the entire product design and manufacturing phase as a wrongly selected material may often lead to premature product failure causing loss of revenue and repute of the concerned manufacturing organization. While selecting the most suitable material for a specific application, the designers often need a sound and systematic methodology to deal with this problem having multiple candidate alternative choices and conflicting objectives. Most of the previously applied methodologies for material selection have either adopted criteria weights estimated using subjective judgments of the designers or failed to give due emphasis on the voice of the customers to meet their requirements. In this paper, a maiden venture is taken to solve the material selection problems using a quality function deployment (QFD)-based approach that can integrate the voice of the customers for a product with its technical requirements. The applicability and solution accuracy of this QFD-based material selection model is demonstrated with the help of four illustrative examples. To ease out the materials selection decision-making process, a user-friendly software prototype in Visual BASIC 6.0 is also developed.

© 2013 Elsevier Ltd. All rights reserved.

1. Introduction

Selection of material for a particular product plays an important role in engineering design. In the present day manufacturing environment, where a large number of engineering materials and manufacturing processes are available, many difficult decisions need to be taken while selecting a material for a specific application. A large number of factors ranging from mechanical, electrical and physical properties to corrosion resistance and economic considerations should be taken into account by the designers depending upon the application domain of the product. The complex interrelationships that exist among various selection criteria make the material selection process more challenging and time consuming to the designers [1]. The designers should have the knowledge of material properties, cost, design concept and their interrelationship, as the inappropriate choice of a material may often lead to an overall increase in production cost and/or early failure of the product in the field of application, thereby affecting the reputation of the manufacturing organization. Therefore, the designers must identify and select the most appropriate material for a product with the minimum possible cost and specific performance considerations [2].

In the process of selection of an appropriate material for a given product, so many influencing factors, such as desired properties, operating environment, production process, cost, availability of supplying sources etc. need to be considered, which make the selection process a multi-criteria decision-making (MCDM) problem. Thus, to ease out the material selection procedure, a systematic and efficient approach is required. The first step in material selection process is to specify the performance requirements and relate them to the main material properties and processing requirements. Based on the fulfillment of the desired properties, some materials may be discarded and some may be selected as the probable candidates. The short-listed materials are then ranked in the order of their performance.

Till date, several mathematical techniques, specially various MCDM methods, like graph theory and matrix approach [3], grey relational analysis [4,5], fuzzy axiomatic design [6], multi-objective optimization techniques [7–9], digital logic method [10,11], utility additive model [12], linear assignment approach [13], ELECTRE (elimination and choice expressing the reality) method [14–16], VIKOR (Vlse Kriterijumska Optimizacija Kompromisno Resenje) method [17–20], TOPSIS (technique for order preference by similarity to ideal solution) method [21–24], preference ranking-based methods [25–27], etc. have been proposed and applied for solving numerous material selection problems arising from diverse engineering domains. The main problem associated with the above-mentioned mathematical approaches is that a majority of them require the determination of criteria weights either by analytic hierarchy process (AHP) or entropy method. Thus, the final material selection decision is affected by the criteria weight values which are based on designers' perception and subjective judgments. Again some of those methods are mathematically too complex to comprehend and apply. Some of them are also influenced by additional mathematical parameters.

* Corresponding author. Tel./fax: +91 033 2414 6153.
E-mail addresses: s_chakraborty00@yahoo.co.in, schakraborty@production.jdvu.ac.in (S. Chakraborty).

0261-3069/$ - see front matter © 2013 Elsevier Ltd. All rights reserved.
http://dx.doi.org/10.1016/j.matdes.2013.01.035

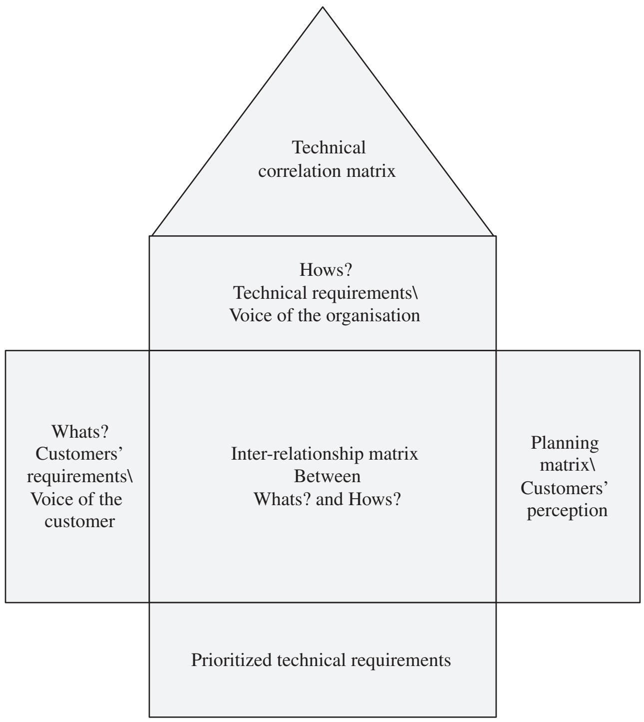

Fig. 1. The house of quality.

Fatchurrohman et al. [28] presented a conceptual design selection approach accommodating concurrent engineering and MCDM strategies, and combining concurrent network, quality function deployment (QFD) and AHP. Using that approach, the best material for a wing spar was selected for aerospace application. It was proved to be a sound method which would consider product performance, product specification, technical specification and selection of the best alternative. It would also aid the designers to perform systematic and parallel analysis involving early consideration of the technical-customer requirements during conceptual design, leading to better product design and increased product competitiveness.

Mayyas et al. [29] integrated QFD and AHP to assist the designers in material selection for vehicular structures, mainly automotive body-in-white panels. The AHP method would discriminate between the competing options where the interrelated objectives would need to be met, whereas, QFD being a customer focused approach, would start by collecting the customer needs and try to integrate those needs into the product. Mayyas et al. [29] did not establish any typical scaling for the interrelationship matrix, which may constrain the discriminating ability of the adopted QFD approach.

Now-a-days, the success an organization has become more and more customer oriented. It has become very important to meet the real and latent needs (or quality) of the customers to be successful in the marketplace. Although a huge amount of work has already been carried out on materials selection, it is observed that those mathematical approaches did not take into account the voice of

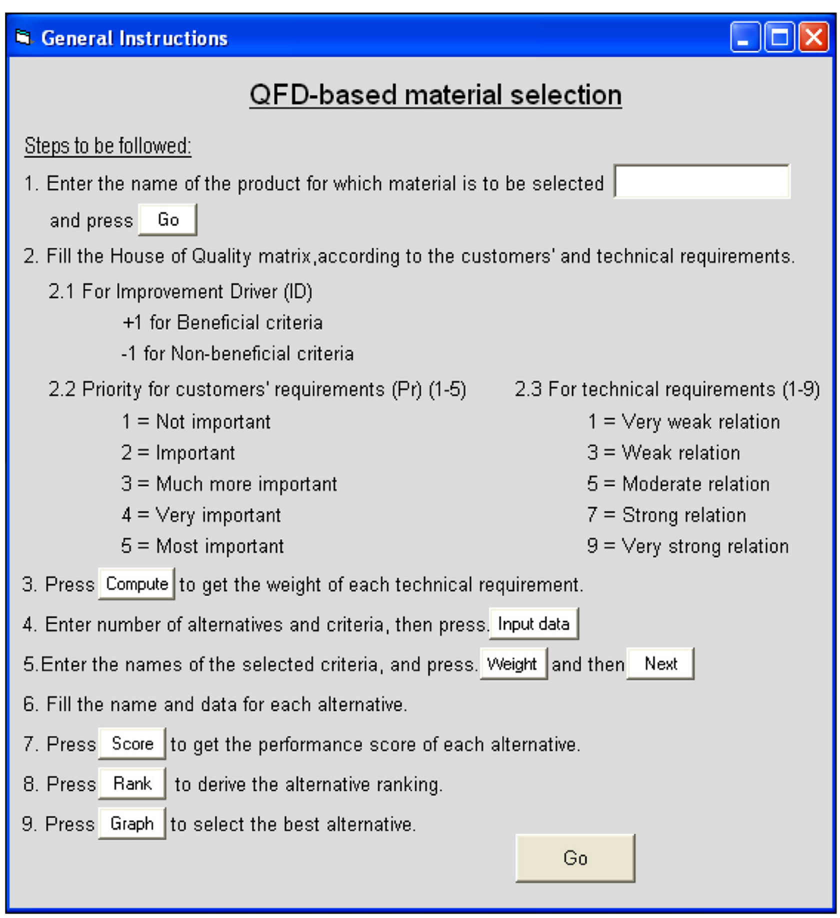

Fig. 2. Opening window of QFD-based material selection software.

Download English Version:

https://daneshyari.com/en/article/7221667

Download Persian Version:

https://daneshyari.com/article/7221667

Daneshyari.com