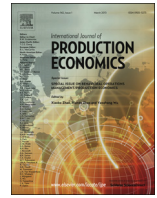




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# Product design scenarios for energy saving: A case study of fashion apparel



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## ABSTRACT

In participating in today's green movement, the development of sustainable products enables firms to drive changes to achieve business excellence and enhance corporate culture. The purpose of this paper is to develop guidelines for the design and production of sustainable energy-saving fashion products (ESFPs). A three-stage methodological approach was adopted: (1) a preliminary study using multiple sources of evidence to identify energy-saving factors for apparel products; (2) a questionnaire survey to investigate fashion consumers' behavioral attitudes toward ESFPs; and (3) an analytical study on the development of product design scenarios for sustainable fashion. Three categories of energy-saving factors were identified in the first study, four clusters of consumers were found in the second, while two scenarios were developed in the third. Practically, this study enables enterprises to obtain a deeper understanding of the green demands of their target customers and provides designers with a reference for the design and production of ESFPs to meet the specific needs of different customers. Theoretically, this study demonstrates a systematic and logistical procedure for the identification of energy factors for sustainable fashion and the development of feasible and practical scenarios for the design and production of ESFPs.

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## 1. Introduction

Sustainable development is generally regarded as the assurance of a balance among economic growth, social equity, and environmental protection (Levett, 1998). The harmful consequences of environmental problems in recent decades have caused many people to rethink their role in the protection of the natural environment. Indeed, the green movement is now thought to be a priority for many people and organizations (Solomon and Rabolt, 2009; Benedict and McMahon, 2002; Freeman and Audia, 2006). In the fashion world, industrialists always strive hard to establish competitiveness to meet their customers' different needs, and thus to surpass other competitors. Given the growing concern regarding environmental protection, better responsiveness and affordability were no longer sufficient once sustainability started to gather momentum (Yeung and Yeung, 2011). Supplying fashion products that meet consumers' green demands reflects a new business direction. To achieve this purpose, fashion entrepreneurs

must find a way to design and develop products with a focus on sustainability.

Fashion is a unique tangible consumer product with the following features: timeliness, styles, trendiness, and many knock-offs. Although fashion is no longer regarded as a necessity product, it is almost a must-buy product for every season (Solomon and Rabolt, 2009) and probably consumers' most frequently purchased non-food product. This implies the existence of a market with huge consumer demand. As a logical result, the supply of fashion products to such a big global market consumes a large proportion of the world's resources. More importantly, the textile and fashion industries pose a series of threats to the natural environment, from the chemicals used in planting and producing raw materials to the energy consumed in manufacturing, distributing, and retailing the final products. Another crucial issue is that pollutants and detergents are widely used to launder and take care of an apparel product throughout its entire usage life. Irrespective of its 'gimmicky' image on the catwalk, many people feel that the fashion industry is a 'dirty industry' (Fredriksson, 2011; Solomon and Rabolt, 2009).

Sustainable products, also called green products, are products aimed at reducing negative effects on the environment. Specifically, they are designed to minimize energy consumption, use fewer natural resources (biotic or abiotic), and reduce toxic substances in the water, air, and soil. To address the urgent need to reduce

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harmful effects on the environment, cut back on the exploitation of resources, and eliminate inequities in labor practices, sustainable products have been developed to reflect the trend that is likely to affect every facet of the global fashion industry (Yeung and Yeung, 2011), irrespective of the fact that sustainable apparel still constitutes only a small part of the current fashion market.

In the global green movement, energy-saving is the first and probably the most important issue in the fashion industry because energy consumption in the industry is high and constantly increasing (Ngai et al., 2012). In addition to contributing to sustainability development, producing energy-saving products can generate economic and efficiency benefits for a firm, especially in terms of cost reduction. Fashion companies are therefore more willing to develop policies to practice energy saving than any other environmental policies. In recent years, a number of research studies have focused on energy-saving in the clothing and textile industry; for example, Caniato et al. (2012), Hasanbeigi and Price (2012), Ngai et al. (2012), Ozturk (2005) and Woolridge et al. (2006). However, most of these studies focused on the efficiency of using energy in manufacturing or supply chain management. There have been few investigations related to fashion consumers' concerns about the consequences of environmental problems and the influences of these concerns on their demand for energy-saving fashion products (ESFPs). More importantly, there are no guidelines provided for the industry to design and produce ESFPs. To bridge this gap, our main objective was to develop logical and feasible product design scenarios for ESFPs that correspond to consumers' pro-environmental concerns.

This paper is organized into several sections. In the next section, we provide a literature review on the basic concepts relevant to the current study. We then describe how the three adopted studies were conducted and how the collected data were analyzed. Finally, a discussion on the contribution of the study and an overall conclusion are provided.

## 2. Literature review

The literature review in this section focuses on the basic concepts of sustainable fashion and the pro-environmental attitudes of consumers. The findings form the basis for the development of the survey questionnaire and, subsequently, of the product design scenarios.

### 2.1. Sustainable fashion

The term 'sustainability' can be understood in many ways. Taking the definition of World Commission on Environment and Development (1987) as a reference, Yeung and Yeung (2011, p. 1267) define the concept of sustainability in the fashion industry as "satisfying the present needs for fashion but without compromising the ability of future generations to meet their own fashion needs". Based on this perspective, we confine our concept of sustainable fashion to those apparel products that maximize positive and minimize negative environmental, social, and economic effects along their supply and value chain (Department for Environment, Food and Rural Affairs (DEFRA), 2011). In other words, a fashion product that is sustainable will have the least possible adverse effects on human beings, other living creatures, and the planet Earth during its entire life.

In the context of the fashion product lifecycle, the concept of sustainability can be seen in terms of three stages: manufacturing, utilization, and disposal. A green-oriented firm aims to design and produce products that can minimize the negative impact on the environment by giving special attention to the waste, carbon emissions, and energy used in each of these three stages (Beamon, 1999; Green et al., 1998).

Issues such as supply of raw materials, production of final products, application of chemical treatments, and/or processing of operational and logistical activities are involved in the manufacturing stage. The supply of raw materials for fashion products comes from different sources, either natural or man-made. In general, sustainability-oriented materials include organic fibers, naturally colored fibers, and recyclable fibers (Caniato et al., 2012). The production of the final products includes the production of textiles (i.e., both yarns and fabrics), making up of garments, and dyeing and finishing. From the perspective of sustainability, sustainable processes require a minimum of resources or effort to accomplish (Baskaran et al., 2012). Furthermore, application of chemicals, such as dyestuffs, resins, softening agents, washing detergents, and many others, is common in the creation of special effects for an apparel product. These chemicals cause serious pollution problems within the natural environment; and dealing with them properly requires a large amount of resources and effort (Lo et al., 2012). Therefore, only minimal use of toxic chemicals is acceptable for a sustainable fashion product. In addition, in managing a textile and apparel supply chain, various operational and logistical processes are involved, such as transportation of goods, adoption of information system, distribution and sales, and marketing and promotion. The term, sustainable operations, refers to the use of minimal energy or resources to undertake these activities.

In the utilization stage, there are two sustainability concepts. The first refers to the resources used to care for a fashion product during its usage life, such as laundering, bleaching, and ironing. According to a study on the total effect of a blouse's entire lifecycle on the environment, it has been found that most of the effects, such as energy consumption, solid waste, carbon dioxide, and biological oxygen demand, occur during the utilization stage (Fletcher, 2008). The second sustainability concept addresses the ways in which clothing products can assume their basic functions effectively; that is, keep the body warm or enhance body ventilation. Practically, appropriate use of materials (e.g., fiber nature, textile construction, and fabric finish) and design of styles (e.g., width of necklines, number of layers, and shape of openings) can effectively control body temperature.

The disposal stage offers several sustainability perspectives, most of which relate to extending the life of a product. The first perspective considers life extension primarily through reuse and sometimes through redistribution and resale. The second focuses on the repair and reconditioning of the product to maintain its usefulness for as long as possible. The third perspective relates to recycling; that is, recycling the product or its materials to provide new inputs for manufacturing other goods (Fletcher, 2008; De Brito et al., 2008). If life extension or recycling is impossible, the final perspective relates to waste management. Many suggestions concern the reduction of the load on landfills, such as the use of biodegradable raw materials.

Because of the complicated energy-saving concepts in these three stages, producing sustainable fashion products should be considered in an integrated way. For example, cotton is a biodegradable material that is sustainable in terms of reducing load on landfills, but at the same time, the planting, processing, and utilization of cotton require extreme quantities of chemicals and more water. As another example, special finishing facilitates the care of clothes but requires special chemical treatment and additional heat processing. In actual fact, no fashion product can be regarded as perfectly sustainable. To balance such positive and negative issues, every energy-saving element in each stage should be taken into account, evaluated, and weighted so as to obtain an optimum solution; that is, the lowest level of energy used through a fashion product's entire life. The amount of carbon footprints can be used as a common evaluation scale. An integrated approach in such evaluations can prevent people misjudging the concept of sustainable fashion.

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