

## An investigation of design management applications in the textiles and apparel industries

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### Abstract

This study is concerned with identifying and classifying the design management research approaches and concepts focusing on the textiles and clothing industries. This is to illustrate areas of study that textile design researchers have addressed. Three primary levels of design management were the basis of this study, namely, strategic, tactical, and operational levels. The approach and methodology adopted in several research studies were reviewed and then classification was carried out. It was found that strategic-level studies focused on consumers' needs, preferences, perceptions, and collection of design information. The tactical/processes level reflected areas of staff development, and the creation of tools, systems, and frameworks employed in production stages. Developing knowledge systems resources and mass customization to meet consumer needs were highlighted in these research studies. At the operational/implementation level, research studies were focused on actions conducted in day-to-day operations such as chemical and physical techniques used in manufacturing processes and quality control.

**Keywords:** Apparel, consumer, design, management, strategic, tactical, textiles;

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## 1. Introduction

Textile design products are essential commodities needed and used by people of various socioeconomic classes, ages, and genders (Hutchison, 2014). Moreover, the economy of many countries is based on the textile industry making job opportunities for skilled and unskilled workers (Veselinova & Samonikov, 2013). The textile design process including what it requires of developing creative decorations, embellishments, or ornaments on fabrics is not only considered an integrated part of the textile industry but as well of other important businesses such as the fashion and apparel industries (Sadowski et al., 2021; Akter et al., 2022; Domnich, 2022). It is worth noting that fashion and clothing designers play a pivotal role in requesting, making, and identifying the used textile design in their products.

Nowadays, textile companies have understood that design is a valuable means to achieve their targets. Therefore, researching the textile design process has an impact on comprehending and managing the textile industry and other industries linked to it. Textile design research has been expanded and conducted in several main areas including history, theory, business, psychology, and technology. Although, the area of managing textile design products has been the interest of several researchers (Abbate et al., 2023; Dolgui et al., 2022; Lee, 2023; Malinverno et al., 2023; Saccani et al., 2023).

In terms of research studies concerned with managing textile and clothing industries, an initial review of current and latest research studies was found extensively inspired by some topics such as the circular economy and sustainability applications (Debnath et al., 2023). Abbate et al., in 2023, have concerned with gaps that would be found in the textile, apparel, and fashion industries. They found that researchers would extend their work in several areas such as stakeholders' behavior toward sustainable clothing and difficulties faced by industries (Abbate et al., 2023). Lee (2023) investigated methods of using apparel waste in producing an identified type of fabric. Produced items showed high creative and quality scores. Malinverno et al. (2023) studied the sustainability of work wear as one of the potential products reducing the negative impacts of the textile industry on the environment due to its concepts and how manufacturers use their wastes. Saccani et al. (2023) investigated managerial challenges and opportunities of textile makers to achieve and meet the circular economy approach. Dolgui et al. (2022) focused in their study on the shift in industries based on assembly processes producing limited quantities of various products rather than high quantities of a few products. They highlighted the importance of dealing with this new trend from the decision-making at strategic, tactical, and operational levels of management.

This initial review of research studies was conducted investigating design management in the textile and apparel industries. Most research studies currently were found to focus on certain areas. However, other concepts would be adopted in textile and apparel industries especially design to reach the ethical and creative goals of industries and companies. Consequently, this research was conducted to answer the question, what are the significant areas, levels, and types in which these industries could be managed and would have been the concern of researchers. This could be extracted from the research studies conducted and published in specialized textile, fashion, and apparel journals.

Moreover, these days there is an increased need to understand design tools, planning, and implementation in the textile design area. Hence, "Design management" has become one of the textile design research fields focusing on investigating the administration of all aspects of design at levels of corporate and project to meet business targets varying across companies (Best, 2006). Consequently, studying the practice of managing the textile design process will lead to efficient and effective control and organization of the textile industry supply chain (Metcalf, 1989; Nayak, 2022).

### **1.1. Purpose of study**

In this context, researchers in the field of textile, clothing, and fashion industries have conducted research studies concerned with textile design management. These research studies have a scope of aims and methodologies, that is, the justification of used approaches, methods, and tools by the researcher/s to investigate a study area or question. Since, constructing a research methodology – which is defined as a scheme of exploring a targeted subject or topic – is an initial challenge for design researchers to embrace the exceptional theoretical concepts of ontology (type of its existence), epistemology (study of knowledge could be acquired), and axiology (study of its value)(Killam, 2013). In addition, developing a research methodology is almost preceded by studying former relevant research methodological outlines and structures. Therefore, it was found important to analyze and study these methodologies to update researchers in this field with possible tools and methods that could be used. This paper is concerned with informing design researchers of frameworks and outlines in the field of managing textiles and apparel design. Another aim of this study is to identify gaps in this research area in the field of textile design management. It is believed that this paper's findings will be supportive for design researchers as an inspiring resource for further future research work which could support a deep analysis of the textile design industry. Methodologies used in the "Design management" studies of textile products in three stages/levels, namely, strategic, tactical, and operational will be the focus of this study.

## **2. Materials and Methods**

To fulfill this study's aim and answer its questions, it was decided to adopt a methodology based on the following stages to systematically analyze the collected data and journal papers. These stages and methods include reviewing and searching published research studies, extracting, and analyzing these research studies' aims and methods, and concluding the main and detailed finding relevant to the area of the current research addressing design management research methods.

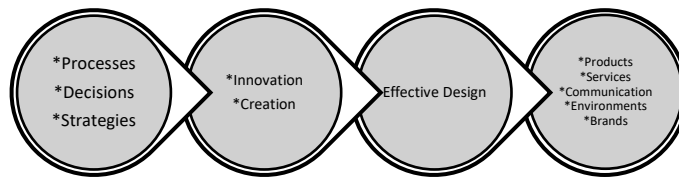
*Therefore, in this study systematic review and analysis of significant published, research studies were conducted to extract the research questions' answers.* Ethical considerations were made to ensure that all sources of data were duly acknowledged. This research did not require any special permissions.

## **3. Results**

### **3.1. Background and concepts**

These days "Design" has been approached by companies in a more managed way – a business approach – to represent themselves professionally and to deepen their existence in the business sector. "Design management" term has been defined and expressed variably by different researchers and references. Definitions found could be summarized as "The deployment of design resources (means, tools, and methods) and organization of processes to reach the company targets." It is active at different levels affecting design strategies, decisions, and processes leading to producing innovative and creative products, services, environments, or brands that are effectively designed (see Source: ). Design management can be applied in one or all three levels of the design-making process, that is, strategic, tactical, and operational levels in various business magnitudes and contexts such as world-renowned, global manufacturers, and studios (Best, 2006). These different levels and their focus areas are illustrated in Figure 2 and highlighted below.

**Figure 1. Definition of Design Management**



Source: Design\_Management\_Institute (n.d.)

**Figure 2. Design Management Levels**

### **3.2. Design management at a strategic level**

Strategy is targeting goals using resources. In design management at a strategic level, a design leader works on the company's "vision," that is, planning is focused on setting priorities and actions needed to reach the goal/s set using resources. In the design area, this level includes all concepts of recognizing and assessing design use and prospects, understanding and interpreting consumer needs, and planning, establishing, promoting, and selling a design product. Consequent expected actions could be establishing relationships in both working and purchasing environments and controlling design decisions (Best, 2006).

### **3.3. Design management at the tactical/processes level**

At this level, the design specialists are concerned with commencing design projects, forming the business firm, working on the design competitive advantage, increasing awareness of design, and expressing the brand through design, its methods, and processes. At this level of design management, the main aim is to interpret design strategies and processes into the final product. This includes implementing, planning, and organizing the available resources within identified time and budget. Accordingly, three important factors are considered, namely, cost, time, and performance (or quality). Skills to be highlighted in this area are organizing inventive teams, accelerating the design process and evolving cooperative cultures, and visual communication (Best, 2006).

### **3.4. Design Management at the operational/implementation level**

Designers at this level work on the processes and practices of design projects. Several aspects of design are the focus of this level including social and environmental concerns, design policies, procedures, and guidelines, the transformation of universal design into the native, assessment of design accomplishment, reviewing, and revising the design strategy. The main skills to be highlighted are managing, controlling, and supporting design (Best, 2006).

Factors and driving forces of designers' creativity and inspirations, engaging consumers in the making process of designs were studied as well (see Table 1 concluding textiles and apparel industries' "Design Management" levels and their areas investigated in research studies).

**Table 1. Design Management levels and their areas investigated in research studies.**

Author/Research	Strategic Level study Evidence	Tactical/ Processes Level study Evidence	Operational/implementation level study Evidence
(Robinson et al., 1997)	Influence of product attributes on perceived fabric characteristics <b>CONSUMER PERCEPTION</b>		
(Hyllegard Morgado, 2001)	Consumer preference for design elements. <b>CONSUMER PREFERENCE</b>		
(Woodard et al., 2002)		Importance training programs. <b>STAFF DEVELOPMENT</b>	
(Jung & Na, 2004)		Developed a Textile Design Recommendation System matching to the customers sensibility. <b>CREATION OF SYSTEMS</b>	
(Parsons & Campbell, 2004)		Design Stages discussed. <b>CREATION OF FRAMEWORKS</b>	
(Ariyatun et al., 2005)		Developed a system for textile design retrieval and extraction. <b>CREATION OF SYSTEMS</b>	
(Powell, 2006)	Aesthetic and technical requirements for textiles including existing issues, currently produced products and possible new products and technologies. <b>CONSUMER NEEDS</b>		
(Jennings, 2007)		Developed a framework for mass customization of printed garments. <b>CREATION OF FRAMEWORKS</b>	
(Jiang et al., 2007)			chemical technique to produce design. <b>MAKING PROCESS OF DESIGNS</b>
(Lee, 2012)	Understand consumers' tools to collect data. <b>CONSUMER PERCEPTIONS</b>		
(Guo et al., 2012; Guo et al., 2013)			electroless plating fabrics to make alternative designs. <b>MAKING PROCESS OF DESIGNS</b>
(Guercini et al., 2014)	Analyze the main interactions in the fashion industry. <b>COLLECTION OF DESIGN INFORMATION</b>		investigated time as product and process <b>DAY-TO-DAY ACTIONS</b>
(Shin & Cassidy, 2015)		Making a comprehensive educational online resource for all fashion. <b>CREATION OF TOOLS</b>	
(Shin et al., 2015)	Cultural reinvention of traditional products <b>CONSUMER PERCEPTIONS</b>	Design tools were developed for customizing the created designs <b>CREATION OF TOOLS</b>	
(Strickfaden et al., 2015)			creativity and inspiration in the design process <b>MAKING PROCESS OF DESIGNS</b>
(McNeil & Tapp, 2016)	The impact of textile design visual characteristics on consumer. <b>CONSUMER PERCEPTIONS</b>		
(Qayum & Naseer, 2017)			detecting faults in textile products <b>MAKING PROCESS OF DESIGNS</b>
(Hong et al., 2018)		Developed a knowledge-based system assisting fashion designers to select fabrics. <b>CREATION OF SYSTEMS</b>	
(Lee, 2012; Vanderploeg & Lee, 2019)	Factors affecting crafts business towards environment. <b>CONSUMER PERCEPTIONS</b>		
(Li et al., 2019)		Studied the making of co-design of skirts. <b>CREATION OF TOOLS</b>	to engage stakeholders in the design making process. <b>CREATIVITY AND INSPIRATION</b>
(Tian et al., 2020)	Design of apparel product suitability to consumer. <b>CONSUMER NEEDS</b>		
(Cui & Liu, 2020)		Smart thermoregulatory fabric inspired by birds' plumage process <b>CREATION OF SYSTEMS</b>	
(Choudhary, 2020)	Designers' understanding of users' needs. <b>CONSUMER NEEDS</b>		
(Hahn, 2021)			discussed the designer journey starting by inspiration in the design making process and creative practice. <b>CREATIVITY AND INSPIRATION</b>
(Jiang, 2021)		Investigated the development of smart textiles to enhance emotional aspects of users. <b>CREATION OF FRAMEWORKS</b>	
(Vukasović & Zver, 2021)		Built a conceptual model of consumer behavior towards environmentally friendly textile products. <b>CREATION OF FRAMEWORKS</b>	

### **3.5. Applications of design management research in the textile design industry**

In this section, levels of design management in representative samples of textiles design research studies are reviewed and highlighted in chronological order, and then forms or classes of design management are summarized. Robinson et al. (1997) studied the influence of pattern design, color, fabric type, and pigment used for printing designs on perceived fabric characteristics. An experiment was designed to evaluate a range of variable samples by panelists in terms of geometric, mechanical, and sound characteristics. A survey study was conducted by Hyllegard and Morgado (2001) to investigate Hawaii's visitor's preference for print shirt design attributes in terms of design elements, that is, esthetic character, motifs, colors, and size.

Woodard et al. (2002) researched training programs taken by expatriates working in the textiles and apparel industries and their believed importance by managers. Jung and Na (2004) developed a Textile Design Recommendation System. This tool uses user preference and evaluation for sensibility into recommending textile designs matching the customer's sensibility. This system has shown effectiveness in this regard. Parsons and Campbell (2004) studied the textile and apparel design methodology and process employing digital technology. Several projects were discussed in terms of design stages, that is, problem statement, conceptualization, development of a prototype, and final implementation.

Ariyatun et al. (2005) developed a system for textile design retrieval and extraction using image segmentation techniques. It is believed that this system will be supportive for reconstructing stacked stored textile samples of the design. This method retrieved the experimented designs efficiently. Esthetic and technical requirements for automotive interior textiles were studied. This is in terms of this industry's existing issues, currently produced products, and possibly new products and technologies to be developed in this industry (Powell, 2006). Jennings (2007) developed a framework for mass customizing digitally printed garments in response to known customers' inclination to customized products. This is based on using PAD and Adobe Illustrator software for both garment pattern-making and print-making processes, respectively.

Jiang et al. (2007) studied chemical etching techniques to produce a design on Nylon metallic fabric employing variable temperature degrees, PH level, and time. Lee (2012) used the content analysis method to study consumers' used tools and information resources to collect data to limit their uncertainty about the environmental aspects of purchased products online. These tools were classified into social, physical, and people's environments. A series of research studies were conducted by Guo et al. focusing on electroless plating fabrics to make alternative designs for decorative and fashion applications (Guo et al., 2012; Guo et al., 2013).

Guercini et al. (2014) investigated time as a product and process in the fashion business. In this research, a case study methodology was adopted to analyze the main interactions in the fashion industry between the focal company, the luxury clothing manufacturer, and its suppliers. Making a comprehensive educational online resource for all fashion students was investigated by Shin and Cassidy (2015). A focus group was conducted for students working on a design project to investigate the usability of the website. Participants reviewed the website and then were asked to assess its usability. This was followed by an in-depth group discussion to fill open questionnaire focusing on the website form and contents.

A cultural reinvention of traditional products is one of the approaches that could be employed by designers in the design management area and adopted by Shin et al. (2015). In this research, alternative contemporary designs based on existing and old-style designs were created. On the way, design tools were developed for customizing the created designs such as application software or website. Consumer attitudes toward the newly developed designs and tools made for commercializing them in terms of their preference were investigated to test their marketability for consumers. Therefore, a new digital design tool was developed, evaluated, and modified with three



strategies and five possible scenarios. A design tool (app) was developed to show and apply the design ideas created. This tool could be used as a communication tool for publicity.

A range of patterns, colors, and textures are available in this tool. Options and settings such as repeating and scaling patterns. Evaluation of designs made is conducted in two phases, firstly the design tool was tested for its usability and options available by employing 9 in-depth interviews. In this stage, a group of participants representing designers, merchandisers, craft practitioners, and customers was interviewed. They were asked to assess the tool according to a list of criteria. These points were general, representability, usability, and suggestions for areas and industries of use. Then, it was examined for prospects of further adjustments employing a checklist. To check the criteria of applicability to make: all, only, some, and no to determine the scenario of digitization Complete, Incomplete or Partial bespoke, Universal, or Inappropriate. A category of possible scenarios based on the results of the interviews for further improvements was set (Shin et al., 2015). Strickfaden et al. (2015) investigated the creativity and inspiration of ten textile designers in the design process. The participants/designers were provided with samples of textiles and photos as references or sources of the developed designs during the research observed using different tools and methods. Studio design actions were studied by Parsons (2015) in terms of comparing and analyzing historical patents of apparel pattern making. In this investigation, the potentialities and advantages of making digital prints for these patterns were studied in terms of esthetic and environmental values.

McNeil and Tapp (2016) studied the impact of visual characteristics of carpets on people with walking and vision problems due to age. Various designs of carpets were made and produced and then experimented with using realistic carpets of similar dimensions. First, subjects were asked about their primary impression of carpets patterns, that is, overpowering, busier, and the reasons for this. Carpets' colors were investigated in terms of their discriminability. The second experiment was conducted to test subjects' ease of walking and then a preference.

Qayum and Naseer (2017) developed a fast method for detecting faults in textile printing patterns using rotary machines. This method is based on finding design repeats with low cost and time as only part of the image will be matched rather than the whole image. Hong et al., (2018) developed a knowledge-based system assisting fashion designers to select fabrics meeting consumers' needs. The study was conducted through three stages: analysis of consumers' and designers' evaluation criteria using the Analytic Hierarchy Process to obtain their relevant weight and to evaluate the alternatives, TOPSIS is used later to rank the obtained alternatives suggesting the most appropriate alternative according to consumers' recognition.

Vanderploeg and Lee (2019) studied the factors affecting crafts business owners' and managers' behavior toward the environment. The value-Belief-norm theory was considered (Lee, 2012; Vanderploeg & Lee, 2019). Li et al. (2019) studied the making of codesign of skirts and found a better approach to engaging stakeholders in the design-making process. Tian et al. (2020) studied the design process of women's car racing suits and their suitability for women because the available suits in the market were designed as unisex but based on men's measurements. Survey studies were conducted to collect the problems. It was believed that the surveys provided the researchers with the basis for developing the design of these suits. Prototypes and Design sketches were developed for evaluation by professionals as a basis for future research work.

Cui and Liu (2020) investigated the making process of smart thermoregulatory fabric inspired by birds' plumage process. Choudhary (2020) explored designers' understanding of users' needs regarding digitally printed textile design in two interior places, that is, Hospital rooms and waiting areas, and the Vegan dining area. The design process from start to end was investigated highlighting designers' empathy to understanding users. Hahn (2021) discussed the designer journey starting with inspiration in the design-making process and creative practice by focusing on ten design projects showing the designer's development throughout the projects as well as the designed design

framework. Research through the design approach was used by Jiang (2021) to investigate the development of smart textiles to enhance the emotional aspects of users. Vukasović and Zver (2021) worked on understanding consumer behavior toward conventional and environmentally friendly textile products. This is through developing a conceptual model.

#### 4. Discussion

The referenced research studies are summarized, this is to find the evident link between each study and the design management level assigned to it. It is evident from the review conducted in the previous section that the research studies carried out in the field of design management have been concerned with the fields of the strategic, tactical, and operational levels; in terms of the strategic aspect, researchers aimed at studying consumers' needs, preferences, perceptions, collection of information of design. Methods used in these research studies were questionnaires and focus groups.

At the tactical/ processes level, areas of research studies focused on the development of staff and tools, systems, and frameworks employed in production stages. Mass customization and fulfilling consumer needs were highlighted in these research studies. Developing knowledge systems resources were considered in terms of making web pages offer information and knowledge required by designers and design students. This level is of the highest frequency in the reviewed papers.

At the operational/implementation level, research studies were focused on actions conducted by designers to achieve the targeted plan identified at the tactical and processes level. These actions include chemical and physical techniques used in manufacturing processes and quality control including detecting design faults during the production process. The impact of time as a factor in the production processes was studied at this level.

#### 5. Conclusion

This study reflected the potential and possible applications in the three main levels of textile and apparel products design management, that is, strategic, tactical, and operational levels. Managing design at the strategic level was reflected in studying the design company vision, recognizing, and assessing design understanding consumers, reinvention existing designs, and developing alternative ones. At the tactical level, the design company and researchers are concerned with fulfilling the company's vision using developed frameworks, systems, or tools. Daily basis processes and steps of production are the actions addressed at the processes level. It was found that researchers are more concerned with strategic and tactical levels rather than the processes level.

This study was limited to investigating and analyzing methodologies adopted by researchers in the field of design management research studies, this is in terms of tools and methods used. A range of research studies investigating textile and clothing product design were analyzed. However, further future research work would consider widening the range of the analyzed papers to find out the existing gaps if any in the field of design management. This is to be considered in future research studies by design researchers. Moreover, deepening the analysis to comprise wider scope than methods used to include their findings would be supportive and informative for researchers.

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