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A STRATEGY FOR ECO-FASHION DESIGN BASED ON THE CLOTHING LIFE CYCLE

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ABSTRACT

This study aims to design the Eco-fashion model as an approach to reduce waste by extending the life span of clothes based on the clothing life cycle concept. Therefore, it is reasonable to investigate the related factors in the phases involved in the clothing life cycle. Moreover, applying the proposed model to design the multifunctional dress for evaluation purposes is considered in this study. The contamination caused by fast fashion clothes is a significant issue in the production, consumption, and disposal stage. Although many fashion scholars investigated to develop innovative designs for minimizing waste and environmental pollution in the fashion industry, it was not successful due to the lack of consideration the human behaviour and their well-being health. This article shows the successful procedure of the design in sustainable clothing and improves the cotton tricot dress design by applying the Eco-fashion design model. Although customization of multifunctional clothing dress is one of the problems in the sustainable apparel design process, the Eco-fashion design model is highly flexible and adjusted to apply in the industry. It addresses the multifunctional design potential to significantly reduce fabric and clothing waste related to environmental impacts. This study adopts a mixed-method approach to develop an Eco-fashion design model. The finding shows multifunctional dresses provide a solution to control consumption and buy the dress.

Disciplinary: Fashion, Clothing and Textile Design Technology, Environment and Sustainability.

1. INTRODUCTION

Global pollution and increased awareness about the loss of the globe are encouraging people to consider healthier living choices. Consumers are interested in purchasing more clothing items than

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what they need, only because of the lowest prices. Therefore, either many clothing items are not worn at all or they are consumed and discarded less than they should be worn. Thus, it is reasonable to understand the huge clothing and fabric waste is created (Fletcher, 2008). Recently, fashion designers and scholars have responded concerns in preserving the environment and have proposed design alternatives and solutions to address the effects of clothing production toward sustainability. The importance of incorporating the sustainable subject into fashion is showing effects on society, the environment, and the economy.

The sustainable fashion is not only limited to the product or clothing, but also to push design processes toward healthy living with considering profit, green strategies toward conserving the planet, and consumption practices for keeping people healthy. Nowadays, the "Eco-fashion" became a key concept for those encouraging the ecologically responsible design of fashion and clothing products (Fletcher, 2008). According to the growing necessity of environmental practices in the fashion and apparel industry, there is not efficient research to help designers to consider environmental issues in their design process. The design is responsible to use the maximization value of clothes during their life cycle. So, the structure of the Eco-fashion design process which considers all environmental impact related to the fashion product throughout its entire life cycle from production to disposal (Niinimäki, 2006), is an understandable subject for all designers. Also, 3.753.63 million pieces of dress from womenswear item were produced and purchased which it is expected to reach 3.940.31 million until 2023 (Statista, 2020).

Therefore, this research develops an Eco-fashion model formed based on the phases in the clothing life cycle. In terms of the practical aspects in the sustainability issues, this Eco-fashion model can be an alternative guideline to encourage designers and other individuals who are interested in the Eco-fashion design by switching the focus from preventing waste production to the maximum usage of the waste. Using the Eco-fashion design model may lead designers and manufacturers to more attention to selecting the materials and techniques based on human safety and environmental health. However, designers may have a better understanding of their ability to modify the design process based on their experiences and the consumer's demand. Moreover, dresses with multifunctional property would increase clothing utilization, reduce the need to purchase unnecessary clothes and eliminate clothing waste. Hence, this research aims to develop the Eco-fashion design model and to design sustainable multifunctional dresses as named 'Eco-Dress' to reduce fabric and clothing waste. This study adopted a mixed-method strategy. This study provided a platform to design eco-fashion clothes based on the proposed eco-fashion model.

2. LITERATURE REVIEW

2.1 SUSTAINABILITY AND APPAREL DESIGN MODEL

According to Rodriguez et al. (2002), sustainability is achieved by making profits through communication with consumers, and respect to environmental responsibilities. In terms of the fashion and apparel industry, it is a core responsibility to do business by satisfying consumers, the environment and government laws (Naz, 2019). Jin Gam et al. (2009) developed the Cradle To Cradle Apparel Design Model to address sustainability and human health issues in the apparel design process. However, Kozlowski et al. (2018) stated that most of the fashion and apparel designers, as a

centre of the design process, are not aware of Eco-fashion and apparel models, due to the lack of knowledge and time to choose effectively decision and techniques (Kjaerheim, 2013; Kozlowski et al., 2019).

Indeed, all sustainable techniques that are created to encourage sustainability must allow designers to quickly understand and get updated with news toward applying on designer's artworks (Kjaerheim, 2013). Also, one of the most barriers identified in the implementation of the sustainable design model process is reported the lack of consideration of the design criteria such as aesthetic styles, costs, and fashion trends (Hur & Cassidy, 2019). Moreover, the previous sustainable apparel design processes have developed for application in large corporate businesses. In addition, using assessment tools for choosing materials may lead to requiring training or learning for usage. Hence, it cannot connect and speak to designers directly and may lead to being confusing and difficult to use (Kozlowski et al., 2019). Therefore, focus on the "design phase" in the Eco-fashion design model is valuable rather than assessment tools. Nevertheless, from the designers, the design phase has interactions in the material selection, manufacture, transportation, packaging, use, and disposal of clothes. So, one of the factors and essential tool in sustainable design is related to the investigation of all phases involved in the clothing life cycle (Fletcher, 2008). Thus, the clothing life cycle needs more consideration in sustainability (Kozlowski et al., 2018) of the fashion and apparel design process.

2.2 CLOTHING LIFE CYCLE

Koo et al. (2014) stated that designers are at the centre of clothing the life cycle, so designers need to consider all phases during the design process. Also, they can create a significant relationship between the production phase and the consumer's need to promote the consumer's behaviour toward sustainability (Loker, 2008). Kozlowski et al. (2018) claimed that phases involved with consumers should address in the design conceptualization. Koo et al. (2014) showed a correct view of the clothing life cycle can be found in the relationship among the materials used in the production, designers those are creating them, design processes applied, and consumers those supposed to use and dispose of clothes (Koo et al., 2014). All materials in sustainable design need to meet the criteria for recyclable (McDonough & Braungart, 2002; Rumsey, 2009). Most studies are investigated cotton, polyester and recycled polyester as Eco-fashion materials for reusing and recycling purposes (Sandin & Peters, 2018).

Also, the role of the designer is not only designing clothes; most of the fashion and apparel designers often fulfill multiple roles (Kozlowski et al., 2019; 2018). However, Niinimäki (2006) stated that the attributes considered by the designer to use the sustainable materials are perceived of the quality, functionality and aesthetic attributes that will be neglected during the process, occasionally. Henceforth, understanding of the designer's behaviour toward sustainability and Eco-fashion design is a notable issue (Li et al., 2015). Moreover, Jalil and Shaharuddin (2020) showed that the designer's attitude toward the Eco-fashion design can be influenced and measured through environmental knowledge, perceived quality, price, functional, aesthetic attributes, and technology.

Regarding promote the Eco-fashion design and reduce the waste, designers are thinking to

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apply new techniques such as zero-waste designs (Jalil & Hosseini, 2020; McQuillan, 2011), design for disassembly (Jin Gam et al., 2011), technology-enabled designs (Loker, 2008) and transformable designs methods (Fletcher, 2008). However, in the production and the sustainable design process, reducing fabric waste is one of the main challenges toward sustainability which is neglected since the limitations are to apply such techniques in mass-production (Rissanen, 2013). According to Loker (2008), transformable clothes have great potential to be worn in different ways during the life cycle of clothing which can lead to reducing the customers' needs for purchasing new clothes. Besides, for developing successful sustainable products, it is essential to understand how consumers perceive and evaluate new sustainable products and what evaluative criteria they use to purchase such products (Ghalachyan, 2018). According to Jalil and Shaharuddin (2019b), the positive attitude towards the quality, price, and design is the best predictor of intention to purchase of sustainable clothing. Based on the gaps created in the previous studies, this study is proposed the Eco-fashion design model.

3. METHOD

3.1 DEVELOP THE ECO-FASHION DESIGN MODEL

This step involved in-depth interviews with eight fashion designers with more than 10 years of work experience in sustainable fashion and clothing subjects in Malaysia and Iran. The interview schedule was organised into three main parts: participant's sustainable design process, effective factors existed in their design process and demographic data. Nvivo software is employed to transcribe and analyze the interview's data. Inter-rater reliability is calculated by Cohen's kappa with an optimum value between 0.75 and 1 (as almost perfect agreement).

3.2 MULTIFUNCTIONAL ECO DRESS DESIGN

Then regarding the proposed Eco-fashion model, this study develops three multifunctional Eco dresses. Hence, a workshop was composed of four fashion designers with more than 4 years of experience and interested in sustainable design. According to the objectives of this study, two different surveys were conducted between young women consumers. The first questionnaire was about the investigation of the design concept, and the second one was designed to evaluate the multifunctional dresses. Firstly, a survey was conducted to study the "dress" items among young women and their favourite dress items for selecting a design concept. The second survey was performed to investigate the new multifunctional dresses created among those women who participated in the first questionnaire and were asked about the quality and design attributes of such dresses. The Statistic Package for Social Science (SPSS®23) is computed for descriptive statistics.

4. RESULT AND DISCUSSION

4.1 FINDING OF THE ECO-FASHION DESIGN MODEL

Eight fashion and apparel designers described their design and production processes regarding sustainability. Overall inter-rater reliability (Cohen's kappa) was 0.919, and define idea ($\kappa = 0.923$), product design ($\kappa = 0.937$) and product evaluation ($\kappa = 0.901$), all are at almost perfect agreement.

Table 1: Coding and Comparison Results from the Interviews

Steps	Coding Terms		Kappa	Agreement	Disagreement
Define User Needs and Define Idea	Market' needs (Price/Quality/Design)		0.92	92.39	7.60
	Consumer's needs	Price and Quality	0.95	95.35	4.64
		Design	0.87	88.20	11.79
	Personal belief and perception (Environmental knowledge and concern)		0.93	92.31	7.68
Design Criteria and Product Design	Personal belief and perception (Environmental knowledge and concern)		0.91	92.44	7.55
	Designers' need	Price and Quality	0.95	97.11	2.89
		Design	0.95	95.68	4.31
Evaluation and Development	Market' needs (Price/Quality/Design)		0.87	92.29	7.70
	Consumer's needs	Price and Quality	0.93	93.59	6.41
		Design	0.86	91.21	10.03
	Personal belief and perception (Environmental knowledge and concern)		0.93	93.84	6.15

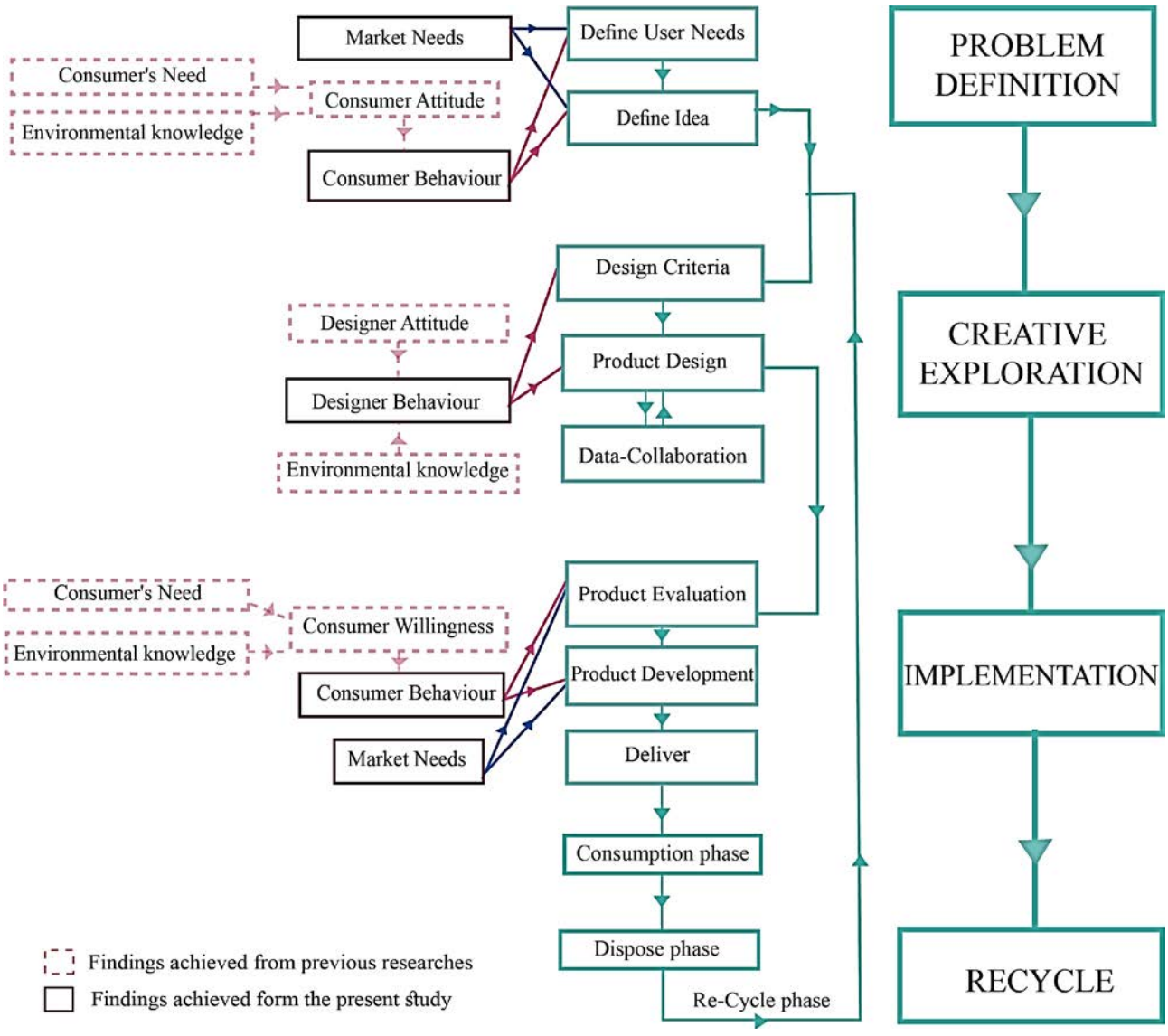

Figure 1: Eco-fashion design process model with factors derived from the clothing life cycle.

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Most participants (87.5%) reported that they had some extent changed their behaviour concerning the environment. Some small changes were implemented, such as recycling, keeping products for extended periods and resource conservation. Responses are not varied from the limitation of knowledge resources and emphasising consumer needs. Afterward, respondents were asked about criteria and factors that affect their working conditions to issue and set up sustainable design after settle style and idea. Regardless of varying descriptions rooted in professional experience, feeling and psychological themes help to put sustainable criteria during the sustainable design. A frequency analysis of coding terms in the interview can be found in Table 1. As seen from the finding, the environmental knowledge and concerns occur rather than other factors during the Eco-fashion design process (more than 92.39% of all explicit utterances in each phase). This shows that this factor is not only for the discovery of the problems but also to design and development of the product is a significant issue. The data also indicate the consideration of consumer's needs from the discovery of the problem to the implementation phase in the Eco-fashion design process is a notable issue. Consideration of the fair price and acceptable quality (economic features) rather than other needs are understandable subjects (more than 93.59% of all explicit utterances in each phase). Also, data suggest that in the design process of eco-fashion design, it is very valuable to generate ideas and evaluate items regarding the designers' experiences and perceptions. The interviews provided this study with the opportunity to further analyze important design criteria, related factors and considerations that are vital to the Eco-fashion design process. Figure 1 shows an Eco-fashion design model with related factors. Moreover, blurred boxes have been discovered by previous researchers discussed in the literature.

4.2 DESIGNING MULTIFUNCTIONAL ECO DRESS WITH FOLLOWING THE ECO-FASHION DESIGN MODEL

As shown in Figure 1, a basic model consists of three main steps which are originated from previous research (Gam et al., 2009). Indeed, it is created through an investigation between existing apparel design and the Eco-fashion design models, then it developed through the data obtained from the interview session.

Step One. The problem was identified as excessive fabric waste in the production process, as well as clothing waste in the usage phase, especially women's dresses. Hence, the main issue is the creation of the Eco dress that helps clothing consumption problem and fabric waste. The concept idea of Eco dress was primarily based on sustainable design practices that represent both basic and fashion items. Therefore, the design theme for this project was "casual style" for women age 20-30 years old. Consequently, a survey was conducted to investigate among young women and their favourite dress items for choosing a suitable and acceptable design.

A total of 128 respondents completed questionnaires that were distributed in Malaysia and Iran. 43.8% of respondents possessed a bachelor's degree (n=56) with most purchasing every 3 to 4 months (n=87). Regardless of religion or culture, young women consumers desire to have multifunctional clothes (85.9%, n=110). However, most of the respondents (78.9%, n=101) have not purchased multifunctional clothes before. 25% (n=32) claimed that they have not heard about such clothes, 76.5% (n=98) indicated that in the fashion market cannot find such clothes. As seen in Table 2, descriptive statistics of the casual dresses according to the participant's comments show

that dresses with no 3, 4, 5, 6, 9 and 12 are most attractive rather than others.

Step Two. In this step, materials were chosen. The initial goal in fabric sourcing was to use organic cotton because of body health. The significant point was that all materials were recyclable. By collaboration with the textile knitting company in Iran, the designers evaluated the double face cotton tricot as a biological nutrient from the traditional textile market in Big Bazaar Tehran. Additionally, neutral colours were chosen as a colour palette. Hence, the main issue is respect to nature, navy blue, grey and crimson colour. The designers were desired to use 90% Cotton / 10% Lycra as the Eco-fashion material. By increasing the Lycra ratio in tricot fabric, the breaking strength, weight of the fabric and resistance to pilling will be significantly improved. However, the Lycra is considered as a synthetic yarn which cannot be composed easily. Hence, according to the purposes of this study, the combination of two different materials in the construction of clothing is a major problem for the recycling program. Consequently, to achieve acceptable quality after recycling, as well as easy recycling, 98% Cotton / 2% Lycra Tricot fabric was chosen for this study.

Table 2: Descriptive Statistics of the Casual Dresses for Step One (N=128)

No	1	2	3	4	5	6	7	8	9	10
										
Mean	2.98	3.20	4.13	4.35	4.69	4.23	3.11	2.73	4.67	2.68
SD	1.07	0.95	0.68	0.75	0.67	0.51	0.93	0.99	0.42	0.98
No	11	12	13	14	15	16	17	18	19	20
										
Mean	2.88	4.52	3.23	3.03	3.49	3.16	3.32	2.70	3.76	3.38
SD	0.95	0.37	0.88	0.88	0.77	0.71	0.53	0.99	0.72	0.88

The design concept and development of these prototypes were primarily based on the zero-waste concept and the multifunctional design. All designers were familiar with a computer-aided design which was applied to pattern making and grading through using zero-waste design methodology. For this study, medium size (38) in the global standards grading was accepted. All dresses were made with some detachable parts using a zipper as attaching or detaching joints that increased interchangeability. Since the designers created all dresses based on the zero-waste technique, so the little different shape in style can occur. Henceforth, six dresses with high means (more than 4) were chosen. However, regarding multifunctional design, only three dresses were selected. It means, each dress can covert and be worn in different styles, then all three dresses can support more than six different outfits. A multifunctional sheath dress can support four different outfits: sheath dress, sheath blouses, straight skirt, and sleeveless tonic (Figure 2-A). A multifunctional jumper dress can support three different styles with different designs in sleeve

length (Figure 2-B). A multifunctional jumpsuit can support four different outfits: shirtwaist dress, jumpsuit, tonic and overall dress (Figure 2-C).


(A)


(B)


(C)

Figure 2: (A) Multifunctional Sheath Dress, (B) Eco Jumper Dress and (C) Eco Jumpsuit.

Step Three. Overall, all Eco dresses have a casual look designed with multifunctional ability. After a useful lifespan, they can be disassembled easily. Cotton fabrics can either become compost or use into a new purpose. The polyester fabrics can be melted down and then remade into new fabric or burned for energy. From the consumer's evaluation, participants of the design concept survey (first questionnaire), were asked again to rate the following three questions on a five-point scale about their experiences: (1) Are you interested in the multifunctional Eco dress design? (mean = 4.28); (2) Are you satisfied with the cotton as the fabric for the multifunctional Eco dresses? (mean = 4.04). Our participants were pleased and satisfied with this type and creative designs, and (3) Did you enjoy and satisfied with the Eco dresses and prices? (mean = 4.15). Interestingly, 27.5% and 20.0% of the participants were willing to pay 1-15% and 16-30% more for a piece of the multifunctional dresses, respectively. This finding agrees with the previous study conducted by Jin Gam et al. (2011). Only 10 participants (9.0%) did not want to pay more for such dresses instead of dresses in the fashion market. Only forty participants (31.25%) believed that they shopped for such dresses, they were extremely conscious and paid a great deal of attention to environmental concern. Table 3 shows details of the Eco-fashion design framework in designing the Eco dresses.

Table 3: Steps of the Eco-Fashion Design Process applying in Eco Dress Design

Step	Description
Step One Problem Definition	**Problem Identification**: Excessive clothing consumption, increasing clothes and fabric waste are originated from environmental concerns. Purchasing many dresses only for one event is originated from consumer's needs which affects their behaviour to the intention of purchase clothes.
	Search for Alternative: The multifunctional dress and Eco-friendly attributes based on market needs.
	Generation a Concept: Positive reaction to possessing the multifunctional dresses among young women based on the searching their needs as well as market demands.
	Select Definitive Idea: Creating a multifunctional dress with consideration of the sustainable characteristics which are originated from their concerns and knowledge.
Step Two Creative Exploration	**Environment Protection**: Organic cotton tricot fabric, zipper, and threads were selected based on the environmental protection property, good quality, acceptable price, high performance, and good appearance which is originated from the designer's environmental knowledge, perceived the material attributes, and design features.
	Quality and Pricing value requirements: The price of organic cotton tricot is acceptable (3.1 $ per meter). Moreover, according to the finding achieved in the textile market, the quality of the organic cotton tricot is good and gives a wonderful feeling in touching them which is derived from a designer's attitude of such fabrics.
	Functional and Aesthetic requirements: Good functionality in multi-size (is an important thing in the mass-production of tricot dress), smoothness, durability, elasticity, and good resilience which is derived from the designer's attitude of cotton tricot fabrics.
	Conceptual Design: 3D simulation software is applied to find the best use of the fabric and grading in patternmaking of the mass-production, so no fabric or paper was wasted which is originated from the designer's environmental knowledge and concerns.
	Embodiment Design: Using (1) zero-waste design for minimization or zero fabric waste and (2) multifunctional design for improving utilization dress and allow for adaptation, as well as upgradeability which is originated from the designer's attitude of functional, aesthetic and technology features in the design.
Step Three Implementation	**Cost Evaluation**: In comparison with ready to wear dresses in the market, the price was acceptable (this research is under university research, the evaluation of price is not considered as a goal of this study).
	Evaluation of Design and Quality: All Eco dresses have a casual look designed and they can be disassembled and recycled easily which this evaluation comes from personal environmental knowledge and design features.
	Refinement: For mass production should change some alternations based on the consumer's needs, market demands, and the designer's belief.
	Prototype Development

The first phase is to define consumer's needs and define idea to set a scenario which supports three related factors: market needs, consumers needs such as the desired end-use, suits consumers taste, economic features, and individual's environmental knowledge, where they are in line with findings of Jin Gam et al. (2009). So, it should be considered that aspects of economic issues, aesthetic and function features are significant value in define the best idea for solving problems. Moreover, discovering the consumer's behaviour which is guided through their needs and beliefs is one of the related factors which designers need to know before starting the Eco-fashion design process which is the following findings of Jalil and Shaharuddin (2019b). Hence, in this phase, the designer team seeks to identify and analyze the problems of the dress items among women to create and select the definitive idea. So, it was defined that multifunctional design with consideration of the related factors is a solution design. The second phase is to discover the design criteria and focus on the details in the design process. It can develop Eco-fashion designs from the created idea

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toward matching with the sustainable criteria by considering these three factors; individual's environmental knowledge and concerns, material features such as the quality and price features and design outlook such as functional, aesthetic and technology attributes. The findings resonate well with Niinimäki (2015) showed that designers should explore all these important factors which help to set up the design criteria in designing with sustainable materials.

Therefore, initial imagery of the designer's thoughts and their perceptions of sustainable issues as well as sustainable materials should be exposed in this step for further interaction with the design team, which is in line with the finding of Li et al. (2015). According to the results from the in-depth interviews, the perception of the quality, price, aesthetics, and functionality are common features that designers used to set up the criteria in the Eco-fashion design process which the finding agrees well with Niinimäki (2015). Hence, design features will be created based on these criteria and designers create conceptual and embodiment design through sustainability issue information. Therefore, based on the interview's findings in the conceptual design phase, first, a design sketch including ideas and concepts in text or graphics are developed through utilizing the computer-aided design programmes.

Our findings resonate well with Kjaerheim (2013) that showed utilizing the computer-aided design programme to reach the goal with saving time and money is an effective way in sustainability. Consequently, in the embodiment design phase with considering the related factors, qualified designs are selected, and the design team prepare samples or consult with other companies for improvement to meet the design criteria. Results show that designers commonly used zero-fabric waste design, redesign technique, minimal seam construction, design for disassembly and multifunctional designs to display sustainability perspective during the embodiment design phase, where all are originated from their environmental knowledge and concerns which is line with Jalil and Shaharuddin (2019a) Hence, an effective design technique can be proposed at the end of this phase in response to the original objective.

In this study, using cotton tricot with 100% usage in the pattern-making and draping process as an approach to reduce cotton waste, as well as save time and money to make a prototype is considered. The third phase is about the evaluation and development of the prototype to deliver in mass production. In this step, four categories are to help for judgment: consumer needs, design features of the quality, price, functional and aesthetic features, market needs and individual's environmental knowledge and concerns. The finding agrees well with Jalil and Shaharuddin (2019a) that showed all criteria and design features identified by the designers will help the design team to check and make a correct decision in the sustainable design issues in the evaluation stage. During this phase, the Eco-fashion design output may require modification based on the evaluation by consumers. This phase also provides some suggestions to improve environmental knowledge and concerns in society.

This framework was applied to create three Eco dresses made of Eco-fashion materials by focusing on the multifunctional convertible design. As shown in the findings, each step has the specific concepts that should follow by the designer team based on the design criteria achieved in this study. The importance of developing an Eco-fashion design model with focusing on the clothing life cycle shows positive effects on the consumers, preserving the planet, and making

profits which are regarded as the finding of Koo et al. (2014). In other words, applying the proposed Eco-fashion model with consideration factors can lead to reducing environmental and social impacts. This finding agrees well with Rumsey (2009) since this model can help the designer and manufacture to identify the material, so, the amount of unsafe material released into the planet and living place can be reduced as they are threatening health problems of current society. Besides, all multifunctional dresses can be recycled and returned to the economic system instead of burning.

Hence, it can help to excessive use of Eco-fashion material resources, therefore, it can support the recycling programmes and decrease the use of other material resources and the creation of waste which is in the findings of previous research (Cao et al., 2014). Moreover, Eco dresses with multifunctional properties would increase clothing utilization, reduce the need to purchase unnecessary clothes and eliminate clothing waste. Fashion designers and manufacturers can save money and time to produce Eco multifunctional dresses. It will be focused on the preserve the environment and making profits with consideration design and quality criteria through using Eco-fashion materials, applying zero-waste design processes and sustainable design techniques which are in line with the finding of previous research (Jin Gam et al., 2009). Regarding order to promote improved clothing disposal for recycling, the findings and impacts of this study can be analyzed from a managerial viewpoint. Consequently, it leads to produce clothes made of recycled materials and finally distribute in the fashion market. Using the Eco-fashion design model may lead to designers and manufacturers consider more to choose the materials and techniques based on human safety and environmental health.

5. CONCLUSION

The proposed model of the Eco-fashion design process is constructed based on the consideration of phases involved in the clothing life cycle; consumer, designer, material, and design process toward extending the lifespan of clothing. Also, when research focuses on individuals and their role, it means that effects on the social and psychological issues are involving in the research area. Hence, the developed Eco-fashion design model has combined two important subjects: the structure of Eco-fashion and apparel design process and social issues. Therefore, the proposed Eco-fashion model considers the consumer and their behaviour, the designers and their behaviour, the Eco-fashion material and sustainable techniques in the existing Eco-fashion and apparel design process model. Regarding increase pollutions generated by the fashion industry whether, in production, consumption and disposal, guided by the concept of sustainable apparel design models and adaptable apparel design, this research applied multifunctional design in the fashion process and created three multifunctional Eco dresses.

Thus, the number of harmful chemicals and clothing waste released into the community could be reduced by using Eco-fashion fabrics and applying the zero-waste technique. The attaching and detaching separate parts in Eco dresses are easily and enjoyably figured out. Also, the multifunctional dress provides a solution to control consumption and purchase. However, it is necessary to understand consumer needs to the target in the fashion market. So, in this stage, the fashion industry needs persons who specialise in fashion psychology and Eco-fashion designs for a

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specific purpose. In the future study, additional options for the Eco-fashion design in many styles are suggested to make different outfits daily. Also, studying other design methods, the development of style and accessories in multifunctional dresses would be highly recommended and beneficial for the people, environment, and economic perspective.

Although the mixed approach design used in this research increases confidence in the results, there are also some limitations in this study. This paper considers clothes made of Eco-fashion materials especially materials achieved from recycling technologies; so, the findings may be different for other types of clothing. The current study mostly reported the intention of fashion design with Eco-fashion materials. More details on developing the Eco-fashion design and investigation of technologies in designing could, as a result, be explored in future research. Finally, the author as researchers needs to show the existing gap in fashion education and awareness system about Eco-fashion clothes. Hence, it can be applied to fashion design education. This study's framework may serve as a guideline for future research by the larger sample size in the Eastern and Western worlds.

6. AVAILABILITY OF DATA AND MATERIAL

Data can be made available by contacting the corresponding author.

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8. REFERENCES

Cao, H., Chang, R., Kallal, J., Manalo, G., McCord, J., Shaw, J., & Starner, H. (2014). Adaptable apparel: a sustainable design solution for excess apparel consumption problem. *Journal of Fashion Marketing and Management*, *18*(1), 52-69.

Fletcher, K. (2008). *Sustainable fashion and clothing*, United Kingdom: Basım Routledge.

Ghalachyan, A. (2018). *Evaluation of consumer perceptions and acceptance of sustainable fashion products made of bacterial cellulose.* PhD Dissertation, Iowa State University, USA.

Jalil, M. H., & Hosseini, S. K. (2020). Quest for the Fashion Market: Zero-Waste Skirt Design as a Solution Toward Sustainable Pattern Making. *The Chitrolekha Journal on Art and Design*, *4*(2), 1-11.

Jalil, M. H., & Shaharuddin, S. S. (2019). Adopting C2CAD Model To Eco Capsule Wardrobe Design. *International Journal of Scientific & Technology Research (IJSTR)*, *8*(12), 1224-1233.

Jalil, M. H., & Shaharuddin, S. S. (2019). Consumer Purchase Behaviour of Eco-Fashion Clothes as A Trend To Reduce Clothing Waste. *International Journal of Innovative Technology and Exploring Engineering (IJITEE)*, *8*(12), 4224-4233.

Jalil, M.H., & Shaharuddin, S. S. (2020). Fashion Designers Behaviour Toward Eco-Fashion Design. *Journal of Visual Art and Design (JVAD)*, *12*(1), 1-22.

Jin Gam, H., Cao, H., Bennett, J., Helmkamp, C., & Farr, C. (2011). Application of design for disassembly in men's jacket: A study on sustainable apparel design. *International Journal of Clothing Science and Technology*, *23*(2/3), 83-94.

Jin Gam, H., Cao, H., Farr, C., & Heine, L. (2009). C2CAD: sustainable apparel design and production model. *International Journal of Clothing Science and Technology, 21*(4), 166-179.

Kjaerheim, K.M. (2013). The exploration of a sustainable design method targeting the conceptual and creative design stage. *Master's thesis, University of Iceland, Iceland.*

Koo, H.S., Dunne, L., & Bye, E. (2014). Design functions in transformable garments for sustainability. *International Journal of Fashion Design, Technology and Education, 7*(1), 10-20.

Kozlowski, A., Bardecki, M., & Searcy, C. (2019). Tools for Sustainable Fashion Design: An Analysis of Their Fitness for Purpose. *Sustainability, 11*(13), 3581.

Kozlowski, A., Searcy, C., & Bardecki, M. (2018). The reDesign canvas: Fashion design as a tool for sustainability. *Journal of Cleaner Production, 183*, 194-207.

Li, J., Tam, V.W., Zuo, J., & Zhu, J. (2015). Designers' attitude and behaviour towards construction waste minimization by design: A study in Shenzhen, China. *Resources, Conservation and Recycling, 105*, 29-35.

Loker, S. (2008). A technology-enabled sustainable fashion system: Fashion's future. *Sustainable fashion: Why now*, 95-126.

McDonough, W., & Braungart, M. (2002). Design for the triple top line: new tools for sustainable commerce. *Corporate Environmental Strategy, 9*(3), 251-258.

McQuillan, H. (2011). Zero-waste design practice: Strategies and risk-taking for garment design. *Shaping sustainable fashion: Changing the way we make and use clothes*, 83-97.

Naz, F. (2019). Exploration of Sustainable Practises in Children's Wear Fabric Development. *Master's Thesis, California State University, USA.*

Niinimaki, K. (2006). Ecodesign and textiles. *Research Journal of Textile and Apparel, 10*(3), 67-75.

Niinimäki, K. (2015). Ethical foundations in a sustainable fashion. *Textiles and Clothing Sustainability, 1*(1), 3-13.

Rissanen, T. (2013). *Zero-waste fashion design: a study at the intersection of cloth, fashion design and pattern cutting*. PhD dissertation, University of Technology Sydney, Australia.

Rodriguez, S.I., Roman, M.S., Sturhahn, S.C., & Terry, E.H. (2002). Sustainability assessment and reporting for the University of Michigan's Ann Arbor Campus. *Center for Sustainable Systems, Report No. CSS02-04, University of Michigan, Ann Arbor, Michigan*.

Rumsey, R. (2009). *Design for Disassembly an Implementation of C2CAD Framework.* Master's thesis, Oklahoma State University, USA.

Sandin, G., & Peters, G. M. (2018). Environmental impact of textile reuse and recycling: A review. *Journal of Cleaner Production, 1*, 1-24.

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