Online Journal of Art and Design
volume 11, issue 5 (Special Issue), December 2023

Green Design of Multifunctional Children's Clothing: A Conceptual Framework

Sun Shuyan
Faculty of Art and Design of University Teknologi MARA Shah Alam, Malaysia

Zainudin bin Md Nor
Faculty of Art and Design of University Teknologi MARA Shah Alam, Malaysia

Jiao Yujun
Foshan Nanhai Vocational School of Polytechnic, China

Abstract
This paper discusses the conceptual framework of green design for multifunctional children's wear. There are still many problems with children's clothing on the market, which hinder environmental sustainability and threaten the physical and mental health of children. This topic is mainly devoted to the study of children's wear green design, combining environmental protection with health. This study will contribute to the development of the local economy and sustainable development of children's wear-related enterprises at home and abroad and will also enrich the research on the environmental protection of children's wear. The green design of children's wear is realized from the perspective of optimal design, environmental protection materials and user needs.
Keywords: green design, multifunctional, children, clothing, health

1 INTRODUCTION

In recent years, under the influence of the rapid development of social economy and productivity, people's daily living garbage is increasing day by day, which has brought nonnegligible adverse effects on human life. At present, the number of children in China is about 400 million. It can be seen that the demand for children's clothing is very large (Cao, 2015). According to statistics, more than 100 billion pieces of clothing are produced every year, and the market size of the apparel industry is as high as $2.5 trillion. China is the world's largest producer and exporter of garment textiles. According to the calculation, the number of industrial enterprises in the garment industry in China reached 170,000 in 2020, and the total output of garments was about 71.2 billion. With the rapid increase in consumers' demand for fashion clothing, the resource consumption of the apparel industry and textile waste will increase, which will cause greater pressure on the ecological environment (Li, 2022). In addition to a sewage discharge in the textile industry being the front of all industries, the discharge of other types of pollutants should not be underestimated. In 2015, the chemical oxygen demand of the textile industry was 206,000 tons, accounting for 8.1% of the total industrial chemical oxygen demand, ranking fourth in all industries. In 2015, the ammonia nitrogen emission of the textile industry was 15,000 tons, accounting for 7.5% of the total industrial ammonia nitrogen emission, ranking fourth among all industries (Gao, 2020).

Post-80s and post-90s generations are the first generations of only children in China. They, as the parents of the new generation, are constantly infiltrated by the concept of green development, and their consumption concept is completely different from that of the previous generation. While pursuing practical and beautiful clothing products, they pay more attention to the quality of clothing and green environmental protection performance (Wang, 2019).In face of high pollution and high energy consumption in the industry, in order to cater to the new green consumption trend, the only way for enterprises to move forward is to break the traditional mode of production and operation, the children's clothing industry must realize the sustainability of the whole process of clothing from design,

production, wearing to recycle, and build a transparent, low carbon, high quality and high standard new architecture development model, so as to promote the textile clothing industry into the green economy development period (Ji, 2017).

Against the background, this paper aims to explore the innovative design and application of green children's clothing based on the analysis of the environmental dyeing process, consumer demand and multi-functional design of clothing structure, so as to expand the added value of children's clothing products, and thus accumulate corresponding children' s clothing design experience, and ultimately provide corresponding theoretical and practical experience support for children's clothing design and development.

2 LITERATURE REVIEW

China's children's clothing industry is still in its infancy. Among men's and women's wear industries, the development of the children's wear industry is relatively backward and weak (Wang, 2019). For a long time, it paid more attention to the practicality and beauty of style, rather than environmentally innovative design. This is incompatible with the current trend of advocating green design and focusing on internal quality and cannot meet people's growing spiritual and cultural needs (Zhang, 2011). In addition, children's wear designers lack an understanding of the psychological and physiological characteristics of babies. It is a common phenomenon that the design of children's clothes in the market is often adult-oriented. Influenced by Chinese tradition on the color custom of children's clothes, designers do not consider the psychological and physiological damage caused by strong stimulating colors in clothing colors, and there is no professional organization to study the trend of popular colors in children's clothes (Hu & Liang, 2003).

2.1 Environment Dyeing

Asim Kumar Roy CHOUDHURY (2018) put forward the following requirements for eco-friendly dyes and dyeing. Firstly, dyes must be biodegradable. Then, the non-toxic and non-carcinogenic dyes, when used, do not harm the human body. Finally, green auxiliaries are used in the dyeing process. According to scholars, Chinese people have realized that using natural plant dyes is a way to protect the environment in the textile industry. Chinese plant dyeing has been an important means for people to dye textile fabrics (Cao, 2008). The damage to human skin can almost be ignored (Wang, 2014). Natural plant dyes can not only present special aesthetic quality but also bring culturally added value to textile production. With the development of social civilization, people gradually have a more mature understanding of plant dyeing, and the plant dyeing process has also changed greatly (Jia, 2005). The ancient dyeing process can be summarized as direct dyeing process, mordant dyeing process and complex dyeing process according to whether to add mordant and the types of dyes used in the dyeing process (Li, 2020). Lai and Chang (2021) find that in order to realize the sustainable design of clothing, the color of a light color system should be relied on in the use of the plant dyeing process. The application process of natural dyes is more difficult than that of synthetic dyes (Luo & Chen, 2018). In order to realize industrialization, Only by combining traditional crafts with modern science and technology, can traditional crafts better survive and develop in the new environment (Zhang, 2018). Nowadays, traditional craftsmen can use modern computer-aided design software and engraving machine to complete the sketching and engraving process and can use modern electronic technology achievements to import manually designed patterns into computer systems with digital boards, and thus establish a database of patterns to improve work efficiency (Zhang, 2018). In addition, during the production process, a folding rope can be used to replace manual sewing tie-dyeing, batch flow operation should be carried out, and electric hanging dyeing equipment, electric dyeing equipment, dryer, washing machine and other related mechanical equipment can be used (Luo, 2018).

It takes about 2,700 litres of water to make a cotton shirt and 7,500 litres to make a pair of jeans, while a person only drinks about 1,000 litres a year (Zhao, 2019). The entire product life cycle has an influence on the earth, starting from raw material supply,

transportation, retail and scrap processing (Xu et al., 2008). Textile wastewater usually contains alkali, organic acids, organic dyes, finishing agents and non-biodegradable inorganic salts, which makes the printing and dyeing wastewater carries the characteristics of large quantity, complex water quality, high chemical composition concentration and difficult treatment (Wu, 2021). In order to solve this problem, Ito Chung Commodity in Japan developed an anti-microbial, deodorant, and antiallergic green tea dyeing technology with green tea as the raw material. Germany developed the supercritical sulfur dioxide fluid dyeing technology, which does not contain any carcinogens or involves water or chemical dyes in the whole process of operation. It's an environment-friendly, green and healthy dying technology (Wang, 2013). Sun et al. (2007) in China made a linear molecule containing a bis-epoxy bis-quaternary ammonium salt structure. The cotton fabric changed by linear molecule does not need inorganic salt in dyeing, can be well dyed and fixed, and the levelness and fixation are good after dyeing. Chitosan derivatives (NMA-HTCC) can also be used as salt-free dyeing auxiliaries to improve the dyeing rate and other properties of the fiber (Ma, 2001).

In order to deal with toxic compounds, the textile industry has tried various methods, including adsorption, oxidation, anaerobic decolourization, catalysis, ion exchange, membrane filtration, flocculation and ozone oxidation. However, all these methods have some disadvantages. Although they can effectively reduce pollution, they are expensive and produce corresponding solid waste (Ma,2006). Currently, desalination technologies that have been used globally are membrane separation and ion exchange techniques, whose effect is not satisfactory (Yu, 2014). Some people use electrochemical dyeing for salt-free dyeing of reactive dyes, that is, in the pre-alkali dyeing of reactive dyes, the method of electrochemical salt-free dyeing is used, the positive electrode connected to the fabric to be dyed and the negative electrode is added in the dyeing bath, the direct current connection is made and voltage is applied for dyeing (Zhao,2019).In addition, Foam dyeing is an attractive alternative to traditional dyeing methods due to its potential environmental and economic benefits (Kumar & Yaashikaa, 2018). Foam finishing is another approach to reducing water consumption and processing cost (Lakshmanan & Raghavendran, 2017; Raichurkar & Ramachandran, 2015; Seshama et al., 2017; Teli & Pandit, 2017). By using this technique, dyeing, printing, and different types of functional finishes can be applied by the kiss roll or knife-over-roller coating processes (Samanta et al., 2019).

2.2 Environment-friendly Fabrics

Organic Clothing is defined by how Clothing should be produced without the use of sewer-sludge fertilizers, most synthetic fertilizers and pesticides, and genetic engineering (Aaijaz, 2010). Common environmentally friendly fabrics are organic cotton, hemp, silk, bamboo fiber, colored cotton and regenerated protein fiber, which are not only pollution-free but also more comfortable, and loved by people. Rough fabric or fabric not green enough is easy to affect children's delicate skin, making children uncomfortable or allergic (Lovins, 2008). Therefore, the basic requirements for kids' wear are that they are fit for play, comfort, and rest. In this vigorous world, children are given more care and attention in the selection of their garments. The designers need more concentration on simplicity, comfort, and new looks in designing children's garments. Safety and comfort are considered top priorities when selecting fabrics for manufacturing children's apparel (Dogbey, 2015). Besides, environmentally friendly children's clothing fabric should be in line with the cradle-to-cradle principle (Lovins, 2008), according to which the product can realize multiple life cycles. Products will be reused after being discarded, which means that they can be recycled into new materials. This means that these materials, dyes, chemicals and auxiliary equipment must be biodegradable (Niinimäki & Armstrong, 2013).

Organic Cotton

In agricultural production, organic cotton is mainly based on organic fertilizers, biological control of pests and diseases, and natural farming management, without the use of chemicals, and the production process from seeds to agricultural products is all-natural and

pollution-free (Gao et al., 2011). Pollution-free natural colored cotton is a new type of textile raw material cultivated by modern bioengineering technology, and the fiber has a natural color when cotton is spun (Wei, 2011), It is a kind of fabric without chemical dyeing. This fabric is air-permeable, comfortable, soft, pastel-colored, natural and simple, pure-quality, non-static and et al (Song, et al., 2006). On the premise of not needing bleaching and dyeing, it has realized the "full-process pollution-free" processing technology of spinning, weaving and garments (Chen et al., 2022). The world's major cotton-producing countries are committed to the study of colored cotton. In the "development technology of naturally colored cotton", China is in a leading position in the world. However, naturally colored cotton develops slowly with imperfect chromatography, poor color fastness, fine fiber line density, poor maturity, and low strength and yield (Liu, 2018).

New Environmentally Friendly Fabrics

New environmentally friendly fabrics become one of the main directions for the development of the textile industry. Nature environment-friendly fabrics have one or all characteristics of warmth retention, antisepsis, moisture absorption and permeability (Zhang & Cong, 2013), and become the major fabric to produce special clothing such as children's clothing, underwear, and medical clothing (Wang, 2013). Regenerated protein fibers are the sum of renewable fibers such as milk, peanut, maize and soybean protein (Liu et al., 2019), it has good moisture absorption, and will do no harm to human skin, which has certain health benefits (Jiang, 2020). Clothing made from soybean fiber is soft, with excellent wrinkle resistance and drapability (Liu, 2018). However, clothing spun with pure soybean fiber usually has poor shape retention. This is why soybean fiber is often blended with other fibers in the development of clothing-related products (Tang, 2006). Among other protein fibers, corn fiber clothing made of corn is as soft as cotton, with natural luster and an excellent sense of pendant of silk fabrics. The fabric made of milk fiber is light, soft, smooth, and of special biological health benefits. It is rich in moisturizing factors and can maintain and improve skin quality. It is the best fabric for underwear (Liu et al., 2008).

Modal Fiber

Modal fiber belongs to true wood cellulose fiber. Modal fiber, with a luster like silk and excellent permeability, is natural, degradable, soft, smooth, and hygroscopic, and integrates the beautiful texture of the natural fabric and the practicability of synthetic fiber (Liu, 2010). Its formation requires organic solvent as a medium, which can be spun and processed after dissolution. However, this medium does not harm the human body, and the discharge of residual liquid does not harm the environment. Therefore, Modal is also a common component of infant fabric (Liu, 2015). Bamboo fiber extracted from natural bamboo by high technology can truly be viewed as a new natural environmentally friendly fiber. It is a superior material among natural fibers in terms of permeability, water absorption and abrasive resistance. In addition, people prefer bamboo fiber due to its natural antibacterial and anti-ultraviolet function (Wang et al., 2021).

2.3 The Design of Children's Clothing

Clothing regeneration design is a systematic concept. In a broad sense, it is a targeted design for the waste of resources and environmental pollution that may occur in the whole life cycle of clothing products, so as to minimize the consumption of resources and environmental damage and make full use of various types of waste generated by each stage. Clothing works, with practical, simple and plain design styles, should abandon some complicated designs, avoid the waste of materials, and minimize the use of luxurious materials or materials that consume plenty of manpower and material resources, so as to update the concept of green regeneration design continuously, and finally gradually improve and realize the recycling of the entire textile and garment industry, which covers clothing fabrics, style structure design, color and pattern (Liu, 2021).

Fashion consumer products tend to develop quickly, and pay more attention to quantity, and less to quality. It greatly shortens the average service life of clothing products (Bianchi & Birtwistle, 2010). To achieve the goal, which mainly develop durable and high-quality products that can be used eternally. we can extend the service life of products from the design strategies of product reliability, durability, easy maintenance and maintainability, long life assurance, upgradeability, variability design and classical style design. In addition, there are major challenges to long-term retention of clothing, that is, how to make consumers satisfied with the products all along, and how to effectively expand the use of clothing so that people need not change clothing every season (Van Nes, 2006). Essi Karell et al. (2020) believe that in order to extend the service life of products, designers can try to avoid popular trends, design eternal and durable styles, and consider the design of clothing with multiple uses and functions, such as some practical means including diverse sizes, deformability, or loosen pattern design, especially when designing children's clothing. Designers should pay attention to the casual collocation and functionality of clothing on the basis of ensuring its beauty and comfort (He et al., 2014).

According to Walker, only when products are of great significance to people can they be properly preserved (Walker, 2006). Designers must strengthen consumers' attachment to products. Only when consumers have a profound attachment to certain clothing can they possibly retain the clothing for a long time. From a sustainable fashion point of view, the design of new services is suggested as a way forward for more sustainable fashion practices and buying. Kirsi Niinimäki (2013) writes how for example "services that aim to extend how long garments are used offer value in the sustainable context". She adds, "one challenge in the current system is how to design products added with services that encourage consumers to adopt more environmentally responsible behavior". This is perhaps where Service Design could assist in designing services that trigger an emotional response, that engages and entice customers to use these services, through the experience they provide. Armstrong (2013) suggests the social experience surrounding the object could be a means to move from consumption, while Niinimäki (2013) points out that with a Service Design approach, the focus on designing for experiences could help the consumer become more socially responsible, through the experiential value they offer.

The color design of textile clothing, as the second skin of human beings, plays a vital role in children's growth. Green can well soothe the nervous system, red can force children to act positively, pink can eliminate negative emotions, blue can develop children's imagination and enrich their inner world, and orange can make children happy. Therefore, when designing children's clothing, designers should take these factors into consideration. In addition, the color design of children's clothing can only be determined after professionals' analysis based on psychology and Kansei engineering. According to experts, children aged 2 to 5 can identify different colors and have their own preferences. Children of this age generally prefer red and yellow. After the age of 6, children's knowledge of color becomes richer, and their color views become more personalized. Children's preferences for colors not only vary but also change with seasons. For example, in warm seasons, children prefer cold colors, while in cold seasons, they prefer warm colors. However, no matter in which season, they do not like black, purple, gray and brown, which, in their minds, are often associated with evil characters in cartoon fairy tales (Monika & Tetyana, 2020).

Wu & Yuan (2019) showed that natural fiber fabrics should be selected to design green children's clothing, and the safety, comfort and environmental protection of children's clothing should be fully considered. Green clothing design, with simpleness and elegance, sturdiness and duration, freshness and comfort as its main purpose, combines the enjoyment, safety, comfort, functionality and aesthetics of children's clothing. "The 'Jigsaw Jacket'" mentioned in the paper is a kind of clothing with removable and interchangeable parts, which can be added to the recycled plastic on children's raincoats as the basic

material for children's growth. Therefore, users need only order parts to meet children's growing requirements (Earley, 2017).

Li & Zhang (2007) believed that the research of clothing function was mainly aimed at maintaining individual survival, health, high efficiency and comfort of life. The formation of clothing function, based on the material properties that constitute clothing, is comprehensively formed by various elements that constitute clothing, and can only be shown in the natural and social environment in which the clothing is worn. Therefore, the function of clothing is based on the premise of the human body-clothing-environment system. The design and development of functional clothing are driven by the selection of materials. Based on users' psychological or physiological needs, it considers the design elements, dimensions and suitability from the aspect of ergonomics. Therefore, Deepti Gupta proposes a functional clothing classification system based on a wide range of design parameters for the development of specific functional products. He divided functional clothing into clothing with the function of protection, medical treatment, sports, vanity, cross-functional components and special needs, covering most of the logical types of functional clothing currently in use or under development. Each different category may have a subcategory, which has similar principles to guide product design, and the final product can be applied in various fields. Protective functions include environmental protection, biological, chemical and radiation protection, medical functions include treatment, rehabilitation and monitoring of physiological parameters, sports functions include increasing clothing performance, slowing down fatigue or stress, and body shaping, cross-functional components mainly refer to the clothing with multiple wear forms or suitable for different occasions, and clothing with the function of special needs is mainly designed for special groups and occasions, such as disabled people, mental patients, the elderly and so on (Gupta, 2011).

The design of ecological children's clothing should not only meet children's actual needs of growth, but also pay attention to the service life of children's clothing products, so as to ensure children's healthy growth, and meanwhile save resources and protect the environment. Clothing designers, when designing children's clothing styles, can try to extend the service life of the clothing. For example, they can make some attentive designs at the cuffs, trousers corners and waists to solve the problems brought by children's growth, so as to better extend the service life of children's clothing (Cui, 2014). The color design of ecological children's clothing should fully consider the actual demands of children of different ages. For example, infants usually prefer bright colors, while preschool children prefer clothing with relatively stable colors. In addition, ecological children's clothing should fully consider whether too much pigment is added to the color of clothing, whether the color fastness of the clothing is up to the standard, and whether the offset, laser and other decorations on the clothing are safe (Cui, 2014).

2.4 Post-processing of Textile and Garment

There are relatively few studies on how to dispose of products. Recycling clothing is one of the activities that contribute to sustainable environmental development. Through recycling, the textile industry can reduce the damage to nature by reducing the use of raw materials. However, most consumers do not understand the environmental problems associated with man-made fiber and cotton production (Birtwistle & Moore, 2007). They do not feel guilty when dealing with expensive old clothes in an improper manner and are not interested in matters related to ethics and social awareness (Yee et al., 2016). With regard to the post-processing of textiles and garments, the United States has made a good example. In the United States, with the help of skilled workers, people carry, and change old clothes or modify them at sewing stations. The worn clothes are trimmed, cut, re-sewn, re-repaired and reshaped (Aaijaz & Ibrahim, 2010).

2.5 Sustainable Development of the Cloth Industry

At present, the social and environmental problems brought by the fashion industry are well known. Countries around the world have tried to develop sustainable clothing from the aspects of production methods, materials, design practices and business models. However, despite a number of initiatives and actions, the fashion industry seems to have no great changes. In "Pulse of the Fashion Industry 2019 Update", it is said that fashion companies have not implemented sustainable solutions quickly to offset the negative environmental and social impact of the rapid growth of the fashion industry. In fact, many scholars at home and abroad have put forward environmentally green designs in the clothing industry. For example, Anastas and Zimmerman (2003) believe that preventing waste production is better than treating or cleaning waste. The clothing industry mainly produces chemical residues and residual waste in the production process. Clothing residual waste means that each piece of clothing will produce some textile waste in the process of pattern cutting, with an average of 15 % per piece of clothing. If the textile and garment industry can implement the concept of zero waste and limit the production of waste materials to a number less than 15 %, the waste of raw materials can be greatly reduced. During the process, the role of designers is particularly important. In addition to having a good aesthetic taste, they should also be familiar with the production and sewing process of patterns. When making prototypes for some clothing designs, they should use creative technology to cut or manipulate patterns (Nursari & Djamal, 2019). American researchers, Saeidia & Wimberleyb (2015), tried to reduce the waste production of textile and clothing through two methods: jigsaw puzzles with fixed areas and deformation reconstruction, and explained that it was easier to use deformation reconstruction to make well-fitting clothing compared with jigsaw puzzles with fixed areas.

2.6 Sustainable Apparel Design Conceptual Framework

The unified form of Cradle to Cradle mode (C2C) proposed by Mcdonough and Braungart (2002) has been conceptualized in the fashion design industry. The model introduces a new approach to designing clothing that reduces a large number of environmental issues at the design stage. The model aims to develop, apply and evaluate the Conceptual Framework for clothing design and Production (C2CAD), providing designers and manufacturers with environmentally substantial potential. When Naz (2018) Investigates the possible sustainable practices used in developing children's wear fabrics, he draws on the C2CAD framework, so as to ensure valuable production guidance for designers and manufacturers. Through the C2CAD framework, designers and manufacturers have the opportunity to select specific chemicals and materials based on considerations related to human and environmental health and safety.

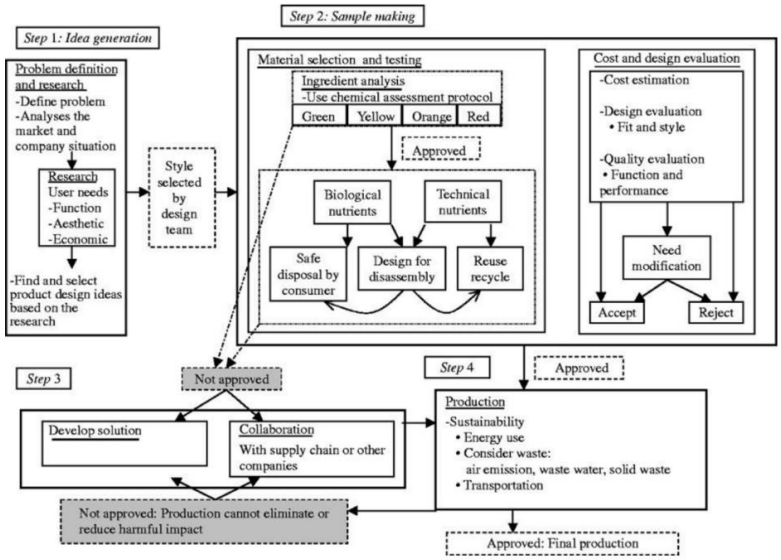

Figure 1: Cradle to Cradle mode (C2C)
(Mcdonough and Braungart,2002)

From what has been discussed above, the particularity of children's physiology and psychology determines that the clothing they wear should be very different from adult clothing in terms of choice of raw materials and production process or design elements. However, infant clothing design research has not received much attention in China (Liu, 2017). Children's products in the current have become a necessary condition for children's growth, but the process of the design of children's and adult products is quite different, therefore, the design of children's products shall be based on children's physical and mental development demand as the design basis to design children's products, at the same time also need to preschool children as the main design objects, children's products are hierarchical design, Each level is matched by children's products (Wang, 2018). Chemical and synthetic textile finishes are often used, even though they are harmful (Santiago et.al, 2020). Children's clothing production ignores safety, such as poor sewing quality (Mao, 2000), and research on the application of natural dyes is limited in children's wear fabrics (Naz, 2018). Mothers' selection of infant clothing is closely related to the total self-concept (Banister & Hogg, 2006). What's more, many children's clothing can no longer be worn when it is still quite new as children's rapid physical growth and parents' frequent purchase of clothing. It means that the wearing cycle of children's clothing is short (Nursari & Djamal, 2019). A lot of industrial wastewater was released by the Textile and Garment industry in China (Yuan, 2017). This is not conducive to the sustainable development of the environment (Nursari & Djamal, 2019).

Therefore, solving the above series of problems is very important for children's growth.

3 CONCEPTUAL FRAMEWORK

In general, a series of issues such as material selection, psychological needs of users and post-processing of clothing should be fully considered when designing children's clothing. Figure 2 below shows the Conceptual Framework of this study. Firstly, the sustainable development status of the clothing industry was investigated to understand the current problems faced by green children's clothing, and then the raw materials, design elements and production process suitable for children's clothing were gradually analyzed to promote the sustainable development of children's clothing.

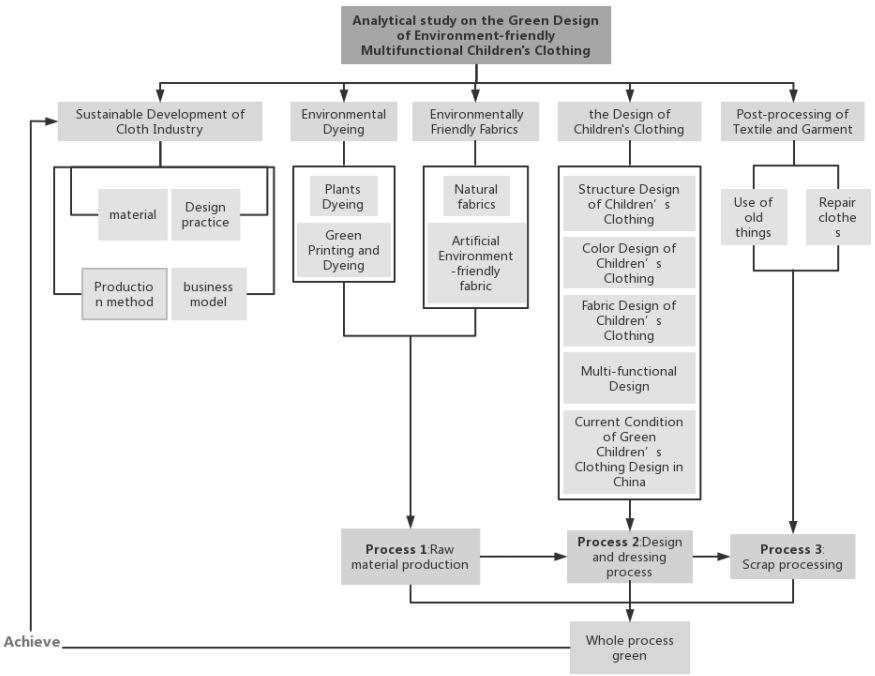

Figure 2: Conceptual Framework (Sun, Nor, & Jiao)

4 THE USAGE

The innovative and comfortable children's wear design based on the concept of environmental protection is not only the focus of the enterprise and the government but also the focus of the whole society. This paper attempts to explore new, healthy, comfortable, beautiful, practical design principles and methods of children's wear, which can provide guidance for the design and production practice of children's wear. At the same time, through the study of environment-friendly clothing materials, dyeing process, structure design and other aspects, this paper carries out green and innovative design for children's clothing provides guidance for the future development of Chinese children's clothing enterprises and makes contributions to the sustainable development of children's clothing production enterprises. At present, there are relatively few studies on green children's wear design in academic circles, especially those related to environmental protection and children's healthy development. Therefore, this study can also provide a reference for further academic research in this field and provide a scientific theoretical basis and data support for children's wear design.

5 SUMMARY

The research on environmental protection in children's wear design at home and abroad includes qualitative research and quantitative research. Qualitative research is mainly based on the design concepts and ideas of children's clothing, and studies ethics, aesthetics, principles, and methods. Based on the life cycle assessment theory of children's clothing, the quantitative study studied resource consumption, energy consumption, service life, evaluation system and other contents. Through the comparison of relevant literature, a series of problems in the current Chinese children's wear market are summarized as follows:

First of all, China's children's wear industry started late. Most products cater too much to adult aesthetics but ignore the influence of clothing on children's bodies and minds, and the design of children's clothing lacks the characteristics of environmental protection, comfort, and aesthetics. Secondly, the overall development level of the children's wear industry is relatively backward, mainly processing and assembly, and research and development innovation is less. Most of the relevant studies on multifunctional children's wear only put forward some good concepts and ideas and did not design and develop corresponding styles according to the growth characteristics of children. In addition, there are many studies on plant dyeing, but there are no cases and studies on the application of plant dyeing technology in multifunctional children's clothing. Therefore, it is very important to explore the green design of children's clothing by combining environmental protection and health and establishing an effective design model.

REFERENCES

Aaijaz, N., Ibrahim, D.B.I (2010). Green clothing and Eco-fashion: a growing sustainable market for SME'S.Proceedings of 2010 International Conference on Technology Innovation and Industrial Management. 102-123.

Armstrong, C.M. (2013). "Product-service systems design thinking for sustainable fashion", in Niinimäki, K. (Ed.), Sustainable Fashion: New Approaches, Aalto University, Helsinki, pp. 102-110.

Anastas, P.T., Zimmerman, J.B. (2003). "Design through the 12 principles of green engineering", Environmental Science & Technology, Vol. 37, pp. 95A-101A.

Bianchi, C., Birtwistle, G. (2010). Sell, give away, or donate: an exploratory study of fashion clothing disposal behavior in two countries. Int. Rev. Retail, Distrib.Consum. Res. 20, 353- 368.

Birtwistle, G., Moore, C.M. (2007). Fashion clothing-where does it all end up? Int. J. Retail Distrib. Manag. 35, 210-216.

Banister, E.N., Hogg M.K. (2006). Experiencing motherhood: the importance of possible selves to new mothers. Advances in Consumer Research 33: 343- -344.

Cao, X.Z. (2015). "'Something Wrong' Delays Children's Physical Growth", Enlightenment

(0–3 years old).
Li, M.M. (2022). Fashion consumption leads green consumption. China Economic Net, http://m.ce.cn/bwzg/202210/06/t20221006_38145531.shtml.
Choudhury, A.K.R. (2018). Eco-friendly dyes and dyeing.Advanced Materials and Technologies for Environmental Applications-AdvMatTechEnv Open Acces Journalpowered by SciEdTech,145-176.
Cao, Z.Y. (2008). Research on the Production and Dyeing Technology Development of Synthetic Dyes in Modern China.Doctor Degree thesis of Donghua University.
Cui, Y. (2014). Analysis on the Ecological Culture in the Design of Children's Clothing. Academic Forum,223.
Chen, Y.T., Li, L.X. & Shang, S.F. (2022).Current Situation and Development Strategy of Green Consumption in Textile and Garment Industry [J], The Industrial Study, 84-86.
Dogbey, R. (2015). The Effect of Fabrics and Designs on the Physical Comfort of ChildrenClothes in the Accra Metropolis. Choice, 30.
Earley, R. (2017). Designing Fast & Slow. Exploring fashion textile product lifecycle speeds with industry designers, The Design Journal, 20:sup1, S2645-S2656, DOI: 10.1080/14606925.2017.1352776.
Gao Y. (2020). Study on development path of Chinese textile industry based on water footprint theory, Shanxi University of Science and Technology.
Gao, Y., Yu, J.N. & Wang H. (2011). Toxicity determination of organic pesticides to cotton aphid and field efficacy test [J]. Xinjiang Agricultural Science, 71-74.
Gupta, D. (2011). Functional clothing—Definition and classification Deepti.Indian Journal of Fibre & Textile Research.
Hu, X.M., Liang, Y.L. (2003). Research on Children's Wear Brand Based on Children's physiology and psychology, Silk.40-42.
He, Y.J., Shu, Y.Z., Shen, L & Liu, M.Y. (2014). One-Piece-But-Multi-wear Concept Design of Multifunctional Knitted Children’s Garments, Knitting Industries.2-4.
Ji, Z.W (2017). Research on the Design and Application of Environmentally Friendly Fabrics in Modern Clothing under the Concept of “Green Development, Master of Qingdao University.
Jiang, L.Zh. (2020). Discussion on application prospect of soybean protein fiber, Textile Reports.26-28.
Jia Gaopeng. (2005). Dyeing of natural plants. International Textile Review (4), 4.
Kumar, P. S., Yaashikaa, P. R. (2018). Sustainable Dyeing Techniques, S. S. Muthu(ed.), Sustainable Innovations in Textile Chemical Processes, Textile Science and Clothing Technology,1-29.
Luo, Y., Chen, Y.M. (2019). Research on Product Design and Industrialization of Traditional Indigo Clothing, Acadamic Forum.190-191.
Lai, C.-C., Chang, C. -E. (2021). A study on sustainable design for indigo dyeing color in the visual aspect of clothing, Sustainability 2021, 13, 3686.
Li, Y.F. (2020). Analysis and Identification of Several Common Natural Botanical Dyes in Ancient China, University of Science and Technology Beijing.1-159.
Lakshmanan, S.O., Raghavendran, G. (2017). Low water-consumption technologies for textile production. Sust. Fibr. Text.7, 243- -265.
Li, H.Y., Zhang, W.Y. (2007). Progress in the research for clothing functions, Journal of Textile Research.28(8),117-123.
Liu, L.P. (2021). Application research of garment regeneration design based on sustainable development, Research on industrial innovation.58-60.
Liu, Y.F. (2015). Research on Green Concept in fashion design, Cultural Industry Forum.52.
Liu, Y.F. (2010). Application and development prospect of Modal fiber. Light Textile Industry and Technology, 39(3), 28-30.
Liu, W.W., Wan, Z.Y. (2008). Talking about the "environmental protection" fashion of clothing fabrics, Age of education.
Liu, RQ. (2018). Development of textile fiber and application of new fiber. Textile

Equipment, 45(2), 7.
Liu, L.L., Tang, Y., Bellavitis, A.D-A.& Shen, L. (2019). Status quo of sustainable clothing design.Wool Textile Technology, 47(10), 6.
Lovins, L.H. (2008). Rethinking production. In State of the World. Innovations for a Sustainable Economy. A Worldwatch Institute Report on Progress Toward a Sustainable Society. NewYork: Norton & Company, 32-44.
Liu, H., Liu, Y.L. (2018). Study on functionality of infant clothing, Wool Textile Journal. 48(4),31-36.
Liu, H. (2017). Functional analysis and market strategy research of infant clothing. Doctoral dissertation, hebei university of science and technology.
Ma, W. (2006). Research on salt-free dyeing with reactive dyes.Doctoral dissertation, Dalian University of Technology.
McDonough, W., Braungart, M. (2002). Cradle to Cradle: Remaking the Way We Make Things. Macmillan USA.
Monika, T., Tetyana, B. (2020). International Scientific and Practical Conference, Topical Issues of Modern Design.14-16.
Naz, F. (2018). Exploration of sustainable practices in children's wear fabric. California State University, Northridge, December, 1–55.
Niinimäki, K. (2013). "Sustainable fashion", in Niinimäki, K. (Ed.), Sustainable Fashion: New Approaches, Aalto University, Helsinki, pp. 13-29.
Nursari, F., Djamal, F.H. (2019). Implementing Zero Waste Fashion in Apparel Design,6h Bandung Creative Movement International Conference in Creative Industries 2019.1-7.
Niinimäki, K., Armstrong, C. (2013). From pleasure in use to preservation of meaningful memories: a closer look at the sustainability of clothing via longevity and attachment.International Journal of Fashion Design, Technology and Education, 2013 Vol.6, No.3, 190–199.
Raichurkar, P., Ramachandran, M. (2015). Effluent generated from the textile process industries. Int. J. Text. Eng.Proc.1, 47-50.
Sun, J., Pan, C.X. (2007). Research on the Application of Kansei Engineering in Product Color Matching Design.Packaging Engineering,91-93.
Song, K.X., Liu, L.J. & Xing, H.X. (2006). The production practice of Spinning colored cotton/Rabbit wool blended Yarn with Cotton Spinning equipment."Technology Upgrading, Industry Innovation and Future"-Proceedings of 2006 "Sula Cup" National Modern Spinning Technology Conference.
Samanta, K.K., Pandit, P., Samanta, P. & Basak, S. (2019). Water consumption in textile processing and sustainable approaches for its conservation. Water in Textiles and Fashion. 41-59. https://doi.org/10.1016/B978-0-08-102633-5.00003-8.
Seshama, M., Khatri, H., Suther, M., Basak, S. & Ali, S.W. (2017). Bulk Vs nano ZnO: influence of fire retardant behaviour on sisal fibre yarn. Carbohydr. Polym. 175, 256- 262.
Saeidi E., Wimberley V.(2015). Precious Cut: A Practice-Based Research Toward Zero-Waste Design by Exploring Creative Pattern.International Journal of Fashion Design.Technology and Education.1-2.
Santiagoa, D., Felgueirasb, H.P., Formana, G. & Souto, A.P. (2019). Antibacterial Potential of Cotton Fabrics Dyed with Indigofera Tinctoria Derived-Dye.ResearchGate.147-154.
Teli, M.D., Pandit, P. (2017). Novel method of ecofriendly single bath dyeing and functional finishing of wool protein with coconut shell extract biomolecules. ACS Sustain. Chem.Eng.5, 8323- -8333.
Tang, R.C. (2006). Stusies on the structure, properties and dyeing and finishing process of soybean fiber, Doctoral dissertation, Dong Hua Univercity. 1-110.
Van Nes, N. (2006). Design strategies for lifetime optimization of products. Journal of Sustainable Design, 3, 101-107.
Wang, X.l. (2019). Children's Wear Market Will Become A New Growth Point in Apparel Industry, China Fiber Inspection, 100-103.

Wang, B.C. (2013). Importance of the application of green material in clothing design.Doctor Degree Thesis of Tianjin University of Science and Technology.
Wang, W.Y., Xu, G, B., Zhang, Y.H., Liu, H.R. & Sun, Y.N. (2021). The invention relates to green environmental protection bamboo fiber fabric and processing technology. CN112647180A.
Wu, Y. (2021). Design of Textile Dyeing Wastewater Treatment Process. Guangdong Chemical Industry.
Wang, Y.H. (2014). The application of green concept in garment enterprises is discussed briefly, Light textile industry and technology. 171(6).47-65.
Wu, X.M., Yuan, Q.Y. (2019). Research on the design and Production of green children's Wear. Textile Report (4), 3.
Walker, S. (2006). Sustainable by design: Explorations in theory and practice. I ondon: Earthscan.
Wei, F. (2011). On the innovative development of clothing design in a low-carbon economic environment. Art Education Research, 2011(10): 68-74.
Wang, X.S. (2018). Research on children's product design based on children's physiological and psychological needs. Industry & Technology Forum, 17(4), 2.
Xu, H.X., Yang, W.H., Wang, Y.Q., Zhou, D.Y., Feng, X.N. & Kuang, M. (2008). Investigation and analysis of pesticide application in cotton production. Vol.35, pp.2.
Yu, B. (2014). Alternative salt reactive dyeing and dyeing waste water recycling research. Doctoral dissertation, Gonghua university.
Yee, L.W., Hassan, S.H. & Ramayah, T. (2016). Sustainability and Philanthropic Awareness in Clothing Disposal Behavior among Young Malaysian Consumers. SAGE Open,6. https://doi.org/10.1177/2158244015625327.
Yuan, C.M. (2017). "Water Improvement in Textiles" To give the world a responsible Chinese textile industry. Textile Machinery (12), 2.
Zhang, Y. (2011). Analysis the development status of the local kids. Shandong Textile Economy.
Zhang, L. (2018). Research on the Technique and Culture of Tianmen Blue Calico. Doctoral dissertation, Donghua University.
Zhang, Y.C., Cong, H.L. (2013). Development and properties of coffee carbon fiber weft knitted fabrics. Journal of Textile Science, 34(11), 5.
Zhao, F. (2019). Salt-free electrochemical dyeing of cotton fabrics with M-type reactive dyes. Printing and Dyeing, 45(8), 7.
Zhao, S. (2019). Lycra• "Prescription". Chinese Apparel (12), 3.

ABOUT THE AUTHORS

Sun Shuyan: Faculty of Art and Design of University Teknologi MARA Shah Alam, Malaysia, 234516797@qq.com
Zainudin bin Md Nor: Faculty of Art and Design of University Teknologi MARA Shah Alam, Malaysia, zainu570@uitm.edu.my
Jiao Yujun: Foshan Nanhai Vocational School of Polytechnic, China, 425471039@qq.com