

A REVIEW OF EMERGING SUSTAINABLE FASHION BUSINESS MODELS: TRIPLE BOTTOM LINE PERSPECTIVE

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ABSTRACT

This paper explores and review the emerging sustainable fashion business models as a potential solution to the current catastrophic impact of the Global Fashion Industry on the Ecosystem. There has been emergence of several new innovative fashion business models recently namely circular fashion business, renting and sharing, slow fashion, durability, upcycling and recycling, waste management, ecofriendly materials, subscription models, modular design, additive manufacturing and zero waste fashion. There is a research gap to evaluate the effectiveness of some these models in the perspective of triple bottom line, especially in developing countries. This study has investigated the status of some of these new business models such as durable products, modular design, advanced communication technologies, waste management and additive manufacturing in Vietnam. An exploratory study approach involving six fashion enterprises was used to know the status of these techniques in Vietnamese fashion sector. It was found that some of the concepts such as additive manufacturing and waste management are quite new in Vietnamese fashion sector. However, some sustainable models such as waste management and durable products are well understood by the fashion enterprises.

INTRODUCTION

Fashion and textile manufacturing are always at odds when sustainability is considered. A range of problems relating to the triple bottom line (TBL) of sustainability has been associated with the manufacturing and supply chain processes of clothing, textiles, and accessories (Carey & Cervellon, 2014). The environmental approach or planet relates to the pollution of air, water and land. The manufacturing and distribution processes pollute the planet due to emission of greenhouse gases (GHG), effluent and solid wastes (Gupta, Kushwaha, Dave, & Mahanta, 2022). Use of traditional technologies, lack of stringent regulations and lackadaisical approach by the manufacturers is the major cause of environmental problem. Further, consumer's intention to buy cheaper and excessive manufacturing by fast fashion brands accentuate the problem. The social aspect of sustainability or people relates to the relationship of the enterprises with the community. Problems such as low wages, forced labour, child labour, and unsafe working conditions are some of the problems in this category (Nayak, Akbari, & Far, 2019; Nayak, Van Thang, et al., 2021). The economic aspect or profit relates to generating profit but in a sustainable manner. In a simple language, economic sustainability relates to the processes devised to make profit managing the manufacturing process and economic

development to run indefinitely. It relates to using the resources in a controlled manner without depletion at the same time reducing the environmental and social impacts.

Fashion and textile sustainability are gaining significance in recent years due to increased consumer awareness, global pressure, and increased competitiveness for ethical fashion. Several fashion brands are focusing on reducing the environmental impacts, take care of the society while using resources in a controlled manner to make profit. The manufacturing of fashion and textiles is a primary activity in many developing countries such as Bangladesh, Vietnam, and India (Heinze, 2020). On the other hand, the developed countries are focusing on designing of these products and retailing activities. The increasing cost of labour and utilities in developed countries has led to the shifting of labour-intensive processes to the developing countries. However, the developing countries are facing several sustainability related challenges due to various reasons. In order to make the entire supply chain process of fashion and textile sustainable, fashion brands and manufacturers should work in collaboration following the sustainable business model.

Almost all the textile raw materials used in the fashion and textile products have the potential to get recycled into new products. Surprisingly, about 14% of fashion and textiles are being recycled and the remaining meet their nemesis in the landfill. The recycling percentage is still lower in developing countries, which is less than 2%. Huge quantities of reusable natural and synthetic materials are being wasted in the landfill leading to excessive greenhouse gas (GHG) generation. The natural fibres in the landfill can be biodegraded, however, synthetic materials take several hundred years to biodegrade.

This paper explored the approaches to become sustainable in the manufacturing, and supply chain activities relating to fashion and textiles. Various models such as durable products, modular design, advanced communication technologies, waste management and additive manufacturing have been discussed in this paper. Six different industries were interviewed to find the status of these sustainable business models in Vietnam. The findings of the exploratory study have been discussed in this paper.

METHODOLOGY

In order to perceive the level of understanding of sustainable fashion models, this project followed the qualitative approach of survey in Vietnamese fashion and textile industries due to their increased significance in today's competitive marketplace. A total of 6 industries located in the North (2), Central (1) and South (3) provinces of Vietnam were included in the survey. The type of industries includes manufacturers of textiles, clothing and accessories. Out of the six industries, three were large enterprises and three were small and medium-sized enterprises. The survey questions and PICF form were sent to the participants one month prior to the survey so that they could read and give their consent for interview. The time and date were fixed either by email or by telephone calls by the research team members. The qualitative in-depth interviews were conducted either online via the Microsoft Teams or inside the premises of the industry.

At least two members of the research team were included during the interview and each interview lasted for 45-60 minutes. We had taken proper care so that the research questions and propositions were accurately addressed. The entire interview was recorded, which was then transcribed, and the data was used for further analysis. Intensive notes were taken to ensure the research findings are exactly represented in the publications. Qualitative data analysis software NVivo was used to analyse the data following the case study protocol (Yin, 2003) and cross-case analysis. These approaches help in identifying the similarities and differences among the interviewees to support empirical generalizability and theoretical predictions. The important findings are discussed in the results and discussion section.

RESULTS AND DISCUSSIONS

The term “Sustainability” was analysed using four different models in this project, namely: (a) Durable products, (b) Modular design, (c) Use of advanced communication technology, (d) Waste management and (e) Additive manufacturing. Vietnamese ethnic minorities have a strong cultural background, which is reflected through their traditional elegant clothes, expressive garments, costume, and other accessories. As such, boutique fashion businesses preserve and promote the cultural traditions of ethnic minority groups to the public through the fashion product designs. Further, local resources are used in the process of manufacturing, such as employing talented artisans, and using local silk, fabrics, and traditional handicrafts. This builds up the reputation for Vietnamese ethnic eco-friendly products to attract attention from potential foreign investors and visitors to the ethnic minority travel destinations.

Durable products

The increasing trend towards fast fashion has led to the consumption of more trendy products with short-usage time (Niinimäki et al., 2020). In many developed countries, the consumers buy cheap products and discard them even after a single usage. This leads to a throw-away culture as well as resource depletion (Shirvanimoghaddam, Motamed, Ramakrishna, & Naebe, 2020). In order to save resources and become sustainable, consumers should think about durable products that can last longer, reduce resource depletion in addition to reducing the environmental impacts. Durability is a characteristic of clothing that can be developed by using good quality raw materials and improved processes. Various parameters such as mechanical strength, pilling, tear strength, abrasion resistance and fastness are some of the indicative properties of clothing durability.

Durable products last longer, hence, reduce the necessity to buy too many garments as the manufacturing process has environmental impacts. A durable product may be expensive, however, the cost over the entire life of the product will make it cheaper. Durable products reduce the amount of clothing waste ending in the landfill and waste management problem. It has been an established fact that durable products are of better quality, and they are produced with better craftsmanship. Further, durable products are produced with better fit and drapability, hence, they ensure improved comfort to the wearer. Investment in durable products is a smart choice for the consumers as they are more ecofriendly. Rather than buying several products, which create more environmental and social impacts, consumers should focus on durable products as it can help to reduce the total environmental impact. However, several trendy consumers believing in style and trend, focus on non-durable products.

We tried to investigate the level of understanding by Vietnamese fashion manufacturers on the durability-sustainability relationship. It was found from the study that the three large fashion enterprises understood the durability concept very well. As the LEs are involved with large global fashion brands, they emphasize more on quality and durability. However, one out of the three fashion SMEs mentioned that they really take care of durability while designing the product. For this SME, they want to produce trendy as well as durable products which can be sold at higher prices. Further, they mentioned that durable products help to save resources and reduce environmental impacts. One of the SMEs mentioned that consumers pay more attention to the style rather than the quality, hence, the company is not worried about durability. Once, they had attempted to include high quality fabrics and trims to manufacture garments with improved quality and price. The increased price was not supported by some trendy customers; hence, they stopped this trend. The third SME mentioned that they are not aware of durability-sustainability relationship as consumers never ask for durable products. The findings are explained through the interview extracts 1-3:

Extract 1 (SME): “We take care of quality, durability and style as our products are sold at higher prices. In this approach, we receive less complaints from customers as they spend less over long period of time, hence, they return to us. The use of quality materials and craftsmanship helps to save resources and reduce environmental impacts as the products last longer.”

Extract 2 (SME): “Our brand policy focuses on the style of the clothing, and we are not worried about durability. The main aim is to satisfy our customers who want to look trendy. Once we tried to produce better quality clothing and sale them at higher prices. However, the consumers ask several questions on durable products and

never buy them.”

Extract 3 (LE): “(...). As all our clients are from overseas and they produce traditional fashion, we focus more on durability and quality products. The quality requirements for our suppliers are very stringent and inspection is an important aspect for us. At the same time, we need to take care of various sustainability standards as it is very important for foreign market.”

MODULAR DESIGN

The concept of modular design is gaining popularity in the sustainability drive to save resources and reduce waste (Chen & Lapolla, 2021). In modular design, garments are produced in module-shaped components that can be integrated to make different outfit combinations. By combining different modules, a number of garments could be formed that are suitable for different occasions. Modular garments facilitate multiple looks, which are easy to upgrade and replace. The other names for modular garments are convertible, or multifunctional garments. Various fastenings such as zippers, studs and Velcro play a major role in modular designs to transform one to the other garment. For example, shorts can be converted into a pair of trousers by attaching a bottom leg section using zipper or snap buttons. Geometric modular designs can be folded into different shapes and sizes to fit different body sizes.

Modular garment designs are moving from concept stage to commercial stage (Hailu, 2021). Some global fashion brands have started experimenting with modular designs. Some designers and luxury brands have also adopted modular designs into their product lines. Brands such as Studio 189, House of Sunny and ACBC are some of the fashion brands focusing on modular designs. For example, Studio 189 produces various modular garments to be worn in different occasions that are inspired by African textiles. House of Sunny produces pullovers with detachable sleeves. Similarly, the brand ACBC produces zip-shoes, that can have a sole zipped to different uppers. The market for modular garments is yet at infancy on the market potential needs to be explored. Consumers need proper instructions on how to combine various modules and for what type of functionality.

The research team wanted to investigate the status of modular designs in Vietnam in the drive towards sustainability. It was found that the concept of modular design was almost new for four out of the six interviewees. Two of the LEs were aware of the modular designs although they did not directly work for bulk production of modular garments. The remaining four interviewees were unaware of modular garments. The LEs in most instances have experienced staff in the design team who understand the concept of modular design due to global exposure. The SMEs on the other hand are not very much aware of some of the recent trends, hence, don't understand the new concepts well. Also, the local market is ready for modular designs, which is also the reason for SMEs not producing modular designs. The findings are explained in extracts 4 and 5.

Extract 4 (LE): “Our design team is aware of modular designs are beneficial for sustainability. They are also competent to work with any of the global brands if they receive any order for modular garments. However, there has not been many orders for modular garments from global fashion brands.”

Extract 5 (SME): “The market in Vietnam is not ready yet for the new concept of modular garments. We have never designed modular garments nor planned to design in the future. If the trend moves to modular garments in global marketplace, we can have designers who can produce modular garments.”

USE OF ADVANCED COMMUNICATION TECHNOLOGY

Various communication technologies are getting increased attention from consumers and fashion brands. Some of these technologies include RFID (Radiofrequency identification), IoT (Internet of things), blockchain technology, mobile commerce, and virtual and augmented reality (AR/VR). RFID technology is well known for its speed and accuracy in record keeping. The use of this technology has been proven to be beneficial for fashion manufacturers and

retailers. This technology can be applied starting from the fibre stage still the retailing stage or even managing the end-of-life (EOL) clothing (i.e., waste management). A recent study has established that the use of RFID can help to achieve the TBL of sustainability (Nayak, George, Haq, & Pham, 2022a). However, in developing countries like Vietnam, this technology is still in its infancy.

The IoT includes several objects, i.e., the 'things' networked together to facilitate exchange of information using the Internet (Kochar, 2023). The use of IoT is rapidly increasing, which is impacting how we work with our surroundings, others, and our bodies. The use of wearable electronics, smart textiles, and responsive sportswear are some of the devices that can be used using IoT. For businesses, they can use IoT for data sharing, security, better efficiency, improve customer relationship management (SRM) and inventory management. Smart watches from Apple and FitBit can be considered as the smallest IoT devices to monitor human body. The use of 5G network coupled with faster rate of data transfer, and lower latency has facilitated the use of IoT. The use of blockchain technology helps fashion brands in traceability, and transparency, improving the supply chain efficiency. This technology is widely used for record keeping such as time, date and amount of money and it allows easy information sharing between various stakeholders. It can help to keep records of every stage of production and move towards sustainability.

Mobile commerce is getting more and more advanced day-by-day. Starting from online shopping to e-wallet, consumers are widely using this technology in everyday life. The integration of social media shopping features is also improving consumer experience in addition to improving the sales for fashion brands. Online fashion apps such as Depop and Vinted have revolutionised the second-hand fashion market. Finally, AR/VR are also playing important roles in the technology domain of fashion and textiles. With the use of AR/VR, consumers can try any garment virtually before they buy it, which helps in improving customer loyalty with the brand. Further, AR/VR can be used for accurate fit of garments to improve the design and style of garments leading to customer satisfaction. Some of the recent trend in AR/VR is the digital clothing which can be used for profile images in the social media (Kochar, 2023). The use of above-mentioned technologies is helping directly or indirectly to achieve the TBL of sustainability. Saving resources; speed, and accuracy in information sharing; transparency; traceability; reduced human workload; improved efficiency; reduced environmental and societal impacts are some of the sustainable benefits of using various technologies. Our research has established some interesting findings relating to the use of various technologies in fashion supply chain and distribution processes. Although several of these technologies are getting more attention in the global marketplace, some of these technologies are still not widely adopted in Vietnamese fashion supply chain. Vietnam is playing a major role in manufacturing of fashion and textiles for many global fashion brands. However, cost, skill, and technology related challenges are preventing the fashion enterprises from using these technologies. These facts were established revealed by the participants as mentioned in the Extracts 6, 7 and 8.

Extract 6 (LE): "We are in the transition stage from traditional technologies to new technologies. We use RFID and IoT at our manufacturing units and warehouses. These technologies make the process simple as they are fast and accurate. The brands also ask for quick response, which can't be fruitful without using these technologies. However, the initial expenditure for getting them is very high."

Extract 7 (LE): "Various technologies are getting popular in the fashion and textile sector. Automation and artificial intelligence are at the frontier of our business plan. We need them to become more efficient as the brands want them."

Extract 8 (SME): "For our company, these technologies are not that helpful. The cost is very high for us to afford. Our investment is small, and we want to do many operations by manual practices. We have focused on increasing our sales by using mobile commerce. However, RFID, AR/VR and IoT is never in our business plan."

WASTE MANAGEMENT

Waste management has become a major problem in fashion and textile sector. The fashion and textile waste can be classified to two groups: pre- and post-consumer waste (Gupta et al., 2022). Pre-consumer waste involves wastes

from various types of industries such as fibre, yarn, fabric, and garment waste produced in industrial context. Post-consumer waste on the other hand is produced by the consumers when they discard their clothing and textiles at end-of-life (EOL). In several developing countries, both the types of wastes are a major problem to manage due to lack of recycling facilities, low awareness, and lack of strict regulations on recycling (Islam, 2021; Nayak, Nguyen, Patnaik, & Khandual, 2021). The global average for clothing and textile waste management is just 14%, which indicates 86% of the materials that could have been recycled end up in the landfills (Nayak et al., 2020). This leads to the unnecessary stage of a huge number of resources. Looking at the scarcity of resources, the industries, fashion brands and consumers should focus on recycling the wastes. There are several approaches for waste management, which includes reuse, mechanical recycling, chemical recycling, and upcycling. Both synthetic and natural fibres can be recycled to new products by various processes, which are discussed in the following section. The next section discusses about the research findings from Vietnamese industries relating to waste management.

RECYCLED SYNTHETIC FIBRES

The most common recycled synthetic fibres include polyester and nylon, from pre- and post-consumer waste in addition to plastic bottles (Dissanayake & Weerasinghe, 2021). Recycled polyester is well known as rPET, which has been widely used by many brands. Similarly, recycled nylon is also used for various sportswear and swimwear. Pre-consumer wastes include the waste collected from spinning, weaving, and garment industries. Post-consumer wastes include clothing and textile materials made from synthetic fibres, and fishing nets. The recycling process may involve mechanical and chemical recycling. Mechanical recycling process involves steps such as collection, sorting, cleaning, shredding, and converting to fibrous materials that can be reused to make yarns and fabrics for manufacturing fashion and textiles. Chemical recycling involves converting the fibres back to the polymer stage and then spinning the fibre by various fibre manufacturing methods. Some brands have also started recycling plastic bottles into various types of fashion and textile products.

RECYCLED NATURAL FIBRES

Like synthetic fibres, natural fibres such as cotton, wool, silk, hemp, and linen can also be recycled into various products (Pandit, Ahmed, Singha, & Shrivastava, 2020). The mechanical recycling of natural fibres is relatively easier compared to the chemical recycling process. Several research groups are focusing on extracting cellulose and protein, from plant and animal fibres, respectively, which can be converted back to fibres by wet- or dry-spinning. However, these approaches are still at their infancy for the commercialization stage. Where it is the recycling of synthetic or natural fibres, each stage of the recycling process reduces the mechanical properties of fibres. Hence, the subsequent use of these recycled materials should focus on lower end-use applications.

GARMENT WASTE RECYCLING

The waste in a garment industry can be classified as: (a) process waste and (b) material waste (Nayak & Patnaik, 2021). The process waste mainly includes idle time of machine and workers and reworking. Due to improper production planning and line balancing, the workers have to wait for materials from previous process or material has to wait for the process (Das & Patnaik, 2015). Similarly, various machineries that need high start-up time such as fusing machine, logo-printing machine and ironing equipment stay idle due to lack of supply of semifinished components. During the idle time, these machineries consume large amounts of energy without any production. The reworking is mainly related to stitching defects in garments such as puckered seam or missing stitch, which reduces the aesthetic value (Keist, 2015). Hence, the stitches are opened, and the components are stitched together again. In some instances, the irreparable faults lead to the rejection of the garments leading to the generation of hard waste. The material waste includes fabric waste, rejected component waste and the hard waste from packaging materials. As suggested by Abdulmalek and Rajgopal (Abdulmalek & Rajgopal, 2007), the "Lean concepts" can be used to identify and eliminate various wastes in a manufacturing industry, which are discussed in the following section.

MINIMIZING FABRIC WASTE

As fabric is the major component in a garment, controlling material waste can make the garment manufacturing process more sustainable. The amount of fabric waste depends on the marker efficiency, which can be in the range of 80-90 %. This means that about 10-20% of the fabric waste is inevitable depending on the garment style and fabric width. Many of the SMEs use manual method of marker planning, which results in reduced marker efficiency and higher waste. The use of interactive CAD software can improve marker efficiency, hence reduce fabric waste (Rajkishore Nayak & Rajiv Padhye, 2015).

Fabric waste can be reduced even to zero by implementing the concept of "Zero waste pattern cutting" (Saeidi & Wimberley, 2018). The fabric waste is generated during cutting due to the curved shape of the patterns that do not match each other. Hence, the concept of zero waste pattern is making the patterns that fit each other like jigsaw puzzle pieces without any gap. In other approach, the fabric waste from the pattern cutting can be used to make embellishments, piping, or bias tape. The concept of zero waste garment design existed for centuries in traditional garments like Indian saris or Japanese kimono. Design elements such as gussets or gores, minimal arm shaping, rectangular sleeves or pants, and designers engineered garment pieces to match the available fabric's length and width can also be adopted for zero waste.

CONTROLLING ALLIED MATERIAL WASTE

The other hard waste generated during garment production such as paper, plastic, fabric remnants, packaging material, and wire coat hangers are generally discarded into landfills leading to the problem of greenhouse gas (GHG) emission (Jha et al., 2008). However, more than 80% of these materials can be recycled back to new packaging material such as packaging paper or plastic packaging material (Metin, Eröztürk, & Neyim, 2003). Textile hard waste such as cut fabric pieces, third quality rejected garments or threads can be opened back to fibres and reprocessed into the fabric with slightly inferior properties (Jacometti, 2019). The second quality garments, which are rejected during the garment inspection can be sold in the second outlets.

CONTROLLING WASTE BY LEAN CONCEPTS

The operational costs in garment production can be reduced by adopting the concept of "Lean manufacturing", which focuses on eliminating the process waste, improving productivity, empowering people with greater communication, and converting the organization into a learning organization. The process waste can be reduced by continual improvement (generally known as the Japanese word 'Kaizen'), which is the fundamental principle of lean manufacturing. 'Kaizen' promotes continuous and necessary changes (big or small) towards the achievement of a desired goal. The fundamental thrust of lean manufacturing is to produce a high-quality product at lower cost by reducing or eliminating the seven cardinal wastes such as waiting, inventory, overproduction, repair, inappropriate processing, excess motion, and transportation from the value stream through continuous improvement and to deliver the value to the customer (Fercoq, Lamouri, & Carbone, 2016).

The goal of the lean manufacturing is to create an integrated system using multi-dimensional approach that includes adoption of management practices such as pull strategy, just-in-time (JIT) philosophy, total quality management (TQM), cellular manufacturing, total preventive maintenance (TPM), electronic data interchange (EDI), Kanban, 5S and Muda (Nayak, George, Haq, & Pham, 2022b). Lean concept creates a sustainable and positive work environment by emphasizing on empowering the workers and adopting the tools, which enhance the operational efficiency by cycle reduction, cellular manufacturing, working in teams and stabilizing workflow. Yang et al (Yang, Hong, & Modi, 2011) added that when the different forms of wastes in lean culture are reduced, the productivity and efficiency are increased, which in turn helps in managing the environmental waste by reducing its volume. The use of digital technologies such as RFID, and ERP can help to achieve the objectives of lean manufacturing (George, Ulhaq, & Nayak, 2020). The interview findings for waste management have been explained in Extracts 9, 10 and 11.

Extract 9 (LE): "The waste management problem is a major source of environmental pollution in the fashion sector. Several companies have started to recycle or reuse waste to reduce the environmental impact. We have also taken steps to recycle our fabric waste and packaging waste. The fabric wastes are collected and supplied to a recycling center to make yarn and fabric by mechanical recycling. Waste recycling is a priority area for our business."

Extract 10 (SME): "Our company is always trying to reduce different types of waste in the manufacturing process. Some of the clothing that fails the quality analysis is sold in the local market rather than discarding them into the landfill. We also collect rejected clothing from consumers to facilitate recycling with the support from the local recyclers."

Extract 11 (SME): "Recycling is important for reducing waste. We try to recycle as much of our waste as possible. There is a lack of recycling facilities in Vietnam. Hence, it creates a lot of challenge to recycle the fashion and textile waste."

ADDITIVE MANUFACTURING

Generally, garment manufacturing is associated with a large amount of waste generated in different processes (Khajavi, 2021; R. Nayak & R. Padhye, 2015). The traditional process of marker making from fabrics is associated with about 20% of fabric waste during the cutting process. Hence, this process is known as a top-down approach where we start with a bulk and remove excess material to make the final product. The recent trend is moving towards additive manufacturing where small components are added to make the final product. Hence, in this process there is no wastage as the smaller components are joined together to reach the final product. Additive manufacturing is also known as 3D printing, which is being used by some fashion brands. Several products such as shoes, clothing, and accessories can be printed by using additive manufacturing technology. Additive manufacturing can be cost effective for small batch sizes compared to traditional processes. In this study we wanted to investigate the status of additive manufacturing in Vietnamese fashion supply chain. It was observed that the fashion SMEs are not worried about using additive manufacturing in their product line due to high cost and low demand. However, the LEs are involved with some additive manufacturing techniques due to the global trend moving towards new technologies. The findings are indicated in Extract 12 and 13.

Extract 12 (LE): "Additive manufacturing is a new technology for global fashion brands. Some of the leading fashion brands have started making products using additive manufacturing. From our buyers we have not received any order till date. This technology is comparative new in Vietnam. There are some large Vietnamese suppliers who have this technology. However, we have not planned to use additive manufacturing in our current business plans."

Extract 13 (SME): "We are a small company and never heard the term "Additive manufacturing. We know that 3D printers can directly print some products. In Vietnam nobody is worried about this new technique. Hence, we have not familiar with this technique."

CONCLUSIONS

This research paper investigates various business models adopted by the fashion and textile enterprises in a developing country. To understand the status of sustainable models, we have interviewed six large and small enterprises in Vietnam. The interview questions focused on concepts such as durable products, modular designs, use of advanced technology, waste management and additive manufacturing. It was established that consumers in Vietnam focus more on the trendy clothes rather than durable products. However, the fashion LEs focus on durability and quality products as they produce for global slow fashion brands. Modular design is not popular among Vietnamese fashion LEs and SMEs. However, the LEs well understand the modular design concept.

The use of advanced communication technologies such as RFID and IoT are popular among the LEs. The SMEs on

the other hand are new to many of the communication technologies. The use of these new communication technologies was helpful to improve the efficiency of the supply chain process as well as transparency. Waste management is important for both LEs and SMEs to reduce the environmental impacts. However, the approach of SMEs in this area is slower compared to the LEs. Finally, additive manufacturing is almost a new area of focus for both the LEs and SMEs. The market size for additive manufacturing is rather small in Vietnam. Hence, neither the SMEs nor the LEs have manufacturing facilities for large scale production of 3D printed products. This research will be helpful to disseminate new knowledge to the researchers in this area.

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