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DIGITALIZATION AND SRI LANKAN APPAREL INDUSTRY: PROSPECTS AND CHALLENGES

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ABSTRACT

The apparel industry is undergoing rapid changes of digitization induced by the latest technological innovations. This dynamic process opened the ways to revolutionize the conventional manufacturing processes and traditional business models. This evolution derives essentially from the need for industrial upgrading, which is achieved through the strategic digital technology integration. The transformation of the apparel industry into a fully digitalized form covers every stage from design and production to distribution, warehousing, and retail paving way for an enterprise disruption led by technology. This paper aims to address the opportunities and challenges associated with the adoption of digitalization in the Sri Lankan apparel manufacturing industry, considering its dynamic context. Accordingly, the objectives are to analyze the current digitalization landscape, effectiveness value and operational efficiency and also to assess the challenges and government policies for supply chain dynamics. This paper adopts a deductive methodology by reviewing the relevant literature and accordingly a discussion and recommendations for future research is provided. The introduction to the industry 4.0 technologies, including AI, IoT and Blockchain contended that digitalization is indeed very transformative. However, it emphasizes the need for developing a digital mindset, encouraging lifelong learning and digitally literate training at all levels in organizations. It is essential that digitalization overcomes the challenges like cyber threats, cultural changes and the demand for seamless integration. Digitalization in the apparel sector does not boil down to mere technology adoption but it entails a mental shift, cultural change and improved data management. A digital mindset is essential for the successful digitization, which involves continuous learning and adaptation that really drives the organization forward. This paper serves as a valuable resource for stakeholders by contributing to informed decision-making in the evolving landscape of the apparel industry's digital revolution. Future research could delve into the long-term socio-economic and

environmental impacts of a holistic digitalization approach, exploring how technologies and a digital mindset contribute to sustainable growth, efficient supply chain optimization, and the preservation of natural ecosystems within the Sri Lankan apparel industry.

Key Words: *Apparel industry, Cybersecurity, Digitalization, Operational efficiency, Supply chain dynamics, Sustainability*

1. INTRODUCTION

The global apparel industry finds itself on the point of a profound transformation, controlled to navigate and succeed in an era dominated by swift in technological advancements. A principal driving force behind this transformation is digitalization, a dynamic phenomenon that holds the indicate of revolutionizing age-old manufacturing processes and traditional business models (Parida, et al., 2019). At the heart of this evolution lies the crucial necessity for industrial upgrading through the strategic integration of digital technologies, a strategic imperative that will determine the industry's ability to sustain competitiveness, augment efficiency, and seamlessly meet the ever-evolving demands of consumers (Pech & Vrchota, 2022). In the context of the apparel industry, digitalization is an encompassing concept, adoption, and integration of digital technologies throughout the entire value chain. From the initial stages of design and production to the final phases of distribution, ware housing and retail, the industry is observing a comprehensive transformation (Reis, et al., 2020). This transformational pathway includes processes of digitalization, fusion with the strength of data analytics as well as smart technology to improve operations and enhance efficiency on all levels from productivity upwards (Bailu Fu, 2018). Empowering individuals with continuous skill upgrading is an imperative for successfully navigating the challenges posed by digitalization, ensuring a capable workforce adept at operating and managing advanced systems (Brito, et al., 2008). Apparel industry may face a shortage of skilled personnel with expertise in areas such as data analytics, digital application and software development (Victoria, 2002). Bridging the skill gap through training programs and educational initiatives become essential for successful technologies adoption (Dennis, et al., 2017). The implementation of automation technologies may result in job losses, particularly for low skilled workers involved in manual labor tasks. Companies need to consider strategies for retaining and reskilling their workforce to mitigate these challenges and ensure a smooth transition (Romero, et

al., 2019). Investing in training programs, hiring tech-savvy professionals and encouraging upskilling and reskilling initiatives to empower employees to adapt to new technologies and processes (Dennis, et al., 2017). In doing so, it highlights an epoch-making shift that compels the companies to adopt a tech-driven approach cultivating nimbleness in responding to the market dynamics and momentous change through consumers' preferences (Dennis, et al., 2017). Crucial to the benefits of digitalization is that it enables the stakeholders who have real-time data analytics capabilities, and this allows for objective decisions based on systems (Herold, et al., 2020). This data-driven strategy not only ensures the operational efficiency but also reduces errors, eventually ensuring agile responses to market instabilities (Parida, et al., 2019). The critical positions of robotics, artificial intelligence and IoT reveal how far-reaching is the integration process in this industry (Frank & Bramwel, 2020). At the same time, one of the most remarkable characteristics that define digitalization is establishing a unified connectivity throughout the entire supply chain. This connection enhances the communication and collaboration among the different players, essentially removing all unnecessary lags while also substantially reducing wasteful costs due to unparalleled transparency through the supply chain (Ngai, et al., 2013). Accordingly, the objective of this paper is to contend the adoption of digitalization in the Sri Lankan apparel manufacturing industry by highlighting the challenges and opportunities. Accordingly, this papers emphasizes that the adoption of digitalization is no longer an but a strategic necessity to be competitive in the challenging apparel industry. Moreover, the papers contends that apparel manufacturers are required to advocate the adoption of digitalization offering evidence-based insights into why they must embrace digital technologies and how they can navigate associated barriers.

2. METHODOLOGY

This research paper has been developed as a concept paper by adopting the deductive research approach as contended by (Trochim, 2006) where theoretical propositions guide the review and synthesis of existing knowledge. Accordingly, authors have undertaken an extensive review of existing literature, with a specific focus on digitalization prospects and challenges. This review of literature enabled to establish the conceptual foundation related to digital transformation and organizational innovation. This was used as a foundation for how digitalization manifests within

the Sri Lankan apparel manufacturing sector. Deductive reasoning is appropriate for conceptual studies of this nature where Creswell and Clark (2007) noted that it enables scholars to connect broader theoretical frameworks with empirical patterns and as a result a logically coherent argument can be developed based on prior scholarship.

To achieve this, authors conducted a extensive review of literature focusing specifically on the opportunities and challenges associated with digitalization. The empirical studies were given a priority in global and regional apparel industry, since those courses offer rich insights in terms of technological adoption, challenges and evolving industry dynamics. This ensured that the collection of not only general principles of digitalization but also the specific industry related nuances relevant to apparel manufacturing is essential. In addition to empirical sources, the review included a wide range of academic and professional sources such as peer-reviewed journal articles, book chapters, conceptual papers, and industry reports. The integration of multiple sources enhanced the conceptual foundation of the paper and authors were able to synthesize theoretical constructs with industry practices.

3. RESULTS

The global shift towards digitalization, converting information into digital forms, has become a powerful compound, revolutionizing industries and societies worldwide, compelling businesses to consistently integrate digital technologies and reshape their models in response to this transformation (Reis, et al., 2020). In considering the industry 4.0, industrial revolution is characterized by the incorporation of physical, digital, and biological domains and it is essential to strike a balance between technological advancement and the preservation of the natural environment (Xu, et al., 2018). As per the literature, a comprehensive realm of digitalization, with a specific focus on its integration is presented within the manufacturing and service industries (Parviainen, et al., 2017). Failing to embrace digitalization, which is already influencing business landscapes and corporate practices, positions a significant risk of falling behind in aggressively competitive markets, as it has the potential to service a company's entire operational framework. Parviainen, et al., (2017) mentioned that digitalization enhances the internal efficiency through prompt a revision of internal processes, open external opportunities such as new business ventures within existing domains and leads to acquire of new customers thereby leading to a transformative

and disruptive change in business roles. Moreover, the internet's advent and the fulfill of smart devices have connected people across geographical boundaries by fostering a global community (Leao & Silva, 2021).

The disruptive impact of digitalization is evidenced in traditional industries and catalyzing the rise of new ones. These disruptions fundamentally changed the established operational logics and contributed to develop new industry configurations. Apparel industry which historically characterized by labor-intensive practices, fragmented supply chains and intense competitive pressures went through a profound digital transformation. The developments in Artificial Intelligence (AI), the Internet of Things (IoT), and Blockchain technologies accelerated this shift by reshaping production systems, supply-chain transparency, and value-creation mechanisms (Parida et al., 2019). The improvements in product quality and reduction of production waste is evidenced due to AI applications like machine learning-based forecasting and automated defect detection systems. For example, Adidas has started to use AI and robotics in its “Speedfactory” operations to manufacture footwear with less lead times and improved customization (Kinkel et al., 2020). The integration of IoT technologies has facilitated the development of smart factories where machines, materials, and operators are linked through sensor-based systems that allow real-time monitoring and data-driven decision-making. Moreover, the IoT based solutions have been implemented in the apparel sector for machine maintenance, fabric inspection and workflow optimization. For example, MAS Holdings in Sri Lanka uses IoT based platforms for monitoring energy usage and machine efficiency in production lines which have contributed to enhance operational transparency and sustainability performance (Wijesinghe & Perera, 2021).

In the meantime, Li, et al., (2021) emphasized the importance of fostering a digital mindset, which involves promoting continuous learning and experimentation. Additionally, providing training programs for digital literacy at all organizational levels becomes imperative for successful digitalization. Successful digitalization also entails seamless integration, breaking down silos through collaboration and cross-functional teamwork (Leao & Silva, 2021). This cooperative method is also critically important to take advantage of the full potentials that can be offered by digital technologies (Ghoreishi, et al., 2020), but equally, high-quality robust data management systems are necessary for managing the large amounts of information generated while ensuring

accuracy and security as well as accessibility (Dennis, et al., 2017). Benefits of the Industry 4.0 technologies and digitalization influence on the product customization. Digitalization minimizes the variation and increases accuracy in the manufacturing processes, resulting to uniformity and top-level performance. Real-time quality monitoring, data analysis and the feedback loops created by digitalization facilitate instant corrective measures as well as ongoing improvements (Lacasa, et al., 2018). The study of challenges becomes very critical for the organizations aiming to implement many progressive methodologies basing on artificial intelligence, IoT technologies and data analytics in their activities (Majid, et al., 2022). Additionally, the knowledge of integrated measures to strengthen the inner ecosystem in apparel clothing industry by digitalization is necessary for continuous development and competitiveness.

Digitalization is a very dominant entity capable of shaping the landscape of apparel (Dennis, et al., 2017). The implementation of the digital technologies can really improve efficiency, simplify processes and deliver a lot more customer-centric service to the consumers (Pech & Vrchota, 2022). For ultimate gains, organizations need to face the challenges of cybersecurity issues as a result of cultural change and also the requirement for complete collaboration (Majid, et al., 2022). Regular audits, employee training and skill updates are the key components in protection of digital assets. Data privacy regulations also have strict compliance that must be observed (Irene & Simpson, 2013). With the advancement of digitalization in the industry, it is very important to preserve the stability between innovation and protection. Digital technologies play a major role in the developing product and service quality within the apparel industry (Pech & Vrchota, 2022). The use of various technological components is widespread throughout the apparel sector should be able to not only streamline processes but also improve efficiency while transforming its whole value chain as well (Szalavetz, 2019).

The apparel manufacturing industry is adapting by digitalization and sustainability driven initiatives. Leveraging data analysis and process transformation, digitalization plays a massive role in extending the product life cycle. Through innovative approaches like product maintenance service and digital platforms facilitating the resale of secondhand product the industry is forcing a circular economy. Smart connected cloths are emerging as key player in meeting precise market demand and supporting retailers in managing inventory efficiently. Considering the total value chain product level garment tracking is most important to the waste management (Ghoreishi, et

al., 2020). The internet of things (IoT) contributes significantly to the upcycling and recycling of second-hand clothes through digital platforms, preserving the usable value of products and also IoT facilitates rapid prototyping and sampling in the fashion industry, reducing waste from these processes and enhancing energy efficiency (Ghoreishi, et al., 2020). The integration of these technologies not only aligns with environmental consciousness but also propels the industry towards a more sustainable and circular future. A comparative life cycle assessment focusing on environmental sustainability emphasized the favorable impacts of digital fashion sampling over traditional physical sampling in the realms of design and development. The adoption of digital methods in iterating design and prototyping expeditiously advances product development, resulting in shorter cycles that effectively hasten the time to market. This not only product development cost but also significantly reduces material waste as well. The integration of 3D modeling emerges as a key factor in simplifying the zero-waste design approach, enabling sustainability driven decisions in the early stages of the creative process and cubing textile waste during design (Daria, et al., 2022). While digitalization eliminates materials, shipping and return are crucial to recognize that digital garment consumption retains a carbon footprint due to the energy consumption associate with digital technologies. Radio Frequency Identification (RFID) technology plays a crucial role in recycling apparel products. RFID facilities the identification of a garment's origin, material composition and its journey through the supply chain. The recycling of garments, especially those containing challenging components like plastics and metals, encounter difficulties in fiber recycling often due to issues in separating dyes and different polymers in the original fibers. Introducing RFID to the recycling process offers a solution by simplifying the identification of specific polymers used in each garment (Navodya, et al., 2019). This streamlined approach avoids unnecessary time and resource wastage in attempting to recycle non-recyclable materials. A significant finding pertains to waste reduction, wherein RFID contribute to extending the life cycle of clothing by reducing pre-consumer waste. Garments typically destined for incineration or recycling pre consumers' waste. However, garments reaching consumer first undergo a usage before disposal (Navodya, et al., 2019). As a result, increasing the life cycle of clothing and it generates a positive environmental impact through energy saving from reduced product burning. The integrating of RFID technology thus emerges as promising avenue for enhancing sustainability in the fashion and recycling industries. In the apparel sector, the transformative impact of digitalization extends beyond mere technological advancements to a

profound cultural shift among stakeholders. Particularly, the employees have to be taken into consideration as they become a part of the ecosystem along with integration, value chain optimization, and customization requirements.

4. CONCLUSION

The digitalization of the apparel industry shows a transitory process and not only it is about acquiring technology. This revolutionary integration of digital technologies, data analytics along with smart solutions leads to the establishment of a technologically driven approach. This new paradigm shift gives the stakeholders real-time data analytics that enables them to operate effectively in an efficient manner, eliminating both manufacturing and also service errors as well a great deal of agility towards responding to market dynamics. This transformation is driven by the essential elements such as AI, IoT, Digital twin virtual reality (VR) and augmented reality (AR) that play a critical function in perfecting production processes, minimizing lead times delivery while also improving overall quality. These advances not only make the systems much more efficient but also pave the way for a digital supply chain. Digitalization transforms its power around in operational efficiency, productivity and supply chain optimization. But this transition is not limited to technological upgrades; there must be a change in the mindset, cultural transformation, and reliable data management systems. If we achieve success in digitalization, then turning points on the cultivate is a digital mindset where organizations should focus more upon continuous learning and adaptability as well as continuous improvements. It subsequently becomes apparent that cybersecurity concerns are a very important factor to consider while addressing the digitalization journey. With more and more interconnected systems leading to the adoption of digital infrastructure by many companies, securing valuable information becomes very critical in business processes. When combined with the sustainable approaches, digitalization can contribute to the development of an eco-friendly and socially oriented manufacturing ecosystem. Not only does the study provide a detailed picture of the current situation regarding digitalization in relation to apparel companies, but it also serves as a very useful source for stakeholders. In this way, the research contributes to informed decision-making and strategic target setting in the industries by providing insights into existing challenges, opportunities and impacts of government policies. With the evolution of industries, the apparel sector is at the vanguard of a

digital revolution wider than technologies adoption. It is about re-configuring the industry even beyond the operational procedures, to values, ethic traditions and environmental impact. The digitalization of operations is a very strong engine that can lead the apparel industry to resilience, efficiency and sustainability. Basically, the digitalization must not be seen as a one-off event but rather an ongoing process that necessitates dedication, adaptability and should imply a systemic approach. The quest towards a digitized future requires that we walk with the technological improvements, establish an environment nurturing innovation and growth while confronting cybersecurity issues supported as well by sustainability. Further studies of the holistic digitalization application in the apparel industry may explore its socio-economic and environmental longstanding effects for assessing how embedded technologies influence sustainable growth, supply chain optimization efficiencies as well as natural ecosystems preservation.

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