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Understanding the Drivers of Digital Transformation Implementation in the Apparel Industry: An Extended TOE Framework

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Abstract

In recent years, digital technologies have transformed the people's lifestyles and the way businesses operate. These changes have become increasingly evident in various industries, including the apparel industry, especially after the emergence of the Fourth Industrial Revolution. The apparel industry, which has traditionally relied on physical supply chains, traditional design, and face-to-face sales, is now being influenced by drivers of digital transformation (DT) such as emerging technologies, organizational restructuring, Data Analytics, artificial intelligence (AI), digital platforms, and smart design and manufacturing technologies. In such circumstances, companies operating in this industry are forced to redesign their business models, processes, and structures in accordance with the requirements of the digital age in order to remain competitive. Accordingly, DT has become an inevitable necessity for players of apparel industry. One of the most important steps in this direction is to extract and integrate the drivers of DT implementation and present them in a five-dimensional framework including strategic, organizational, environmental, operational, and competitive drivers. Using the meta-synthesis method, this study organized the scattered literature on digital transformation into a coherent framework with 139 codes, 25 concepts, and 5 categories. By calculating the presence of each code in the selected studies, this study determined the level of support between studies and the relative consensus of the literature on drivers. Operational drivers with technology and infrastructure concepts, organizational drivers with diverse concepts at the organization level, and competitive drivers with concepts including customer, market, and sales channels had the most scientific support.

Keywords

Drivers of Digital Transformation, Apparel Industry, TOE Framework, Meta-synthesis, Shannon Entropy.

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Introduction

With the advancement of the Fourth Industrial Revolution, industrial companies and businesses are seeking to adapt to the changes brought about by global digitalization and to create genuine transformations in the foundations, procedures, and current approaches of their organizations (van Tonder et al., 2020). Industry 4.0 has brought about a fundamental transformation in the way businesses produce, improve, distribute, and sell products. This transformation is grounded in emerging and disruptive technologies such as the Internet of Things (IoT), Cloud Computing, Data Analytics, AI, 3D printing, and other digital technologies. The appropriate selection, combination, and application of these technologies in organizations can be examined under the concept of digital transformation (Lang & Ramz, 2018). In the contemporary era, digital transformation is no longer a strategic option; rather, it is regarded as a prerequisite for the survival of contemporary organizations (Verhoef et al., 2021). Digital transformation is a pervasive phenomenon that has affected all industries and is expected to play an even more decisive role in the future restructuring of industrial structures. Technological advances, international competition, changes in consumer behavior, and digital disruptions have generated fundamental changes in logical activities of industries (Veldhoven & Vanthienen, 2023). Under such conditions, companies are expected to optimize their resource consumption while maintaining competitive advantages, and digital technologies and Industry 4.0 assist them in moving toward this objective (Spaltini et al., 2021).

Digital transformation (DT) in businesses always requires resources, structures, growth strategies, indicators, and objectives corresponding to each specific stage. DT is a combination of complementary resources because it is a social engineering process (Verhulst & Brenden, 2021). DT is a process through which an organization responds to environmental changes by using digital technologies and transforms its value-added chain (Vial, 2019). In the contemporary era, DT has become an inevitable reality for organizations, enabling them to progress and strive for survival. More and more businesses are engaging in digital transformation and achieving significant outcomes (Hai, 2021). Promising government initiatives and policies toward digitalization in developing countries contribute to the growth of the global digital transformation market. Today's evolving business landscape places organizations under constant pressure to innovate, thereby making DT a core business priority. SMEs are considered the driving force of most economies because, according to the OECD[1] and the European Union, they are key actors in employment, innovation, and growth (Schaller, 2021).

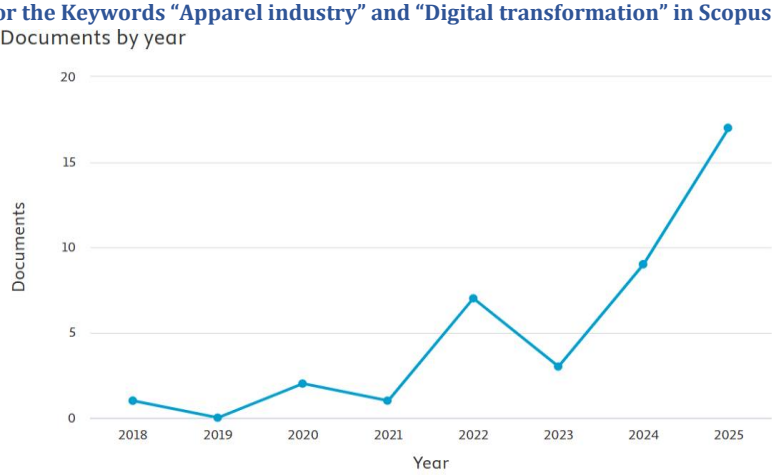
Among various industries, the apparel industry, as one of the largest and most complex industries worldwide, was valued at more than USD 1.7 trillion in the global market in 2023 (Statista, 2024). Compared with many other industries, the apparel industry has followed a more difficult and challenging path in the process of DT. This difficulty is rooted in the industry's unique structural characteristics, which distinguish

1 . Organisation for Economic Co-operation and Development

it from other industries. The apparel industry operates a complex and geographically dispersed supply chain, encompassing raw-material production, textile and garment manufacturing, distribution, and retailing (Christopher et al., 2004).. In addition to its structural complexity, the apparel industry must be accountable for its environmental impacts, including the consumption of water, energy, and chemicals, CO2 emissions, and waste generation, from the fiber production stage to retailing. However, minimizing and reducing these impacts require changes in processes, technologies, and business models (Wagner & Kabalska, 2023). The textile and apparel industry has market characteristics such as short product life cycles, high volatility, low predictability, and a high level of impulse purchasing, which make issues like rapid response highly important (Bruce et al., 2004; Christopher et al., 2004; Şen et al., 2008). In the contemporary era, due to rapid and complex changes in customer demand in this industry, supply chain managers face major challenges in producing and storing the right products at the right time, in the right place, and in the right quantity. This challenge becomes more evident when the market environment is highly unstable. Therefore, given the reasons stated above, companies must rapidly respond to environmental uncertainties and complexities (Xia et al., 2025).

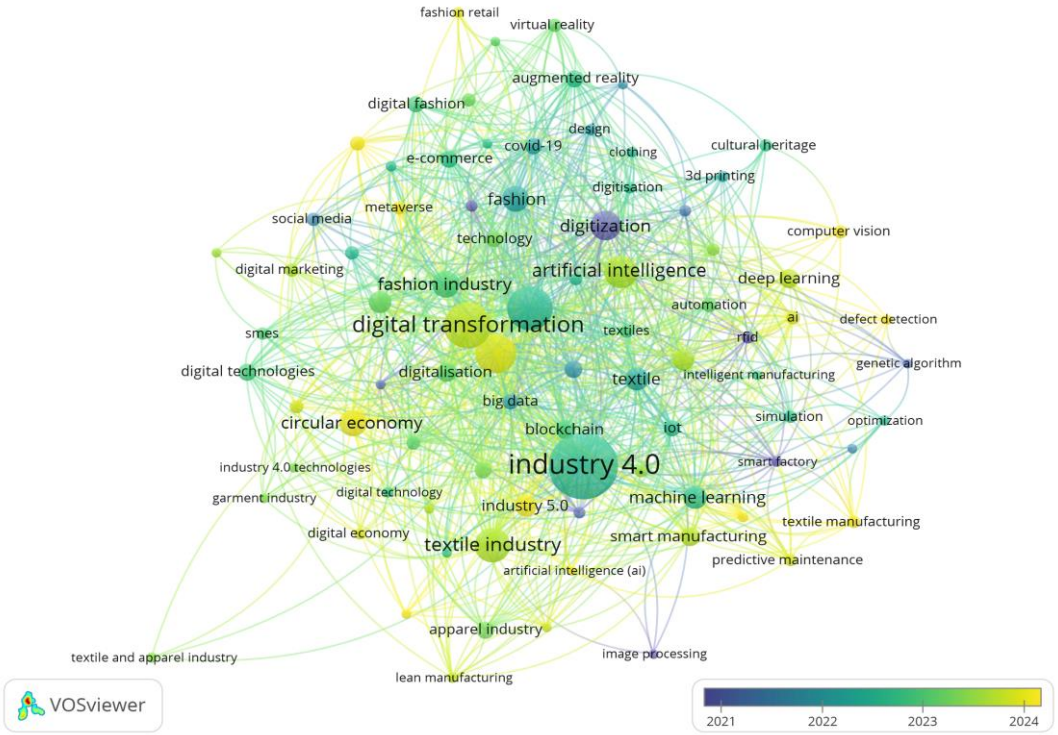
For this reason, DT enables apparel companies to upgrade their position in global value chains (GVCs), and by adopting digital technologies, companies can increase productivity and innovation. These technologies also allow them to move upward in GVCs and thereby capture greater values (Feng et al., 2024; Gastaldi et al., 2018; Matthess & Kunkel, 2020). Under such conditions, DT is regarded as a strategic and organizational process that, through the use of digital technologies, transforms processes, structures, business models, and modes of value creation (Verhoef et al., 2021; Vial, 2019). By facilitating circular economy models, DT prioritizes resource conservation and waste reduction and supports the environment through a shift toward sustainable practices. Companies are increasingly adopting data-driven approaches to enhance sustainability, in alignment with stakeholder pressures for responsible actions (Balloni et al., 2025; Colombi & D'Itria, 2023; Heim & Hopper, 2022). Given the current state of the apparel industry, environmental and competitive pressures, equipment complexity, rapid changes in conditions, and the role of digital technologies in improving business performance, reconsidering the implementation of digital transformation in the apparel industry appears to be important. The importance of this topic is also evident in scientific databases, as a search for the keywords "Digital Transformation" and "Apparel Industry" in the Scopus citation database indicates growing scholarly attention to this field and the need for more in-depth investigations.

Figure 1.
The Search Result for the Keywords "Apparel industry" and "Digital transformation" in Scopus Citation Database



(Source: The Researcher's Findings)

Figure 2.
The Keyword Co-occurrence Map of Digital Transformation Research in Apparel Industry



(Source: The Researcher's Findings)

Figure 2 shows the co-occurrence map of keywords related to DT research in the apparel industry. The data were extracted from Scopus in July 2026, yielding 2,577 articles with keywords related to digital transformation and apparel industry. This map shows that concepts such as Digital Transformation, Industry 4.0, Textile Industry, Artificial Intelligence, and Digitization are located at the center of the network, indicating that they are the most strongly connected to other keywords and form the core of the literature in this field. The concentration of these concepts at the center of

the network indicates that the majority of studies have examined DT in relation to Industry 4.0 technologies and the digitization of the apparel industry through smart technologies. On the other hand, the network shows that the scope of the studies is not limited to technical aspects alone, and topics related to fashion and apparel industry, digital marketing, e-commerce, digital economy, and digital design have also been developed alongside the smart manufacturing technologies. Despite the emphasis on the manufacturing sector in this industry through keywords such as sustainable manufacturing, smart manufacturing, and lean manufacturing, this pattern indicates that DT in apparel industry has also been studied in the areas of product design, supply chain, customer interaction, sales channels, and business models. Furthermore, the simultaneous presence of keywords such as Machine Learning, Deep Learning, Computer Vision, Blockchain, IoT, Big Data, Smart Manufacturing, Circular Economy, and Metaverse shows that the literature in this field has moved toward the use of emerging and smart technologies in recent years.

This study, with particular reliance on a meta-synthesis approach, extended the TOE framework for the apparel industry. First, environmental drivers were conceptualized beyond narrow interpretations limited to sustainability and ecological requirements and were defined as contexts encompassing crises and emergency conditions, the global economy and market, society and lifestyle, and policies and regulations. Second, operational drivers went beyond the technological dimension and included products and services, supply chain and logistics, and processes and operations as driving forces of digital transformation implementation. Third, strategic drivers were distinguished from organizational drivers and were explained as the guiding logic of digital transformation in relation to concepts such as leadership and governance, business model redesign, and firm-level strategy and planning. Therefore, the proposed framework went beyond a general classification of factors and explained DT implementation in the apparel industry as an environment-oriented, operation-oriented, strategy-oriented, organization-oriented, and competition-oriented phenomenon.

Literature Review

Digital Transformation (DT)

DT refers to the comprehensive integration of new digital technologies into all aspects of an organization to enhance performance and adapt to the evolving business landscape (Dănișor et al., 2023; Sehgal, 2024; Yadav & Seranmadevi, 2024). This includes rewriting the rules for customers, innovation, competition, data, and value propositions, and enables digitally empowered companies to remain at the forefront by leveraging the customer insight, an empowered workforce, and an understanding of new market forces (Sehgal, 2024). The DT process is highly important for organizations in anticipating expectations and reconsidering strategies, management practices, and consumer engagement models in response to rapid advances in Cloud Computing, Data Analytics, e-commerce, AI, and other digital technologies (Danso & Danso, 2023; Yadav & Saranmadevi, 2024; Dănișor et al., 2023). The digital revolution brought about by DT

affects not only technical activities but also management and work methods, making a shift toward more agile practices essential for navigating a volatile, uncertain, complex, and ambiguous business environment (Dănișor et al., 2023).

DT refers to the process of using digital technologies to fundamentally change operations, processes, and business models in order to adapt and remain competitive in the developing digital economy (Marino-Romero & Folgado-Fernández, 2024). DT refers to a broad digital evolution that affects businesses, society, and consumers, necessitates organizational adaptation, and influences consumer decisions (Paul et al., 2021). In the contemporary era, DT has become an inevitable reality for organizations so that they can progress and strive for survival. More and more businesses are engaging in DT and achieving significant outcomes (Hai, 2021).

In recent academic literature, DT is regarded as a strategic, multidimensional, and socio-technical process that, through the application of digital technologies, leads to changes in operational processes, organizational structure, business models, customer experience, and modes of value creation. In his systematic review, Vial regarded DT as a process in which organizations respond to environmental changes by using digital technologies and create new pathways for value creation (Vial, 2019). Verhoef et al. also considered DT to be a stage beyond digitization, one that leads not only to changes in technologies but also to the reinvention of strategy, business models, communication channels, and customer interaction (Verhoef et al., 2021). From this perspective, DT does not merely mean the use of technological tools; rather, it is a fundamental transformation in the logic of organizational activity that requires the reconfiguration of resources, the development of dynamic capabilities, organizational agility, and strategic renewal (Warner & Wäger, 2019).

Hanelt et al. (2021), through a systematic review of 279 articles in the field of DT, showed that digital transformation is a multidimensional phenomenon linked to digital technologies, strategy, and organizational change. They regarded DT as a form of organizational change that is stimulated and shaped by the diffusion of digital technologies, and emphasized that understanding and advancing it require simultaneous attention to technological antecedents, organizational and managerial characteristics, digital capabilities, innovation and integration mechanisms, and environmental conditions and digital business ecosystems (Hanelt et al., 2021).

The dimensions and components of DT can be categorized into several main axes. First, the technological dimension of DT includes capabilities and technologies such as the IoT, Big Data, Cloud Computing, mobile technologies, Data Analytics, and flexible digital infrastructures, which, by increasing the power of information processing, storage, and distribution, affect the decision-making speed, time to market, technological integration, and business model transformation (Nadkarni & Prügl, 2021). Second, the organizational and managerial dimension of DT emphasizes a set of human and structural factors, including leadership, organizational culture and climate, human resource management, employees' digital skills and training, organizational adaptability and resilience, and changes in work structures and processes. Trenerry et al. showed

that DT is not merely a technological issue; rather, it requires simultaneous attention to individual, group, and organizational factors for the adoption, adaptation, and institutionalization of digital technologies in the workplace (Trenerry et al., 2021). Third, the strategic and business model dimension of DT includes redefining the value proposition, developing digital channels, using digital platforms, creating value through data, and improving customer experience, because digital tools can make the firms' business models more innovative, create new distribution channels, and provide new ways of creating and delivering value to customers (Matarazzo et al., 2021). Fourth, the environmental and stakeholder dimension of DT includes competitive pressures, changing customer expectations, interaction with partners and suppliers, the formation of digital ecosystems, and the necessity of attending to sustainability. DT blurs the traditional boundaries of the organization and drives companies toward value co-creation networks and platform ecosystems; at the same time, market and stakeholder pressures compel organizations to integrate environmental sustainability into digital strategies and business models (Feroz et al., 2021; Plekhanov et al., 2023).

The Apparel Industry and Digital Transformation

The fashion and apparel industry has begun to integrate Industry 4.0 technologies by using interconnected ICT tools and algorithms to design new collections, forecast fashion trends, or identify market needs. The digital transformation process should be applied from different perspectives in order to cover every stage of the supply chain. Digitalization for only specific processes like purchasing is not sufficient. Every stage of the creation, production, and purchasing processes must be connected to the digital era. The key to success is the creation of a compatible and coordinated omnichannel system that aligns physical and digital activities and provides an interactive and engaging customer experience from concept to conversion and beyond. Ultimately, this is the direction in which the market is moving. In line with what is required for the manufacturing industry, producers of digital technologies have developed new solutions to support this sector and have evolved sustainably. Several providers have developed specific and innovative technologies for the apparel sector (Rosca et al., 2023). The integration of 3D technologies into apparel design provides greater flexibility and creativity and significantly improves the design process (Shevchuk, 2024). Digital tools like Adobe Illustrator simplify pattern making, reduce production time, and increase accuracy, which is critical for meeting the consumer expectations (Afifi et al., 2024; Arribas & Alfaro, 2018; Ramiah & Moore, 2023). DT strategies enable apparel companies to coordinate and prioritize their digital initiatives and affect products, processes, and organizational structures (Matt et al., 2015). Digital tools facilitate the development of apparel products and enable better management of supply chains and customer interaction, which are essential for modern consumer engagement (Hossein et al., 2024; Rosca et al., 2023; Su et al., 2023).

The textile and apparel industry, i.e., fashion, has been affected by transformations in socio-cultural and socio-economic structures. Given the shift in people's preferences from economic functionality to supra-functionality, beyond economic value, the fashion

industry is at the forefront of digitalization. Increasing digitalization in the fashion industry corresponds with digital fashion, which can meet rapid changes in consumer preferences (Akhtar et al., 2022). In the following section, two successful companies in the application of DT in the apparel industry are presented as examples.

- Zara/Inditex is one of the prominent examples of DT in the apparel industry, having built its digital strategy on the integration of physical stores and online channels, the digitalization of the supply chain, data-driven inventory management, and the development of an omnichannel retailing model. Recent studies showed that Inditex, by using technologies such as RFID, integrated information systems, Data Analytics, smart logistics, online sales, and the integration of physical–digital channels, has been able to increase its speed of response to market demand, inventory transparency, and operational flexibility. In this framework, DT at Inditex is not limited merely to online sales; rather, it has led to the redesign of key processes from design and production to distribution and the customer shopping experience. Research indicated that Zara/Inditex's omnichannel model, by linking store data, e-commerce, and supply chain operations, has contributed to improving customer experience, increasing product availability, and strengthening agility in the fast-fashion industry (Aftab et al., 2018; Camargo et al., 2020).
- Nike is one of the successful examples of DT in the sports apparel and footwear industry, having built its digital strategy around direct-to-consumer sales, digital platforms, personalization, value co-creation, and an integrated customer experience. By developing channels such as the Nike App, SNKRS, Nike Run Club, Nike Training Club, and product personalization programs, Nike has sought to transform its relationship with customers from a purely transactional relationship into a data-driven, interactive, and experience-oriented one. In the digital marketing literature, such a model is consistent with the logic of "brand value co-creation in the digital world", because brands can, through digital platforms, behavioral data, social interactions, and user participation, turn customers into part of the process of creating brand experience and brand value (Ramaswamy & Ozcan, 2016). From this perspective, Nike's DT is not limited to online sales; rather, it includes redesigning the customer experience, creating digital sports communities, personalizing offers, and using data to strengthen loyalty and continuous engagement with consumers.

In recent years, Nike's movement toward the Direct-to-Consumer / Direct-to-Customer model and the strengthening of digital channels have been consistent with recent discussions on DT and omnichannel retailing. The study by Verhoef et al. showed that DT occurs when companies use digital technologies to change their business models, communication channels, customer experience, and logic of value creation (Verhoef et al., 2021). This issue is also observed in Nike's strategy, because the company uses applications, an online store, digital membership, Data Analytics, and online sports communities to increase the customer knowledge and deliver a

personalized experience. Moreover, according to Becker and Jaakkola, customer experience in the digital environment results from a set of customers' cognitive, affective, behavioral, and social interactions with the brand throughout the customer journey (Becker & Jaakkola, 2020). Therefore, Nike's digital platforms can be interpreted as tools for managing and enriching the customer experience at different pre-purchase, purchase, and post-purchase stages. In addition, the role of social media, influencers, and online communities in the digital strategy of brands like Nike is aligned with the findings of recent studies on social media marketing and influencer marketing, because these tools can strengthen engagement, trust, brand identity, and consumers' purchase intention (Vrontis et al., 2021).

Drivers of DT in the Apparel Industry

Based on the reviewed articles, the drivers of DT in the apparel industry can be classified into several main categories, including technological, competitive, operational, organizational, and sustainability-oriented drivers. Ngoc Anh et al. emphasized the importance of a strategic approach to DT, ensuring that it is aligned with the overall business strategy in order to maximize benefits (Ngoc Anh et al., 2023). DT in the apparel industry is increasingly recognized as a critical driver of efficiency and innovation. Yingzhe emphasized that the integration of advanced technologies, such as AI and the (IoT), improves supply chain management and production processes, leading to cost reduction and improved responsiveness to market demands (Yingzhe, 2024., Zahra et al., 2024). Similarly, Mardiyah and Pratama emphasized the role of digital tools in facilitating real-time data analysis, which supports better decision-making and customer interaction (Mardiyah & Pratama, 2024). Quoc also noted that DT enhances sustainability by optimizing resource use and minimizing waste, thereby aligning with global environmental goals (Quoc, 2024). DT supports the shift toward sustainable practices by facilitating circular economy models that prioritize resource conservation and waste reduction. Companies are increasingly adopting data-driven approaches to enhance sustainability, in alignment with stakeholder pressures for responsible actions (Balloni et al., 2025; Colombi & D'Itria, 2023; Heim & Hopper, 2022). Moreover, sustainability studies showed that the stakeholder pressure, environmental requirements, pollution reduction, waste management, and the design of sustainable business models are among the key drivers of sustainable DT (Feroz et al., 2021; Mohamed Hashim et al., 2022). Furthermore, changing expectations among younger generations and the growth of virtual and Metaverse spaces have driven fashion brands toward digital experiences, gamification, avatars, virtual goods, and platform-based interactions; as the case study of Gucci Town in Roblox showed, the Metaverse can become a tool for creating new value propositions, increasing customer engagement, and testing new markets in the luxury fashion industry (Heo, 2025).

On the other hand, research on the drivers of DT showed that the success of this transformation does not depend solely on the introduction of technology; rather, it requires alignment among technology, strategy, structure, culture, human resources, governance, and sustainability goals. Plekhanov et al. (2023) emphasized that DT blurs

the traditional boundaries of the organization and brings companies into digital ecosystems and value co-creation networks. Therefore, competitive pressure, the more active role of customers, changes in organizational structure, and cultural transformation are important drivers of DT (Plekhanov et al., 2023). In the apparel industry as well, Alam and Dhamija showed that institutional pressures, the skills gap, and the need to develop Human Resources 4.0 drive apparel companies toward the adoption of Fourth Industrial Revolution technologies such as AI, Big Data, the IoT, robotics, Cloud Computing, and smart manufacturing (Alam & Dhamija, 2021).

Therefore, in the apparel industry, DT can be regarded as a strategic response to a set of simultaneous drivers: competitive pressure, changing customer expectations, the development of digital technologies, the need for operational agility, supply chain transparency, the development of human skills, and the movement toward sustainability. The following table presents some drivers of DT in the apparel industry and other industries.

Table 1.
A Summary of the Drivers of Digital Transformation in the Apparel Industry

Row	xAuthor(s) Name(s)	title	Some drivers of digital transformation
1	Heim & Hopper (2022)	Dress Code: The Digital Transformation of the Circular Fashion Supply Chain	market competitiveness, sustainability, circular economy, increased full supply chain transparency, traceability, waste reduction, Blockchain, RFID, QR, NFC, IoT, and NFT
2	Heo (2025)	Marketing Luxury Fashion in the Metaverse: The Case of Gucci Town on Roblox	changing expectations of Generation Z, immersive experience, gamification, avatars, emerging Metaverse technologies, increased brand awareness
3	Alam & Dhamija (2022)	Human Resource Development 4.0 (HRD 4.0) in the Apparel Industry of Bangladesh: A Theoretical Framework and Future Research Directions	institutional pressures, business model change, the need for new skills, Human Resources 4.0 development, Fourth Industrial Revolution technologies, AI, IoT, and smart manufacturing
4	Zhang et al. (2023)	Digital Transformation of Incumbent Firms from the Perspective of Portfolios of Innovation	rapid technological and market changes, business model innovation, changing customer preferences, the emergence of emerging technologies
5	Wahab et al. (2023)	Comparison of Cross-Border Reverse Logistics of a Fast Fashion Brand in China	development of industry 4.0 and digitalization, advances in tracking systems and RFID, development of Big Data and Analytics, advances in automated customer service systems, growth of e-commerce and online shopping, growth of cross-border commerce, need to improve inventory management, need to reduce logistics costs
6	Hossain et al. (2024)	Adoption of Artificial Intelligence and Big Data Analytics: An Organizational Readiness Perspective of the Textile and Garment Industry in Bangladesh	AI spread, Big Data Analytics (BDA), Cloud-Based technology, industrial automation, decision support systems, export growth competitive pressure, organizational innovation culture
7	Lan & Cleveland (2024)	Transforming Circular Fashion in Vietnam: The Role of Pre-Owned Markets in Sustainable Consumption	the fashion industry's environmental crisis, high consumption of water resources, the growth of e-commerce, social media, the need for diversity and exclusivity
8	Iguma et al. (2025)	The Postadoption of RFID Technology and Quality of Financial Information in Omnichannel Retailing	the advantages of RFID technology, technological complexity, COVID-19 pandemic, consumer behavior

(Source: The Researcher's Findings)

A review of prior studies indicated that research on DT across different industries and contexts has examined distinct subsets of the drivers and dimensions of this phenomenon. Some studies, particularly in the fashion and apparel sector, have focused on specific technologies and outcomes related to supply chains and sustainability. For example, Heim and Hopper (2022), in the context of circular supply chains in the fashion and apparel industry, examined drivers such as market competitiveness, sustainability, the circular economy, end-to-end supply chain transparency, traceability, waste reduction, and technologies such as Blockchain, RFID, QR codes, NFC, IoT, and NFTs. This study effectively demonstrated the importance of digital technologies, sustainability, and supply chain transparency; however, it focused primarily on circular supply chains and technological tools and did not encompass all drivers of DT within a comprehensive and integrated framework.

In another study, Heo (2025) examined DT in the context of luxury fashion marketing in Metaverse, emphasizing the changing expectations of Generation Z, immersive experiences, gamification, avatars, emerging Metaverse technologies, and increased brand awareness. This research demonstrated that changes in consumer behavior, emerging technologies, and the digital customer experience are important drivers of DT in the fashion industry. Nevertheless, its focus was predominantly on digital marketing and customer engagement in Metaverse, and it did not comprehensively examine the competitive, organizational, and strategic dimensions of DT.

Alam and Dhamija (2022) examined DT in the Bangladeshi apparel industry from the perspectives of institutional pressures, business model change, the need for new skills, Human Resources 4.0 development, and Fourth Industrial Revolution technologies such as AI, the IoT, and smart manufacturing. This study was particularly important because of its focus on the apparel industry and its attention to human resources, skills, institutional pressures, and emerging technologies. Nevertheless, it focused primarily on human resource development and institutional requirements, while operational and strategic drivers were not fully conceptualized as independent dimensions on an equal footing with the other drivers.

In the context of small and medium-sized enterprises, Jeza and Lekhanya (2022) identified drivers such as external changes, market pressure, the need to change the business model, cost reduction, and the need for rapid adaptation. This study addressed the environmental, operational, and strategic dimensions insofar as it considered market pressure, cost reduction, rapid adaptation, and business model change. However, it was conducted in the general context of small and medium-sized enterprises and was not specific to the apparel industry. Moreover, its technological and organizational dimensions were not explained comprehensively and systematically.

Zhang et al. (2023) examined DT in established companies across various industries, emphasizing rapid technological and market changes, business model innovation, changing customer preferences, and the emergence of novel technologies. This study was more comprehensive than some other studies because it considered technology, the market, business models, and customer preferences. However, its cross-industry nature

prevented it from fully explaining the specific requirements of the apparel industry, including the rapid pace of fashion change, global market pressures, supply chain complexity, product traceability, manufacturing flexibility, and rapid responsiveness to customer demand.

Wahab et al. (2023) provided significant evidence on the role of e-commerce, DT, inventory management and smart technologies in the fast fashion industry through a comparative study of Zara and Alibaba's cross-border reverse logistics. The paper highlighted the organizational decisions such as outsourcing versus insourcing, centralization versus decentralization, the role of distribution centers, collaboration with third-party logistics providers and the use of automated systems. Furthermore, although Alibaba has developed a formal cross-border logistics platform, neither Alibaba nor Zara has yet developed a fully integrated cross-border reverse logistics system. This suggests limitations in organizational and inter-organizational coordination. However, organizational readiness, including digital competencies, organizational structure, technology adoption culture, transformational leadership, financial resources, employee training and data governance, was not explicitly examined. Therefore, it is still unclear how organizations should move from simply using technology to developing sustainable organizational capabilities. The article implicitly emphasized the strategic importance of expanding e-commerce, establishing overseas warehouses, developing a cross-border logistics platform, and choosing between outsourcing and insourcing. It also showed that Zara is the outsourcing part of its distribution and inventory management operations to insourcing in order to gain greater control over its core competencies. However, the article did not specify how these actions align with the company's long-term vision, digital transformation strategy, international growth goals, and resource allocation. As a result, the gap between "using technology in a process" and "developing and implementing an integrated digital strategy" remained. The external environment was partly addressed in the article through references to customs regulations, international trade policies, free trade agreements, restrictions imposed during the COVID-19 pandemic, differences between the countries' logistics systems, and the role of the Chinese government in establishing return centers and e-commerce pilot zones. However, the institutional and regulatory environment was not systematically analyzed, and the impacts of data protection laws, environmental requirements, return regulations, tax policies, and international standards were not examined. The article also made more mention of garment recycling and supply chain sustainability, but did not examine socio-environmental pressures as a systemic environmental factor.

Another study by Hossain et al. (2024) suggested that the textile and apparel industry in Bangladesh currently has low organizational readiness for adopting AI and Big Data Analytics. This is due to the moderate knowledge and leadership readiness coupled with low human, financial, and collaborative readiness of most business organizations. The aspects of readiness interact with each other and need to be improved comprehensively. Given the significant global and national importance of the Bangladeshi textile and apparel industry, gaining insight into the current state of the industry's readiness for

adopting AI and Big Data Analytics will provide valuable contributions to national and global economies and may enhance the economic outcomes. Although this study examined the organizational readiness of Bangladesh's textile and apparel industry to adopt AI and Big Data Analytics, its primary focus was on the organizational dimension, including knowledge, leadership, human resources, financial resources, and collaboration; other dimensions, however, were not systematically examined.

With regard to the strategic dimension, the article did not specify how the adoption of AI and Big Data aligns with the vision, long-term objectives, DT strategy, and business priorities of apparel companies. Furthermore, the relationship between organizational readiness and strategic decision-making, resource allocation, and value creation remained unclear.

With regard to the operational dimension, the article did not explain how these technologies are applied in the industry's actual processes, including product design, demand forecasting, production planning, inventory management, quality control, and supply chain management. Accordingly, a gap exists between "readiness for adoption" and "the transformation of technology into operational capability and measurable performance". With regard to the competitive dimension, the article did not demonstrate how the adoption of AI and Big Data Analytics affects the productivity, costs, quality, responsiveness, and flexibility of apparel companies. Moreover, the competitive pressure exerted by global brands and the role of technology in maintaining Bangladesh's position in the global value chain have not been explicitly analyzed.

Lan and Cleveland (2024) conducted another study based on observations from local media, two second-hand platforms, and an online survey of 221 young Vietnamese consumers. The findings indicated that motives for purchasing second-hand fashion include seeking value for money, unique personal style, and responsible consumption. The study identified the impact of the fashion industry's environmental crisis, high water resource consumption, the growth of e-commerce, social media, the need for diversity and online media exclusivity, and the role of social commerce as pivotal in changing the second-hand fashion. The study primarily focused on young Vietnamese consumers and did not comprehensively examine the relationships between consumer, organizational, technological, environmental, and competitive factors. Furthermore, the descriptive nature of the study, coupled with its reliance on a limited sample, two platforms, and a specific geographic context, limited the generalizability of its findings. Furthermore, the paper mainly identified consumer motivations but did not explain the mechanisms through which these motivations translate into sustainable behavior, business model development, platform trust, value creation across the supply chain, and the long-term implications of the circular economy. Thus, there is a need for research that integrates the scattered findings of previous studies into a comprehensive, multi-level framework.

Iguma et al. (2025) examined factors such as the advantages of RFID technology, technological complexity, the COVID-19 pandemic, and consumer behavior in an apparel manufacturing company. Owing to its focus on an apparel manufacturer, this study was closely related to the present research and demonstrated that technology, crisis

conditions, and consumer behavior can drive DT. Nevertheless, its focus was limited to RFID and a specific set of factors, and it did not provide a comprehensive framework for simultaneously explaining technological, organizational, environmental, operational, and strategic drivers.

Overall, a comparative analysis of previous studies indicated that, although the DT literature is thematically rich, it faces limitations in terms of theoretical integration and contextualization within the apparel industry. First, many studies were technology-driven and examined DT primarily through technologies such as RFID, Blockchain, the IoT, AI, the Metaverse, Cloud Computing, or Industry 4.0 technologies. Second, apparel-related studies also focused on specific topics, including circular supply chains, Human Resources 4.0, RFID, sustainability, the circular economy, digital marketing, and operational productivity.

From a theoretical perspective, the principal gap is that previous studies have often examined the drivers of DT in a fragmented or partial manner or have subsumed them under one another. Technological drivers have generally received the greatest attention, whereas organizational, environmental, operational, strategic, and competitive drivers have been examined unevenly. In addition, strategic drivers have typically been incorporated into the organizational dimension, and their role as the guiding rationale for DT—including leadership, governance, business-model redesign, strategy, and planning—has been less frequently explained independently. Furthermore, the environmental dimension has been limited in some studies to sustainability, government policies, institutional pressures, or consumer behavior. In the apparel industry, however, the environment encompasses a broader range of factors, including crises, social and lifestyle changes, the global economy and market, policies and regulations, and environmental sustainability. Most importantly, competitive drivers can be attributed to the distinctive characteristics of the apparel industry, including short product life cycles, high demand uncertainty, seasonal fluctuations, extensive variety, geographically dispersed global supply chains, and intense pressure for rapid market responsiveness. These characteristics make operational integration, supply-chain visibility, inventory accuracy, digital product development, and manufacturing flexibility particularly central to the implementation of DT. This finding is consistent with previous studies on fashion and apparel supply chains, which emphasized agility, rapid response, and coordination as key sources of competitiveness in the industry (Bruce et al., 2004; Christopher et al., 2004; Şen, 2008).

Within this framework, the operational driver broadly encompasses the concepts of technology and infrastructure, supply chains and logistics, production and services, and processes. The organizational driver refers to resources, capabilities, skills, training and development, organizational culture, organizational design and structure, managerial support, and leadership. The Environmental drivers go beyond economics and global marketing to include concepts of environment and sustainability, regulations and politics, and emergencies such as pandemics.

Therefore, the theoretical contribution of the present study lies not merely in adding

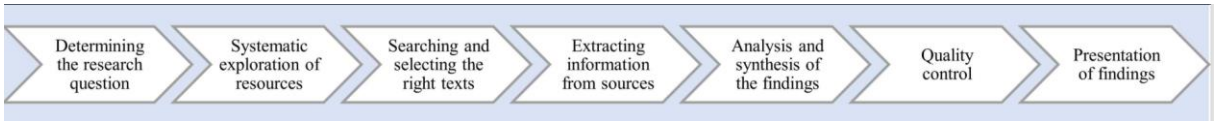
several new factors to the DT literature, but in systematically integrating the previously fragmented body of knowledge and presenting a comprehensive and integrated framework for the apparel industry. By incorporating, in addition to the traditional technological, organizational, and environmental dimensions, an operational driver that extends beyond technology, as well as strategic and competitive drivers, the study expands the TOE framework by analyzing these as distinct and independent dimensions. Accordingly, the implementation of digital-transformation drivers in the apparel industry is explained not solely as a technological issue, but as a multidimensional phenomenon driven by environmental, organizational, operational, strategic, and competitive factors.

Methodology

This study was applied in terms of its orientation, qualitative in terms of its type, and specifically a meta-synthesis. Meta-synthesis is a systematic study that examines previous research. Following the meta-synthesis process, new analyses and interpretations are obtained that do not exist in the original texts (Sandelowski & Barroso, 2003). The strength of the meta-synthesis approach lies in its ability to identify common patterns and construct a comprehensive theoretical framework from prior studies. According to Zimmer, meta-synthesis is a type of qualitative research that examines data and results obtained from other qualitative studies with related and similar topics. Therefore, the statistical sample in meta-synthesis consists of selected qualitative studies and is established based on their relevance to the research question (Zimmer, 2006). Meta-synthesis uses summarized information and findings extracted from other studies with a similar topic (Zimmer, 2006). Meta-synthesis is a general method that refers to a family of methodological approaches for developing new knowledge based on the rigorous and comprehensive analysis of qualitative research findings. More precisely, meta-synthesis is a collection of theories into grand narratives, generalizations, or interpretive translations that are the product of integrated comparisons of qualitative findings (Xu, 2008). Qualitative meta-synthesis is not limited to aggregating or reorganizing previous findings; rather, it aims to extract, analyze, and synthesize qualitative findings across published studies to develop newly synthesized concepts and articulate the dynamic relationships among them (O'Connor & Joffe, 2020).

In this study, the seven-stage meta-synthesis method of Sandelowski and Barroso (2003) was used (Movahed et al., 2023).

Fig. 3.
The Stages of Sandelowski and Barroso's Seven-Step Meta-Synthesis Method



(Source: The Researcher's Findings)

Step One: At this stage, the key elements of the study were determined, including the main topic (what is being examined), the target population (which individuals or organizations), the time frame (when), and the methodological approach (how it is conducted). Accordingly, the central question of this study was defined as follows:

What are the drivers of digital transformation in the apparel industry, and how can they be classified within the TOES framework and operationalized for implementation?

In Step Two, a systematic literature review was conducted. The statistical population of this study included all scientific and research articles from international journals related to the field of DT and the apparel and fashion domain. This review and search were conducted in the reputable international databases ScienceDirect and Scopus for the period 2015–2025 and covered all scientific and research articles in English from the selected sources.

Table 2.
The Keywords Searched in the Meta-Synthesis Process

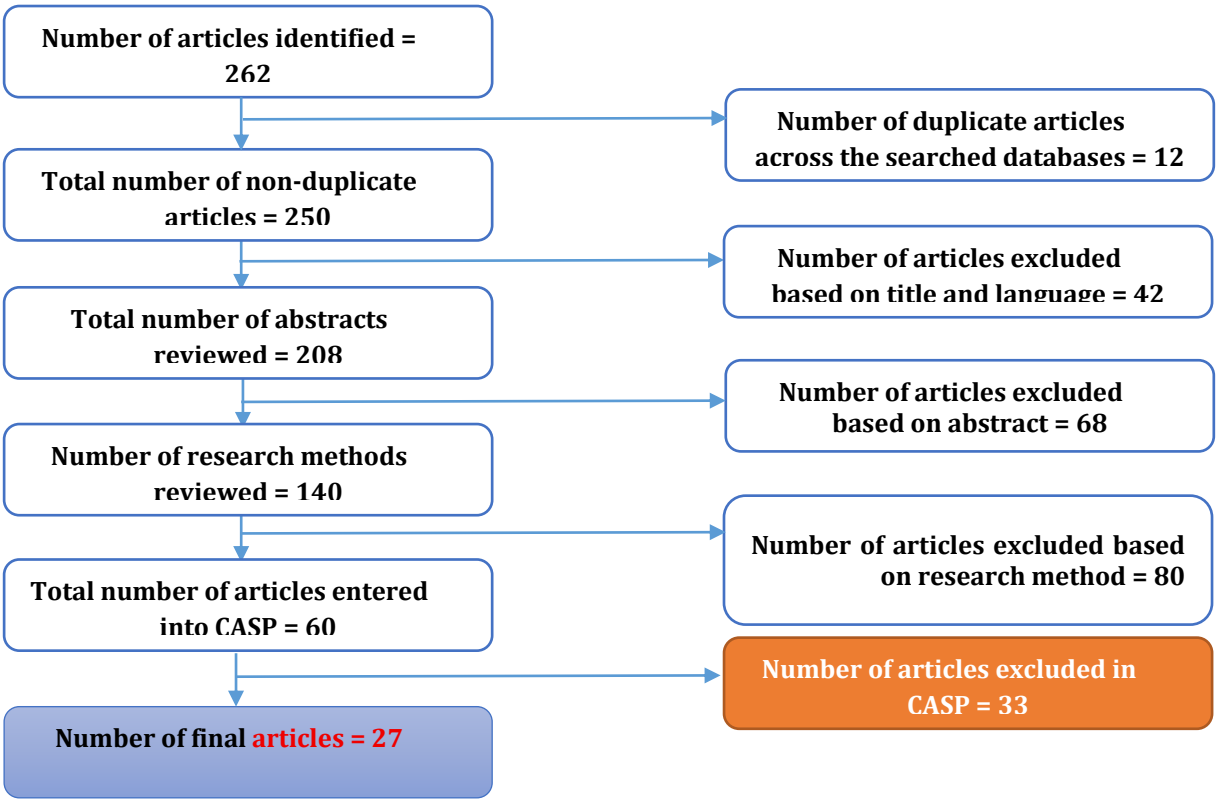
Searched Keyword
"digital transformation" & "apparel industry"
"digital transformation" & "clothing industry"
"digital transformation" & "apparel industry"
"digital transformation" & "fashion industry"
"digital transformation" & "Implementing"
"digital transformation" & "Implementation Framework"
"Critical Factors for Digital Transformation Success"
"Digital Transformation Readiness"
"Digital Transformation Drivers"
"Digital Transformation Consequences"
"Digital Transformation Factors"

(Source: The Researcher's Findings)

In Step Three, the process of searching for and selecting relevant articles was carried out. To identify suitable articles, the following criteria were used to select the relevant studies: (1) articles published between 2015 and 2025; (2) articles published in English; (3) articles indexed in reputable databases such as Scopus and ScienceDirect; (4) articles in the two domains of digital transformation and the apparel and fashion industry; and (5) access to the full text and possession of the required quality for scientific extraction, analysis, and synthesis in the study. In the screening stage, to assess the alignment of the identified articles with the research questions, the studies were examined and reviewed several times by the research team in terms of relevance to the objective, absence of duplication across different databases, relevance of the abstract, relevance of the content, and, finally, evaluation of the quality of the research method. A summary of the process is presented in Figure 3.

In Step Four, information was extracted from the articles. The information for each article, based on the corresponding source, including the author's first and last name, the year of publication, and the drivers of DT, was extracted and presented in the article appendix. At this stage, the initial coding of the extracted information was performed, and the codes related to the drivers of DT were identified.

Figure 4.
The Results of the Search and Selection of Suitable Articles



(Source: The Researcher's Findings)

In Step Five, the findings were analyzed. In this study, open, axial, and selective coding were employed for data analysis. After a comprehensive review and initial coding of each of the selected articles, the initial codes were extracted, and subsequently, axial coding was initiated. First, the selected articles were studied, and then the relevant concepts and codes were identified and assigned under the intended label. The output of this step is presented in detail in the findings section of the study.

In Step Six, to ensure the quality and reliability of the study, the inter-coder agreement method was used. To control and validate the evaluation, the researcher compares his or her coding with the opinion of another expert. In the present study, six articles from among the reviewed articles were examined. Then, to calculate the level of agreement between the two coders, namely the principal researcher and the second expert, Cohen's kappa coefficient was used. The kappa coefficient, calculated using SPSS software, was 0.86, indicating the level of agreement between the two coders and, consequently, demonstrating the appropriate reliability of the study. In addition, to ensure the quality of the selected articles, the researchers used the CASP appraisal tool during the article screening stage. In line with O'Connor and Joffe's (2020) practical guidelines for inter-coder reliability assessment in qualitative research, 10–25% of the dataset is commonly considered appropriate for double coding, depending on the size of the dataset. In the present study, 6 out of 27 articles were independently coded by two coders, representing approximately 12.76% of the final sample. Therefore, the double-coded subset fell within the recommended range. The selected articles were chosen to

represent different study contexts and coding categories (O'Connor & Joffe, 2020).

Step Seven: After extracting codes from the relevant articles and appropriately categorizing them into desired concepts and categories using the researchers' opinions, the entropy results were presented as literature-based salience weights instead of importance weights. Shannon entropy was used as an information-based weighting approach to summarize the relative representation and dispersion of stimuli in the reviewed literature (Shannon, 1948).

Findings

Based on the analyses and content analysis of the articles, 27 final articles were selected (the list of articles with authors will be provided in the appendix of the article).

The data analysis process was carried out based on using the thematic analysis approach of Braun and Clark (2006) and taking into account the methodological explanations provided by Scharp and Sanders (2018). In this study, the analysis was not considered as a linear or mechanical process; rather, it was carried out iteratively. This means that at different stages, the researcher moved back and forth between the extracted texts, the initial codes, the concepts and the final categories, and, if necessary, modified and refined the codes and categories.

In the first stage, the full text of the selected studies was read several times to familiarize the researcher with the content of the data, the context of the studies and the initial patterns arising from them. In this stage, parts of the text related to the research question were extracted as semantic units. A semantic unit is a sentence, multiple sentences, or part of a text that conveys a relatively complete idea or meaning in relation to the purpose of the study.

In the second step, one or more primary codes were assigned to each semantic unit. A primary code is a brief label that describes the main meaning of a text unit. The codes were kept as close as possible to the main content of the text and the interpretations that went beyond the available evidence were avoided. In other words, the primary coding was done to identify the features, actions, conditions, barriers, or consequences presented in the text.

In the third step, similar or related primary codes were compared and organized into concepts. A concept represents a more abstract level than a primary code and includes several codes with similar or shared meanings.

In the fourth step, related concepts were merged into broader categories. A category is a coherent set of concepts that refer to a common domain or analytical structure. Categories represent a higher level of abstraction than concepts and form the primary structure of the research findings.

In the fifth step, the categories were examined in relation to the research question and the data set as a whole. This step examined whether each category had sufficient internal coherence, whether its distinction from other categories was clear, and whether it was sufficiently supported by evidence from the selected studies. Categories that had significant overlap were merged, while categories that were too broad in scope or not

sufficiently supported by evidence were split, modified, or deleted.

Finally, each category was assigned a title that was concise, clear, and representative of its main meaning. In this study, codes represented primary semantic units, concepts represented common patterns across multiple codes, and categories represented broader analytical structures formed by combining related concepts. This hierarchy was defined as follows (Scharp & Sanders, 2019):

Text unit/extracted meaning → initial code → concept → final category

This process did not identify a theme solely based on its frequency of occurrence. It also considered the relevance, importance, and capacity of the theme to address the research question. According to Braun and Clark (2006), a theme is analytically significant when it encompasses a meaningful and patterned aspect of the data, even if it does not appear in all studies or in most data units. The coding and synthesis method of thematic synthesis proposed by Thomas and Harden (2008) also confirms this approach. Based on this approach, qualitative synthesis involves three related steps: line-by-line coding of the findings of the initial studies, development of descriptive themes, and generation of analytical themes. In the present study, the textual findings of the selected articles were considered as the initial data for synthesis. Semantic units that referred to the drivers of DT implementation were extracted and inductively coded. Each code was assigned to a sentence, phrase, or paragraph based on its meaning and content.

In the first step, open coding was conducted to generate initial codes. With each new article reviewed, new codes were added, with the extracted semantic units introducing new aspects of implementing DT. This method resulted in 139 initial codes. In the second step, the initial codes were compared for similarities, differences, and conceptual relationships. The semantically related codes were then grouped into 25 concepts that corresponded to the descriptive themes in Thomas and Harden's terminology. In the third step, these concepts were interpreted and summarized within the developed TOE/TOES framework to create five higher-level concepts. order categories. These final categories corresponded to analytical themes, as they went beyond the literal findings of the primary studies and provided an interpretive structure for understanding the drivers of DT implementation in the apparel industry (Thomas & Harden, 2008). The findings of this stage indicated that no such systematic study has been conducted in previous studies to date, and each of the prior studies has focused on a specific aspect of DT in organizations and businesses in the apparel industry. Subsequently, Table (3) presents the codes, concepts, and categories of the drivers of DT, along with the extracted sources.

Table 3.
The Categories and Themes Extracted from the Review of Codes Derived from the Articles

Category	Concept	Code	Author(s) and Year
Strategic Drivers	Leadership and Governance	• Institutional pressures and environmental uncertainty	Su et al. (2023)
		• Active participation of decision-makers • strengthening decision-making power	Zhang et al. (2023);Nour and Arbussà (2024); Kitsios et al. (2023); Balloni et al. (2025)
		• Support and commitment of top leadership and senior management support	Ramiah and Moore (2023); Kitsios et al. (2023); Iguma et al. (2025); Hossein et al. (2024)
		• Data governance and control	Haim and Hooper (2022); Strazzullo et al. (2025)
	Strategy and Planning	• Need for comprehensive planning beyond technology • strategic planning	Ibrahimi and Benchekroun (2023)
		• Pre-digital transformation strategy • organizational strategies	Arribas and Alfaro (2018); Russo et al. (2025); Hossein et al. (2024); Ramiah and Moore (2023); Su et al. (2023)
		• Alignment of IT and business strategy	Zhang et al. (2023)
		• Need for systems thinking and holistic thinking	Conlon (2024)
		• Need for disaster risk reduction and climate change adaptation (need for DRR and CCA)	Bag et al. (2023)
		• New management tools	Zhang et al. (2023)
	Business Model and Transformation	• Necessity of business model change	Zhang et al. (2023); Russo et al. (2025); Kitsios et al. (2023); Haim and Hooper (2022); Wagner and Kabalska (2023); Balloni et al. (2025); Lan and Cleveland (2024); Alam and Dhamija (2021); Su et al. (2023)
		• Digital economy transformation	Xia et al. (2025); Lan and Cleveland (2024); Su et al. (2023)
		• Need to redefine value	Zhang et al. (2023); Heo (2025)
		• Need for fundamental transformation	Zhang et al. (2023); Heo (2025)
		• Acknowledgment of the importance of digitalization	Zhang et al. (2023); Kitsios et al. (2023)
		• Stimulating business and entrepreneurship	Zhang et al. (2023)
	Digital Capabilities and Competencies	• Need for digital capabilities • dynamic capability	Zhang et al. (2023); Conlon (2024)
		• Necessity of developing technological capabilities for data management • full integration of technology, data, and automation	Zhang et al. (2023); Russo et al. (2025); Shu and Srimuang (2025); Haim and Hooper (2022); Hossein et al. (2024)
		• Need for technical and digital competencies • necessity of employee readiness	Conlon (2024); Russo et al. (2025); Iguma et al. (2025); Matthess and Kunkel (2020); Alam and Dhamija (2021); Zhang et al. (2023)
		• Digital competence • requirement for the digitalization of reporting	Russo et al. (2025); Strazzullo et al. (2025)
	Organizational Culture and Mindset	• Culture of experimentation and innovation • need for technological specialization for the fashion industry	Zhang et al. (2023); Arribas and Alfaro (2018); Lan and Cleveland (2024); Iguma et al. (2025); Hossein et al. (2024)
		• Necessity of managing resistance to change	Su et al. (2023)
		• Need for agile management and leadership • necessity of balancing traditional and digital leadership	Ibrahimi and Benchekroun (2023); Arribas and Alfaro (2018); Trang et al. (2025); Lan and Cleveland (2024)

Category	Concept	Code	Author(s) and Year
	Learning and Development	• Continuity of the learning process • learning by doing • learning-oriented collaboration between the fashion brand and the software company	Arribas and Alfaro (2018)
		• Development of new skills and organizational knowledge	Ibrahimi and Benchekroun (2023); Arribas and Alfaro (2018); Hossein et al. (2024); Alam and Dhamija (2021)
		• Need for comprehensive knowledge and data management • need for faster access to information	Xia et al. (2025)
		• Limitations of the current system and need for a CDE • establishment of digital centers or laboratories for exchanging ideas and knowledge	Ramiah and Moore (2023); Su et al. (2023)
	Leadership and Management	• Importance of resource management in digital transformation • effective resource management	Zhang et al. (2023); Russo et al. (2025)
		• Need for agile management and leadership • necessity of balancing traditional and digital leadership	Ibrahimi and Benchekroun (2023); Russo et al. (2025); Shu and Srimuang (2025)
	Organizational Structure and Design	• Changes in organizational processes	Budiyanto et al. (2024);Nour and Arbussà (2024); Conlon (2024); Trang et al. (2025); Matthess and Kunkel (2020); Su et al. (2023)
		• Outsourcing of services	Matthesss and Kunkel (2020)
		• Division of tasks	Matthess and Kunkel (2020)
		• Formation of project teams comprising different organizational levels • membership in chambers, associations, and industrial networks	Shu and Srimuang (2025); Matthess and Kunkel (2020)
		• Organizational size	Iguma et al. (2025); Matthess and Kunkel (2020)
		• Traditional organizational structure	Ibrahimi and Benchekroun (2023); Lan and Cleveland (2024); Iguma et al. (2025); Matthess and Kunkel (2020)
		• Need for new organizational structures	Nour and Arbussà (2024); Iguma et al. (2025); Matthess and Kunkel (2020)
		• Breaking down organizational dimensions • eliminating operational boundaries and divisions	Ibrahimi and Benchekroun (2023); Shu and Srimuang (2025)
	Employees and Workforce	• Pressure to address staff shortages	Alam and Dhamija (2021)
		• Lack of owners' knowledge and skills	Arribas and Alfaro (2018); Strazzullo et al. (2025); Hossein et al. (2024)
		• Shortage of digital specialists in the market	Ramiah and Moore (2023); Conlon (2024); Hossein et al. (2024)
		• Employee dissatisfaction with access to information	Ramiah and Moore (2023)
		• Generational change and business succession • entry of a new generation with higher education and a different perspective on technology	Shu and Srimuang (2025); Trang et al. (2025)
	Resources and Constraints	• SME resource constraints • financial resource constraints	Fischer et al. (2020); Trang et al. (2025)
		• Low level of digitalization • number of SMEs in Europe that have been digitalized	Matthess and Kunkel (2020)
		• Need for new resources	Su et al. (2023)
	Collaboration and Networking	• Communication problems with manufacturers and partners • need for internal collaboration	Arribas and Alfaro (2018); Xia et al. (2025); Strazzullo et al. (2025)

Category	Concept	Code	Author(s) and Year
		• Cross-functional collaboration • creation of an intra- and inter-organizational collaborative environment	Ibrahimi and Benchekroun (2023); Balloni et al. (2025)
		• Stakeholder demands for social responsibility	Wagner and Cabalska (2023); Bag et al. (2023)
		• Stakeholder pressure	Strazzullo et al. (2025)
Operational Drivers	Technology and Infrastructure	• Technological transformations based on Cyber-Physical Systems (CPS)	Alam and Dhamija (2021)
		• Existence of basic technological infrastructures • need for digital infrastructure improvement	Zhang et al. (2023); Kitsios et al. (2023); Iguma et al. (2025); Hossein et al. (2024); Alam and Dhamija (2021)
		• Emerging Metaverse technologies	Heo (2025)
		• Development of Big Data and Analytics	Wahab et al. (2023); Bag et al. (2023)
		• Advancement of tracking systems and RFID	Wahab et al. (2023); Iguma et al. (2025)
		• Technology trialability	Iguma et al. (2025)
		• Exploratory stage of the fashion industry in technology adoption	Arribas and Alfaro (2018); Yeo et al. (2022); Balloni et al. (2025); Iguma et al. (2025)
		• Technology convergence • emergence of emerging technologies	Fischer et al. (2020); Zhang et al. (2023); Ibrahimi and Benchekroun (2023); Arribas and Alfaro (2018); Russo et al. (2025); Conlon (2024); Trang et al. (2025); Nour and Arbussà (2024); Shu and Srimuang (2025); Kitsios et al. (2023); Haim and Hooper (2022); Wagner and Kabalska (2023); Wahab et al. (2023); Yeo et al. (2022); Xia et al. (2025); Balloni et al. (2025); Iguma et al. (2025); Hossein et al. (2024); Matthess and Kunkel (2020); Alam and Dhamija (2021); Bag et al. (2023)
		• Rapid penetration of digital technologies across various industries	Shu and Srimuang (2025); Arribas and Alfaro (2018); Conlon (2024); Xia et al. (2025); Matthess and Kunkel (2020)
		• Observability of results	Iguma et al. (2025)
		• Technology complexity	Iguma et al. (2025)
		• Emergence of 3D, virtual reality, IoT, etc., as core technologies for manufacturing transformation • Industry 4.0	Arribas and Alfaro (2018); Iguma et al. (2025); Alam and Dhamija (2021)
		• Development of online platforms	Yeo et al. (2022); Wahab et al. (2023)
		• Need for rapid technology integration	Conlon (2024)
		• Necessity of system integration • necessity of business process integration	Zhang et al. (2023); Haim and Hooper (2022); Iguma et al. (2025)
	Processes and Operations	• Need for process improvement • process optimization • need for process innovation	Zhang et al. (2023); Trang et al. (2025); Nour and Arbussà (2024); Kitsios et al. (2023); Haim and Hooper (2022); Wagner and Kabalska (2023); Su et al. (2023)
		• Reduction of operational costs and productivity improvement	Costa et al. (2023); Nour and Arbussà (2024); Shu and Srimuang (2025); Wagner and Kabalska (2023); Matthess and Kunkel (2020)
		• Need for better resource allocation and waste reduction	Wagner and Kabalska (2023); Matthess and Kunkel (2020)
		• Impact of organizational integration • integration of data and customer insights • advancement of automated customer systems	Nour and Arbussà (2024); Wahab et al. (2023)

Category	Concept	Code	Author(s) and Year
		• Alteration of certain processes with digital technology • digital adaptation	Zhang et al. (2023); Shu and Srimuang (2025); Kitsios et al. (2023)
		• Need for efficiency improvement and better service delivery	Nour and Arbussà (2024); Haim and Hooper (2022); Matthess and Kunkel (2020)
	Supply Chain and Logistics	• Need to reduce logistics costs	Wahab et al. (2023)
		• Need to improve inventory management	Wahab et al. (2023); Balloni et al. (2025)
		• Need to address value chain issues • Global Value Chains (GVCs)	Matthess and Kunkel (2020)
		• Digitalization as a key objective for supply chain efficiency • fashion supply chain complexity / supply chain complexity	Arribas and Alfaro (2018); Russo et al. (2025); Conlon (2024); Iguma et al. (2025); Bag et al. (2023)
		• Necessity of connecting the extended supply chain • need to improve supply chain performance	Conlon (2024); Shu and Srimuang (2025); Russo et al. (2025); Haim and Hooper (2022); Bag et al. (2023)
		• Need to improve return systems	Wahab et al. (2023)
		• Improvement of traceability and transparency • increased full supply chain transparency	Haim and Hooper (2022); Strazzullo et al. (2025)
		• Requirements of supply chain partners	Iguma et al. (2025)
	Product and Service	• Innovation opportunity • stimulation of innovation in the education sector • possibility of new creative scenarios with 3D	Fischer et al. (2020); Arribas and Alfaro (2018)
		• Organizations' investment in PLM systems • improvement of product lifecycle management	Arribas and Alfaro (2018); Conlon (2024); Heim and Hooper (2022)
		• Designer's motivation to reduce development time / tangible and intangible technologies	Arribas and Alfaro (2018)
		• Excess costs of traditional projects / the lengthy and costly iterative process of design–prototyping–fitting	Ramya and Moore (2023); Arribas and Alfaro (2018)
		• Need for product personalization and customization	Yeo et al. (2022); Xia et al., 2025). (2025); Balloni et al. (2025)
		• Reduction of overproduction	Bag et al. (2023)
Environmental Drivers	Policy and Regulations	• National need for the digitalization of government services	Kitsios et al. (2023)
		• Regional regulatory pressures	Alam and Dhamija (2021)
		• Governance model and digital policies	Russo et al. (2025); Kitsios et al. (2023)
		• Government support and policies	Costa et al. (2023); Trang et al. (2025); Shu and Srimuang (2025); Haim and Hooper (2022)
		• Legal and regulatory requirements • government regulations and standards	Trang et al. (2025); Strazzullo et al. (2025); Balloni et al. (2025)
		• International regulations • GDPR	Hussain et al. (2024); Bag et al. (2023)
		• Double materiality principle • integration of two perspectives	Strazzullo et al. (2025)
	Economy and Global Market	• The imperative global trend of DT • the need to respond to global changes • globalization	Trang et al. (2025); Ramya and Moore (2023); Jeza and Lakhaniya (2022); Arribas and Alfaro (2018); Nour and Arbussà (2024); Shu and Srimuang (2025); Xia et al. (2025); Strazzullo et al. (2025); Hussain et al. (2024); Alam and Dhamija (2021); Su et al. (2023); Bag et al. (2023)

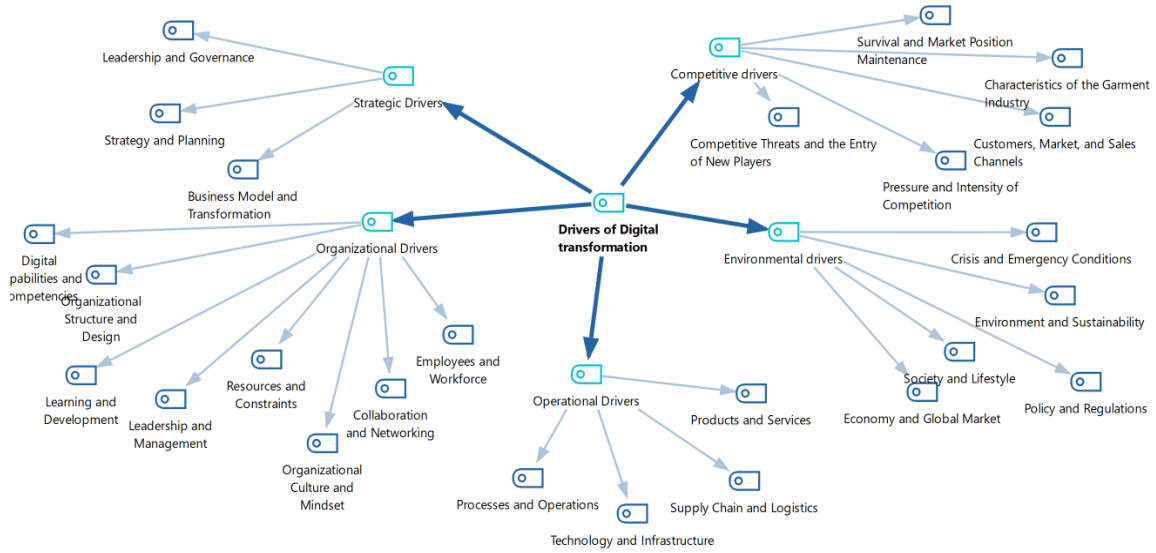
Category	Concept	Code	Author(s) and Year
		• Market forecasting • demand • the need for intelligent analytics	Nour and Arbussà (2024); Balloni et al. (2025)
		• Changes in income elasticity • relatively strong demand growth	Matthess and Kunkel (2020)
		• Economic viability • cost-effective expansion	Lan and Cleveland (2024); Hussain et al. (2024)
		• Extensive stakeholder engagement	Heo (2025)
		• Market instability	Ibrahimi and Benchekroun (2023); Shiba et al. (2025)
		• Risk absorption capacity	Iguma et al. (2025)
		• Pace of change in the business environment	Zhang et al. (2023); Ibrahimi and Benchekroun (2023); Mattis and Kunkel (2020)
	Environment and Sustainability	• The need to reduce risk and improve sustainability	Wahab et al. (2023); Yeo et al. (2022); Lan and Cleveland (2024); Bag et al. (2023)
		• Reduction of ESG risks	Yeo et al. (2022); Strazzullo et al. (2025)
		• Natural risks	Bag et al. (2023)
		• Environmental challenges • textile waste crisis	Mohamed Hashim et al. (2022); Haim and Hooper (2022); Wagner and Kabalska (2023); Balloni et al. (2025); Lan and Cleveland (2024)
		• Climate change	Lan and Cleveland (2024); Bag et al. (2023)
		• High consumption of water resources	Lan and Cleveland (2024)
		• Prioritization of sustainable development	Wagner and Cabalska (2023); Wahab et al. (2023)
	Society and Lifestyle	• Demand for immersive experiences	Balloni et al. (2025)
		• Effectiveness of social media	Shu and Srimuang (2025); Yeo et al. (2022); Lan and Cleveland (2024)
		• Transformation in economic and social attitudes / pressure for social change	Lan and Cleveland (2024); Matthess and Kunkel (2020)
		• Increased brand awareness	Heo (2025)
		• Educational policies for digital learning	Conlon (2024)
		• Trend toward blended learning	Conlon (2024)
		• Formation of education–industry partnerships	Conlon (2024)
		• Modes of technology use and the benefits of technology in everyday life • lifestyle change	Shu and Srimuang (2025)
	Crisis and Emergency Conditions	• COVID-19 pandemic • urgent pressure to adapt to new conditions	Ibrahimi and Benchekroun (2023); Conlon (2024); Russo et al. (2025); Shu and Srimuang (2025); Trang et al. (2025); Wagner and Kabalska (2023); Wahab et al. (2023); Yeo et al. (2022); Iguma et al. (2025)
Competitive Drivers	Competitive Threats and the Entry of New Players	• Need for competitor monitoring • monitoring the competitors' behavior across regions and seasons	Balloni et al. (2025)
		• Threat to the traditional model	Fischer et al. (2020); Xia et al. (2025)
		• Threat from new competitors • emergence of China as a superpower • shift in the balance of economic power • entry of new players	Zhang et al. (2023); Xia et al. (2025); Hussein et al. (2024)
		• Entry of new players • online fashion platforms in the fashion market	Russo et al. (2025)
	Customer, Market, and Sales Channels	• Customer pressure	Bag et al. (2023); Shu and Srimuang (2025)

Category	Concept	Code	Author(s) and Year
		• Changes in consumer behavior and new expectations changing customer expectations • rapid changes in consumer demand	Zhang et al. (2023); Ramiah and Moore (2023); Arribas and Alfaro (2018); Russo et al. (2025); Shu and Srimuang (2025); Nour and Arbosa (2024); Kitsios et al. (2023); Heim and Hopper (2022); Wahab et al. (2023); Xia et al. (2025); Yeo et al. (2022); Strazzullo et al. (2025); Balloni et al. (2025); Iguma et al. (2025)
		• Growth of e-commerce and online sales	Russo et al. (2025); Wahab et al. (2023); Yeo et al. (2022); Lan and Cleveland (2024)
		• Integration of online and offline channels • growth of omnichannel commerce	Xia et al. (2025); Iguma et al. (2025)
		• Growth of cross-border commerce	Wahab et al. (2023)
		• Electronic channel	Russo et al. (2025); Xia et al. (2025)
		• Growth of young consumers • growth of the domestic markets	Xia et al. (2025); Su et al. (2023)
		• Decline in foreign orders	Su et al. (2023)
		• Need for export growth • tariff-free access	Hussein et al. (2024)
	Pressure and Intensity of Competition	• Increasing competitive pressure • changing the nature of competition	Ibrahimi and Benchekroun (2023); Arribas and Alfaro (2018); Trang et al. (2025); Nour and Arbosa (2024); Shu and Srimuang (2025); Iguma et al. (2025); Hussein et al. (2024); Alam and Dhamija (2021); Su et al. (2023)
		• Digital competition	Ramiah and Moore (2023)
		• Tender failure	Ramiah and Moore (2023)
	Survival and Maintenance of Market Position	• Protecting the market position • Need for market survival • Necessity of safeguarding survival • Need for the survival of private institutions	Zhang et al. (2023); Ibrahimi and Benchekroun (2023); Nour and Arbosa (2024); Heim and Hopper (2022); Strazzullo et al. (2025); Wagner and Kabalska (2023); Xia et al. (2025)
		• Imperative of competitive survival • Risk of organizational extinction • Strengthening the market position	Zhang et al. (2023); Shu and Srimuang (2025); Nour and Arbosa (2024); Wagner and Kabalska (2023); Hussein et al. (2024)
	Characteristics of the Apparel Industry	• International product standards • Product labeling	Yeo et al. (2022)
		• Expansion of fast fashion and seasonal changes • Necessity of rapid adaptation to market changes	Arribas and Alfaro (2018); Russo et al. (2025); Wagner and Kabalska (2023); Xia et al. (2025); Iguma et al. (2025)
		• Unique challenges of the apparel industry	Xia et al. (2025); Balloni et al. (2025)
		• Low level of digitalization in the apparel industry	Xia et al. (2025)
		• Performance pressure	Zhang et al. (2023)

(Source: The Researcher's Findings)

As can be seen, with the Maxqda 2020 software, the output from the meta-synthesis for the drivers of DT was plotted as follows:

Figure 5.
The Proposed Framework for Implementing DT Drivers in Apparel Industry



(Source: The Researcher's Findings)

Shannon entropy was used to quantify the relative importance of the extracted codes, concepts, and categories. Shannon entropy is an information theory-based method that measures the uncertainty and dispersion of a probability distribution (Shannon, 1948). Shannon entropy has also been used in previous studies (Huang & Yun, 1981; Jafarnejad Chagoushi et al., 2012; Lotfi & Fallahnejad, 2010; Manian et al., 2014; Zelny, 1982). We acknowledge this as a limitation of the study and address it in the limitations section. However, the present study was primarily a literature review and exploratory study rather than a quantitative study. Since the main focus of the study was not prioritization or weighting, Shannon entropy was used to rank the stimuli based on their frequency. By calculating the occurrence of each code in the selected studies, we determined the cross-study support and relative consensus in the literature on the stimuli (Asl et al., 2012).

In this study, to determine the salience of the extracted codes, first the cross-frequency of each code was calculated based on the number of studies in which it was identified. A higher frequency indicates that a code is more widely reported and supported by a larger portion of the selected literature. We used the following relationship in Excel to calculate the Shannon entropy:

$$P_i=f_i/(\sum f_i)$$

Subsequently, the information contribution of each component was calculated using the following equation:

$$E_i=-P_i \ln(P_i)$$

In addition, the coefficient K=1/ln(n) was used to calculate the normalized entropy. $H^{'}=-K\sum_{i=1}^{n} P_i \ln(P_i)$

Finally, the weight percentage of each component was calculated by multiplying the frequency ratio by 100 and the components were ranked based on their weight percentage. This method enables the researcher to report the relative importance of the components in a quantitative and comparable manner, in addition to qualitative

analysis. The results of calculating the frequency, frequency ratio, information share, weight percentage, and rank of each identified code based on the Shannon entropy method are presented in Table 4.

The unit of analysis was the article. A frequency of 2 indicates that the code in question was identified in 2 separate articles, regardless of the number of times that code appeared in each article. Each article was counted only once for a given code. The frequency of each code indicates the number of articles in which that code appeared, along with the authors' names in the findings and Shannon entropy tables. For example, the code "Advancement of tracking and RFID systems", from the category of technology and infrastructure, had a frequency of 2 and was examined by Wahab et al. (2023) and Iguma et al. (2025).

Table 4.
The Calculation of Frequency, Frequency Ratio, Information Contribution, Percentage Weight, and Rank of Each Identified Code

Category	Concept	Code	Frequency	Frequency Ratio	Information Contribution	Percentage Weight	Rank
Strategic Drivers	Leadership and Governance	• Institutional pressures and environmental uncertainty	1	0.002688172	0.015911005	0.268817204	86
		• Active participation of decision-makers • strengthening decision-making power	4	0.010752688	0.048737629	1.075268817	22
		• Support and commitment of top leadership and senior management support	4	0.010752688	0.048737629	1.075268817	22
		• Data governance and control	2	0.005376344	0.028095412	0.537634409	49
	Strategy and Planning	• Need for comprehensive planning beyond technology • strategic planning	1	0.002688172	0.015911005	0.268817204	86
		• Pre-digital transformation strategy • organizational strategies	5	0.01344086	0.057922795	1.344086022	11
		• Alignment of IT and business strategy	1	0.002688172	0.015911005	0.268817204	86
		• Need for systems thinking and holistic thinking	1	0.002688172	0.015911005	0.268817204	86
		• Need for disaster risk reduction and climate change adaptation (need for DRR and CCA)	1	0.002688172	0.015911005	0.268817204	86
		• New management tools	1	0.002688172	0.015911005	0.268817204	86
	Business Model and Transformation	• Necessity of business model change	9	0.024193548	0.090040386	2.419354839	4
		• Digital economy transformation	3	0.008064516	0.038873238	0.806451613	31
		• Need to redefine value	2	0.005376344	0.028095412	0.537634409	49
		• Need for fundamental transformation	2	0.005376344	0.028095412	0.537634409	49
		• Acknowledgment of the importance of digitalization	2	0.005376344	0.028095412	0.537634409	49
		• Stimulating business and entrepreneurship	1	0.002688172	0.015911005	0.268817204	86
	Digital Capabilities and Competencies	• Need for digital capabilities • dynamic capability	3	0.008064516	0.038873238	0.806451613	31
		• Necessity of developing technological capabilities for data management • full integration of technology, data, and automation	5	0.01344086	0.057922795	1.344086022	11
		• Need for technical and digital competencies • necessity of employee readiness	6	0.016129032	0.066566684	1.612903226	9
		• Digital competence • requirement for the digitalization of reporting	2	0.005376344	0.028095412	0.537634409	49
	Organizational Culture and Mindset	• Culture of experimentation and innovation • need for technological specialization for the fashion industry	5	0.01344086	0.057922795	1.344086022	11
		• Necessity of managing resistance to change	1	0.002688172	0.015911005	0.268817204	86
		• Need for agile management and leadership • necessity of balancing traditional and digital leadership	4	0.010752688	0.048737629	1.075268817	22
	Learning and Development	• Continuity of the learning process • learning by doing • learning-oriented collaboration between the fashion brand and the software company	1	0.002688172	0.015911005	0.268817204	86
		• Development of new skills and organizational knowledge	4	0.010752688	0.048737629	1.075268817	22
		• Need for comprehensive knowledge and data management • need for faster access to information	1	0.002688172	0.015911005	0.268817204	86

Category	Concept	Code	Frequency	Frequency Ratio	Information Contribution	Percentage Weight	Rank
		• Limitations of the current system and need for a CDE • establishment of digital centers or laboratories for exchanging ideas and knowledge	2	0.005376344	0.028095412	0.537634409	49
	Leadership and Management	• Importance of resource management in digital transformation • effective resource management	2	0.005376344	0.028095412	0.537634409	49
		• Need for agile management and leadership • necessity of balancing traditional and digital leadership	3	0.008064516	0.038873238	0.806451613	31
	Organizational Structure and Design	• Changes in organizational processes	6	0.016129032	0.066566684	1.612903226	9
		• Outsourcing of services	1	0.002688172	0.015911005	0.268817204	86
		• Division of tasks	1	0.002688172	0.015911005	0.268817204	86
		• Formation of project teams comprising different organizational levels • membership in chambers, associations, and industrial networks	2	0.005376344	0.028095412	0.537634409	49
		• Organizational size	2	0.005376344	0.028095412	0.537634409	49
		• Traditional organizational structure	4	0.010752688	0.048737629	1.075268817	22
		• Need for new organizational structures	3	0.008064516	0.038873238	0.806451613	31
		• Breaking down the organizational silos • eliminating operational boundaries and divisions	2	0.005376344	0.028095412	0.537634409	49
	Employees and Workforce	• Pressure to address staff shortages	1	0.002688172	0.015911005	0.268817204	86
		• Lack of owners' knowledge and skills	3	0.008064516	0.038873238	0.806451613	31
		• Shortage of digital specialists in the market	3	0.008064516	0.038873238	0.806451613	31
		• Employee dissatisfaction with access to information	1	0.002688172	0.015911005	0.268817204	86
		• Generational change and business succession • entry of a new generation with higher education and a different perspective on technology	2	0.005376344	0.028095412	0.537634409	49
	Resources and constraints	• SME resource constraints • financial resource constraints	2	0.005376344	0.028095412	0.537634409	49
		• Low level of digitalization • number of SMEs in Europe that have been digitalized	1	0.002688172	0.015911005	0.268817204	86
		• Need for new resources	1	0.002688172	0.015911005	0.268817204	86
	Collaboration and networking	• Communication problems with manufacturers and partners • need for internal collaboration	3	0.008064516	0.038873238	0.806451613	31
		• Cross-functional collaboration • creation of an intra- and inter-organizational collaborative environment	2	0.005376344	0.028095412	0.537634409	49
		• Stakeholder demands for social responsibility	2	0.005376344	0.028095412	0.537634409	49
		• Stakeholder pressure	1	0.002688172	0.015911005	0.268817204	86
Operational Drivers	Technology and Infrastructure	• Technological transformations based on Cyber-Physical Systems (CPS)	1	0.002688172	0.015911005	0.268817204	86
		• Existence of basic technological infrastructures • need for digital infrastructure improvement	5	0.01344086	0.057922795	1.344086022	11
		• Emerging Metaverse technologies	1	0.002688172	0.015911005	0.268817204	86
		• Development of Big Data and Analytics	2	0.005376344	0.028095412	0.537634409	49
		• Advancement of tracking systems and RFID	2	0.005376344	0.028095412	0.537634409	49
		• Technology trialability	1	0.002688172	0.015911005	0.268817204	86
		• Exploratory stage of the fashion industry in technology adoption	4	0.010752688	0.048737629	1.075268817	22
		• Technology convergence • emergence of emerging technologies	21	0.056451613	0.162262903	5.64516129	1
		• Rapid penetration of digital technologies across various industries	5	0.01344086	0.057922795	1.344086022	11
		• Observability of results	1	0.002688172	0.015911005	0.268817204	86
		• Technology complexity	1	0.002688172	0.015911005	0.268817204	86
		• Emergence of 3D, virtual reality, IoT, etc., as core technologies for manufacturing transformation • Industry 4.0	3	0.008064516	0.038873238	0.806451613	31
		• Development of online platforms	2	0.005376344	0.028095412	0.537634409	49
		• Need for rapid technology integration	1	0.002688172	0.015911005	0.268817204	86
		• Necessity of system integration • necessity of business process integration	3	0.008064516	0.038873238	0.806451613	31
	Processes and Operations	• Need for process improvement • process optimization • need for process innovation	7	0.018817204	0.074760446	1.88172043	7
		• Reduction of operational costs and productivity improvement	5	0.01344086	0.057922795	1.344086022	11
		• Need for better resource allocation and waste reduction	2	0.005376344	0.028095412	0.537634409	49

Category	Concept	Code	Frequency	Frequency Ratio	Information Contribution	Percentage Weight	Rank
		• Impact of organizational integration • integration of data and customer insights • advancement of automated customer systems	2	0.005376344	0.028095412	0.537634409	49
		• Alteration of certain processes with digital technology • digital adaptation	3	0.008064516	0.038873238	0.806451613	31
		• Need for efficiency improvement and better service delivery	3	0.008064516	0.038873238	0.806451613	31
	Supply Chain and Logistics	• Need to reduce logistics costs	1	0.002688172	0.015911005	0.268817204	86
		• Need to improve inventory management	2	0.005376344	0.028095412	0.537634409	49
		• Need to address value chain issues • global value chains (GVCs)	1	0.002688172	0.015911005	0.268817204	86
		• Digitalization as a key objective for supply chain efficiency • fashion supply chain complexity / supply chain complexity	5	0.01344086	0.057922795	1.344086022	11
		• Necessity of connecting the extended supply chain • need to improve supply chain performance	5	0.01344086	0.057922795	1.344086022	11
		• Need to improve return systems	1	0.002688172	0.015911005	0.268817204	86
		• Improvement of traceability and transparency • increased full supply chain transparency	2	0.005376344	0.028095412	0.537634409	49
		• Requirements of supply chain partners	1	0.002688172	0.015911005	0.268817204	86
	Product and Service	• Innovation opportunity • stimulation of innovation in the education sector • possibility of new creative scenarios with 3D	2	0.005376344	0.028095412	0.537634409	49
		• Organizations' investment in PLM systems • improvement of product lifecycle management	3	0.008064516	0.038873238	0.806451613	31
		• Designer's motivation to reduce development time / tangible and intangible technologies	1	0.002688172	0.015911005	0.268817204	86
		• Excess costs of traditional projects / the lengthy and costly iterative process of design–prototyping–fitting	2	0.005376344	0.028095412	0.537634409	49
		• Need for product personalization and customization	3	0.008064516	0.038873238	0.806451613	31
		• Reduction of overproduction	1	0.002688172	0.015911005	0.268817204	86
Environmental drivers	Policy and Regulations	• National need for the digitalization of government services	1	0.002688172	0.015911005	0.268817204	86
		• Regional regulatory pressures	1	0.002688172	0.015911005	0.268817204	86
		• Governance model and digital policies	2	0.005376344	0.028095412	0.537634409	49
		• Government support and policies	4	0.010752688	0.048737629	1.075268817	22
		• Legal and regulatory requirements • government regulations and standards	3	0.008064516	0.038873238	0.806451613	31
		• International regulations • GDPR	2	0.005376344	0.028095412	0.537634409	49
		• Double materiality principle • integration of two perspectives	1	0.002688172	0.015911005	0.268817204	86
	Economy and Global Market	• The imperative global trend of DT • the need to respond to global changes • globalization	12	0.032258065	0.110773781	3.225806452	3
		• Market forecasting • demand • the need for intelligent analytics	2	0.005376344	0.028095412	0.537634409	49
		• Changes in income elasticity • relatively strong demand growth	1	0.002688172	0.015911005	0.268817204	86
		• Economic viability • cost-effective expansion	2	0.005376344	0.028095412	0.537634409	49
		• Extensive stakeholder engagement	1	0.002688172	0.015911005	0.268817204	86
		• Market instability	2	0.005376344	0.028095412	0.537634409	49
		• Risk absorption capacity	1	0.002688172	0.015911005	0.268817204	86
		• Pace of change in the business environment	3	0.008064516	0.038873238	0.806451613	31
	Environment and Sustainability	• The need to reduce risk and improve sustainability	4	0.010752688	0.048737629	1.075268817	22
		• Reduction of ESG risks	2	0.005376344	0.028095412	0.537634409	49
		• Natural risks	1	0.002688172	0.015911005	0.268817204	86
		• Environmental challenges • textile waste crisis	5	0.01344086	0.057922795	1.344086022	11
		• Climate change	2	0.005376344	0.028095412	0.537634409	49
		• High consumption of water resources	1	0.002688172	0.015911005	0.268817204	86
		• Prioritization of sustainable development	2	0.008064516	0.038873238	0.806451613	31
	Society and Lifestyle	• Demand for immersive experiences	1	0.002688172	0.015911005	0.268817204	86
		• Effectiveness of social media	3	0.008064516	0.038873238	0.806451613	31
		• Transformation in economic and social attitudes / pressure for social change	2	0.005376344	0.028095412	0.537634409	49
		• Increased brand awareness	1	0.002688172	0.015911005	0.268817204	86

Category	Concept	Code	Frequency	Frequency Ratio	Information Contribution	Percentage Weight	Rank
		• Educational policies for digital learning	1	0.002688172	0.015911005	0.268817204	86
		• Trend toward blended learning	1	0.002688172	0.015911005	0.268817204	86
		• Formation of education–industry partnerships	1	0.002688172	0.015911005	0.268817204	86
		• Modes of technology use and the benefits of technology in everyday life • lifestyle change	1	0.002688172	0.015911005	0.268817204	86
	Crisis and Emergency Conditions	• COVID-19 pandemic • urgent pressure to adapt to new conditions	9	0.024193548	0.090040386	2.419354839	4
Competitive drivers	Competitive Threats and the Entry of New Players	• Need for competitor monitoring • monitoring of competitors' behavior across regions and seasons	1	0.002688172	0.015911005	0.268817204	86
		• Threat to the traditional model	2	0.005376344	0.028095412	0.537634409	49
		• Threat from new competitors • emergence of China as a superpower • shift in the balance of economic power • entry of new players	3	0.008064516	0.038873238	0.806451613	31
		• Entry of new players • online fashion platforms in the fashion market	1	0.002688172	0.015911005	0.268817204	86
	Customer, Market, and Sales Channels	• Customer pressure	2	0.005376344	0.028095412	0.537634409	49
		• Changes in consumer behavior and new expectations changing customer expectations • rapid changes in consumer demand	14	0.037634409	0.123434708	3.76344086	2
		• Growth of e-commerce and online sales	4	0.010752688	0.048737629	1.075268817	22
		• Integration of online and offline channels • growth of omnichannel commerce	2	0.005376344	0.028095412	0.537634409	49
		• Growth of cross-border commerce	1	0.002688172	0.015911005	0.268817204	86
		• Electronic channel	2	0.005376344	0.028095412	0.537634409	49
		• Growth of young consumers • growth of the domestic market	2	0.005376344	0.028095412	0.537634409	49
		• Decline in foreign orders	1	0.002688172	0.015911005	0.268817204	86
		• Need for export growth • tariff-free access	1	0.002688172	0.015911005	0.268817204	86
	Pressure and Intensity of Competition	• Increasing competitive pressure • The changing nature of competition	9	0.024193548	0.090040386	2.419354839	4
		• Digital competition	1	0.002688172	0.015911005	0.268817204	86
		• Tender failure	1	0.002688172	0.015911005	0.268817204	86
	Survival and Maintenanceof Market Position	• Protecting market position • Need for market survival • Necessity of safeguarding survival • Need for survival of private institutions	7	0.018817204	0.074760446	1.88172043	7
		• Imperative of competitive survival • Risk of organizational extinction • Strengthening the market position	5	0.01344086	0.057922795	1.344086022	11
	Characteristics of the Apparel Industry	• International product standards • Product labeling	1	0.002688172	0.015911005	0.268817204	86
		• Expansion of fast fashion and seasonal changes • Necessity of rapid adaptation to market changes	5	0.01344086	0.057922795	1.344086022	11
		• Unique challenges of the apparel industry	2	0.005376344	0.028095412	0.537634409	49
		• Low level of digitalization in the apparel industry	1	0.002688172	0.015911005	0.268817204	86
		• Performance pressure	1	0.002688172	0.015911005	0.268817204	86

(Source: The Researcher's Findings)

The greatest source of support pertained to the operational drivers, with a frequency of 105, followed by organizational drivers, with a frequency of 82. This finding is logical for the apparel industry, as DT in this industry advances primarily through technology, infrastructure, processes, the supply chain, organizational competencies, and workforce readiness. The greatest scientific support pertained to the concept of technology and infrastructure, followed by the concept of processes and operations.

Discussion and Conclusion

The innovation of the present study laid in extracting and integrating the drivers of DT and presenting them in a five-dimensional framework including strategic,

organizational, environmental, operational, and competitive drivers. This study organized the scattered literature on DT into a coherent structure using the meta-synthesis method and determined the inter-study support and relative consensus of the literature on the drivers by calculating the presence of each code in the selected studies.

The results of Shannon entropy in this study showed that in the implementation of DT drivers in the apparel industry, operational drivers with a frequency of 105 and a weight of 28.47 percent have the largest share among the main categories, followed by organizational drivers with a frequency of 82 and a weight of 25.09 percent. This finding showed that DT in the apparel industry, not simply a technological decision or a promotional program, first makes sense for companies at the operational level. Enterprises should prioritize the concepts of technology and infrastructure, processes and operations, supply chain and logistics, and product and service to implement DT and implement issues related to these concepts in the organization. Therefore, the apparel business managers should start DT from the points that have the greatest impact on efficiency and productivity. These included the development of digital infrastructure, technology convergence and the fashion industry's exploration of the use of technology, the use of AI and the development of online platforms, and the reduction of operating costs and process changes with the need for employee readiness and agile leadership and management, changes in organizational processes, and the need for new organizational structures. In the logic of the TOES approach, this part of the results is mostly related to the technological and organizational dimensions, because technology only becomes economic value when it is integrated into real business processes, organizational structure and decision-making methods of managers. It also showed that digitalization will not lead to sustainable results without reforming traditional structures, eliminating boundaries between units, forming cross-functional teams and strengthening the agile leadership. In practice, apparel companies must simultaneously focus on technology, processes, structure, and human resources to succeed in DT, as weaknesses in any of these links can prevent the true exploitation of DT. On the other hand, the results showed that environmental drivers, with a frequency of 67 and a weight of 20.10%, competitive drivers, with a frequency of 78 and a weight of 17.26%, and strategic drivers, with a frequency of 40 and a weight of 9.07%, also play a complementary and guiding role in DT of the apparel industry. The prominence of concepts such as customers, market, and sales channels, economy and global market, with a high frequency indicated that the pressure for DT does not come solely from within the organization; it also comes from changes in consumer behavior, the growth of e-commerce, the development of omnichannel, digital competition, the globalization of markets, demand volatility, and new value chain requirements. In addition, concepts such as business model and transformation, strategy and planning, survival and maintaining market position, and competitive pressure and intensity indicated that the apparel industry managers should not reduce DT to a temporary program or a limited project in the IT department; rather, they should make it part of the logic of competition, market development, and business model modernization. In the TOES framework, the

environmental dimension was manifested in policies, the global market, lifestyle, crises, and sustainability, while the competitive dimension was manifested in changing customer expectations, the entry of new players, competitive pressures, and the need to maintain market position. Accordingly, the combination of the results showed that the successful path of DT in the apparel industry is technology-driven, operations-driven, organization-compatible, market-responsive, and competitive; That is, companies will be more successful if they align investments in technology and infrastructure with process improvements, organizational redesign, strengthening the digital capabilities of the workforce, understanding the customer in detail, developing digital sales channels, monitoring competitors, and paying attention to environmental and sustainability issues. The main innovation of the researchers in the present study was quite remarkable. The researchers did not consider DT as a purely technological issue; rather, they considered it as a multidimensional phenomenon that simultaneously addresses operational, organizational, environmental, competitive, and strategic drivers. Therefore, components such as technology, processes and operations, equipment and logistics, products and services, organizational structure and design, culture and human resource management, leadership, management and sales channels, economy and global market, competition, business model innovation, and sustainability requirements can be used to integrate the scattered literature and transform it into a usable stage for implementing DT in the apparel industry.

Limitations and Future Research Directions

Finally, this study suggests that future studies can be conducted to validate the proposed framework through case studies in Iranian apparel enterprises and determine the relative weight of each category of drivers using multi-criteria decision-making techniques. Furthermore, examining the interactions and causal relationships among the drivers, rather than adopting a linear perspective, can provide a deeper understanding of the dynamics of DT in this industry.

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