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From Design to Production: Innovations Driving Leadership Transformation in the Textile Industry

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Abstract

In the context of digitalisation, the adoption of Industry 4.0, and the intensification of ESG requirements, the textile industry is confronted with the necessity of structural transformation. The functional gap between design, production, and the market, which reduces the efficiency of value creation chains, remains a systemic problem of the sector. This study aims to analyse the mechanisms of textile business transformation through the integration of design and production within design-to-production (D2P) systems and to identify the role of innovative leadership. Methodologically, the work is grounded in a qualitative conceptual approach comprising an analytical literature review, the synthesis of D2P models, and the interpretation of industry practices. Drawing on the cases of Inditex (Zara), Nike, and SAG, the study demonstrates that digital technologies acquire strategic significance only when organisationally integrated into a unified value chain management system. The most effective transformation models are based on three elements: digital integration, sustainable production models (circular economy, ESG), and innovative leadership as the key mechanism for coordinating change. The principal conclusion is that D2P transformation in the textile industry is not merely a technological but also a managerial process, the success of which depends on integrated digital systems and leaders capable of synchronising design, production, and market.

Keywords

Design-to-Production Systems, Digital Transformation, Textile Industry, Innovative Leadership, Sustainable Development (ESG)

1. Introduction

In recent years, the textile industry has been undergoing large-scale structural

transformation driven by the simultaneous impact of digitalisation, the adoption of Industry 4.0 technologies, and the intensification of sustainable development requirements (the ESG agenda). These processes are radically altering the principles of organising production and distribution chains, as well as establishing new standards of competitiveness in global markets.

One of the key directions of this transformation is the formation of integrated design-to-production (D2P) systems that ensure end-to-end interconnection between the stages of design development, production, logistics, and market realisation of products, based on digital technologies and unified data management.

The persistent gap between the stages of design, production, and market realisation remains one of the systemic problems of the industry. In the majority of traditional textile business models, these functions remain organisationally and managerially fragmented, which leads to a reduction in the efficiency of the entire value creation chain and limits companies' capacity to respond rapidly to shifts in demand.

The traditional model of textile production is characterised by a number of structural constraints, including the functional fragmentation of business processes, extended production cycles, and, in some cases, limited flexibility of operational systems and a high dependence on mass standardised production. In conditions of intensifying global competition, such constraints become critical and undermine companies' resilience in international markets.

The contemporary demands of key sales markets, including the European Union and the United States, are shifting significantly towards product customisation, reduced time-to-market for new collections, increased environmental sustainability of production, and deep digital integration of supply chains. This is generating a new technological and managerial imperative for the transition from linear production models to integrated digital ecosystems.

In these circumstances, the question of the mechanisms of industry transformation and the factors that ensure the successful integration of design and production processes acquires particular relevance. The role of leadership in transforming the textile business through innovation remains a subject of keen interest to both researchers and industry practitioners.

2. Methodology

This study employs a qualitative conceptual approach aimed at analysing the transformation of the textile industry through the integration of design processes, production, and innovative management.

The methodological foundation of the study comprises:

- an analytical review of scientific literature dedicated to Industry 4.0, digital transformation, innovative leadership, and sustainable production;
- a conceptual synthesis of design-to-production system integration models;
- the interpretation of industry practices based on the author's managerial and operational experience in the international textile industry.

The study is conceptual-analytical in character and does not involve quantitative statistical analysis or large-scale empirical surveys. The principal objective of the article is the theoretical systematisation of contemporary approaches to the digital transformation of the textile industry and the development of a conceptual model describing the mechanisms of integrating design, production, and market management within design-to-production systems.

The literature review conducted within this study was carried out as a structured conceptual analysis, including systematisation and identification of key thematic areas.

The search for sources was conducted in the Scopus and Web of Science databases, as well as in open scientific repositories (Google Scholar, CyberLeninka), and in specialised academic and industry publications focused on the digital transformation of industry and the textile sector. The following keywords were used in the search: "digital transformation textile industry", "design-to-production systems", "Industry 4.0 manufacturing", "digital supply chains", "sustainable fashion ESG", "innovative leadership manufacturing", and "smart manufacturing value chain".

The selection of sources was based on principles of thematic relevance, currency (publications from the last 5 - 10 years), and conceptual significance. The literature analysis was carried out in three stages: grouping by themes (digital manufacturing and Industry 4.0, supply chain integration, sustainable development and ESG, leadership and change theories), comparative analysis of approaches to digital integration, the role of data and the interaction between technologies and managerial decision-making, and then the formation of a conceptual design-to-production (D2P) model integrating digital technologies, Industry 4.0 infrastructure, organisational integration, sustainability principles, and innovative leadership.

Thus, we were able to move systematically from disparate theoretical sources to a coherent practical model, linking technology, organisational processes, sustainable development, and leadership into a unified logic.

The conceptual model of textile business transformation proposed in the article was developed on the basis of a comparative analysis of existing research in the following areas.

Additionally, to assess the practical applicability of the proposed model, industry practices associated with export-oriented textile production, digital integration of manufacturing processes, and the implementation of circular production models were employed.

Thus, the study combines theoretical systematisation of contemporary scholarly approaches with a practice-oriented analysis of textile business transformation in the context of digitalisation and global competition.

3. Theoretical Foundations of Textile Business Transformation

3.1. Digital Transformation of the Textile Industry in the Context of D2P Systems

The digital transformation of the textile industry has, in recent years, acquired a

systemic character and manifests not as a set of isolated technological implementations, but as the formation of integrated design-to-production systems. Within this logic, the competitiveness of companies is determined not by individual technological solutions, but by the degree of integration of all stages of product creation into a continuous, managed system.

In the traditional model of the textile business, the processes of design, production planning, procurement, manufacturing, and sales have historically developed as functionally isolated blocks. This organisational fragmentation resulted in a disconnect between the stages of product creation, extended time-to-market for new collections, the accumulation of errors in the transmission of information between departments, and a limited capacity to adapt quickly to changes in demand. As a result, the value creation chain functioned as a sequence of unconnected operations rather than as a unified system.

From an economic standpoint, the implementation of design-to-production systems leads to the reduction of three key types of costs:

- transaction costs between departments;
- costs associated with product reworking and correction;
- costs related to excess inventory and demand forecasting errors (Khan et al., 2016).

It is important to emphasise that this effect does not arise automatically, but rather as a result of the simultaneous action of digital integration and organisational coordination of processes, which ensure continuous alignment of design, production, and market demand.

Simultaneously, the speed of bringing a product to market (time-to-market) increases, which becomes a critical competitive advantage.

The transition to design-to-production systems entails a fundamental change in this logic. Product design ceases to be an autonomous stage and becomes the starting point of a digital production system, within which design is carried out with regard to the constraints and capabilities of subsequent stages of production, logistics, and market distribution. A seamless interconnection between the creative, operational, and commercial functions is thus formed.

The key technological foundation of such systems is the Industry 4.0 concept, which provides digital connectivity across all stages of the product lifecycle. Within design-to-production systems, integrated digital environments are employed, comprising CAD/CAM platforms, ERP and PLM systems, IoT technologies, RFID, and cloud computing (Ahmad et al., 2020; Stulga et al., 2022). Their role, however, lies not in independently improving the efficiency of individual operations, but in ensuring the continuous exchange of data between the stages of design, production, and supply.

Of particular importance within the structure of design-to-production systems is the analytical level of data management, implemented through business intelligence and digital planning systems. These tools ensure the synchronisation of information on demand, production capacities, and supply chains, forming a unified information environment for decision-making. As a result, the gap between

product design and actual production is reduced, enabling a significant decrease in time-to-market and improved alignment of products with market demand.

3.2. Innovation and Sustainable Production as a Structural Element of D2P Systems

The contemporary transformation of the textile industry is defined not only by the digitalisation of production processes, but also by the growing role of sustainable development (ESG) as a systemic factor integrated into the architecture of design-to-production systems. It is important that ESG does not act as an external constraint, but rather as an internal mechanism that transforms the very logic of decision-making within the value chain, influencing economic outcomes through the redistribution of resource and technological choices.

Within design-to-production systems, the principles of sustainable development begin to shape requirements at the design stage itself, influencing the selection of materials, technological solutions, and production parameters. ESG factors thus cease to be a post-hoc assessment and transform into an element of preliminary configuration of the production and distribution chain. This means that sustainability becomes an embedded characteristic of the product rather than an external attribute of the company.

One of the key mechanisms for integrating sustainable development into D2P systems is the concept of the circular economy, which presupposes the closing of material flows and the minimisation of waste at all stages of the product lifecycle (Curran & Joltreau, 2026). The integration of the circular economy into D2P systems enables the simultaneous achievement of two effects: the reduction of raw material and operational costs, and the increased resilience of supply chains through the reuse of resources.

A significant driver of the formation of sustainable design-to-production systems is the requirements of key international markets, primarily the European Union and the United States (Tamames-Sobrino et al., 2026). In these markets, the competitiveness of products is increasingly determined by companies' capacity to ensure supply chain traceability, low-carbon production, and the use of sustainable materials. These parameters are becoming not external regulatory conditions, but embedded constraints of D2P systems that determine the structure of product solutions and production processes.

An important element of this transformation is the development of traceability systems. Within the design-to-production approach, they perform not only a monitoring function, but also a data integration function between the stages of production and the market. Traceability provides continuous visibility of the value creation chain, enabling the synchronisation of environmental, production, and commercial product parameters within a unified digital management contour.

3.3. The Role of Innovative Leadership in the Integration of D2P Systems

Digital technologies and ESG requirements do not, by themselves, transform the

textile industry. The transition from a fragmented functional model to integrated design-to-production systems requires not mere automation, but innovative leadership. It is precisely this that serves as the key factor ensuring the managerial and organisational integration of all stages of value creation.

In this study, innovative leadership is understood as a managerial capability to integrate technological, organisational, and market changes into a unified value-creation system, ensuring the synchronisation of design, production, and commercialisation processes. Unlike other approaches, innovative leadership is not limited to adaptation to change; rather, it involves the deliberate formation of a new business system architecture based on digital integration and cross-functional coordination.

In comparison with adaptive leadership, which is focused on response and uncertainty management, innovative leadership is proactive in nature: it effectively restructures the value-creation system. Unlike agile leadership, which operates at the level of teams and projects, innovative leadership encompasses the entire value chain, ensuring the integration of design, production, and market functions, as well as the alignment of digital platforms. Unlike cross-functional leadership, it does not merely coordinate departments but redesigns their boundaries, shifting the organisation from a functional structure to an end-to-end digital management system.

The key behavioural characteristics of an innovative leader include:

- decision-making based on end-to-end data,
- initiating the integration of digital systems (ERP, PLM, IoT),
- restructuring the organisation into a process- or platform-based model,
- active management of the link between design,
- production and market integration, embedding ESG as a design parameter,
- creating feedback mechanisms “market - data - design - production”,
- as well as managing change at the level of the entire business ecosystem.

The effectiveness of D2P systems is determined by a company’s capacity to synchronise the processes of design, production, supply chains, and market realisation into a unified, managed ecosystem. Within this logic, it is the leader who becomes the connecting element between technological possibilities and the actual transformation of the business model.

In this model, digital integration ensures the flow of data, ESG defines the parameters for decision-making, and innovative leadership coordinates these elements and translates them into managerial actions, which collectively lead to reduced time-to-market, lower costs, and increased organisational adaptability.

Innovative leadership in the context of design-to-production systems manifests above all in the capacity to overcome the functional fragmentation of an organisation. In traditional textile companies, design, production, marketing, and sales function as autonomous departments with their own objectives and KPIs. This leads to a disconnect between the creative and operational logic of the business. A leader oriented towards innovation transforms such a structure into a cross-func-

tionally integrated system, in which decisions are made with regard to their impact on the entire value creation chain.

This approach corresponds to the concept of adaptive and flexible leadership, according to which the capacity to manage change under conditions of uncertainty becomes the key factor of organisational effectiveness (Yukl & Mahsud, 2010). Within D2P systems, this implies the necessity of continuously adjusting strategic, operational, and product decisions in response to changes in the market environment.

An important aspect of innovative leadership is the management of the digital integration process. The implementation of ERP, PLM, CAD/CAM, IoT, and analytics systems does not, in and of itself, ensure the formation of a design-to-production system without coordination from a managerial centre. In this regard, digital transformation is viewed not as a technological, but as an organisational process, requiring structural changes and the active engagement of leadership.

As Gregory Vial (2019) notes in his review of digital transformation, the key condition for successful transformation is not the introduction of technologies as such, but the alteration of organisational architecture and managerial practices, including the strengthening of cross-functional coordination. In the context of D2P systems, this means the transition from functional management to end-to-end management of product creation processes.

Additional significance is acquired by the concept of cross-functional integration, which examines an organisation's capacity to ensure coordination between different functional units. In design-to-production systems, this integration becomes a critical factor of effectiveness, since the gap between design and production directly affects the speed of product launch, the level of costs, and the capacity to adapt to changes in demand.

A particular role is also played by the agile approach to management, which presupposes that work is carried out in cycles and ensures the flexibility of design-to-production systems under conditions of high uncertainty in global markets. Agile logic allows for the rapid adjustment of design, production plans, and product strategies based on market feedback, forming a closed cycle of "design - production - market - data - design". The leader thus ensures not only the integration of processes, but also their continuous adaptation.

Within design-to-production systems, the innovative leader performs three key functions:

1) They act as systems integrators, connecting previously disparate business functions into a unified architecture.

2) They serve as agents of organisational change, transforming corporate culture and managerial practices.

3) They fulfill the role of interface between technological capabilities and market strategy, ensuring that production decisions correspond to the requirements of global markets.

Innovative leadership may thus be regarded as the central mechanism for the

formation and functioning of design-to-production systems in the textile industry. Unlike the technology-centric approach, in which digitalisation is viewed as the primary driver of change, this approach emphasises that it is managerial integration and leadership coordination that determine the success of industry transformation.

As can be seen in Figure 1, the success of design-to-production transformation depends primarily on leadership coordination, with digitalisation playing a supporting role.

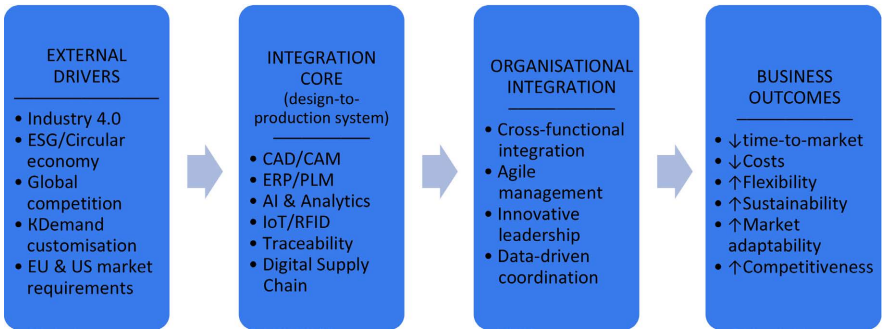

Figure 1. Conceptual framework for design-to-production transformation.

4. Transformation of the Textile Industry through Innovative Leadership

The practical application of the proposed approach enables a transition from the theoretical level of digital transformation analysis to the examination of the actual mechanisms of textile business change. The focus of this section is on companies that demonstrate different trajectories of integrating the processes of design, production, and market realisation—from global fashion conglomerates to manufacturing enterprises in developing economies.

For the analysis, the companies Inditex (Zara), Nike, and SAG were selected, as they represent different models of transformation in the textile and related industries under conditions of digitalisation and the implementation of design-to-production systems.

These case studies represent illustrative examples of different levels of D2P system maturity:

- Inditex demonstrates a highly integrated fast fashion model with an end-to-end "market - design - production" linkage.
- Nike represents a digitally oriented distributed model with a global supplier network.
- SAG reflects a production transformation model in a developing economy, focused on modernisation and ESG-driven solutions.

In addition, the case studies differ in terms of organisational structure type (vertically integrated, brand-based with outsourcing, and local manufacturing) as well as geographic location (Europe, the United States, and Central Asia), which makes it possible to account for the influence of institutional environments.

Despite differences in industry specialisation and organisational models, all of the companies under consideration demonstrate a common principle: competitive advantage is formed not only through technology, but also through leaders' capacity to construct integrated systems of interaction between design, production, and the market.

The comparative analysis of the case studies is conducted using a unified set of criteria: the degree of digital integration of the value chain, the level of D2P system implementation, the role of data in production and demand management, organisational flexibility and cross-functional coordination, the integration of ESG and circular economy principles, as well as the role of leadership in transformation processes. These criteria ensure a systematic comparison of different models within a single conceptual framework.

Despite differences in scale and organisational models, the companies under consideration demonstrate similar transformation mechanisms based on the integration of digital technologies, sustainable development, and managerial coordination. The case studies are not treated as a statistically representative sample but are used as theory-driven case selections, enabling the identification of universal patterns in the development of D2P systems and the formulation of substantiated industry-level conclusions.

The analysis of the cases of Inditex, Nike, and SAG draws on data from open academic publications, corporate reports, and industry analytical materials, as well as the author's generalised practical observations based on professional experience in the textile industry.

The SAG case additionally relies on empirical data obtained through professional interaction with the company, including observation of production and managerial processes and analysis of aggregated operational indicators. The data are used in a generalised form without disclosure of any confidential company information.

4.1. The Experience of the Inditex Group (Zara)

The practical realisation of the proposed framework can be traced through the example of Inditex—one of the world's largest fashion conglomerates, operating the Zara brand. The company is regarded in academic literature as one of the most developed examples of the integration of design, production, and distribution processes into a single managed system.

The transformation of Inditex is grounded in the transition from the traditional linear model of the fashion industry, in which the stages of design, production, and retail realisation are separated and temporally distinct, to an integrated system characterised by a high degree of synchronisation of all elements of the value creation chain. Within this model, stores perform not only a sales function, but also serve as a key source of consumer demand data, which is promptly transmitted to design centres and production planning units.

The key element of this transformation is the formation of a continuous design-

to-production cycle, ensured through the integration of digital supply chain management systems, including ERP and PLM platforms, as well as logistics and analytics systems. This allows for the reduction of the temporal gap between product development and its appearance on the market, ensuring a high speed of response to changes in consumer demand.

One of the defining characteristics of this model is the compressed time-to-market cycle. According to industry research and case analysis, the full cycle of "design - production - delivery to store" at Inditex amounts to approximately two to six weeks (Harbott, 2021), depending on the product category and the nature of the collection, which is substantially faster than in traditional fashion industry models, where the analogous process may take several months.

A further element of the transformation is the use of digital analytics and inventory management systems that allow the minimisation of unsold products and reduce dependence on price discounting as a sales tool. The model of small-batch production and frequent assortment renewal ensures a more precise alignment between actual demand and production volume, which reinforces the economic efficiency of the value creation chain.

4.2. The Experience of Sportswear and Footwear Manufacturer Nike

Another instructive example is Nike, one of the world's largest companies in the sportswear and footwear industry, and a recognised leader in the field of innovative value chain management.

Nike's transformation is grounded in the transition from a classical outsourcing production model to an integrated digital ecosystem (Samson & Selvam, 2025), in which data, technology, and sustainable development play a central role. Within this model, the company is progressively shifting emphasis from traditional mass production towards a flexible, technology-driven system that unifies the stages of design, product development, production, and distribution.

The key element of this transformation is the integration of digital technologies into the design and product development processes. Nike makes extensive use of computer-aided design (CAD) systems, 3D design technologies, and virtual prototyping, which allows for a significant reduction in the number of physical samples and the acceleration of decision-making at the product development stage. Additionally, artificial intelligence-based demand forecasting and analytics tools are employed, ensuring more precise alignment between design and market expectations.

The digitalisation of the production and logistics chain plays an important role in the transformation. Nike uses automated supply management systems and digital coordination platforms with its global network of suppliers, enabling greater transparency in production processes and improved management of delivery timelines. Despite the high degree of production outsourcing, the company constructs a centralised data management system that ensures synchronisation be-

tween design, production, and retail realisation.

A distinct direction of the transformation has been the implementation of principles of sustainable development and the circular economy. Nike actively develops material recycling and secondary raw material programmes, including initiatives for the recycling of textile waste and the production of goods from recycled materials. These approaches are integrated directly into the product development processes, allowing environmental parameters to be considered at the design stage itself, thereby reducing the environmental footprint of products throughout their entire lifecycle.

The results of this transformation are reflected in greater flexibility of the product portfolio, accelerated time-to-market for innovative products, and enhanced adaptability of the supply chain to changes in demand. The use of digital technologies and analytics enables the company to forecast market needs more accurately and to reduce excess inventory levels. Furthermore, the integration of sustainable practices strengthens Nike's competitive position in the US and European Union markets, where environmental standards and supply chain transparency requirements play a decisive role.

4.3. The Experience of Carpet Manufacturer SAG

The practical application of the proposed framework can also be traced through the example of SAG—one of the largest manufacturers of carpet products in Central Asia.

The company's transformation began with a comprehensive modernisation of its production and management model. One of the key directions was the implementation of digital and automated production technologies. The enterprise acquired modern equipment oriented towards reducing manual labor, improving the precision of production processes, and lowering operational costs. Technological modernisation made it possible to reduce the share of manual labor in individual production areas to 5%, as well as to lower levels of production defects and energy consumption.

In parallel, the company automated its business processes, including the management of procurement, logistics, sales, and internal production operations.

A significant element of the transformation was the integration of artificial intelligence and digital analytics. AI technologies were introduced into order processing, shipment planning, and the development of new carpet designs. This enabled the integration of design, production, and market analysis processes into a unified digital management system, consistent with the design-to-production systems concept.

A further direction of transformation was the introduction of sustainable production principles and the circular economy model. The company was the first in the industry to recycle PET bottles into raw materials for the manufacture of carpet backing and artificial turf. This approach enabled the combination of environmental sustainability, reduced dependence on virgin raw materials, and supply

chain optimisation within a unified production model. The enterprise currently processes approximately one million plastic bottles daily, including raw materials supplied from neighboring Central Asian countries.

The results of this transformation demonstrate the high effectiveness of the integrated design-to-production model. Between 2020 and 2022, the company's production volume increased from 12 million to more than 22 million square metres of carpet products per year, reflecting an almost twofold growth in production capacity. This has allowed the manufacturer to strengthen its position in the international market—its products are currently exported to ten countries.

4.4. Synthesis of Case Analysis Results

The analysis of the Inditex, Nike, and SAG cases enables the formulation of key patterns in the transformation of the textile and adjacent industries through the implementation of design-to-production systems and innovative leadership.

First, in all of the cases examined, digital technologies (AI, ERP/PLM systems, demand analytics, production automation) function not as an independent driver of transformation, but as an infrastructural foundation, the effectiveness of which is determined by the degree of organisational integration. Technologies begin to create value only when the functions of design, production, and distribution are synchronised.

Second, the key element of transformation is the reduction of the gap between design and the market. Inditex achieves this through the integration of retail points as sources of demand data; Nike—through digital modelling and predictive analytics; SAG—through the combination of AI tools with production planning. Despite differences in approach, all models are oriented towards the formation of a continuous design-to-production cycle.

Third, all three cases demonstrate that the acceleration of time-to-market and the improvement of demand satisfaction accuracy are directly linked to the level of organisational flexibility. Inditex achieves a compressed product launch cycle through flexible logistics and small-batch production; Nike—through the digitalisation of design and global supplier coordination; SAG—through the integration of automation and local production. This confirms that the effectiveness of design-to-production systems is determined not only by technology, but also by the architecture of the value creation chain.

Fourth, sustainable development (ESG and the circular economy) is becoming a universal element of all transformation models. Nike integrates material recycling into product design; SAG implements large-scale PET bottle recycling as part of the production cycle; Inditex develops environmental standards for supply chains. This indicates that sustainability has ceased to be an external constraint and has become an embedded characteristic of design-to-production systems.

Finally, the key unifying factor across all cases is innovative leadership. It is precisely leadership-driven managerial decisions that ensure the integration of technologies, the transformation of organisational structure, and the synchroni-

sation of functions within the company. In this context, the leader fulfills the role of systems integrator, uniting design, production, and the market into a single managed ecosystem.

Thus, the results of the case analysis confirm that the transformation of the textile business through innovation is achieved not only through the implementation of digital technologies, but above all through the formation of integrated design-to-production systems, in which innovative leadership, ensuring the strategic coordination of all elements of the value creation chain, plays the central role.

5. Conclusion

This study was aimed at analysing how innovative leadership influences the transformation of the textile industry through the integration of design and production processes within design-to-production systems. In the context of accelerating digitalisation, intensifying competition, and growing demands for sustainable development, traditional linear models of the textile business are losing their effectiveness and require a transition to more flexible and integrated digital ecosystems.

The study demonstrates that the functional fragmentation between the stages of design, production, and market realisation remains the key problem of the industry. This gap leads to an increase in time-to-market, a reduction in companies' adaptability, and higher costs associated with the mismatch between supply and demand. In response to these challenges, the concept of design-to-production transformation is taking shape—one that presupposes the creation of a continuous, digitally managed cycle: from product development to delivery to the end consumer.

Based on an analysis of existing theoretical approaches and practical cases (Inditex, Nike, and SAG), it has been established that technological digitalisation, in and of itself, is not a sufficient condition for industry transformation. Technologies such as artificial intelligence, ERP/PLM systems, digital modelling, production automation, and big data analytics acquire strategic significance only when organisationally integrated into a unified value chain management system.

The results of the case analysis confirm that the most effective transformation models are grounded in three interrelated elements.

The first is the digital integration of design, production, and distribution processes, ensuring the reduction of time cycles and improved precision in responding to changes in demand.

The second is the implementation of sustainable production models, including circular economy principles and ESG-oriented supply chains, which are becoming an important factor of competitiveness in the EU and US markets.

The third is innovative leadership, serving as the key mechanism for coordinating change and ensuring the alignment of technological, organisational, and market transformations.

The principal conclusion of the study is therefore that design-to-production transformation in the textile industry constitutes not merely a technological, but

also a managerial process. Its successful realisation depends on companies' capacity to construct integrated digital systems and on the presence of leaders capable of synchronising design, production, and market within a unified strategic logic.

The framework proposed in the study enables the conceptualisation of this transformation as a multi-level process in which Industry 4.0 technologies, sustainable development principles, and innovative leadership interact. This approach expands existing conceptions of the digital transformation of industry and may be employed for further empirical research aimed at the quantitative assessment of the effectiveness of design-to-production systems in different segments of the textile and adjacent industries.

This study has several limitations that should be taken into account when interpreting the results.

First, the textile industry is characterised by a high degree of heterogeneity, including differences between mass production segments, the premium segment, and regional models of value chain organisation. In this regard, the proposed conceptual model reflects a generalised logic of transformation and does not account for all industry-specific variations.

Second, the study is conceptual-analytical in nature and is not based on large-scale quantitative empirical data. This limits the possibility of statistical verification of the findings and requires further applied research for their empirical validation.

Third, the case studies used (Inditex, Nike, and SAG) are illustrative in nature and do not represent a statistically representative sample of the entire industry. Their use is intended to demonstrate different models of design-to-production system integration rather than to generate statistically generalisable conclusions.

Thus, the proposed model should be considered a theoretical framework that requires further testing and refinement in subsequent empirical studies.

Conflicts of Interest

The author declares no conflicts of interest regarding the publication of this paper.

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