HSR (LONDON),
HOUGHTON STREET REVIEW JOURNAL
ISSN: 2058-5519|Impact factor-15.9
http://houghtonstreetreview.com/index.php/hsr

CONTEMPORARY TRANSFORMATION OF THE PRODUCT LIFE CYCLE (IN TEXTILE PRODUCTS)

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doi:https://doi.org/10.5281/zenodo.23236893

Abstract: This article examines how digitalization, fast and ultra-fast fashion, and circular-economy regulation are reshaping the conventional product life cycle (PLC) in the textile and apparel industry. The study combines conceptual synthesis with secondary-data analysis from academic literature, the European Environment Agency, the European Commission, the Ellen MacArthur Foundation, McKinsey & Company, and the National Statistics Committee of Uzbekistan. The analysis distinguishes between the commercial life of a fashion item, which is becoming shorter and more data-driven, and the material life of textile products, which policy and circular business models seek to extend through durability, reuse, repair, resale, and fibre-to-fibre recycling. Evidence from Europe and Uzbekistan is used to show that competitive PLC management increasingly depends on rapid market sensing, flexible production, demand forecasting, circular design, and traceability. The paper proposes a dual-loop PLC framework and practical priorities for Uzbek textile enterprises seeking to move from cost-based competition toward higher-value, responsive, and sustainable export models.

Keywords: Product Life Cycle (PLC), textile industry, fast fashion, ultra-fast fashion, circular economy, digitalization, PLM, sustainability, Uzbekistan.

1. Introduction and problem statement

The product life cycle remains one of the most widely used concepts for linking market evolution with product, pricing, distribution, and promotion decisions. In its conventional form, the PLC moves through introduction, growth, maturity, and decline, with managerial priorities changing as sales and competitive intensity evolve [1]. The international product-cycle perspective further showed that production and trade patterns may change as products mature and become standardized [2].

The textile and apparel industry, however, increasingly challenges a purely sequential interpretation of the PLC. Digital commerce, social-media trend formation, algorithmic recommendation, rapid design iteration, and flexible sourcing have compressed the commercial window of many fashion products. At the same time, environmental policy is pushing in the opposite direction: products are expected to last longer, be repairable and reusable, and ultimately circulate as materials rather than become waste [3–5]. This creates a central paradox: the market life of fashion styles is shortening while the desired physical and material life of textile products is lengthening.

This contradiction is economically important. The Ellen MacArthur Foundation reports that clothing production roughly doubled over a 15-year period while clothing utilization fell substantially, and less than 1% of material used to produce clothing is recycled into new clothing [3]. The European Environment Agency (EEA) likewise identifies textiles as a high-pressure consumption category and argues that durability, reuse, repair, and recyclability must be designed into products from the beginning [4]. Therefore, contemporary PLC management can no longer be reduced to the question of

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when a product enters decline; it must also address how quickly firms sense demand, how efficiently they manage inventory, and how products and materials remain in circulation after the first sale.

Research objective and method

The objective of the study is to clarify the contemporary transformation of the PLC in textile products and to derive managerial implications for Uzbekistan. Methodologically, the paper uses a structured conceptual review and descriptive secondary-data analysis. The evidence base includes classic marketing literature [1–2], circular-economy research [3, 8], European policy and environmental statistics [4–5, 9], fashion-industry evidence [6], and official Uzbek textile-export statistics [7, 10]. No primary survey or firm-level causal estimation is claimed; numerical indicators are interpreted descriptively and only where a traceable source is available.

2. The Classic PLC model and its transformation in textiles

2.1. The classic PLC model

In the classic model, the introduction stage is characterized by low sales and high development and market-creation costs; growth brings accelerating sales and entry by competitors; maturity is associated with market saturation, differentiation, and pressure on margins; and decline occurs when demand shifts toward substitutes or new solutions [1]. For textile enterprises, the model traditionally aligned reasonably well with seasonal collection planning, but digital retail has weakened the stability and duration of these stages.

Stage	Traditional managerial focus	Contemporary textile interpretation
Introduction	Awareness, distribution build-up, trial	Digital testing, social listening, small-batch launch, rapid A/B validation
Growth	Capacity expansion and market penetration	Fast replenishment of validated items; algorithmic promotion
Maturity	Differentiation, cost control, line extension	Dynamic pricing, personalization, channel optimization, resale/repair options
Decline	Harvest, discontinue, replace	Markdown, rapid delisting, redesign, reuse, remanufacture or recycling pathway

Table 1. Evolution of managerial priorities across PLC stages. Source: author's synthesis based on [1, 3–6].

2.2. Fast and Ultra-Fast fashion as a PLC compression mechanism

Fast-fashion competition shifts advantage from the size of a seasonal collection toward the speed and accuracy of the demand-response loop. In a digitally mediated system, search data, clickstream behaviour, social-media signals, conversion rates, and return rates can be used as early indicators of product acceptance. This does not eliminate the PLC; rather, it compresses and partially overlaps its stages. A product can move from market test to growth, maturity, markdown, and replacement within a much shorter planning horizon than in the traditional seasonal model.

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The economic consequence is a change in inventory risk. Under long lead times, forecasting errors accumulate before market feedback becomes available. Under small-batch and rapid-replenishment models, the firm can postpone part of the volume commitment until demand is observed. The relevant performance question therefore changes from "How long is the PLC?" to "How quickly can the enterprise detect the stage transition and reallocate design, production, marketing, and inventory resources?"

3. Digitalization, PLM and Data-Driven PLC management

Product Lifecycle Management (PLM), 3D design, digital sampling, enterprise resource planning, customer analytics, and AI-assisted demand forecasting connect previously separated decisions. The value of these technologies lies not merely in faster design but in reducing information latency across the PLC. When product-development data, order data, inventory, consumer response, and supplier capacity are visible in one decision environment, firms can shorten feedback cycles and reduce the probability of producing large volumes of weak-demand items.

This direction is consistent with current fashion-industry priorities. McKinsey's 2025 industry discussion reports that 75% of surveyed fashion executives prioritize AI for demand forecasting, inventory optimization, and cost control, while 45% see AI-driven marketing as a major value driver [6]. These figures suggest that AI is increasingly positioned at the interface between demand sensing and resource allocation rather than as a stand-alone promotional tool.

Digital capability	PLC mechanism	Expected managerial effect
3D/digital sampling	Faster concept and prototype iteration	Lower sampling cost and shorter pre-market cycle
Demand forecasting	Earlier detection of likely growth/decline	Lower overstock and stockout risk
Real-time sales analytics	Stage-transition monitoring	Faster replenishment, markdown or delisting
CRM/personalization	Segment-specific product response	Higher conversion and more precise assortment decisions
Digital traceability / product passport	Post-sale information continuity	Supports repair, resale, compliance and recycling

Table 2. Digital capabilities and their role in PLC management. Source: author's synthesis based on [4–6, 9].

4. Circular economy and the extension of the material life cycle

Circularity changes the endpoint of the PLC. A linear model treats decline as the point at which the product exits the economic system. A circular model separates commercial decline from material end-of-life. A garment may leave its first-owner market but continue through repair, resale, rental, remanufacturing, or fibre recovery. Shirvanimoghaddam et al. describe this as a fundamental shift from a make-use-dispose model toward retaining resources and value in circulation for as long as possible [8].

The environmental rationale is substantial. The EEA estimated that EU textile consumption in 2020 generated 121 million tonnes of CO2-equivalent emissions and required 175 million tonnes of primary raw materials; it also emphasized that circular design is critical for durability, reuse, and recyclability [4]. More recent EEA evidence shows that apparent EU textile consumption increased

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from 17 kg per person in 2019 to 19 kg in 2022, while textile waste was about 16 kg per person in 2022 [9]. These figures demonstrate that technological efficiency alone is insufficient if total consumption and waste continue to rise.

Regulation is also turning circularity into a market-access issue. The EU Strategy for Sustainable and Circular Textiles sets a 2030 vision in which textile products placed on the EU market are durable, repairable and recyclable, increasingly use recycled fibres, and are supported by measures such as ecodesign requirements, Digital Product Passports, and producer responsibility [5]. For exporters, these developments imply that PLC management will increasingly include product data, material composition, durability, repairability, and end-of-life planning.

Dimension	**Linear PLC logic**	**Dual-loop / circular PLC logic**
Success criterion	Sales and margin during first market life	Margin + utilization + retained material value
Decline stage	Discontinue and replace	Redirect to resale, repair, remanufacture or recycling
Design priority	Cost, style, manufacturability	Cost, style, durability, disassembly, recyclability, traceability
Data horizon	Until sale / warranty	Across ownership and end-of-life stages
Competitive implication	Speed and price	Speed + adaptability + circular compliance

Table 3. From a linear PLC to a dual-loop PLC. Source: author's conceptual development based on [3–5, 8–9].

5. Statistical evidence and analytical interpretation

5.1. European textile consumption and circularity

Indicator	**Observed value**	**Analytical implication**
EU textile consumption per person	17 kg (2019) → 19 kg (2022)	Consumption pressure increased despite sustainability initiatives
EU textile waste per person, 2022	≈16 kg	End-of-life management remains a major PLC challenge
Textile-to-new-clothing recycling	<1% globally	Closed-loop material recovery remains structurally weak
EU textile/clothing sector turnover, 2019	€162 billion	Circular transition affects a large industrial ecosystem
AI priority among surveyed fashion executives, 2025	75% for demand/inventory/cost; 45% AI marketing	Digital capability is becoming central to PLC decisions

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Table 4. Selected evidence relevant to contemporary textile PLC management. Sources: [3–4, 6, 9]. Values refer to different geographies and years and are therefore used for structural comparison, not as a single time series.

The evidence points to two simultaneous forces. First, rising consumption and rapid assortment turnover strengthen the commercial incentive for faster forecasting and inventory response. Second, low fibre-to-fibre recycling and high waste levels increase regulatory and environmental pressure to extend the physical life of products. The result is not a single "shorter" or "longer" PLC, but a bifurcated system: commercial cycles become faster while circular material loops must become longer and more traceable.

5.2. Uzbekistan: Export structure and PLC implications

Uzbekistan has made significant progress in moving textile exports toward processed and finished products. According to the National Statistics Committee, textile exports in January–November 2025 amounted to USD 2.266 billion, equal to 7.3% of total exports. Finished textile products represented 51.6% of textile exports, yarn 28.4%, knitted fabric 11%, fabrics 6%, hosiery 2%, and carpets 1% [7]. In January–April 2026, textile exports were USD 454.5 million; finished textile products accounted for 50% and yarn for 32% [10].

Export category	Jan–Nov 2025 share	Jan–Apr 2026 share
Finished textile products	51.6%	50%
Yarn	28.4%	32%
Knitted fabric	11%	9%
Fabrics	6%	6%
Hosiery	2%	2%
Carpets	1%	1%

Table 5. Structure of Uzbekistan's textile exports. Source: National Statistics Committee of the Republic of Uzbekistan [7, 10]. Periods are not directly comparable as annualized growth rates; the table is used to illustrate export composition.

The dominance of finished products is strategically important because value creation increasingly depends on assortment design, speed-to-market, branding, market intelligence, and compliance rather than on fibre or yarn volume alone. At the same time, the decline in January–November 2025 textile exports relative to the same period of 2024, reported by the Statistics Committee at 14.6%, indicates that upgrading the product mix does not automatically guarantee export growth [7]. Competitiveness therefore requires a stronger link between product development and market demand.

For Uzbek enterprises, PLC capability can be interpreted as an export-readiness capability. Firms serving European markets need not only faster collection development but also the ability to document materials, respond to ecodesign requirements, manage small and frequent orders, and demonstrate circularity-related attributes. This makes PLM, traceability, forecasting, and flexible manufacturing complementary rather than independent investments.

6. SWOT analysis of PLC management in Uzbekistan's textile industry

Strengths	Weaknesses
Established cotton and textile production	Limited global brand power; uneven

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base; vertically integrated capacity; growing share of finished textile exports.	adoption of PLM/3D/data analytics; limited closed-loop recycling and traceability capability.
Opportunities	**Threats**
Higher-value finished products; nearshoring and rapid-order models; GSP+ access; eco-design, recycled-content and traceable products.	Intense Asian price competition; fast-changing fashion demand; stricter EU sustainability requirements; inventory and markdown risk under shorter commercial cycles.

The SWOT perspective shows that Uzbekistan's raw-material and manufacturing advantages are necessary but no longer sufficient. The strategic gap lies in converting production capability into market-response capability. In PLC terms, this means detecting introduction and growth opportunities earlier, shortening the time needed to scale successful products, and creating economically viable pathways after first use.

7. Proposed Dual-Loop PLC framework for textile enterprises

Based on the analysis, a contemporary textile PLC can be represented as two interconnected loops. The first is the commercial loop: trend sensing → digital design → small-batch launch → market validation → replenishment/scale → markdown or withdrawal. The second is the circular material loop: durable use → repair → resale/reuse → collection → sorting → recycling → secondary fibre → new product. Data generated in both loops should feed back into assortment planning and product design.

This framework suggests five measurable managerial indicators: (1) concept-to-market lead time; (2) forecast error or sell-through rate during the early sales window; (3) replenishment lead time; (4) share of products designed for durability/repairability/recyclability; and (5) share of returned or collected products routed to reuse or fibre recovery. Unlike a purely chronological PLC, these indicators make the model operational for management and allow firms to compare product families over time.

8. Conclusions and practical recommendations

The contemporary transformation of the textile PLC is best understood as a dual movement. Digitalization and fast-fashion competition compress the commercial life of styles, while circular-economy principles and regulation seek to extend the useful and material life of products. Consequently, the decline stage should no longer be treated as a simple terminal point. It becomes a decision node connecting markdown, redesign, resale, repair, collection, and recycling.

For Uzbekistan, four priorities follow. First, textile clusters should integrate PLM, 3D design, demand analytics, and production planning so that assortment decisions respond to market evidence rather than long planning cycles. Second, export-oriented firms should develop flexible small-batch and rapid-replenishment capabilities, particularly for higher-value finished products. Third, circular design, material traceability, repairability, and fibre recovery should be treated as future market-access capabilities in the EU rather than only as environmental initiatives. Fourth, enterprise KPI systems should include speed-to-market, early sell-through, forecast accuracy, markdown exposure, return/reuse rates, and recycled-content indicators alongside traditional production and export-volume measures.

The study is limited by its reliance on secondary aggregate evidence and does not estimate causal relationships at enterprise level. Future research should test the proposed dual-loop PLC framework

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using firm-level panel data from Uzbek textile enterprises, including product-level launch dates, sales trajectories, inventory turnover, marketing expenditure, replenishment times, markdown rates, and recycling or take-back outcomes. Such evidence would allow the contemporary PLC to be evaluated not only as a conceptual framework but also as a measurable determinant of marketing and operational efficiency.

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