Shifting the Burden in Fashion: A View on Fast Reordering Production Strategies Business Models

Juan Esteban Martinez-Jaramillo
University of Stuttgart,
Institute for Diversity Studies in Engineering,
Pfaffenwaldring 9,
70569 Stuttgart, Germany
Tel.: +49 711 685-60702
juan.martinez@ids.uni-stuttgart.de

Leonard Veit
University of Stuttgart,
Institute for Diversity Studies in Engineering,
Pfaffenwaldring 9,
70569 Stuttgart, Germany
Tel.: +49 711 685-60702
st177544@stud.uni-stuttgart.de

Meike Tilebein
University of Stuttgart,
Institute for Diversity Studies in Engineering,
Pfaffenwaldring 9,
70569 Stuttgart, Germany
Tel.: +49 711 685-60700
meike.tilebein@ids.uni-stuttgart.de

Keywords: Digital textile microfactories, Digital on-demand production, Archetypes

Fashion supply chains are structurally vulnerable to demand–supply misalignment. High demand volatility, short selling windows of around ten weeks, and upstream lead times of three to six months (Ye et al., 2023) force firms to commit to production decisions long before reliable market information is available (Anitha & Neelakandan, 2025). This creates a recurring trade-off between overproduction, leading to inventory costs, markdowns, and regulatory risk under the EU Ecodesign for Sustainable Products Regulation (ESPR, 2024/1781; European Commission, 2024), and unmet demand, which is largely irrecoverable once a collection's selling window closes (Talay et al., 2022).

Digital Textile Microfactories (DTMFs), combining digital design, inkjet printing, laser cutting, and semi-automated assembly (Artschwager et al., 2023), have been proposed as an agile, on-demand production concept that enables Fast Reordering Business Models (FRBMs) (Winkler et al., 2022). Under FRBMs, retailers may place smaller initial orders and rely on rapid, point-of-sale-triggered replenishment during the selling season, reducing dependence on forecast-driven upfront production (Winkler et al., 2022). However, while this approach may alleviate retail-level inefficiencies, its upstream supply chain implications remain underexplored (Tilebein, 2022).

This paper presents a qualitative System Dynamics approach, using Causal Loop Diagrams (CLDs), to examine the unintended economic consequences of DTMF-enabled FRBMs. Given the early-stage nature of DTMFs, the aim is not quantitative prediction but the exploration of feedback structures, delays, and systemic dynamics (Wolstenholme, 1999). The study follows a four-stage modelling process: literature synthesis, dynamic hypothesis formulation, CLD development, and structural validation through polarity consistency and boundary adequacy checks. System archetypes are applied retrospectively as interpretive tools rather than predefined frameworks (Lane & Smart, 1996), enabling comparison with established patterns of instability and risk displacement (Wolstenholme, 2003).

The integrated CLD identifies nine feedback loops across five clusters: demand–fulfilment planning, responsiveness, capacity and inventory constraints), upstream buffering and lead time effects, and cost–margin feedbacks. These clusters generate cross-tier trade-offs that are not visible from a single supply chain perspective. At the retail–DTMF level, fast reordering enables rapid replenishment that reduces unmet demand within the selling window without relying on forecasts or long lead times (Moyano-Fuentes et al., 2020). Since unmet demand is lost after collection closure (Talay et al., 2022), this can reduce overproduction ex ante (Chen et al., 2019). However, fast reordering increasingly replaces rather than complements planning-based adjustments under limited cross-tier coordination (Lu, 2021).

Upstream, shorter processing times and higher replenishment frequency results in suppliers responding with higher safety stocks, larger inventories, and increased raw material production (Moyano-Fuentes et al., 2020; Vanichchinchai, 2019). While this preserves flexibility in DTMF contexts (Mishra et al., 2025), it increases capital lock-up and cost exposure. Over time, these inventories raise raw material costs, which transmit downstream via higher input prices and lower retailer margins (Manzoor et al., 2022), with effects that accumulate outside immediate retail decision horizons (Lee, 2021).

Viewed through the Shifting the Burden archetype (Kim, 1992, 2000), the analysis reveals a structural vulnerability in fashion supply chains. Fast reordering alleviates short-term demand–supply mismatches while shifting buffering and adjustment pressures upstream toward Tier-2 suppliers. As dependence on this symptomatic solution grows, incentives for more fundamental solutions, such as coordinated buffering, selective capacity planning, and cross-tier design alignment, weaken over time (Krishnan & Winter, 2010; Wolstenholme, 2003).

This study contributes to the SD and supply chain literature in three ways. First, it conceptualises fast reordering as a structural response to irreversible demand uncertainty rather than purely an efficiency mechanism. Second, it shows how responsiveness-enhancing digital production technologies can trigger a classic Shifting the Burden dynamic, even when they reduce overproduction locally. Third, it highlights the role of tier-specific inventory characteristics and temporal irreversibility in shaping how risk and cost propagate across supply chain tiers. Overall, the findings demonstrate the value of qualitative SD modelling as an early-stage diagnostic tool for emerging business models (Veldhuis et al., 2023), while providing a basis for future quantitative and empirical research as DTMF adoption evolves.

Acknowledgment

This work was carried out in the context of the “SysTem” research project. The project, with grant number 01IF24621N, is funded by the Federal Ministry for Economic Affairs and Energy on the basis of a resolution of the German Bundestag.

References

Anitha, S., & Neelakandan, R. (2025). Demand forecasting new fashion products: A review paper. Journal of Forecasting, 44(2), 270–280. https://doi.org/10.1002/for.3192

Artschwager, A., Winkler, M., & Brunner, L. (2023). Textile microfactory and distributed production – Digitalization as a game changer for backshifting. DITF. https://www.ditf.de/en/index/more-information/interactive-whitepaper-on-textile-microfactory-and-distributed-production.html

Chen, Q., Xu, Q., & Wang, W. (2019). Optimal policies for the pricing and replenishment of fashion apparel considering the effect of fashion level. Complexity, 2019, Article 9253605. https://doi.org/10.1155/2019/9253605

European Commission. (2024). Ecodesign for sustainable products regulation: Making sustainable products the norm in the EU. https://commission.europa.eu/energy-climate-change-environment/standards-tools-and-labels/products-labelling-rules-and-requirements/ecodesign-sustainable-products-regulation_en

Kim, D. (1992). Systems archetypes I: Diagnosing systemic issues and designing interventions. The Systems Thinker.

Kim, D. (2000). Systems archetypes III: Understanding patterns of behavior and delay. Pegasus Communications.

Krishnan, H., & Winter, R. A. (2010). Inventory dynamics and supply chain coordination. Management Science, 56(1), 141–147. https://doi.org/10.1287/mnsc.1090.1100

Lane, D. C., & Smart, C. (1996). Reinterpreting 'generic structure': Evolution, application and limitations of a concept. System Dynamics Review, 12(2), 87–120.

Lee, Y. K. (2021). Transformation of the innovative and sustainable supply chain with upcoming real-time fashion systems. Sustainability, 13(3), 1081. https://doi.org/10.3390/su13031081

Lu, C. (2021). Research on bullwhip effect management in supply chain based on system dynamics. Journal of Physics: Conference Series, 1910, Article 012034. https://doi.org/10.1088/1742-6596/1910/1/012034

Manzoor, U., Baig, S. A., Hashim, M., Sami, A., Rehman, H.-U., & Sajjad, I. (2022). The effect of supply chain agility and lean practices on operational performance: A resource-based view and dynamic capabilities perspective. The TQM Journal, 34(5), 1273–1297. https://doi.org/10.1108/TQM-01-2021-0006

Mishra, N. K., Sharma, P. P., & Chaudhary, S. K. (2025). Redefining agile supply chain practices in the disruptive era: A case study identifying vital dimensions and factors. Journal of Global Operations and Strategic Sourcing, 18(1), 64–90. https://doi.org/10.1108/JGOSS-04-2023-0031

Moyano-Fuentes, J., Maqueira-Marín, J. M., Martínez-Jurado, P. J., & Sacristán-Díaz, M. (2020). Extending lean management along the supply chain: Impact on efficiency. Journal of Manufacturing Technology Management, 32(1), 63–84. https://doi.org/10.1108/JMTM-10-2019-0388

Talay, C., Oxborrow, L., & Goworek, H. (2022). The impact of asymmetric supply chain relationships on sustainable product development in the fashion and textiles industry. Journal of Business Research, 152, 326–335. https://doi.org/10.1016/j.jbusres.2022.07.034

Tilebein, M. (2022). Dynamic challenges of new digital technology-based business models for customer diversity in the fashion industry [Conference presentation]. System Dynamics Conference, Frankfurt, Germany.

Vanichchinchai, A. (2019). The effect of lean manufacturing on a supply chain relationship and performance. Sustainability, 11(20), 5751. https://doi.org/10.3390/su11205751

Veldhuis, G. A., Smits-Clijsen, E. M., & van Waas, R. P. M. (2023). Techniques to enhance the public policy impact of qualitative system dynamics models. System Dynamics Review. Advance online publication. https://doi.org/10.1002/sdr.1758

Winkler, M., Moltenbrey, F., & Tilebein, M. (2022). Business model scenarios for digital textile microfactories. In D. Herberger & M. Hübner (Eds.), Conference on Production Systems and Logistics: CPSL 2022 (pp. 574–582). Publish-Ing. https://doi.org/10.15488/12141

Wolstenholme, E. F. (1999). Qualitative vs quantitative modelling: The evolving balance. Journal of the Operational Research Society, 50, 422–428. https://doi.org/10.1057/palgrave.jors.2600700

Wolstenholme, E. F. (2003). Towards the definition and use of a core set of archetypal structures in system dynamics. System Dynamics Review, 19(1), 7–26. https://doi.org/10.1002/sdr.259

Ye, Y., Hung Lau, K., & Teo, L. (2023). Transforming supply chains for a new competitive market alignment – A case study of Chinese fashion apparel companies. International Journal of Logistics Research and Applications, 26(3), 365–397. https://doi.org/10.1080/13675567.2021.1951690