

FASHION BUSINESS

WHY RESALE PLATFORMS NEED SECURITY ARCHITECTURE

ABSTRACT

Circular fashion cannot scale without verification. Luxury resale markets are growing on fragmented authentication, leaving counterfeits in circulation and brands without supply chain visibility. Drawing on financial technology and defense practices, this paper sets out a four-layer verified resale model for luxury fashion.

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WHY RESALE PLATFORMS NEED SECURITY ARCHITECTURE



The fashion industry increasingly points to resale and circular models as a pathway toward sustainability.^{1,2,3} Secondhand marketplaces are growing rapidly and many fashion brands now promote resale as a way to extend product lifecycles and reduce waste.⁴

However, resale networks today operate with limited product traceability, inconsistent authentication standards and fragmented verification processes^{5,6}, and circular fashion is failing to scale as a direct result. The verification infrastructure required to support a truly circular fashion economy does not yet exist in any meaningful systemic form within today's fragmented fashion technology industry.

As resale volumes increase, these gaps introduce significant challenges: counterfeit goods circulate through secondary markets, brands lose visibility into product life cycles and consumers remain uncertain about authenticity, reducing overall supply chain visibility. We take this opportunity to challenge current fashion industry structures and propose solutions that allow resale to scale in an environmentally conscious manner, while improving data integrity across platforms. We begin by borrowing solutions from other sectors.

Trust infrastructure, a standard in sectors such as financial technology and cybersecurity,⁷ offers a framework for solving this challenge in circular fashion. Operational models that manage identity, track provenance and verify transactions have enabled entire industries to operate securely at global scale.^{8,9} Resale commerce and its current structure must adapt these functions to operate across increasingly complex global supply chains.

Also drawing on principles from technology, security and risk management,¹⁰ the scalability of circular fashion depends entirely on whether the industry builds the infrastructure required to make trust and sustainability scalable; it is not a function of consumer demand or market size.

Circular fashion cannot scale without verification infrastructure. Learning from financial technology and security's practices of trust architecture and shared certification standards is the most viable path forward for the emerging fashion tech industry.

¹ Hector Guadalupe Ramirez-Escamilla et al., "Advancing Toward Sustainability: A Systematic Review of Circular Economy Strategies in the Textile Industry," *Recycling* 9, no. 5 (2024): 86, <https://doi.org/10.3390/recycling9050096>.
² M. P. Mirzachi et al., "Second-hand Fashion Consumers Exhibit Fast-Fashion Purchasing Behaviour," *Scientific Reports* 15 (2025), <https://www.nature.com/articles/s41598-025-19089-1>.
³ Daniel Hellstrom et al., "Let's Go Thrift Shopping: Exploring Circular Business Model Innovation in Fashion Retail," *Technological Forecasting and Social Change* 199 (2024), <https://www.sciencedirect.com/science/article/pii/S0040162523006886>.
⁴ Mirzachi et al., "Second-hand Fashion Consumers."
⁵ Robert Zimmermann et al., "Methods to Authenticate Luxury Products: Identifying Key Features and Most Recognized Deficits," *SN Computer Science* 4, no. 6 (2023): 747, <https://doi.org/10.1007/s42979-023-02201-5>.
⁶ M. Thanasi-Bope et al., "The Secondary Luxury Market: A Systematic Review and Future Research Agenda," *Cogent Business & Management* 12, no. 1 (2025), <https://doi.org/10.1080/23315769.2025.2523405>.

⁷ Bank for International Settlements, *Blueprint for the Future Monetary System: Improving the Old, Enabling the New*, BIS Annual Economic Report, 2023, <https://www.bis.org/pub/arpdf/ar2023e3.pdf>.
⁸ Signaturn Group, "Why Is Digital Trust Infrastructure Becoming an Essential Pillar of Europe?" *Signaturn Blog*, accessed March 13, 2026, <https://www.signaturn.com/blog/why-is-digital-trust-infrastructure-becoming-an-essential-pillar-of-europe/>.
⁹ Ankit Singla et al., "Decentralized Identity Management Using Blockchain," *Journal of Information Security and Applications* 72 (2023), <https://www.sciencedirect.com/science/article/pii/S1062737223000783>.
¹⁰ Mita Ahmed Umer, Luis Borges Gouveia, and Catherine Getachew Beke, "Provenance Blockchain for Ensuring IT Security in Cloud Manufacturing," *Frontiers in Blockchain* 6 (2023), <https://www.frontiersin.org/articles/10.3389/fbloc.2023.1273394/pdf>.

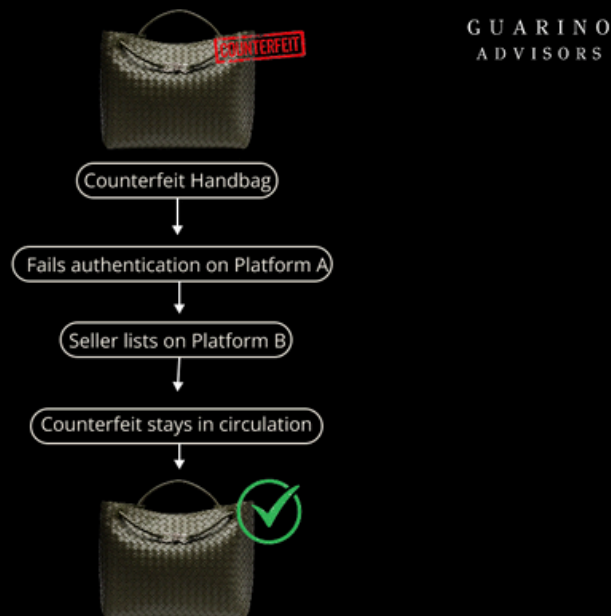
RAISING GAPS IN CIRCULAR FASHION BRANDS AND RETAILERS

Concerns of the climate crisis and its shifting consumer values have put circular fashion as one of the dominant narratives in sustainability discussions across the apparel industry.^{11,12} Resale marketplaces, rental models and peer-to-peer platforms are positioned to extend garment lifespans and reduce the environmental and carbon footprint of clothing production.^{13,14,15}

The global secondhand apparel market is projected to reach approximately \$350 billion by 2028, growing significantly faster than the primary apparel market.¹⁶ The logic appears straightforward: if clothing remains in circulation longer, consumers will break free from high volume shopping trends, thus, fewer new garments need to be produced.^{17,18}

That said, the resale model requires a significant attribute: it requires trust. Trust that the resold piece is authentic and valued at market price, when being sold from consumer to consumer. Trust for brands that their products are represented accurately across the value chain. Trust that goods circulating on marketplaces meet consistent standards. It's a free market, and when it comes to luxury, it's a market that must be regulated to succeed.

The below diagram displays the problem contemporary fashion brands must avoid:



Authentication in luxury resale markets remains inherently limited. Current methods rely heavily on manual inspection and expert judgment, introducing subjectivity and inconsistency across platforms. Furthermore, the increasing sophistication of counterfeit goods has made it progressively more difficult to distinguish authentic products from high-quality replicas using traditional verification techniques.¹⁹

Fragmentation is not unique to fashion. Research on digital trust architecture shows that there is often no uniform set of criteria for evaluating trust, with

product data distributed across multiple sources and difficult to standardize or operationalize.²⁰

Authentication practices vary widely across platforms, reflecting a broader structural issue observed in digital landscapes, where trust lacks standardized evaluation criteria and relies on disconnected, multi-source data that is difficult to integrate into a unified system.

Progress toward a more sustainable fashion industry, and ultimately a more sustainable planet, begins by identifying the structural gaps that prevent true circularity.

¹¹ Kiri Ninimäki et al., "The Environmental Price of Fast Fashion," *Nature Reviews Earth & Environment* 4 (2023): 189–200, https://www.researchgate.net/publication/340636670_The_environmental_price_of_fast_fashion.

¹² Aya Abdelmeguid, Mohamed Afy-Shararah, and Konstantinos Salonitis, "Towards Circular Fashion: Management Strategies Promoting Circular Behaviour Along the Value Chain," *Sustainable Production and Consumption* 48 (2024): 143–164, <https://doi.org/10.1016/j.spc.2024.05.010>.

¹³ Linda Lisa Maria Turunen and Maik Gossen, "From Preloved to Reloved: How Second-Hand Clothing Companies Facilitate the Transaction of Used Garments," *Journal of Sustainability Research* 6, no. 1 (2024), <https://sustainability.hogrefe.com/ArticleDownload.aspx?article=JSR&id=15558&type=pdf>.

¹⁴ Eni Amazeiva et al., "Can Rental Platforms Contribute to More Sustainable Fashion Consumption? Evidence from a Mixed-Method Study," *Cleaner and Responsible Consumption* 8 (2022): 100103, <https://doi.org/10.1016/j.clrc.2022.100103>.

¹⁵ Abdelmeguid, Afy-Shararah, and Salonitis, "Towards Circular Fashion."

¹⁶ ThredUp, 2024 Resale Report, 2024, https://cf-assets-tup.thredup.com/resale_report/2024/ThredUp_2024_Resale%20Report.pdf.

¹⁷ Ninimäki et al., "Environmental Price of Fast Fashion."

¹⁸ Abdelmeguid, Afy-Shararah, and Salonitis, "Towards Circular Fashion."

¹⁹ Zinnerman et al., "Methods to Authenticate Luxury Products."

²⁰ F. Hou and S. Jansen, "A Systematic Literature Review on Trust in the Software Ecosystem," *Empirical Software Engineering* 28 (2023): 8, <https://doi.org/10.1007/s10664-022-10238-y>.

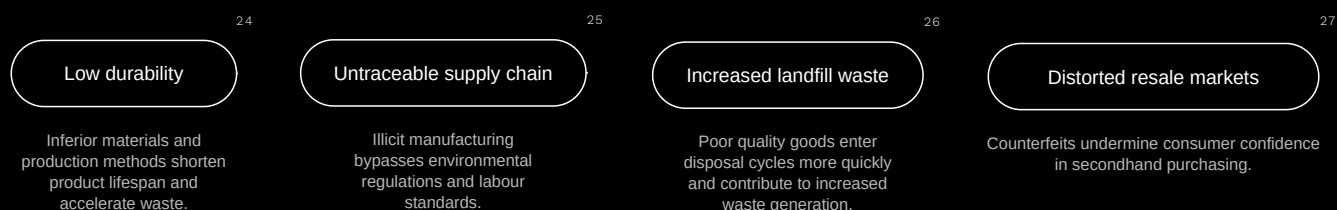
At the consumer level, platforms such as Whering are pioneering the structured organisation of wardrobe-level product data, creating visibility into ownership, usage and behaviour patterns that have historically remained untracked across the broader fashion scene. This type of product data layer, built around how consumers actually interact with clothing across its lifecycle, represents the upstream foundation on which validation infrastructure, Digital Product Passports and circular commerce protocols must ultimately be built. The absence of shared verification standards across the industry, however, means that even well-structured consumer data cannot yet travel between platforms or integrate into broader resale milieu. This is a gap that shared infrastructure must address.

Resale platforms continue to operate independently without shared standards for authentication, data exchange or product traceability across the fashion supply chain, which is exactly why resale markets struggle to build the foundations necessary for scalable growth.

COUNTERFEITS AND THE ENVIRONMENTAL COST OF UNVERIFIED RESALE

One of the most critical environmental risks in the resale economy is the continued circulation of counterfeit goods.²¹ According to the Organisation for Economic Co-operation and Development (OECD) and EU Intellectual Property Office, counterfeit and pirated goods represent roughly 3.3% of global trade, valued at over \$500 billion annually.²² A significant portion of these products move through informal or lightly regulated secondary markets.²³

Counterfeit fashion products present multiple environmental concerns:



In this context, authentication and verification are not simply matters of brand protection or intellectual property enforcement in the apparel industry. They are critical infrastructure for achieving measurable sustainability outcomes in circular fashion strategies and enabling trust in fashion tech environments.

²¹ Jens Perret, Christiane Beyerhaus, and Leonie H. Steinkamp, "Counterfeit Luxury Goods: Effects on the Brand Image and Exclusivity Perception," *International Journal of Applied Research in Management and Economics* 7, no. 4 (2024): 21–31, <https://doi.org/10.33422/ijarmer.v7i4.1443>.
²² OECD and European Union Intellectual Property Office, *Global Trade in Fakes: A Worrying Threat* (Paris: OECD Publishing, 2021), <https://www.oecd.org/publications/global-trade-in-fakes-factsheet-en.htm>.
²³ Thanasi-Boje et al., "Secondary Luxury Market".
²⁴ European Union Intellectual Property Office, *IP Infringement and Enforcement Tech Watch Discussion Paper*, 2023, https://euipo.europa.eu/tunnel-web/secure/webdav/guest/document_library/observatory/documents/reports/2023_IP_Tech_Watch_Discussion_Paper/2023_IP_infringement_and_enforcement_Tech_Watch_Discussion_Paper_FullR_en.pdf.

²⁵ OECD and EUIPO, *Global Trade in Fakes*, 46.
²⁶ Abdelmeguid, Afy-Sharrah, and Salontis, "Towards Circular Fashion".
²⁷ Thanasi-Boje et al., "Secondary Luxury Market".

WHY FASHION STRUGGLES WITH DIGITAL DESIGN VERIFICATION

The second gap in circular fashion is of course, verification. Despite the importance of authentication, the fashion technology domain has historically approached verification as an operational task rather than a sectoral problem.²⁸

These commonly implemented approaches include:

- Specialist manual authentication by expert staff
- Platform and channel based verification procedures
- Brand-issued certificates and digital identifiers
- Consumer-initiated certification actions

While existing expert and consumer authentication measures mitigate some risk, they do not address persistent deficits in process complexity and integration across actors, particularly, fashion tech startups. As a result, authentication remains fragmented and actor-specific rather than a fully integrated, shared system.

This disconnect creates several issues: authentication standards vary across platforms, product identity is not portable between marketplaces, brands lack visibility into secondary market activity, consumers cannot easily verify provenance across entities.

Without shared verification standards and interoperable protocols, authentication remains reactive rather than systemic, limiting supply chain visibility and cross-platform coordination.

In contrast, digital offerings in other industries rely on shared frameworks and formalized actions to enable trust and coordination across multiple actors, highlighting the importance of integrated infrastructure.²⁹



BORROWING FROM HIGH RISK INDUSTRIES TO IMPROVE FASHION TECH VERIFICATION LAYERS

Industries that manage high-risk transactions have long relied on architectures designed to establish trust at scale.³⁰ Financial technology platforms verify millions of transactions daily through layered infrastructure that includes identity validation, fraud detection and transaction monitoring.³¹ Many of these risk-mitigating solutions are increasingly AI-powered, enabling scale and automated confidence enforcement. Cybersecurity frameworks similarly rely on integrated technological controls, encryption and continuous system monitoring to maintain trust within digital environments.³² Trust in complex networks is built, not discovered, through predictable mechanisms implemented throughout. This is an architectural lesson we must learn from fintech and security.

The most important lesson from financial infrastructure goes beyond showing that layered authentication works. The lesson is that when accountability is assigned, standards bodies are established and interoperability becomes a regulatory requirement rather than a voluntary choice, the entire industry scales with it. Financial operations scaled only after liability, governance and enforceable rules were put in place, not simply because individual platforms improved their own authentication.

Drawing on experience in defense technology, defense-grade solutions take this accountability even further.

In high-risk environments where the cost of verification failure is catastrophic, identity and authentication are not added on later, they are requirements built into the product lifecycle management and operations from the day one.³³ Configurations used for high-stakes tasks such as ISR and target tracking establish and embed proof of identity at the point of creation and that proof travels with the asset permanently and unalterably. Thus, authentication is not retrofitted, but rather foundational.

That is precisely the model luxury resale needs. Embedded molecular tracking or digital product passports are structurally stronger than platform-level authentication programs, which are inherently reactive. The key question is how to make counterfeits structurally impossible to introduce into a verified chain in the first place. Defense solved that problem; fashion is destined to borrow the architecture.

Fashion's resale ecosystem is already evolving toward these environments. Circulating across multiple platforms and global markets, with limited direct relationships between parties, these marketplaces demand shared infrastructure for trust.

FASHION TECHNOLOGY IMPLEMENTATION PATHWAYS

The clearest current piece of evidence that verification infrastructure is becoming a mandatory reality comes from European regulation. The European Commission's Ecodesign for Sustainable Products Regulation, introduced in 2022, establishes a framework for requiring structured, digitally accessible product information on lifecycle, materials and environmental impact.³⁴ This framework forms the basis for Digital Product Passports, which will require products to carry standardized, interoperable data through their entire lifecycle.

Digital Product Passports fundamentally change where and how verification occurs across global supply chains. Rather than relying on downstream authentication at the point of resale, they establish product identity and traceability at the point of creation. This transforms verification from a reactive product data process to a built-in system requirement, aligning directly with the architectural model observed in financial and defense domains.

Brands treating product identity and verification as a voluntary innovation are misreading the direction of the market, as this evolution has direct implications for fashion retailers, apparel companies and platform operators. Said evolution is mandated by a changing regulatory landscape that is truly moving from voluntary guidance to enforceable standards.

The transition to Digital Product Passports indicates that verification infrastructure is not an optional layer to be added later. It is coming to be a condition for participation in the market.

³⁰ Hsu and Jansen, "Trust in the Software Ecosystems."

³¹ Peter Gombier et al., "On the Fintech Revolution: Interpreting the Forces of Innovation, Disruption, and Transformation in Financial Services," *Journal of Management Information Systems* 36, no. 1 (2018): 220-266, <https://doi.org/10.1080/03742122.2018.1440766>.

³² Aunruh et al., "Modeling a Digital Trust Framework to Address Cybersecurity Issues in Malaysia's Digital Economy," *International Transaction Journal of Engineering, Management, & Applied Sciences* 16, no. 4 (2024), <https://ruengr.com/V16/I6A46.pdf>.

³³ National Institute of Standards and Technology (NIST), *Zero Trust Architecture*, NIST Special Publication 800-207, Gaithersburg, MD: NIST, 2023.

³⁴ <https://european-council.europa.eu/media/en/press-articles/2022/09/22/1234567890.pdf>.

³⁵ European Commission, *Proposal for a Regulation of the European Parliament and of the Council Establishing a Framework for Setting Ecodesign Requirements for Sustainable Products and Repealing Directive 2009/125/EC*, Brussels, 2022, https://environment.ec.europa.eu/publications/proposal-ecodesign-sustainable-products-regulation_en.

PRACTICAL BARRIERS TO FASHION INDUSTRY ADOPTION

Even with a clear regulatory signal and technology examples, the industry will face real, practical barriers to adopting verification infrastructure. These barriers reflect the practical constraints that must be addressed for verification infrastructure to move from concept to implementation.

1. Upstream manufacturer readiness

Embedding persistent product identifiers requires changes at the point of production in fragmented supply chains. Many manufacturers supplying fashion brands at volume face limited digital infrastructure and misaligned incentives to implement such technologies without brand mandates or regulatory pressure.³⁵

2. Retrofitting legacy inventory

Digital Product Passports and embedded identifiers are designed to assign product identity at the point of creation, enabling traceability across the lifecycle.³⁶ However, the resale market is dominated by products manufactured before such capabilities existed, creating a structural gap in verification across the historical fashion supply chain. It remains a challenge for institutions to establish credible methods for authenticating existing inventory, not only new items.

3. Consumer-facing friction

Any verification process that adds visible steps to a resale transaction risks adoption resistance. The most viable implementations will make verification invisible to the end user. It must be a seamless process within the online shopping environment.

4. Absence of a dominant standard

Until a single interoperable protocol emerges or is mandated, fashion tech startups will continue building proprietary solutions that cannot communicate with each other, reproducing exactly the fragmentation the framework is designed to solve.



Recognizing these barriers upfront is the first step to designing mechanisms, governance and incentives that overcome them rather than repeating the fragmentation and friction of today.

FASHION TECHNOLOGY IMPLEMENTATION PATHWAYS

To support sustainable resale arenas, verification must operate as an integrated infrastructure layer across fashion tech platforms rather than a collection of independent authentication processes.

A resilient verification architecture can be understood through four interconnected layers.

INTRODUCING A SOFTWARE CENTRIC LAYER

THE VERIFIED RESALE INFRASTRUCTURE MODEL

01

Product Identity

Each product must possess a secure, persistent identifier that remains attached to the item throughout its product lifecycle management process.

EXAMPLES INCLUDE

- Digital Product Passports
- Embedded identifiers (RFID, NFC)
- Secure digital records linked to manufacturing data

These components establish the baseline for traceability.

02

Verification Protocols

Authentication processes must be standardized across platforms to ensure consistent evaluation of product authenticity, data integrity and provenance.

PROTOCOLS INCLUDE

- Digital verification tools
- AI-assisted authentication
- Government and Policy enforcement
- Standardized inspection frameworks

03

Marketplace Trust Layer

Marketplaces must be able to interact with shared verification infrastructure, allowing authentication results to travel with the product across global supply chains rather than remain platform-specific.

THIS LAYER ENABLES

- Interoperability across resale platforms
- Transparent verification status
- Improved consumer confidence

04

Impact Measurement

04

Impact Measurement

Once product identity and product data verification elements exist, brands and marketplaces can measure the true environmental impact of resale.

Impact measurement is only credible if the data feeding it is verified at the source. Impact claims built on unverified product data reproduce the same trust problem the framework is designed to solve. Sustainability metrics in circular fashion remain narrative rather than measurable until the identity and verification layers beneath them function reliably.³⁷

WITH VERIFIED DATA AS THE FOUNDATION, METRICS MAY INCLUDE

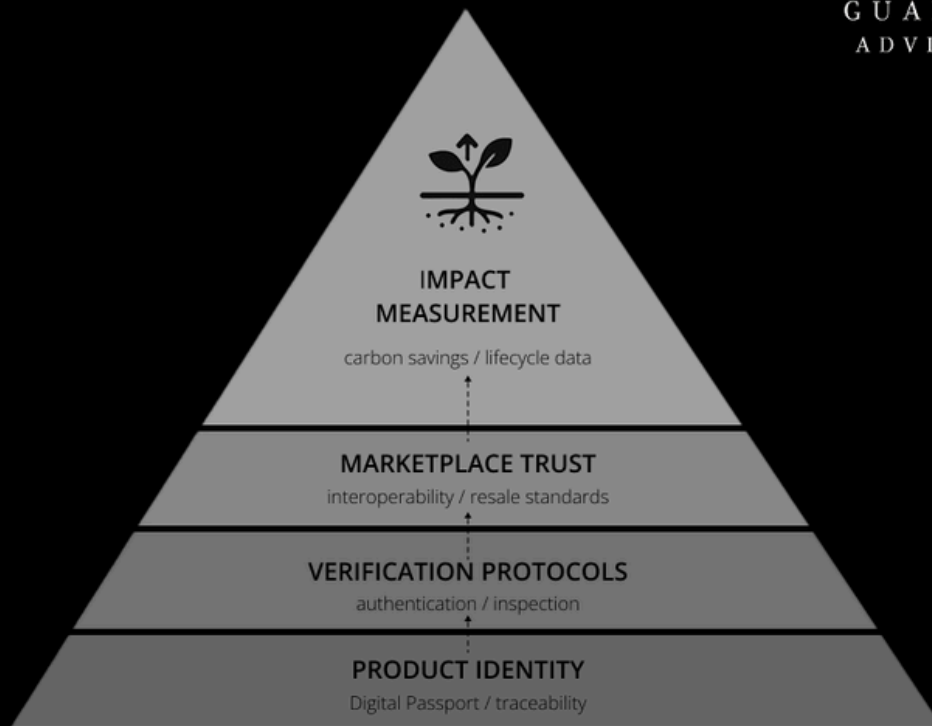
- Extended product lifespan
- Carbon savings through resale
- Reduced production demand

Only with reliable product data can circular fashion move from narrative to measurable impact.

INTRODUCING A SOFTWARE CENTRIC LAYER

THE VERIFIED RESALE INFRASTRUCTURE MODEL

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VALIDATION FROM ADJACENT INDUSTRIES

The proposed verification framework is not conceptual. Similar architectures are established across adjacent industries through the convergence of technology, regulation and policy, providing a practical foundation for its implementation in fashion technology models. The European Commission's Eco-design for Sustainable Products Regulation (ESPR) establishes a framework for requiring structured, digitally accessible product information on lifecycle, materials and environmental impact, forming the basis for Digital Product Passports.³⁸

Building on these technological foundations, regulatory developments are beginning to formalize requirements for product-level traceability.

Policy frameworks in financial services further illustrate how trust is operationalized across decentralized actors. The Financial Action Task Force (FATF) recommendations require financial institutions to implement standardized identity verification and transaction monitoring procedures, establishing consistent compliance and risk management frameworks across institutions and jurisdictions.³⁹ Such regulation reflects a transition from voluntary innovation toward standardized, enforceable verification trust infrastructure across industries.

THE PROPOSED PATH FORWARD FOR FASHION

Circular fashion will not be achieved through consumer engagement alone. The scalability of resale markets ultimately depends on whether the industry develops the infrastructure required to support them. Verification systems, product identity frameworks and shared trust protocols represent foundational components of that fashion industry infrastructure. As resale markets expand, brands, technology companies and marketplaces must collaborate within an enforceable governance structure to construct these foundations.

GOVERNANCE AND OPERATIONAL RISKS

The history of infrastructure development in fintech and cybersecurity shows that collaboration between competing commercial and public actors requires structured governance frameworks to ensure consistency and scalability.⁴⁰ In the absence of such structures, outcomes remain inconsistent until governance mechanisms are established to enforce shared standards. An industry consortium with shared protocols, a regulatory body with enforcement authority, or a combination of both represent the most viable governance models. Without a clearly defined structure, implementation remains inconsistent and difficult to scale. In this context, accountability functions as a core system requirement for the fashion industry rather than an outcome of voluntary alignment.

Operational risks represent a primary barrier to adoption. These concerns explain why participation stalls even when all parties align on the problem in principle. For shared infrastructure to be viable, such risks must be explicitly defined and addressed rather than overlooked.

Competitive data exposure is a key concern. Participation in shared infrastructure could reveal secondary market volume, pricing patterns and consumer behavior that brands consider proprietary. Liability transfer is another.

Joining a shared verification framework may create new legal exposure if the framework certifies a product that later proves counterfeit. Interoperability risk is also real. Connecting platform infrastructure to shared verification layers introduces new security vulnerabilities if the architecture is not designed carefully from the outset.

These risks are manageable. Fintech and cybersecurity have solved analogous problems through data sharing, tiered access protocols and clearly defined liability frameworks that specify what each participant is responsible for verifying and what they are not.⁴¹ A governance structure that makes participation safe for all parties is essential for adoption. Without such a structure, shared infrastructure will remain theoretical rather than operational.

Only with clear governance and risk safeguards will the verification infrastructure achieve the scale and trust needed to deliver measurable environmental impact.

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Photo Courtesy of
The New York Times

FINAL NOTE

The fashion industry has already demonstrated its ability to innovate in areas such as supply chain management, product design and consumer-facing data platforms. Digital wardrobe and product data platforms such as Whering structure product data at the user level, providing visibility into ownership and usage patterns that have historically remained untracked. The next phase of innovation will focus on trust architecture. Without it, circular fashion will remain a promising concept.

The industry must draw from established financial technology and security predecessors. As described, this innovation requires building and governing the infrastructure that establishes trust and enables resale markets to operate reliably at scale, something no amount of consumer demand or additional platforms can substitute for.

G U A R I N O
A D V I S O R S