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MANUFACTURER-USER COLLABORATIVE INNOVATION VIA E-COMMERCE PLATFORMS*

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Abstract. This study examines how e-commerce ecosystems reconfigure manufacturer-user (MU) collaborative innovation networks, drawing on evidence from China's fashion and apparel industry. Through a qualitative multi-case analysis of two platform-mediated collaborations—modular knitwear co-creation and sustainable denim development—we identify that e-commerce platforms act as proactive architects of innovation. They enable role fluidity among problem setters, solvers, and reviewers; facilitate hybridisation of collaboration modes (e.g., resource transfer with strategic alliances); and institutionalise digital, knowledge, and organisational mechanisms that reduce information asymmetry and accelerate iteration. The paper presents an integrated framework that bridges service-dominant logic, user innovation theory, and platform ecosystem perspectives, providing practical insights for managers and platform designers on structuring effective, trust-based co-innovation in digital environments.

Keywords: Manufacturer-user collaborative innovation; E-commerce ecosystems; Fashion industry; Platform intermediation; Value co-creation

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1. Introduction and Review of Literature

In an era of accelerating digital transformation, firms increasingly assume multiple, evolving roles: they define market needs, develop and validate technologies, translate scientific discoveries into commercial offerings, evaluate market applications, and co-construct future industry trajectories. High-quality innovation, particularly inter-firm collaborative innovation, has become a central driver of sectoral linkages and innovation-led growth in this new stage of development. While existing research has extensively examined collaborative technological innovation within industrial chains and regional clusters, it has largely overlooked the heterogeneity across firm types—especially the distinctive and increasingly influential role of users. Traditionally, manufacturers have dominated innovation studies; yet users are far more than passive buyers. They are active participants whose market positions, technical demands, and contextual knowledge increasingly shape innovation processes and outcomes.

The influence of users in product and technological development now extends well beyond transactional purchasing. Empirical evidence indicates that when manufacturers systematically integrate user feedback into new product development, innovation performance improves significantly. Downstream lead users—armed

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with substantial bargaining power and stringent technical requirements for intermediate goods—often catalyse upstream technological advances (Vanleene et al., 2017). Compared to ordinary manufacturers, end users or final assemblers frequently operate on a larger scale and possess stronger capacities to steer innovation across entire industry chains. Consequently, a growing number of firms are adopting collaborative innovation strategies to share knowledge, access complementary resources, and accelerate capability building. Within this collaborative paradigm, lead users—those with forward-looking needs and strong incentives to secure early-mover advantages—have gained particular salience. These users often initiate innovation activities when existing products fail to meet their advanced requirements and actively seek partnerships with manufacturers to co-create solutions (Tekic & Willoughby, 2019).

As innovation logic increasingly shifts toward post-Schumpeterian perspectives—where demand-side factors and real-world usage contexts drive technological trajectories—there is a pressing need to broaden scholarly attention to user-led innovation paradigms and the specific mechanisms underpinning MU collaboration. This paradigm shift is substantiated by a growing body of empirical research that delineates the multifaceted roles users play in co-development processes. For instance, Dean, Zhang and Xiao (2024) elucidate how customer involvement in co-development enhances problem-solving efficacy and decision-making quality during new product development (NPD), particularly through iterative feedback loops that bridge experiential user knowledge with technical feasibility. Similarly, Sabatini, Pascucci and Gregori (2023) provide empirical evidence from the smart product sector, demonstrating that deep customer involvement in technological development not only refines product functionality but also accelerates market adoption by ensuring alignment with latent user needs. These studies underscore that users are not merely passive recipients but active co-developers whose contextual insights are critical for reducing developmental uncertainties and enhancing product-market fit.

Extending this perspective, recent research further unpacks the contingent nature and performance implications of user involvement. Zaefarian et al. (2025) systematically examine when and how customer involvement as a co-developer translates into superior supplier NPD performance, highlighting the mediating roles of knowledge integration and relational governance. Their findings suggest that the benefits of co-development are maximised when involvement is structured around clear intellectual property frameworks and aligned incentives—an insight particularly relevant for platform-mediated ecosystems. Complementarily, Lu, Zou, and Du (2024) investigate the differential impacts of two forms of customer involvement (information provision versus co-development) across various NPD stages within digital contexts. They find that co-developing yields greater performance benefits in later stages, such as testing and launch, where real-world usage feedback is paramount. This staged approach to involvement aligns with the lead user theory advanced by de Jong et al. (2024), who conceptualise lead users as a vital source of Schumpeterian opportunities in industrial product development. Their work posits that lead users, by articulating advanced needs and pioneering solutions, effectively de-risk radical innovation and chart new technological trajectories, thereby embodying the core of post-Schumpeterian innovation dynamics.

Beyond functional and commercial outcomes, the user-led paradigm is increasingly linked to strategic initiatives such as sustainability and systemic innovation. Reppmann et al. (2025) investigate how involving customers in corporate sustainability initiatives can "activate" sustainable consumption behaviours, thereby creating a virtuous cycle where user feedback directly informs eco-innovation. This aligns with the growing emphasis on sustainable co-creation observed in platform ecosystems. Furthermore, Marty and Ageron (2024) propose a conceptual framework for directly connecting customers to the supply chain, arguing that such integration enhances transparency, responsiveness, and value co-creation across the network—a notion central to understanding MU collaboration in digitally linked value chains. The collaborative ethos extends to the creative industries as well, where Bujor, Avasilcai and Avram (2024) document, through case studies, how co-innovation with users fosters novelty and cultural resonance.

Meanwhile, the digital infrastructure enabling these collaborations is scrutinised by Rohit, Ranjan and Shainesh (2025) in their meta-analysis of service marketing mix and customer engagement, and by Gupta and Khan (2024) in their systematic review of artificial intelligence's role in facilitating personalised and scalable customer engagement for co-creation. These digital enablers are critical for managing the complexity of multi-actor

collaboration, as noted by Sonta-Draczkowska et al. (2025) in their systematic literature review, which identifies project management challenges and solutions in user co-creation initiatives. Finally, the motivational and experiential dimensions are addressed by Kieling and Boeing (2025), who find that product co-creation can positively influence consumer hedonic adaptation, thereby enhancing long-term engagement and satisfaction. Collectively, this literature substantiates a comprehensive view of user-led innovation as a multi-mechanism, context-dependent process that is fundamentally reshaping collaboration paradigms, setting the stage for our investigation into its reconfiguration within e-commerce ecosystems.

The manufacturer-user (MU) collaborative innovation process is inherently characterised by high uncertainty and information asymmetry. Knowledge regarding product usage, contextual requirements, and emergent needs predominantly resides with users, while solution expertise, technical know-how, and production capabilities are concentrated among manufacturers. This division of knowledge creates both barriers and opportunities: lead users can act as critical brokers of demand-side insights and strategic partners in co-development, yet misaligned incentives and imperfect information flows can impede effective collaboration. Notwithstanding the rising strategic importance of MU collaborative innovation, two critical research gaps persist. First, the literature provides a limited understanding of user-led collaborative innovation, particularly in terms of how lead users initiate, shape, and sustain co-innovation processes with manufacturers. Second, comprehensive theoretical frameworks that integrate firm-type heterogeneity, information asymmetry, and multi-stakeholder coordination within digitally-mediated industry ecosystems remain underdeveloped. These gaps are especially salient in platform-driven contexts, such as e-commerce ecosystems, where digital intermediaries, data-rich interactions, and rapid feedback loops fundamentally reshape the relationships between manufacturer s and users.

To address the indicated gaps, this study examines the following research question: **How do e-commerce ecosystems reconfigure the structure and dynamics of manufacturer-user (MU) collaborative innovation networks?**

We examine this question empirically within the fashion and apparel industry-a sector that vividly exemplifies MU co-innovation. Here, lead retailers, brands, and large buyers exert significant influence on upstream suppliers' technology adoption, design standards, and production processes. Consumers and trend-setting users provide rapid, granular signals about preferences and usage contexts, while e-commerce platforms actively mediate interactions, data flows, and market-testing mechanisms. By exploring MU collaboration in this setting, the paper seeks to (1) theorise how lead users and manufacturers co-create innovation under conditions of information asymmetry and platform mediation, (2) identify the mechanisms through which user knowledge is integrated into technical problem-solving and product development, and (3) evaluate the implications for firm-level innovation capabilities and industry-wide innovation diffusion.

The contributions of this paper are threefold. Empirically, it introduces a user-centric perspective into the study of collaborative innovation within digital commerce ecosystems, an area traditionally dominated by manufacturer-focused accounts. Theoretically, it develops an integrated framework for understanding MU collaborative innovation that foregrounds firm-type heterogeneity, knowledge complementarities, and platform-enabled coordination mechanisms. Practically, the findings offer actionable guidance for managers and platform designers on structuring collaborations that effectively harness lead-user insights while aligning incentives and mitigating informational frictions. Collectively, these advances aim to deepen our understanding of how manufacturer-user partnerships can drive high-quality innovation and reshape industry trajectories in the digital age.

2. Conceptual Basis

The conceptualisation of manufacturer-user (MU) collaborative innovation within e-commerce ecosystems lies at the intersection of service-dominant logic, value co-creation theory, and the digital transformation enabled by platform technologies. This integrative perspective is essential for understanding how e-commerce

ecosystems reconfigure traditional innovation networks, shifting them from manufacturer-centric, linear processes to dynamic, user-driven value co-creation systems.

Service-Dominant Logic and Value Co-Creation in Innovation

The Service-Dominant (SDL) logic framework, pioneered by Vargo and Lusch (2004, 2008a, 2008b, 2016), provides a robust theoretical foundation for understanding MU collaborative innovation. SDL reconceptualises value creation as the result of resource integration among multiple actors within a service ecosystem. In this view, all economies are service economies, and goods—including innovative products—are merely vehicles for service provision. Applied to innovation contexts, this means that manufacturers, users, platform intermediaries, and technologies all act as resource integrators, each contributing unique knowledge, capabilities, or contextual insights to the innovation process (Vargo & Lusch, 2016). Value co-creation becomes the operational mechanism through which this resource integration is enacted. Unlike traditional innovation models, where value is created by manufacturers and consumed by users, value co-creation emphasises collaborative processes in which both manufacturers and users jointly generate innovative outcomes (Saunila, Ukko & Rantala, 2019; Fonferek, Kleinaltenkamp & Möller, 2019). This paradigm shift is particularly salient in e-commerce ecosystems, where digital platforms facilitate continuous interaction and knowledge exchange between manufacturers and users, enabling real-time resource integration and iterative solution development.

The Evolution of Innovation Paradigms: From Producer-Led to User-Driven Collaboration

The theoretical understanding of innovation has evolved significantly through several distinct paradigms. The Schumpeterian perspective initially emphasised the entrepreneurial spirit (Mark I) and later large firms (Mark II) as primary innovation drivers, focusing predominantly on manufacturer-led, internally confined processes. The Neo-Schumpeterian paradigm expanded this view to include social institutions through concepts such as the "National Innovation System" (Freeman, 1987) and the "Triple Helix" model (Etzkowit & Leydesdorff, 1995), which highlighted the importance of university-industry-government collaborations. While broadening the scope of innovation beyond individual manufacturers, this paradigm remained predominantly macro-level and manufacturer-centric. The emergence of the Post-Schumpeterian paradigm, significantly advanced by von Hippel's user innovation theory (1986, 2017), marked a fundamental shift in the understanding of innovation. Von Hippel (2017) demonstrated that users—both individuals and firms—frequently innovate to address their specific needs, often without assistance from manufacturers. This theoretical development expanded the boundaries of innovation beyond manufacturers as sole sources to propose user-driven innovation paradigms. Hippel (2017) further argued for a paradigm shift from individual manufacturer innovation to user-driven and open collaborative innovation, providing crucial theoretical grounding for MU collaborative innovation theory. Within this evolving landscape, three distinct innovation models coexist: manufacturer-alone innovation, user-alone innovation, and manufacturer–user collaborative innovation. While manufacturer innovation typically leverages economies of scale and focuses on value capture through intellectual property, user innovation is fundamentally demand-driven, often resulting in "free innovation" that prioritises use value over proprietary control (von Hippel, 2017). MU collaborative innovation represents a hybrid approach that simultaneously leverages the distinct knowledge sets of both manufacturers and users, leading to joint value creation through structured collaboration.

E-commerce Ecosystems as an Inflexion Point for MU Collaboration

Digitalisation has already transformed the boundaries and complexity of innovation networks. Technologies such as big data analytics, digital prototyping tools, and communication platforms have enabled greater user participation, real-time feedback, and decentralised innovation activities (Lember Brandsen & Tönurist, 2019; Chen et al., 2021). However, e-commerce ecosystems represent a qualitative leap within this digital transformation. Unlike prior technologies that primarily facilitated discrete interactions, e-commerce platforms possess capabilities in data aggregation, matchmaking, and ecosystem orchestration, enabling them to act as active architects of innovation networks. E-commerce platforms transform MU collaboration through several unique capabilities. They aggregate diverse user needs and preferences at unprecedented scale, enabling manufacturers to identify emerging trends and innovation opportunities. They provide digital toolkits that lower barriers to user participation in design and customisation. They facilitate rapid prototyping and market testing through integrated feedback mechanisms. Most importantly, they reconfigure innovation networks from

sequential, manufacturer-driven processes to dynamic, multi-directional value co-creation ecosystems where users transition from passive recipients to active co-designers, quality assessors, and innovation drivers.

These transformative potential positions e-commerce ecosystems not merely as transactional platforms but as new structural conditions for MU collaborative innovation in the digital age. By synthesising these three conceptual streams—service-dominant logic, the evolution of innovation paradigms, and the transformative role of e-commerce ecosystems—this research establishes a foundation for investigating how digital platforms reconfigure the structure and dynamics of manufacturer-user collaborative innovation networks.

3. Methodology

To investigate how e-commerce ecosystems reconfigure the structure and dynamics of manufacturer-user (MU) collaborative innovation networks, we employed a qualitative multi-method research design, which is well-suited for theory building in complex, emerging contexts (Yin, 2016). A multi-method approach enables data triangulation and provides rich, contextual insights into the mechanisms and processes underpinning platform-mediated innovation. Our study focuses on the fashion and apparel industry within leading Chinese e-commerce ecosystems, a context where digital platform mediation, fast-changing consumer preferences, and intense competition make MU collaborative innovation particularly salient.

3.1 Research Design and Case Selection

We adopted a multiple-case study design to capture the heterogeneity and complexity of MU collaborative innovation across different platform contexts. Multiple cases allow for comparative analysis and enhance the theoretical generalizability of emerging patterns (Eisenhardt & Graebner, 2007). Case selection followed a theoretical sampling logic, aiming to maximise variation in platform types, firm sizes, and collaboration models while ensuring relevance to the research question (Yin, 2016). We selected two in-depth cases that represent distinct yet complementary models of MU collaborative innovation within Chinese e-commerce ecosystems:

Case A: Co-creation with Micro-Influencers and Fast-Fashion Retailers. This case examines a vertically integrated OEM (anonymised as "Shandong Knit Co.") that collaborated with a leading fast-fashion retailer ("BuyFast") and micro-influencer communities on Xiaohongshu to co-create a line of modular knitwear. This case exemplifies user-led ideation and platform-facilitated, on-demand production.

Case B: Platform-Analytics-Driven Sustainable Line Development. This case focuses on a large online-native brand ("BrandX") that leveraged Tmall's co-creation tools, platform analytics, and livestreamer co-design sessions to develop a new sustainable denim line in partnership with an upstream fabric mill and several lead retailers. This case illustrates data-driven, platform-orchestrated collaboration across the value chain.

Together, these cases cover a spectrum from socially driven (Xiaohongshu) to transactionally oriented (Tmall) platforms, and from product-level customisation to strategic sustainable innovation, offering a robust basis for analysing the reconfiguration of MU innovation networks.

3.2 Data Collection

We conducted intensive fieldwork between April and September 2024, employing a multi-method data collection strategy to ensure triangulation and depth. Our data corpus combines platform data, semi-structured interviews, and archival documents, as detailed in Table 1.

Table 1. Data Collection Overview

Data Source	Details and Period
Semi-structured Interviews	28 interviews (mean length: 60 minutes) with respondents from across the e-commerce ecosystem, including 6 Brand/Manufacturer representatives, 5 Platform managers, 7 Lead Users/Retailers, 6 Independent Designers/Micro-brands, and 4 Technology/Logistics providers.
Platform Data	Aggregated, anonymised datasets (2019-2024) from Tmall and Taobao (via official APIs), public user-generated content from Xiaohongshu, and selected livestreaming campaign records. Analysed metrics included search trends, SKU launch cadence, review sentiment, and co-design participation rates.
Archival Data	Internal firm documents from case companies, platform white papers (e.g., Tmall Trend Insights Report), annual reports, patent/licensing disclosures, and media coverage of collaborative initiatives (2018-2024).

A total of 28 semi-structured interviews were conducted with a diverse range of stakeholders across the e-commerce ecosystem, ensuring insights from platform orchestrators, innovation leaders, and implementation partners.

The interviewees included:

Brand and Manufacturer Representatives (6 persons): Including R&D leads, product managers from heritage manufacturers, and fast-fashion OEMs involved in co-creation projects;

Platform Management (5 persons): Including product managers from Tmall Innovation Centre and community operation leads from Xiaohongshu;

Lead Users and Retailers (7 persons): Including product development managers from large omni-channel retailers, buying group representatives, and merchandising specialists;

Independent Designers and Micro-Brands (6 persons): Key figures in platform-led co-design initiatives;

Logistics and Technology Providers (4): Offering perspectives on supply chain integration and digital tooling that enable rapid iteration.

This composition allowed us to triangulate data between platform architects, manufacturing innovators, and user representatives, capturing a holistic view of MU collaborative innovation dynamics.

3.3 Data Analysis

To systematise the analysis across multiple data sources and cases, we applied a hybrid approach of deductive and inductive thematic analysis, supported by the grounded theory technique of constant comparison (Charmaz, 2006). The study was facilitated by NVivo software for data management, coding, and memoing.

The analysis unfolded through three iterative stages:

Initial Coding: We began with open coding of interview transcripts and key sections of archival documents. First-order codes captured in-vivo terms and specific actions described by participants (e.g., "real-time trend spotting," "co-design livestreams," "modular component sharing").

Theme Development: Through constant comparison within and across cases, we grouped first-order codes into second-order themes. This stage involved identifying recurring patterns related to how platforms alter information flows, redefine participant roles, create new collaboration modes, and introduce new coordination mechanisms.

Aggregate Dimension Integration: Finally, we abstracted the second-order themes into aggregate dimensions that constitute the core mechanisms through which e-commerce ecosystems reconfigure MU innovation networks. This process resulted in the identification of the framework presented in the Findings section.

This rigorous, iterative process ensured that the resulting conceptual model was deeply grounded in empirical evidence while being sufficiently abstract to offer theoretical contributions.

4. Case Introduction: Collaborative Innovation in E-commerce Fashion Ecosystems

China's fashion and apparel industry is undergoing a profound digital transformation, with e-commerce ecosystems emerging as pivotal forces in reconstructing manufacturer-user (MU) collaborative innovation networks. This evolution shifts the focus from manufacturer-centric, sequential development processes to platform-mediated, user-integrated co-creation pathways. The following two cases from leading Chinese e-commerce platforms exemplify this paradigm shift, demonstrating how digital ecosystems enable more responsive, efficient, and consumer-centred innovation models.

4.1 Case A: Modular Knitwear Co-creation (Shandong Knit Co. × BuyFast × Xiaohongshu)

Background and Context

Shandong Knit Co. represents a medium-sized original equipment manufacturer (OEM) with advanced 3D knitting capabilities, historically focused on producing standardised lines for domestic fast-fashion brands. BuyFast operates as a national fast-fashion retailer with a dominant e-commerce presence and substantial

category buying power. The collaboration integrated Xiaohongshu micro-influencer communities, known for pioneering modular fashion styling trends.

Problem Setting: Identifying Innovation Opportunities

The collaborative initiative emerged from the convergence of challenges and opportunities. BuyFast identified persistent operational inefficiencies, including rapid churn of knitwear trends and elevated return rates (approaching 25%), primarily attributable to fit inaccuracies and personalisation gaps. Concurrently, Xiaohongshu platform analytics detected a surge in consumer interest in "modular" and "multi-way" knitwear configurations among fashion-forward demographics. This convergence prompted BuyFast to articulate a strategic innovation challenge: developing a knitwear line that enabled extensive personalisation while minimising inventory risk and maintaining viable profit margins.

Collaborative Process and Mode

The partnership adopted a hybrid Resource Transfer and Strategic Alliance model. BuyFast formally commissioned Shandong Knit Co. for a co-design pilot program leveraging 3D knitting technology. Xiaohongshu micro-influencers participated as lead users, contributing to the modular configuration definitions—including removable collars, variable sleeve lengths, and interchangeable patch elements—while providing crucial validation of the prototypes. Tmall's platform analytics and BuyFast's sales volume guarantee financially underwrote initial small-batch production runs, mitigating manufacturing risk.

Problem Solving and Technical Implementation

Shandong Knit Co. deployed integrated digital toolkits—including 3D patterning software and virtual fit simulation—that directly connected with platform feedback mechanisms, enabling rapid design iterations. Technical adjustments focused on optimising stitch gauge, selecting yarn blends, and engineering modular connectors. Micro-influencers provided detailed fit documentation through video content and suggested practical use cases for modular components, directly influencing the design of connectors and the development of fastening systems.

Review and Validation Mechanisms

The innovation process incorporated multi-stage validation through platform-enabled mechanisms. Initial product releases utilised livestreamed pre-sales campaigns, which generated real-time consumer response metrics. Platform data—including add-to-cart rates, conversion performance during livestream events, and detailed analysis of return reasons—enabled continuous refinement throughout the product lifecycle. This integrated approach significantly compressed design-to-market timelines, reducing traditional 12-week cycles to 4–6 weeks for pilot SKUs.

Documented Outcomes and Performance Impact

The modular knitwear pilot demonstrated significant performance improvements across multiple dimensions. Pilot SKUs achieved a 20% higher conversion rate and 35% reduction in return rates compared to conventional knitwear lines. Manufacturer margins improved substantively through reduced overstock liabilities and premium pricing enabled by customisation capabilities. The collaboration established a new operational paradigm for responsive, demand-driven production within fast-fashion ecosystems.

4.2 Case B: Sustainable Denim Co-creation (BrandX × Fabric Mill × Tmall)

Background and Context

BrandX operates as an online-native fashion brand, targeting environmentally conscious consumers, and faces increasing market pressure to accelerate the adoption of sustainable practices. MillY represents an innovative fabric manufacturer that possesses novel low-water indigo finishing technology but lacks established market channels for technology commercialisation. Tmall's co-creation campaign infrastructure provided the technological platform connecting brands, suppliers, and consumer panels.

Problem Setting: Defining Sustainability Parameters

The collaboration addressed dual challenges: BrandX required commercially viable, sustainable denim that maintained traditional indigo aesthetic qualities while substantially reducing water and chemical utilisation.

MillY sought strategic partnerships to scale its proprietary technology beyond laboratory implementation. Platform analytics have identified a growing consumer segment that prioritises verifiable sustainability credentials in their fashion purchasing decisions.

Collaborative Process and Mode

The partnership established a hybrid model combining Technical Patent Cooperation and R&D Outsourcing. BrandX convened a specialised consumer panel—comprising eco-influencers and sustainability-focused lead users—through Tmall and Xiaohongshu integration to establish acceptability thresholds for colourfastness, hand feel, and price sensitivity. MillY contributed process intellectual property and co-developed finishing recipes with BrandX's design team through joint laboratory sessions.

Problem Solving and Technical Development

Collaborative R&D incorporated iterative pilot batches, laboratory performance testing, and consumer blind wear trials. Intellectual property arrangements were negotiated proactively, resulting in joint patent filings for process modifications and structured revenue-sharing agreements for future technology licensing. This formal governance framework enabled open knowledge exchange while protecting the interests of participants.

Review and Validation Mechanisms

Tmall's ecosystem enabled phased product validation through exclusive early access for panel members, followed by livestreamed production documentation sessions that transparently communicated manufacturing provenance and laboratory performance metrics. User-generated content, structured wear-test feedback, and detailed return analysis created continuous feedback loops that informed ongoing process optimisation and product refinement.

Documented Outcomes and Performance Impact

The sustainable denim line achieved substantial market and environmental impact. Products commanded premium pricing (15-20% above conventional alternatives) while reducing water consumption per garment by 60% compared to BrandX's previous denim lines. The collaboration generated secondary licensing interest from two regional brands, demonstrating the commercial viability of the underlying technology. Consumer response metrics indicated particularly strong conversion performance among environmentally conscious demographic segments, validating the platform-mediated sustainability positioning.

5. MU Collaborative innovation

5.1. MU Collaborative Roles

The analysis of the two cases reveals that at the core of manufacturer-user (MU) collaborative innovation within e-commerce ecosystems lies a dynamic and often fluid interplay of three distinct roles: the Problem Setter, the Problem Solver, and the Reviewer. The assignment of these roles is not fixed; instead, actors shift between them depending on the context and stage of the innovation process, a pattern clearly evidenced in our field data.

The Problem Setter is the entity that identifies and articulates the initial need or challenge, thereby framing the innovation agenda. Contrary to traditional innovation models, our findings underscore that users frequently initiate this process. In Case A, the fast-fashion retailer BuyFast identified operational pain points, including high return rates and the inability to keep pace with rapidly changing trends. Concurrently, micro-influencer communities on Xiaohongshu detected and amplified emerging consumer interest in modular apparel. As one platform product manager from Tmall noted, "The most valuable innovation signals often come directly from the users' side. Our analytics can quantify a trend, but it's the users who first give it a name and a concrete form." This convergence of user-articulated problems ensured the subsequent collaboration was precisely targeted at genuine market gaps.

Following the problem definition, the Problem Solver role emerges, entailing the development of technical solutions. While manufacturers like Shandong Knit Co. (Case A) and the fabric mill MillY (Case B) brought essential R&D infrastructure and production expertise to this role, users were far from passive. In Case A,

micro-influencers actively co-designed modular components, providing specific inputs on connectors and fastenings. A lead designer from a micro-brand involved in similar initiatives explained, "We're not just giving a brief. We are in the digital room with the manufacturers, manipulating 3D models together. Our practical sense of what works on a body directly changes the technical parameters." This iterative, co-design approach, supported by digital toolkits, ensured that solutions were both technically sound and user-validated.

Finally, the Reviewer role is critical for evaluating and validating solutions through real-world application and testing. Users are the primary actors in this role, and their feedback, mediated by platform mechanisms, creates rapid iteration loops. In Case A, real-time metrics from livestreamed pre-sales and detailed return analysis served as continuous review inputs. A merchandising specialist from BuyFast stated, "The livestream comments and post-purchase reviews became our real-time focus group. We weren't waiting for a quarterly report; we were adjusting product descriptions and even production plans within days based on what we saw." In Case B, the structured wear-test feedback from the consumer panel was indispensable for finalising the denim's technical specifications. This reviewing function, scaled and systematised by the platform, de-risks the innovation and bridges the gap between prototype and market success.

In summary, these three roles—Problem Setter, Problem Solver, and Reviewer—form a cooperative nexus in MU innovation. The empirical data demonstrates that their fluid adoption by different actors, facilitated by the e-commerce ecosystem, underpins the shared responsibility and continuous interaction that characterise effective value co-creation.

5.2. MU Collaborative Modes

Our empirical investigation into the two cases reveals that the engagement between manufacturers and users manifests through a spectrum of collaborative modes, each characterised by distinct levels of resource integration intensity and collaboration depth. These modes represent strategic choices for partners, contingent upon their objectives, capabilities, and the nature of the innovation challenge they face. The data from the fashion e-commerce ecosystems allow us to delineate and illustrate five primary modes: R&D Outsourcing, Technical Patent Cooperation, Resource Transfer (platform-based sharing), Strategic Alliance, and Integration (vertical M&A/holding).

The R&D Outsourcing Mode is characterised by relatively low resource integration and collaboration depth. In this mode, users contract specialised manufacturers to execute specific development tasks. This approach was observed in a supporting role within our cases, where brands leveraged external technical expertise to complement their own capabilities. As one product manager from an online-native brand noted, "For specific technical challenges, like perfecting a new fabric finish, it's more efficient to partner with a specialist mill that has the R&D staff and equipment. It allows us to stay agile and focus on our core design and marketing competencies." This mode enables users to tap into specialised knowledge and infrastructure without deep, ongoing coordination, thus optimising resource allocation for discrete tasks.

Conversely, the Technical Patent Cooperation Mode exhibits high collaboration depth with relatively lower resource integration, focusing on the joint creation and ownership of intellectual property. Case B serves as a prime exemplar, where BrandX and the fabric mill MillY engaged in deep R&D collaboration. This partnership resulted in joint patent filings for process modifications derived from their co-development efforts. A senior R&D lead from MillY explained, "This wasn't a simple buyer-supplier transaction. We were in the lab together with BrandX's team, iterating on the low-water indigo recipe. The joint patent was a natural outcome of this deeply integrated technical problem-solving." This mode underscores a commitment to shared technical advancement and the strategic management of co-created IP, without necessitating full resource merger.

The Resource Transfer Mode, frequently platform-mediated, involves high resource integration but often with less intensive, project-specific joint R&D. This mode leverages the ecosystem's ability to pool and channel distributed assets. In Case A, this was evident as Tmall's analytics and sales volume guarantees from BuyFast were transferred to underwrite Shandong Knit Co.'s initial production runs. At the same time, Xiaohongshu micro-influencers contributed user-generated content and styling knowledge. A platform manager from Tmall

described this as "orchestrating idle resources across the network—be it data, capital, or creative input—and directing them towards a common innovation goal." This mode maximises collective intelligence by broadly integrating complementary resources from multiple entities within the platform ecosystem.

Moving towards greater integration and sustained cooperation, the Strategic Alliance Mode involves forming structured partnerships, such as joint innovation initiatives. While the cases demonstrated elements of this, interviews with platform managers highlighted its growing prevalence. For instance, an informant from the Tmall Innovation Centre detailed collaborations where "a brand and a manufacturer establish a dedicated 'co-creation lab' on our platform, with shared KPIs and roadmaps for seasonal collections." Such alliances are driven by shared long-term goals and complementary resources, aiming for mutual strategic benefits that are unattainable individually. They provide a formal framework for continuous learning and co-development beyond a single project.

The Integration Mode represents the highest level of integration and collaboration depth, typically achieved through vertical mergers or acquisitions. Although not fully observed in our two short-term cases, the interview data suggest it as a strategic direction for firms seeking to internalise innovation capabilities fully. A logistics provider working with major brands observed, "We see leading players considering acquisitions of key component suppliers or even tech startups to lock in core innovations and secure their supply chain." This mode, whether forward or backward integration, aims to bring critical stages of the value chain under unified control, thereby minimising coordination friction and accelerating innovation cycles. However, it requires significant capital and managerial commitment.

In practice, as evidenced by our cross-case analysis, collaborations are often hybridised, blending multiple modes. Case A combined Resource Transfer with a Strategic Alliance-like co-design program. Case B blended Technical Patent Cooperation with R&D Outsourcing elements. This strategic flexibility allows firms to tailor their collaborative approach to the specific risks, IP considerations, and opportunities at hand, a nuance that is central to understanding MU collaboration in dynamic e-commerce ecosystems.

5.3 MU Collaborative Process

The MU collaborative innovation process is not a linear sequence of steps but rather a dynamic and often iterative journey, with manufacturers and users engaging in distinct roles and adopting different modes at various stages. The framework identifies three primary process types, reflecting varying degrees of user and manufacturer leadership throughout the innovation lifecycle, illustrating the spectrum of collaborative engagement.

A clear sequence characterises the first process type: the user acts as the problem setter, the manufacturer as the problem solver, and the user again as the reviewer. This process effectively transfers the responsibilities of problem identification and solution validation to the user, allowing the manufacturer to concentrate its expertise on technical execution. A classic example of this is found in Case A. The problem was jointly identified by the fast-fashion retailer BuyFast, which highlighted the challenges of high return rates and trend churn, and the Xiaohongshu micro-influencer communities, which revealed the specific demand for modularity. As a product development manager from BuyFast stated, "Our role was to translate the operational pain points and the community's styling ideas into a clear technical brief for Shandong Knit Co. They were the experts in making it happen." Shandong Knit Co. then took on the role of problem solver, deploying its 3D knitting expertise to develop solutions. Finally, the users—both micro-influencers and the broader consumer base, as indicated by platform metrics—served as reviewers, validating the prototypes and the final product through livestream feedback and post-purchase data, leading to continuous refinement.

The second process type involves intensive joint problem-solving, where both manufacturer and user collaborate deeply throughout the R&D phase. This model features continuous, iterative interaction that goes far beyond initial briefings or final testing. Case B serves as a clear illustration. While BrandX and its consumer panel set the initial problem of creating commercially viable, sustainable denim, the subsequent development was a deeply collaborative effort. The fabric mill MillY was not a passive executor but an active co-creator. A

technical lead from MillY described the process: "It wasn't a hand-off. We worked side by side with BrandX's team in joint lab sessions, adjusting the finishing recipe based on real-time feedback from their consumer wear tests. Our proposals were evaluated, and the design was adjusted in a loop." This process leveraged BrandX's market knowledge and MillY's technical prowess in a tightly integrated feedback loop, embodying a partnership where problems were actively solved together.

The third process type is defined by comprehensive leadership, where one entity—either the user or the manufacturer—takes charge of problem setting, problem solving, and reviewing across all stages. In user-led innovation, a powerful user drives the entire process to fulfil their strategic needs. While our cases demonstrated strong user leadership, interviews revealed even more pronounced examples. For instance, a merchandising specialist from a large retail group explained their approach: "For our private label, we don't just set the brief. We have an in-house tech team that works on material specifications and pattern engineering from day one. We set the problem based on our sales data, co-develop the solution with the factory's engineers, and conduct a final quality review against our own standards. The factory provides essential production capacity and technical support." This showcases how a dominant user can orchestrate the entire value chain. Conversely, in manufacturer-led innovation, the manufacturer assumes the primary visionary and driving role. This was observed in initiatives where manufacturers, armed with proprietary technology, proactively developed new product platforms and then engaged lead users for feedback and market integration, effectively leading the innovation trajectory while integrating user input for refinement.

In conclusion, the existence and application of these process types are not rigid but are strategically contingent. The choice depends on factors such as the specific capabilities of the firms involved, the nature of the innovation (incremental vs. radical), and the strategic intent of the collaboration, highlighting the inherently dynamic and adaptable nature of MU collaborative innovation within e-commerce ecosystems.

5.4 MU Collaborative Mechanisms

To ensure the effective functioning and sustainability of MU collaborative innovation, a set of underlying mechanisms facilitates interaction, manages knowledge, structures organisations, and leverages digital technologies. These mechanisms are crucial for maintaining systemic health and driving innovation forward by creating a supportive environment for co-creation.

The Strategic Collaboration Mechanism addresses the foundational alignment between manufacturers and users, focusing on the complementarity of their strategic identities and capabilities. Manufacturers typically aim to serve broad market needs with scalable products, whereas lead users often innovate to meet specific, advanced, or heterogeneous requirements that existing products cannot satisfy. Strategic collaboration helps bridge this gap, ensuring that innovation efforts address both general market demands and the specific needs of niche users. A user's foresight in identifying emerging technological trends or market opportunities can guide a manufacturer's R&D strategy, providing a strategic advantage by directing efforts toward high-potential areas. Conversely, a manufacturer's technical prowess and production capacity can enable users to achieve their advanced operational goals. The ability of users to initiate innovative procurement can create initial market scale, reduce market risk for manufacturers by demonstrating demand, and validate new products, offering powerful strategic incentives for collaboration. This mutual reinforcement, stemming from complementary identities and capabilities, is a primary driver for MU collaborative innovation. In Case B, BrandX's strategic need for verifiable sustainability aligned perfectly with MillY's goal of commercialising its proprietary low-water technology. A business development manager from MillY noted, "BrandX didn't just want to buy fabric; they wanted a technology partner to build a sustainable product line with. Their market pull gave our R&D a clear, commercially viable direction it previously lacked." Conversely, in Case A, Shandong Knit Co.'s strategic objective to move up the value chain was realised through BuyFast's commitment to a co-creation pilot, which de-risked the manufacturer's investment in flexible production. This strategic symbiosis ensures innovation efforts are simultaneously ambitious and grounded in market reality.

Central to any collaborative endeavour is the effective management of information and expertise, which the Knowledge Collaboration Mechanism encapsulates. This mechanism focuses on the mutual transformation and

enhancement of both tacit and explicit knowledge between manufacturers and users. Users are invaluable sources of insight, particularly regarding unmet needs and practical application contexts. Their knowledge, often tacit and embedded in daily operations, is crucial for identifying genuine problems that may not be apparent to manufacturers. Manufacturers must develop strategies to capture this user knowledge, which can be challenging due to its implicit nature and the difficulty users may have in articulating abstract needs. Early engagement, continuous feedback loops, and co-design activities are crucial for capturing and converting insights into actionable information.

Furthermore, the mechanism addresses intellectual property (IP) disclosure and sharing. Users may choose to share IP—either for direct compensation or for indirect benefits, such as enhanced reputation, access to advanced solutions, or influence over industry standards. Manufacturers, in turn, leverage this shared knowledge to inform and refine their solutions. The use of a modular product architecture, for instance, can allow users to experiment and innovate with different configurations, with the manufacturer then capturing these innovations and integrating them into future product designs, creating a continuous knowledge feedback loop. Our findings underscore the crucial importance of early and ongoing engagement. In Case A, micro-influencers on Xiaohongshu provided "fit documentation" through videos, translating subjective comfort into actionable technical insights for Shandong Knit Co. A designer from a micro-brand emphasised the depth of this exchange: "The factory engineers initially didn't understand why a certain seam was uncomfortable until we showed them, in motion, how it restricted movement. That video was worth a thousand words in a spec sheet."

Regarding IP, Case B demonstrated a proactive approach. The joint patent filings and structured revenue-sharing agreements created a formal framework that incentivised open knowledge exchange. A technology provider observed, "Without clear IP rules upfront, that kind of deep laboratory collaboration between MillY and BrandX would never have happened. Trust is key, but a contract enables that trust."

Beyond individual interactions and knowledge flows, the Organisational Collaboration Mechanism structures the relationships between manufacturers and users. This involves designing new management approaches and organisational structures to manage what are often mixed inter-organisational relationships. One aspect is external collaboration, where manufacturers and users establish formal structures such as joint R&D teams, strategic alliances, or shared laboratories. These structures facilitate knowledge activation and continuous learning, offering a robust platform for sharing resources and technical complementarity. Joint laboratories between major industrial players and key clients for technology research, or open innovation centres where users and manufacturers co-develop solutions, exemplify how external organisational structures facilitate sustained co-development. Another aspect is internal collaboration, which involves integrating external entities into one's organisational structure through vertical integration or by adopting ambidextrous organisational designs. For instance, a manufacturer might acquire a key user (forward integration) or a critical component supplier (backward integration) to internalise the innovation process, gaining direct control over all stages. An entity acquiring a specialised component manufacturer enables seamless innovation in integrated systems. Similarly, some organisations create "maker spaces" or dual-structure units that can both leverage existing capabilities and explore new ones, effectively accommodating the diverse needs of collaborative innovation. A logistics provider working with major brands noted, "We're seeing leading apparel companies acquiring smaller, agile factories or tech startups. It's the ultimate way to internalise the innovation process and cut through coordination delays."

The Digital Collaboration Mechanism leverages advanced digital technologies to enhance and support MU collaborative innovation. This mechanism acknowledges the transformative power of tools like artificial intelligence (AI), big data analytics, digital platforms, and innovation toolkits. Digital technologies significantly enhance manufacturers' ability to identify and understand user needs, ideas, and lead users. AI algorithms can analyse vast datasets to pinpoint unmet demands or predict market trends, thereby streamlining the problem-setting phase and making it more data-driven. Digital toolkits and advanced software (e.g., computer-aided design, 3D printing, simulation platforms) empower users to participate more actively in the innovation process, allowing them to rapidly prototype ideas, test concepts, and provide precise feedback, effectively shifting towards more user-led innovation. These tools lower barriers to entry for user engagement and accelerate the iteration cycle.

Furthermore, digital platforms facilitate seamless communication, collaboration, and knowledge exchange between manufacturers and users. An innovative product platform, for instance, can provide a digital ecosystem that enables users to interact with manufacturers, share feedback, and even co-create product features, thereby significantly enhancing responsiveness and continuous innovation by creating a virtual space for ongoing collaboration. By integrating these digital enablers, MU collaboration becomes more efficient, scalable, and responsive to evolving demands. A product manager from Tmall Innovation Centre highlighted the mechanism's efficiency: "Our analytics can identify a nascent trend from search and social data. We then use digital prototyping tools to quickly visualise concepts with brands and manufacturers, compressing months of market research into weeks."

Furthermore, livestreaming sessions served as a digital review platform, generating real-time, rich feedback that replaced slower, traditional focus groups. A livestreamer involved in a co-design session commented, "The comments fly in real-time—I'd buy that if the collar were different" or "That colour is perfect." It's an immediate, massive focus group that directly influences the final product."

The theoretical framework for Manufacturer-User collaborative innovation offers a comprehensive lens through which to understand the intricate dynamics of modern innovation. By systematically analysing the roles, modes, processes, and mechanisms, it highlights how manufacturers and users can synergistically create value. This framework underscores the fundamental shift towards a more distributed and collaborative innovation paradigm, emphasising that successful technological advancement often stems from integrated efforts that leverage complementary strengths and foster continuous interaction. The insights derived from this framework provide valuable guidance for both academics and practitioners seeking to optimise collaborative innovation strategies in an increasingly interconnected and technologically driven world, moving beyond traditional, linear models to embrace a more dynamic and inclusive approach to creating new products, services, and solutions.

6. Cross-Case Insights and Mechanism Mapping

The comparative analysis of the two in-depth cases, complemented by interview data from diverse ecosystem stakeholders, reveals a coherent set of insights into how e-commerce ecosystems reconfigure manufacturer-user (MU) collaborative innovation networks. These insights are synthesised and mapped onto the integrated theoretical framework presented in Figure 1, which positions complementary collaboration as the core dynamic, supported by strategic guidance and three foundational mechanisms: knowledge, organisational, and digital collaboration.

6.1 Key Patterns from Cross-Cases Analysis

Lead User Heterogeneity and Role Fluidity. Our findings confirm that "lead users" in e-commerce ecosystems are not a monolithic group. In the fashion industry, they encompass distinct types—each contributing unique knowledge: 1) Large buyers and retailers (e.g., BuyFast), who bring operational scale, stringent quality standards, and volume-driven procurement power; 2) Micro-influencer communities (e.g., on Xiaohongshu), who provide tacit, trend-forward styling insights and real-world usage scenarios; and 3) Platform-recruited consumer panels, who offer structured feedback on specific attributes like sustainability or functionality. This heterogeneity necessitates that manufacturers and platforms tailor their engagement strategies. Moreover, the assignment of collaborative roles—Problem Setter, Problem Solver, Reviewer—is fluid rather than fixed. As evidenced in both cases, users frequently initiated the innovation (Problem Setter), co-designed solutions (co-Problem Solver), and validated outcomes through platform-mediated feedback (Reviewer). A Tmall product manager captured this fluidity: "The line between who defines the problem and who solves it is blurring. Users come with the insight, but they also stay in the digital room to tweak the 3D model with the factory."

Platform Orchestration as a Critical Enabler. E-commerce platforms do not merely connect parties; they actively architect collaboration. Their roles extend to: matchmaking (linking Shandong Knit Co. with BuyFast and micro-influencers), providing infrastructure (digital toolkits, analytics APIs, livestreaming studios), and setting governance (campaign rules, escrowed IP arrangements, reputation systems). This orchestration reduces transaction costs and enables collaboration at scale. In Case B, Tmall's co-creation campaign framework

provided the necessary structure for BrandX, MillY, and consumer panels to interact iteratively, while its analytics converted user sentiment into actionable research and development (R&D) parameters.

Hybridisation of Collaborative Modes. Real-world MU collaborations rarely adhere to a single pure mode. Instead, firms strategically blend modes to balance risk, control, and resource commitments. Case A combined Resource Transfer (platform analytics and sales guarantees underpinning production) with elements of a Strategic Alliance (a structured co-design program). Case B blended Technical Patent Cooperation (joint IP development) with R&D Outsourcing (specific tasks contracted to the fabric mill). This hybridisation allows partners to maintain flexibility while deepening engagement where it matters most—be it IP creation, risk-sharing, or resource pooling.

Digital Mechanisms Reduce Information and Iteration Friction. The cases highlight how digital tools operationalise theoretical mechanisms. Datafication and AI analytics (e.g., Tmall's trend detection) transform latent user preferences into explicit, quantifiable inputs, directly informing the Problem Setting phase. Digital prototyping and 3D simulation tools (used by Shandong Knit Co.) enabled micro-influencers to co-solve design problems in near real-time, bridging tacit user knowledge with manufacturable specifications—a core function of the Knowledge Collaboration Mechanism. Livestreaming served as a powerful Digital Collaboration tool, creating an instantaneous, scalable review loop that replaced slower, traditional market testing. As one livestreamer noted, "The comments flow in real-time... It's like a massive, interactive focus group that directly shapes the product before it's even finalised."

Governance and Trust as Persistent Constraints. Despite digital efficiencies, collaboration remains underpinned by relational and contractual safeguards. Both cases underscored the necessity of preemptive IP agreements (e.g., joint patent filings and revenue-sharing in Case B) and risk-mitigating guarantees (e.g., BuyFast's volume commitment in Case A) to align incentives and encourage knowledge disclosure. The absence of such formal and informal governance structures was frequently cited in interviews as a barrier to deeper collaboration, highlighting that digital tools alone cannot fully substitute for trust and clear rules.

6.2 Mapping Insights onto the MU Collaborative Innovation Framework

The patterns above align with and empirically ground the components of the framework visualised in Figure 1:

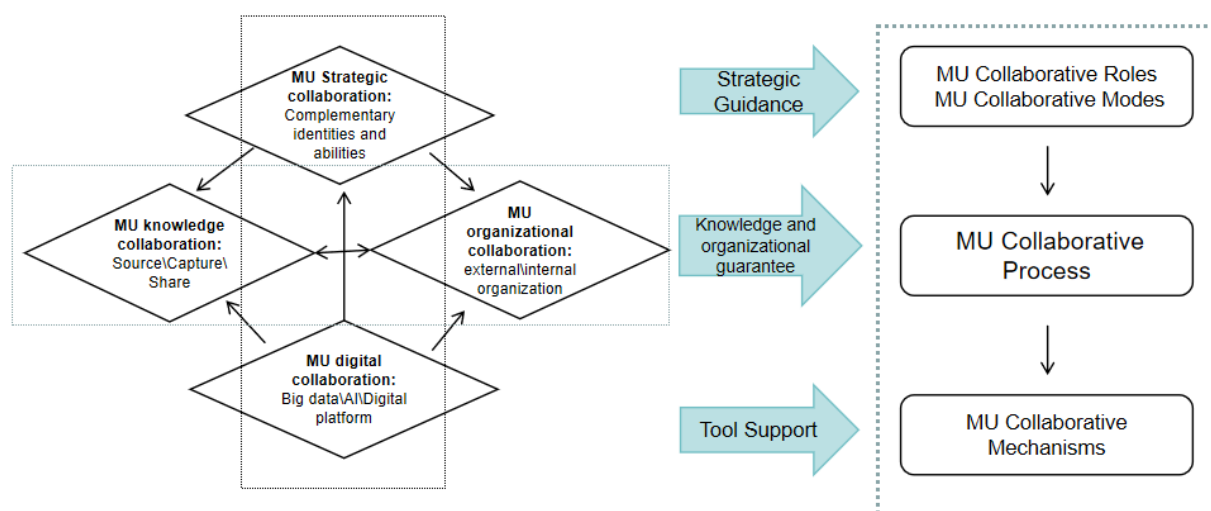


Figure 1. Core Components of Manufacturer-User (MU) Complementary Collaboration

Source: the authors

Strategic Guidance & Complementary Identities: The core driver of collaboration in both cases was the strategic complementarity between manufacturers' technical/production capabilities and users' market/contextual knowledge. For example, Shandong Knit Co.'s ambition to move up the value chain complemented BuyFast's need for agile, personalised supply—forming the strategic rationale for their alliance.

MU Collaborative Roles and Modes: The observed role fluidity and mode hybridisation are operational manifestations of this strategic complementarity. The framework's separation of Roles, Modes, and Processes helps dissect how a single collaboration (e.g., Case A) can involve users shifting between being setters, solvers, and reviewers. At the same time, the partnership itself blends multiple formal modes.

Knowledge, Organisational, and Digital Collaboration Mechanisms: The three support pillars of the framework were actively at work: Knowledge Collaboration was evident in the translation of micro-influencers' "fit documentation" into technical parameters (Case A) and the joint laboratory sessions between BrandX and Milly (Case B). Organisational Collaboration manifested in the creation of temporary but structured co-creation units (e.g., the joint "lab" sessions in Case B, the platform-facilitated project team in Case A). It was discussed as a strategic goal in interviews, indicating a potential for vertical integration. Digital Collaboration was the pervasive enabler, with platform analytics, digital toolkits, and livestreaming serving as the technical infrastructure that made the other two mechanisms scalable and efficient.

6.3 Synthesis: The Platform-Mediated Reconfiguration

Collectively, these insights demonstrate that e-commerce ecosystems reconfigure MU innovation networks by institutionalising the mechanisms that enable complementary collaboration. Platforms compress the innovation cycle not just by speeding up information flows, but by providing an integrated architecture where strategic alignment is facilitated, knowledge exchange is structured, organisational boundaries are softened, and digital tools are embedded. This reconfiguration shifts innovation from a linear, manufacturer-centric process to a dynamic, multi-actor network where users are empowered participants and value is co-created iteratively. However, this study also confirms that this new architecture introduces its own governance complexities, particularly around IP and trust, which require deliberate managerial and platform-level design to ensure sustainable collaboration.

7. Findings

The findings of this study illuminate the nuanced dynamics of manufacturer-user (MU) collaborative innovation within a digitally-mediated context. By grounding the investigation in China's fashion and apparel e-commerce ecosystems, this research makes distinct contributions to both the evolving literature on platform-driven innovation ecosystems and the empirical understanding of innovation processes in a fast-cycle, consumer-facing industry. Beyond these contextual contributions, the study advances theoretical integration by bridging previously siloed perspectives.

Contributions to the Understanding of E-commerce Ecosystems

This research refines the conceptualisation of e-commerce ecosystems from mere transactional or social platforms to active architects of innovation networks. Prior platform literature has emphasised matchmaking and transaction efficiency. Our findings extend this view by empirically demonstrating how platforms perform critical orchestration functions that structurally reconfigure MU collaboration: they codify tacit user knowledge into actionable data, formalise hybrid collaboration modes (e.g., blending resource transfer with strategic alliances), and institutionalise governance mechanisms (e.g., escrowed IP, staged disclosure) that mitigate the inherent risks of co-creation. The study thus positions platforms not as passive infrastructure but as proactive agents that set the rules, provide the tools, and curate the participants for innovation, thereby directly shaping the "how" of MU collaboration in the digital age.

Insights for the Fashion and Apparel Industry

The fashion industry, characterised by short product lifecycles, volatile trends, and rising demand for personalisation and sustainability, serves as an ideal crucible for observing MU collaboration. This study offers a granular, process-oriented perspective on how digital ecosystems enable the industry to address its core challenges. First, it documents the operationalisation of agility: platforms compress design-to-market cycles by integrating real-time user feedback (via livestreaming, UGC analytics) directly into flexible, on-demand production systems (e.g., 3D knitting). Second, it reveals how sustainability transitions can be accelerated through platform-mediated collaborations, as seen in Case B, where consumer panel data and co-development

with a fabric mill de-risked the commercialisation of a novel eco-technology. These insights move beyond general statements about "digital transformation" to show the specific, replicable mechanisms—such as modular co-design and data-driven validation loops—that allow fashion firms to achieve both commercial responsiveness and strategic innovation.

Theoretical Integration and Advancement

At the theoretical level, this study's primary contribution lies in developing and empirically validating an integrated framework that connects macro-level ecosystem structures with micro-level collaborative practices. We achieve this by synthesising three theoretical streams: service-dominant logic (resource integration and value co-creation), post-Schumpeterian/user innovation theory (the agency of lead users), and platform ecosystem theory (the governance and architectural roles of intermediaries).

Specifically, the study advances theory in four ways:

Role Fluidity and Platform-Induced Blurring: It empirically challenges static role typologies by demonstrating that in platform ecosystems, the functions of Problem Setter, Solver, and Reviewer are fluid and often shared. Users are not just sources of requirement but active co-solvers via digital toolkits.

Mode Hybridisation as a Strategic Response: It shows that classical, discrete collaboration modes (e.g., R&D outsourcing, alliances) are strategically blended in practice. This hybridisation is a direct response to the high uncertainty, IP sensitivity, and resource-distributed nature of platform-mediated innovation.

Mechanistic Bridging of Knowledge Asymmetry: It delineates the specific knowledge, organisational, and digital mechanisms that work in concert to bridge the classic manufacturer-user knowledge gap. The Digital Collaboration Mechanism, in particular, is shown not as a standalone force but as the enabler that scales and accelerates the other two.

Introducing Platform Governance as a Core Mediating Layer: The study highlights that the success of MU collaboration is contingent not only on bilateral firm strategies but also on the platform's governance layer—its rules, incentive designs, and trust-building tools. This positions platform governance as a critical new variable in models of inter-firm innovation.

In conclusion, this discussion underscores that the reconfiguration of MU innovation networks within e-commerce ecosystems is a multifaceted phenomenon. It is driven by the strategic complementarity of actors, enabled and shaped by the architectural and governance power of platforms, and operationalised through a set of intertwined mechanisms that are vividly exemplified in the dynamic context of the fashion industry. This integrated perspective offers a more complete toolkit for both researchers studying digital innovation and practitioners navigating collaborative strategies in platform-dominated markets.

8. Implications

The insights derived from this study extend beyond theoretical enrichment, offering actionable guidance for key stakeholders navigating the platform-mediated landscape of collaborative innovation. The implications are delineated for manufacturers, lead users (including retailers and brands), platform orchestrators, and policymakers.

Implications for Manufacturers

For manufacturers, particularly OEMs and component suppliers seeking to move beyond commoditised production, this study underscores the imperative to evolve from passive executors to active co-innovation partners. First, strategic prioritisation of digital absorptive capacity is crucial. Investing in and mastering digital toolkits—such as 3D simulation, virtual prototyping, and data analytics interfaces—is no longer optional. These tools serve as essential translators, converting tacit user feedback (e.g., influencer fit videos) into precise, manufacturable specifications, as demonstrated by Shandong Knit Co.'s use of virtual fit simulation. Second, operational flexibility must be engineered into production systems. Adopting small-batch, on-demand

capabilities (such as 3D knitting or modular assembly) enables manufacturers to participate in platform-led co-creation pilots without incurring prohibitive inventory risks. This flexibility was key to de-risking the collaboration in Case A. Third, a proactive approach to partnership governance is necessary. Manufacturers should initiate clear agreements on intellectual property (IP) ownership, revenue sharing, and data usage at the outset of collaboration. The joint patent and revenue-sharing model in Case B demonstrates how such formal frameworks can protect interests while fostering deep knowledge exchange, turning collaborative projects into sustained strategic advantages rather than one-off transactions.

Implications for Lead Users (Retailers, Brands, and Influential Communities)

Lead users, who possess market influence and contextual knowledge, can leverage platform ecosystems to drive innovation that directly addresses their strategic challenges. They should act as orchestrators of demand articulation and risk mitigation. This involves using platform analytics not just for trend spotting but to construct data-rich problem statements that clearly define innovation parameters for manufacturers, as BuyFast did by linking return-rate issues to modularity trends. Furthermore, lead users can de-risk manufacturer participation by offering tangible commitments, such as pre-sales volume guarantees or access to exclusive consumer panels. These signals of market intent lower the barrier for manufacturers to invest in flexible, collaborative production. Finally, engaging in iterative, micro-scale validation through platform features such as livestreamed co-design sessions or limited pilot releases allows lead users to test and refine concepts with real consumers before a full-scale launch, transforming market validation from a post-hoc checkpoint into an integrated part of the development process.

Implications for Platform Designers and Orchestrators

For e-commerce platforms aiming to transcend their transactional role and become innovation ecosystems, this research highlights critical design imperatives. Platforms must consciously design governance to foster trust. This involves developing and implementing robust mechanisms such as escrowed IP agreements, staged disclosure protocols, and transparent reputation systems. These tools mitigate the collaboration-inhibiting fears of appropriation and misappropriation identified in the cases. Secondly, platforms should curate and empower boundary-spanning intermediaries. The study highlights the emerging role of agencies and studios in translating user needs into technical briefs. Platforms can facilitate this by certifying service providers, creating standardised co-creation protocols, and offering matchmaking services that connect manufacturers with the correct type of lead user (e.g., micro-influencer vs. large retailer). Lastly, democratising access to innovation tools is key. Providing user-friendly digital toolkits, analytics dashboards, and collaboration features lowers the entry barrier for SMEs and diverse user groups, enabling a broader and more vibrant ecosystem of co-creation, which in turn enhances the platform's value and stickiness.

Implications for Policymakers

Policymakers interested in fostering innovation-led growth and digital economy competitiveness can derive several insights. There is a pressing need to modernise regulatory frameworks for the data-driven, collaborative economy. This includes clarifying IP rights over co-created innovations and user-generated data, establishing guidelines for fair data sharing between platforms and business users, and ensuring competition policies account for the gatekeeping power of platform orchestrators in innovation networks. Additionally, policymakers can promote the diffusion of collaborative innovation models by supporting the development of industry-wide standards and certification schemes, particularly in areas such as sustainability metrics. Verified standards reduce transaction costs and build trust, as seen in the market premium for the certified sustainable denim in Case B. Finally, public investment in workforce upskilling for digital manufacturing and co-design competencies can ensure that smaller manufacturers and designers have the necessary skills to participate effectively in platform-mediated innovation, preventing a digital divide within industrial ecosystems.

9. Limitations and Future Research Directions

While this study offers valuable insights, it is bounded by several limitations that pave the way for future inquiry. First, the findings are contextualised within China's fashion and apparel e-commerce ecosystem. The unique dynamism of this market and the specific structure of its platforms may limit direct generalizability to other

industries (e.g., durable goods) or institutional contexts (e.g., markets with different data governance regimes). Second, the research design prioritised mechanistic depth through qualitative case studies, which, while rich in detail, do not provide statistical representativeness or allow for broad causal claims. Third, access to proprietary platform algorithms and complete transactional datasets was constrained, meaning some underlying drivers of matchmaking and trend prediction could only be inferred from interviews and outcomes.

These limitations suggest several promising avenues for future research. Comparative studies across different national markets (e.g., comparing China with the EU or the US) or industrial sectors could elucidate how regulatory environments and industry structures shape MU collaboration models. Longitudinal research tracking firms that institutionalise platform-based co-innovation would be valuable to examine long-term capability development and competitive outcomes. To complement our qualitative findings, large-scale quantitative studies leveraging platform partner data could rigorously test the performance implications of different collaborative roles, modes, and governance mechanisms. Finally, research could delve deeper into specific thematic areas highlighted here, such as the optimal design of platform governance for IP sharing in open innovation, or the role of AI agents in further automating and personalising the co-creation process.

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