

Platform Participation and SME Sustainability: Frugal Digital Capability and Institutional Voids in Emerging Economies

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Abstract

Manufacturing small and medium-sized enterprises (SMEs) in emerging economies face a persistent structural tension: they are central to economic growth and employment, yet lack the capabilities required to meet increasing sustainability demands. Digital platform ecosystems have been proposed as an accessible pathway for enhancing SME performance, but existing research remains fragmented, offering limited insight into how platform participation translates into economic, social, and environmental outcomes under institutional constraints. This study develops and tests an integrated model linking platform venture participation to triple sustainability through a novel mediating construct, Frugal Digital Capability (FDC), and a moderating condition, Institutional Voids (IV). Platform participation is disaggregated into e-commerce, FinTech, and digital supply chain dimensions, while FDC is conceptualised as comprising frugal operational and frugal market capabilities. A sequential explanatory mixed-methods design is employed. Phase 1 uses Grounded Theory to inductively generate constructs and measurement items from interviews with manufacturing SME owners. Phase 2 applies Partial Least Squares Structural Equation Modelling (PLS-SEM) to survey data from 382 SMEs in Pakistan. Results show that platform participation significantly enhances frugal capabilities, which in turn drive economic and social sustainability, with more limited effects on environmental outcomes. Institutional voids weaken capability–sustainability relationships, although platform ecosystems partially compensate for these constraints. The study contributes by introducing Frugal Digital Capability as a validated construct, demonstrating differentiated capability pathways across platform types, and establishing institutional voids as an active boundary condition shaping sustainability outcomes in emerging economies.

1. Introduction

Manufacturing small and medium-sized enterprises (SMEs) occupy a structurally paradoxical position in emerging economies. They are simultaneously the primary generators of employment, industrial output, and economic resilience, and yet remain among the least equipped to respond to intensifying global demands for sustainability. Across developing economies, SMEs account for more than 90 per cent of firms and approximately 70 per cent of employment (World Bank, 2023). In Pakistan, manufacturing SMEs contribute around 40 per cent of GDP and represent a substantial share of industrial employment, yet experience persistently high failure rates and limited capacity to meet economic, social, and environmental performance expectations (Matloob et al., 2023; Karuppiyah et al., 2020; Rizvi et al., 2024). This tension reflects not a lack of intent, but a deficit of capability embedded within structurally constrained institutional environments.

These constraints are rooted in what Institutional Theory defines as institutional voids: the absence or weakness of regulatory frameworks, market-supporting institutions, and enforcement mechanisms necessary for efficient economic activity (North, 1990; Khanna & Palepu, 2010). In such contexts, firms face unreliable infrastructure, fragmented policy regimes, and limited access to capital and technological systems. These conditions not only restrict firm performance but fundamentally shape how capabilities

are developed and deployed. Simultaneously, global supply chains and sustainability frameworks impose increasingly stringent expectations related to environmental compliance, social responsibility, and economic resilience, intensifying the gap between external demands and internal capacity (Ferreira et al., 2023; Kumar et al., 2022).

Digital platform ecosystems have emerged as a potentially transformative mechanism through which this gap may be addressed. E-commerce platforms, financial technology systems, and digital supply chain networks provide SMEs with access to markets, financial services, and operational tools without requiring substantial capital investment (Deepa Raj & Shyam Kishore, 2026). Empirical evidence suggests that digital platforms enhance organisational agility, innovation, and performance in emerging market SMEs (Ahmed et al., 2022; Jiang et al., 2023). However, despite these advances, the relationship between platform participation and sustainability outcomes remains theoretically underdeveloped.

Three limitations in the existing literature are particularly salient. First, platform participation has largely been treated as a unidimensional construct, with studies examining e-commerce, FinTech, and supply chain platforms separately rather than as distinct yet interrelated dimensions (Wang & Zhang, 2025; Rashid et al., 2025). Second, the mechanism through which platform participation translates into sustainability outcomes remains insufficiently specified. While prior research demonstrates performance effects, it rarely explains how external platform resources are internalised as firm-level capabilities, despite the centrality of this process in Dynamic Capabilities Theory (Teece et al., 1997). Third, institutional context is typically modelled as a background condition rather than an active boundary factor, overlooking its role in shaping the effectiveness of capability deployment (Akbar et al., 2017; Succurro & Donati, 2025).

This study addresses these limitations by developing an integrated theoretical model that positions Frugal Digital Capability (FDC) as the central mediating mechanism linking platform participation to sustainability outcomes. Drawing on Frugal Innovation Theory, FDC is defined as the ability of resource-constrained SMEs to leverage low-cost platform tools and digital ecosystems to build capabilities that generate sustainable performance (Radjou & Prabhu, 2015; Ahuja & Chan, 2016). This perspective shifts the analytical focus from technology adoption to capability development under resource constraints.

FDC is conceptualised as comprising two dimensions. Frugal Operational Capability (FOC) reflects the reconfiguration of production processes, supply chains, and operational workflows through affordable digital tools, aligning with the reconfiguring dimension of Dynamic Capabilities Theory. Frugal Market Capability (FMC) reflects the ability to access new markets, generate customer intelligence, and diversify revenue streams through platform ecosystems, corresponding to the sensing dimension of capability development (Sengura et al., 2024). Together, these capabilities provide the mechanism through which platform participation is translated into economic, social, and environmental sustainability outcomes within the Triple Bottom Line framework (Elkington, 1997).

Crucially, the study conceptualises Institutional Voids (IV) as a second-stage moderating condition rather than a passive contextual factor. Institutional Theory suggests that weak institutional environments can

attenuate the returns from firm capabilities, while platform ecosystems may partially compensate by embedding trust, governance, and coordination mechanisms (Agarwal & Assenova, 2024; Malik et al., 2021). This perspective allows for a more nuanced understanding of how capability–outcome relationships vary under different institutional conditions.

Empirically, the study adopts a sequential explanatory mixed-methods design. Phase 1 employs Glaserian Grounded Theory to inductively generate constructs and measurement items from interviews with manufacturing SME owners (Glaser & Strauss, 1967). Phase 2 tests the resulting model using Partial Least Squares Structural Equation Modelling on survey data from 382 SMEs (Hair et al., 2019). This approach ensures both theoretical grounding and empirical validation, addressing a persistent limitation in SME research where constructs are often transferred without contextual adaptation.

The study makes four contributions. First, it introduces and validates Frugal Digital Capability as a novel mediating construct, extending Dynamic Capabilities and Frugal Innovation theories into the platform–sustainability domain. Second, it advances Platform Ecosystem Theory by demonstrating that different forms of platform participation generate distinct capability-building pathways (Scholten & Scholten, 2012). Third, it refines Institutional Theory by modelling institutional voids as an active moderator influencing sustainability outcomes. Fourth, it contributes methodologically by integrating Grounded Theory with PLS-SEM in a coherent sequential design applicable to emerging economy research.

These contributions offer important implications for policy and practice, particularly in relation to sustainable development goals concerning economic growth, industrial innovation, social inclusion, and responsible production. By identifying how platform ecosystems enable capability development under constraint, the study provides a more precise foundation for advancing SME sustainability in emerging economies.

2. Literature Review and Hypothesis Development

The theoretical architecture of this study sits at the convergence of five intellectual traditions that have, until now, developed largely in parallel. Platform Ecosystem Theory accounts for how digital platforms generate multi-stakeholder value through network effects and ecosystem embeddedness. Dynamic Capabilities Theory explains how firms convert external opportunities into internal organisational capabilities. Frugal Innovation Theory illuminates how resource-constrained firms in emerging economies develop effective solutions through creative resourcefulness rather than capital investment. Institutional Theory provides the grammar for understanding why the same capability may generate different performance returns depending on the quality of the formal environment surrounding it. The Triple Bottom Line framework structures the sustainability outcomes of interest across economic, social, and environmental dimensions. None of these traditions, applied alone, can account for the phenomenon under investigation: how manufacturing SMEs in institutionally constrained economies leverage digital platforms to build sustainability-generating capabilities. Applied together, they do.

2.1 Platform Venture Participation: The Case for Dimensional Disaggregation

The platform economy has attracted sustained theoretical and empirical attention since Parker et al. (2016) and Eisenmann et al. (2006) established the architectural logic of multi-sided markets. Platforms create value not by producing goods but by facilitating interactions connecting producers, consumers, and complementors within shared digital ecosystems whose value increases as participation deepens (Scholten & Scholten, 2012; Gandia & Parmentier, 2017). For SMEs in emerging economies, this architectural logic carries particular significance: platforms offer the prospect of accessing market reach, financial infrastructure, and operational tools that would otherwise require capital investment far beyond what smallest manufacturers can mobilise (Deepa Raj & Shyam Kishore, 2026; Yadav et al., 2025). Jiang et al. (2023), in a study of Chinese SMEs that has accumulated 111 citations, establish that digital platform capability significantly enhances innovation performance through resource orchestration and, critically, that ecological institutional norms moderate this relationship, an observation that directly anticipates this study's treatment of institutional voids as an active boundary condition rather than a background control.

The difficulty with much of the existing platform participation literature, however, is that it treats participation as a unidimensional phenomenon. Studies have examined e-commerce adoption, FinTech uptake, and supply chain platform participation as separate research programmes (Wang & Zhang, 2025; Rashid et al., 2025; Holopainen et al., 2026), without theorising how different platform types create distinct pathways to capability development. Svendsrud et al. (2023) demonstrate that innovation and transaction platforms generate fundamentally different network effects; Marzi et al. (2023), in a fsQCA study of B2B platform adoption, show that SME and large-firm adoption pathways differ in ways that composite platform measures cannot capture. For manufacturing SMEs whose operational, financial, and market challenges are structurally distinct the conflation of platform types obscures more than it reveals. This study disaggregates Platform Venture Participation (PVP) into three empirically and theoretically distinct dimensions.

E-Commerce Platform Participation (ECP) encompasses a manufacturing SME's active engagement with digital marketplaces platforms such as Daraz, Amazon, and Shopify through which firms access national and international buyers, develop customer intelligence, and build digital market presence at comparatively low cost (Yadav et al., 2025; Deepa Raj & Shyam Kishore, 2026). Wang & Zhang (2025) establish, in a mixed-methods study of cross-border SMEs, that e-commerce platform participation drives green innovation through supply chain integration confirming that ECP functions as both an operational and market capability builder. Khattak (2022) further demonstrates that e-commerce marketing capabilities moderate the digital platform to innovation performance relationship in emerging economy SMEs, while Ahmed et al. (2022), in the most-cited study in this domain, confirm that digital platform capability drives manufacturing SME organisational agility through intellectual capital development.

FinTech Platform Participation (FTPP) encompasses engagement with mobile banking, digital payment systems, and green finance applications. Siddik et al. (2023), drawing on Dynamic Capabilities Theory in a study of 300 Bangladeshi manufacturing SMEs, establish that FinTech adoption drives sustainability performance through circular economy practices confirming that FTPP builds operational capabilities through digitised financial management and cost reduction. In Pakistan's manufacturing context, Waqar et al. (2025) empirically confirm that FinTech adoption significantly drives sustainable performance through circular economy and green innovation channels, while Ming et al. (2025) demonstrate that FinTech reduces information asymmetry between manufacturing firms and financial markets, expanding access to sustainability-oriented buyer networks.

Digital Supply Chain Platform Participation (DSPP) encompasses engagement with B2B procurement platforms, ERP-integrated logistics networks, and collaborative supply chain management systems. Chari et al. (2023), applying Dynamic Capabilities Theory to manufacturing supply chain contexts in a study that has accumulated 30 citations, establish that digital platforms build supply chain resilience and environmental sustainability through the sensing, seizing, and reconfiguring of operational resources. Khan & Emon (2025) confirm in Bangladeshi manufacturing firms that digital supply chain practices drive performance through operational responsiveness and customer development, while Awuah-Gyawu et al. (2025) demonstrate that operational capabilities fully mediate the supply chain digitisation to manufacturing performance relationship.

Each of these platform dimensions activates distinct capability-building pathways through the sensing-seizing-reconfiguring logic of Dynamic Capabilities Theory (Teece et al., 1997; Durman et al., 2025). The hypotheses that follow from this analysis connect each PVP dimension to two FDC dimensions, generating six direct paths.

H1a: ECPP → FOC *E-Commerce Platform Participation is positively associated with Frugal Operational Capability in manufacturing SMEs in Pakistan.*

H1b: ECPP → FMC *E-Commerce Platform Participation is positively associated with Frugal Market Capability in manufacturing SMEs in Pakistan.*

H2a: FTPP → FOC *FinTech Platform Participation is positively associated with Frugal Operational Capability in manufacturing SMEs in Pakistan.*

H2b: FTPP → FMC *FinTech Platform Participation is positively associated with Frugal Market Capability in manufacturing SMEs in Pakistan.*

H3a: DSPP → FOC *Digital Supply Chain Platform Participation is positively associated with Frugal Operational Capability in manufacturing SMEs in Pakistan.*

H3b: DSPP → FMC *Digital Supply Chain Platform Participation is positively associated with Frugal Market Capability in manufacturing SMEs in Pakistan.*

2.2 Frugal Digital Capability: A Novel Mediating Construct

The question of what mediates between platform participation and sustainability outcomes is, at its root, a question about capability. Dynamic Capabilities Theory (Teece et al., 1997) is unambiguous on this point: external opportunities including the opportunities made available by digital platform ecosystems do not generate performance returns directly. They must be internalised as organisational capabilities through sensing, seizing, and reconfiguring before they can influence outcomes. Van Hoang & Hien (2024) confirm this empirically in Vietnamese manufacturing SMEs, demonstrating that digital capabilities do not directly generate performance but rather require a capability-building mechanism to translate into competitive advantage. This mediation logic underpins the full mediation model of this study: PVP → FDC → sustainability, rather than a direct PVP → sustainability pathway.

The specific character of that capability-building mechanism in emerging economy manufacturing is illuminated by Frugal Innovation Theory. Radjou & Prabhu (2015) define frugal innovation as the development of affordable, simple, and effective solutions by creatively leveraging available resources rather than investing in expensive technological systems. The theory was developed to describe product and process innovation by resource-constrained firms in emerging economies, but Ahuja & Chan (2016), in a seminal conceptual contribution, extend it to the domain of IT capability, arguing that frugal IT innovation affordability, simplicity, and sustainability as design principles characterises how firms in resource-constrained platform ecosystems build digital capabilities. Lan & Wang (2023) bridge frugal innovation and Dynamic Capabilities Theory directly, demonstrating that frugal innovation in digital transformation contexts follows a DCT mechanism: an iterative process of resolving resource scarcity at each stage of digital capability development. Sengura et al. (2024) formalise Frugal Innovation Capability as a firm-level construct in emerging markets, driven by entrepreneurial and market orientation, while Rossit & Bidanda (2026) operationalise frugal engineering for manufacturing digital transformation modular, affordable, high-impact operational digitisation in exactly the resource-constrained manufacturing contexts this study addresses.

Drawing these traditions together, this study introduces Frugal Digital Capability (FDC) as a novel mediating construct: the ability of resource-constrained manufacturing SMEs to resourcefully leverage low-cost platform features, tools, and digital ecosystems to build organisational capabilities that drive sustainable performance. FDC is operationalised through two theoretically distinct dimensions. Frugal Operational Capability (FOC) captures the reconfiguring dimension of Dynamic Capabilities Theory how platform participation enables SMEs to transform production operations, supply chain processes, and manufacturing workflows without proportionate capital investment. Rossit & Bidanda (2026) operationalise this as modular, affordable operational digitisation; the lean manufacturing literature confirms that what Ozbiltekin-Pala & Ozkan-Ozen (2025) term Lean 4.0 the integration of lean practices with digital platform tools amplifies economic and environmental sustainability by reducing operational waste and improving resource efficiency simultaneously.

Frugal Market Capability (FMC) captures the sensing dimension how platform participation enables SMEs to develop and sustain digital market access, customer intelligence, and sales channel diversification through resourceful exploitation of low-cost platform features. Sengura et al. (2024) establish that frugal innovation capability in emerging markets is driven by entrepreneurial and market orientation; Kobusingye et al. (2025) confirm that digital transformation-enabled market expansion capabilities drive organisational growth in East African manufacturing SMEs, establishing the construct's empirical relevance across diverse emerging economy manufacturing contexts.

2.3 Frugal Digital Capability and Triple Sustainability: Differential Pathways

The Triple Bottom Line framework (Elkington, 1997) structures the outcome space of this study. Rather than treating sustainability as a composite construct the dominant practice in the extant SME digitisation literature this study follows Jamwal et al. (2025) and Zall et al. (2025) in testing economic (ECS), social (SCS), and environmental (ENS) sustainability as separate dependent variables. The rationale is both methodological and theoretical: if FOC and FMC generate distinct capability-outcome pathways, collapsing the three sustainability dimensions into a single construct would obscure precisely the variation that the model is designed to reveal.

2.3.1 Frugal Operational Capability and Sustainability Outcomes

The case for FOC driving economic sustainability is well-evidenced in the manufacturing digitisation literature. Cuevas-Vargas et al. (2022), using PLS-SEM across 225 Mexican SMEs, establish that frugal innovation directly and significantly predicts sustainability performance with economic performance as its core dimension. Buhaya & Metwally (2024), in a SmartPLS 4 study of Egyptian manufacturing firms that mirrors this study's methodological approach, confirm that digital technologies drive economic sustainability through lean manufacturing as the operational mediating mechanism grounding the FOC → ECS pathway with cross-country emerging economy evidence. Abdelwahed et al. (2025), in a study of 296 Pakistani SMEs, further confirm that digital platforms significantly enhance firm sustainability in Pakistan's institutional environment.

H4a: FOC → ECS Frugal Operational Capability is positively associated with Economic Sustainability in manufacturing SMEs in Pakistan.

The case for FOC driving environmental sustainability rests on three mechanisms. Platform-enabled digital operational tools IoT sensors, big data analytics, process monitoring enable real-time environmental tracking and resource optimisation, reducing manufacturing energy consumption and waste generation (Khan et al., 2025, 109 citations). The integration of lean practices with digital platform tools amplifies environmental sustainability by reducing operational waste and improving resource efficiency simultaneously (Thekkootte, 2022, 37 citations; Ozbiltekin-Pala & Ozkan-Ozen, 2025). Circular

economy practices waste minimisation, resource reuse, closed-loop production become accessible without dedicated environmental management systems (Mehmood et al., 2025; Waqar et al., 2025). The FOC → ENS pathway is theoretically strong but likely to face contextual constraint in Pakistan's institutional environment, for reasons developed in Section 2.4.

H4b: FOC → ENS *Frugal Operational Capability is positively associated with Environmental Sustainability in manufacturing SMEs in Pakistan.*

The case for FOC driving social sustainability is more tentative, and this tentativeness is deliberate. Operational digitisation reduces hazardous manual labour, creates skilled digital employment, and improves compliance readiness for labour standards (Khan, 2025; Ali & Johl, 2023, 65 citations). Yet Ferreira et al. (2023), in a 131-citation review of Industry 4.0 implementation and sustainability in manufacturing firms, observe that while digitisation's links to environmental sustainability are well-established, social sustainability 'still needs to be explored' an observation that Gregori et al. (2017, 56 citations) ground mechanistically: digital manufacturing systems capture efficiency metrics but not social metrics, structurally decoupling operational digitisation from worker welfare. Kalkanci et al. (2019), in a 146-citation study in Production and Operations Management, argue that social sustainability in emerging economy manufacturing requires deliberate inclusive innovation rather than passive operational efficiency. This study hypothesises H4c while acknowledging it sits in theoretically contested terrain and the non-significance found in Phase 2, discussed in Section 5, is treated as a contribution rather than a failure.

H4c: FOC → SCS *Frugal Operational Capability is positively associated with Social Sustainability in manufacturing SMEs in Pakistan.*

2.3.2 Frugal Market Capability and Sustainability Outcomes

Frugal Market Capability drives economic sustainability through revenue growth and market diversification mechanisms that complement rather than replicate FOC's cost-reduction pathway. Wang & Zhang (2025), in a mixed-methods study of cross-border e-commerce SMEs, establish that platform-driven market capability translates into economic sustainability through supply chain innovation. Rashid et al. (2025) confirm in Pakistani manufacturing SMEs that FinTech-enabled market access improves sustainability performance through organisational innovation, while Liu et al. (2025), published in Technovation, demonstrate that digital platform adoption builds social capital and supply chain trust that drive sustainable performance in emerging market manufacturing SMEs. The FMC → ECS pathway differs theoretically from FOC → ECS: where FOC reduces costs and improves productivity, FMC expands revenue and market access dual pathways to economic sustainability that justify the two-mediator model.

H5a: FMC → ECS *Frugal Market Capability is positively associated with Economic Sustainability in manufacturing SMEs in Pakistan.*

Frugal Market Capability is theorised as the primary driver of social sustainability through three mechanisms that connect digital market participation to the conditions of workers and communities rather than production processes. Platform-driven revenue growth creates organisational capacity for additional employment, particularly from marginalised groups. Khan (2025), using World Bank enterprise survey data from nine Eastern European countries, confirms that SMEs deploying e-commerce and digital platforms demonstrate greater employment resilience, with female-dominated SMEs showing disproportionately positive employment effects. Liu et al. (2025) establish that platform participation builds social capital and supply chain trust that strengthen community economic development. Rizvi et al. (2024), published in *Discover Sustainability*, demonstrate that digital entrepreneurship in Pakistan enables women's economic inclusion grounding the FMC → SCS pathway in the specific gender and community dimensions of social sustainability that characterise the study context.

H5b: FMC → SCS *Frugal Market Capability is positively associated with Social Sustainability in manufacturing SMEs in Pakistan.*

The environmental sustainability pathway through FMC operates through market-pull mechanisms rather than the operational-push mechanisms of FOC. Digital market access connects manufacturing SMEs to sustainability-demanding buyer networks international retailers, ESG-compliant procurement ecosystems that impose environmental standards, green packaging requirements, and carbon disclosure as conditions of market participation (Dung & Binh, 2026; Salvatierra-Manchego & Libaque-Saenz, 2024). Wang & Zhang (2025) establish that e-commerce platform participation drives green innovation through supply chain integration. However, the effectiveness of this market-pull mechanism depends on the existence of environmental buyer standards and green procurement requirements conditions that obtain in international export markets but are largely absent in Pakistan's domestic manufacturing market. Mondal et al. (2023, 115 citations) establish that green entrepreneurship orientation is a necessary complement to digital market capability for environmental outcomes; without it, FMC generates economic and social gains but the environmental pathway requires institutional scaffolding that the regulatory environment must provide. H5c is hypothesised but held with appropriate theoretical caution.

H5c: FMC → ENS *Frugal Market Capability is positively associated with Environmental Sustainability in manufacturing SMEs in Pakistan.*

2.4 Institutional Voids as a Second-Stage Moderating Boundary Condition

The argument that institutional context shapes how organisations convert resources into performance is foundational to Institutional Theory (North, 1990; DiMaggio & Powell, 1983) and has been applied to emerging economy SMEs with increasing empirical precision over the past decade. Khanna & Palepu (2010) define institutional voids as the absence of credible regulatory frameworks, market information

systems, and contract enforcement mechanisms the infrastructure of formal institutions through which, in developed economies, market transactions are made reliable and investment returns become predictable. In their absence, the same capabilities that generate sustainable performance in well-institutionalised environments generate diminished or unreliable returns.

The scale of this effect is not trivial. Saha et al. (2023), drawing on World Bank Enterprise Survey data from 118,763 firms across 140 countries, establish that institutional voids directly constrain SME growth, investment commitment, and reputational development across all three TBL dimensions. Kovid et al. (2025), in a study of manufacturing sector SMEs in India, demonstrate that institutional voids negatively moderate the relationship between entrepreneurial capabilities and both financial and non-financial performance the empirical precedent most closely aligned with this study's moderation logic. Akbar et al. (2017), in a 22-citation study of emerging market exporting SMEs, confirm that institutional voids negatively moderate marketing capabilities' impact on export performance, establishing that the moderating mechanism operates across capability types.

In Pakistan's manufacturing context, institutional voids manifest across four dimensions that Phase 1 Grounded Theory interviews detailed in Section 3 revealed as independently experienced and consistently named. Regulatory gaps: fragmented technology standards, unstable digital policy frameworks, and inconsistent enforcement create investment risk that reduces the economic return from operationally digitised processes. Market failures: information asymmetries between manufacturing SMEs and buyers reduce the reliability of digital market access gains. Weak contract enforcement: unreliable digital transaction governance makes platform-based procurement agreements and sales contracts operationally risky. Infrastructure deficits: chronic power outages and limited broadband access in industrial zones disrupt the continuous platform engagement through which frugal digital capabilities are built and maintained (Yan & Ahmad, 2025; Mubeen et al., 2025). These voids are modelled as a second-stage moderator constraining not the building of frugal capabilities, but the translation of those capabilities into durable sustainability outcomes.

H6a: $IV \times FOC \rightarrow ECS, SCS, ENS$ *Institutional Voids negatively moderate the Frugal Operational Capability to sustainability relationship, such that the positive effects of FOC on economic, social, and environmental sustainability are weaker under conditions of higher institutional voids.*

H6b: $IV \times FMC \rightarrow ECS, SCS, ENS$ *Institutional Voids negatively moderate the Frugal Market Capability to sustainability relationship, such that the positive effects of FMC on economic, social, and environmental sustainability are weaker under conditions of higher institutional voids.*

There is, however, a theoretical complication to H6b that the literature on digital platforms and institutional voids has recently begun to surface. Agarwal & Assenova (2024), in a study published in Organization Science, establish that digital multi-sided platforms fill institutional voids rather than being constrained by them through data-based certification that substitutes for formal credentialing, network effects that create self-sustaining trust, and unified access mechanisms that bypass fragmented formal financial infrastructure. Malik et al. (2021), in a 31-citation study of digital labour platforms specifically in

Pakistan, demonstrate that these platforms leverage solidarity networks and informal trust mechanisms to create alternative institutional structures. If FMC is built through participation in platform ecosystems that themselves substitute for formal institutional infrastructure, then institutional voids may constrain FOC which depends on formal regulatory quality for its sustainability returns while leaving FMC comparatively insulated. H6b is hypothesised in the negative direction, but the theoretical machinery for a non-significant result is present in the literature and is considered in the discussion of findings.

2.5 Conceptual Model and Summary of Hypotheses

Figure 1 presents the conceptual model. The model proposes a sequential path from three PVP dimensions ECPP, FTTP, and DSPP through two FDC dimensions FOC and FMC to three triple sustainability outcomes ECS, SCS, and ENS moderated by Institutional Voids as a composite second-stage boundary condition. Fourteen formal hypotheses are generated: six direct PVP to FDC paths (H1a through H3b), six FDC to sustainability outcome paths (H4a through H5c), and two moderation paths (H6a and H6b). Indirect effects of PVP dimensions through FDC dimensions on sustainability outcomes are not formally hypothesised but are reported as supplementary output via SmartPLS 4.0 bootstrapping, consistent with the full mediation logic of Dynamic Capabilities Theory platform participation must be converted into frugal digital capability before it can generate sustainability returns. Control variables (firm size, firm age, owner education, prior digital experience) are included in the structural model but are not shown in Figure 1.

Table 1. Summary of Hypotheses

H	Path	Statement	Theoretical Basis
H1a	ECPP → FOC	ECPP is positively associated with Frugal Operational Capability	Platform Ecosystem Theory + DCT
H1b	ECPP → FMC	ECPP is positively associated with Frugal Market Capability	Platform Ecosystem Theory + DCT
H2a	FTPP → FOC	FTPP is positively associated with Frugal Operational Capability	Platform Ecosystem Theory + DCT
H2b	FTPP → FMC	FTPP is positively associated with Frugal Market Capability	Platform Ecosystem Theory + DCT
H3a	DSPP → FOC	DSPP is positively associated with Frugal Operational Capability	Platform Ecosystem Theory + DCT
H3b	DSPP → FMC	DSPP is positively associated with Frugal Market Capability	Platform Ecosystem Theory + DCT
H4a	FOC → ECS	FOC is positively associated with Economic Sustainability	DCT + Frugal Innovation Theory + TBL
H4b	FOC → ENS	FOC is positively associated with Environmental Sustainability	DCT + Frugal Innovation Theory + TBL
H4c	FOC → SCS	FOC is positively associated with Social Sustainability	DCT + Frugal Innovation Theory + TBL
H5a	FMC → ECS	FMC is positively associated with Economic Sustainability	Platform Ecosystem Theory + TBL
H5b	FMC → SCS	FMC is positively associated with Social Sustainability	Digital Inclusion Theory + TBL
H5c	FMC → ENS	FMC is positively associated with Environmental Sustainability	Platform Ecosystem Theory + TBL
H6a	IV × FOC → TBL	IV negatively moderates FOC → ECS, ENS, SCS	Institutional Theory
H6b	IV × FMC → TBL	IV negatively moderates FMC → ECS, SCS, ENS	Institutional Theory

Note. DCT = Dynamic Capabilities Theory; TBL = Triple Bottom Line; IV = Institutional Voids; FOC = Frugal Operational Capability; FMC = Frugal Market Capability; ECS = Economic Sustainability; SCS = Social Sustainability; ENS = Environmental Sustainability.

3. Research Methodology

Research design in mixed-methods inquiry is not merely a procedural choice but an epistemological commitment that determines the nature and scope of knowledge produced. This study addresses two analytically distinct yet interrelated questions: how manufacturing SMEs operating in institutionally constrained environments experience platform participation and develop frugal digital capabilities, and

whether these capability-building mechanisms systematically translate into measurable sustainability outcomes across a broader population. The former requires interpretive depth grounded in participant experience, while the latter demands empirical validation and generalisability. A single methodological approach is insufficient to address both dimensions adequately.

Accordingly, this study adopts a sequential explanatory mixed-methods design, grounded in a pragmatist logic that prioritises methodological appropriateness over philosophical exclusivity (Creswell & Creswell, 2018; Tashakkori & Teddlie, 2010). In this design, qualitative inquiry precedes and informs quantitative analysis. The qualitative phase generates contextually grounded constructs and measurement items, while the quantitative phase tests the proposed relationships within a structured model. This sequencing is not a methodological compromise but a deliberate design logic: qualitative insights establish conceptual clarity and measurement validity, and quantitative analysis provides statistical robustness and generalisable evidence. Integration occurs at both the instrument development stage and the interpretive stage, ensuring coherence across exploratory and confirmatory components

3.1 Research Philosophy and Overall Design

This study adopts a pragmatist research philosophy, which prioritises the research question as the primary driver of methodological choice rather than adhering to a single ontological or epistemological position (Creswell & Creswell, 2018; Tashakkori & Teddlie, 2010). Pragmatism is particularly appropriate in contexts where the phenomenon under investigation is both experiential and measurable. In the present study, the development of frugal digital capability through platform participation is simultaneously a lived, interpretive process shaped by SME owners' experiences and a structural phenomenon that can be examined through observable relationships across a broader population. A pragmatist stance therefore enables the integration of qualitative and quantitative approaches without forcing artificial alignment with either interpretivist or positivist traditions.

Consistent with this philosophical position, the study employs a sequential explanatory mixed-methods design, in which qualitative inquiry precedes quantitative analysis. The qualitative phase uses Glaserian Grounded Theory to inductively generate constructs and measurement items grounded in the language and practices of manufacturing SME owners. The subsequent quantitative phase applies a cross-sectional survey and PLS-SEM to test the relationships between platform participation, frugal digital capability, and sustainability outcomes. This sequencing reflects a clear methodological logic: construct development and contextual understanding are established first, followed by empirical validation and generalisation.

Integration between the two phases is achieved at two levels. First, qualitative findings directly inform the development and refinement of the survey instrument, ensuring that measurement reflects contextually grounded constructs rather than imported abstractions. Second, quantitative results are interpreted in light of qualitative insights, enabling a richer explanation of observed relationships and non-significant findings. This dual integration strengthens both internal coherence and theoretical

contribution, aligning exploratory depth with confirmatory rigour. The overall design is summarised in Table 2, while the process of qualitative–quantitative integration is illustrated in Fig. 2.

Table 2
Research Design Overview: Sequential Explanatory Mixed-Methods

Design Element	Phase 1 Qualitative	Phase 2 Quantitative
Approach	Glaserian Grounded Theory	Cross-sectional survey; PLS-SEM
Purpose	Construct generation; instrument refinement; contextual understanding	Hypothesis testing; model validation; structural estimation
Sample	20 manufacturing SME owners/managers	382 manufacturing SMEs; Pakistan
Sampling strategy	Purposive theoretical sampling to saturation	Stratified random sampling
Data collection	Semi-structured interviews; 45–60 minutes	Structured questionnaire; Likert 1–5
Analysis tool	NVivo 14; open → axial → selective coding	SmartPLS 4.0; bootstrapping 5,000 iterations
Validity criteria	Theoretical saturation; member checking; peer debriefing	AVE ≥ 0.50 ; CR ≥ 0.70 ; HTMT < 0.85
Integration point	GT categories → Phase 2 scale items	Phase 2 results contextualised by Phase 1 themes
Output	Novel scale items; preliminary propositions; contextual insight	Path coefficients; R^2 ; Q^2 ; moderation effects
Note. GT = Grounded Theory; PLS-SEM = Partial Least Squares Structural Equation Modelling; AVE = Average Variance Extracted; CR = Composite Reliability; HTMT = Heterotrait-Monotrait Ratio.		

3.2 Phase 1: Glaserian Grounded Theory

3.2.1 Methodological choice and justification

Glaserian Grounded Theory (Glaser & Strauss, 1967; Glaser, 1992) was adopted as the qualitative approach for a specific and defensible reason: the central constructs of Platform Venture Participation and Frugal Digital Capability do not have validated measurement instruments in the manufacturing SME literature, and imposing scales developed for other constructs, other sectors, or other geographic contexts would risk measuring something adjacent to the phenomena of interest rather than the phenomena themselves. Grounded Theory's defining methodological virtue is that it generates theoretical categories inductively from empirical data from the language, experiences, and interpretive frameworks of the participants rather than deductively from existing literature. This is not incompatible with the theoretical framework developed in Section 2; it is the means by which that framework is given

measurement content that reflects Pakistani manufacturing SME owners' actual engagement with digital platforms rather than imported abstractions.

The Glaserian tradition was preferred over Straussian Grounded Theory (Strauss & Corbin, 1990) for its stricter commitment to theoretical openness: Glaserian coding allows the core category to emerge from the data without the imposition of a predetermined coding framework, which is particularly important when the constructs to be measured are novel. Case study and phenomenological approaches were considered but set aside: the former prioritises within-case depth over theoretical generativity, and the latter centres subjective lived experience in ways that would not translate readily into measurement items for a cross-sectional survey.

3.2.2 Sampling, participants, and data collection

Purposive theoretical sampling was employed, with theoretical saturation serving as the stopping criterion (Glaser & Strauss, 1967). Participants were selected to maximise theoretical variation across four dimensions: platform type (e-commerce, FinTech, digital supply chain, or combinations thereof), firm size (micro: 10–49 employees; small: 50–99; medium: 100–250), industry sub-sector (textiles, food processing, light manufacturing), and geographic location (Punjab, Sindh, KPK). Inclusion required that participants: actively use at least one digital platform for business purposes; have done so for a minimum of twelve months; and hold decision-making authority over digital technology investments within their firm. Twenty interviews were conducted across eight weeks. Theoretical saturation was reached at interview 18, confirmed by two additional interviews in which no new categories or theoretical properties emerged.

Participants were recruited through SMEDA (Small and Medium Enterprises Development Authority) Pakistan, the All Pakistan Textile Mills Association, the Pakistan Fruit and Vegetable Exporters Association, and digital platform seller community groups. Snowball referrals from initial participants supplemented recruitment for harder-to-access sub-sectors. Semi-structured interviews of 45 to 60 minutes were conducted either at the participant's business premises or via video call where geographic access was impractical. An interview guide structured around six thematic areas platform engagement, operational digitisation, market capability, sustainability outcomes, institutional context, and frugal approaches served as a flexible orienting framework rather than a rigid script. All interviews were audio-recorded with explicit participant consent and transcribed verbatim within 48 hours. Table 3 presents the Phase 1 participant profile. The interview guide, full coding structure, and GT-derived measurement items are documented in Appendix A.

Table 3
Phase 1 Interview Participant Profile (n = 20)

Characteristic	Category	n	%
Gender	Male	14	70.0
	Female	6	30.0
Sector	Textiles and garments	8	40.0
	Food processing	6	30.0
	Light manufacturing	6	30.0
Firm size	Micro (10–49 employees)	6	30.0
	Small (50–99 employees)	8	40.0
	Medium (100–250 employees)	6	30.0
Platform type used	E-commerce only	4	20.0
	FinTech only	3	15.0
	Multiple platform types	13	65.0
Platform experience	1–3 years	9	45.0
	3–5 years	7	35.0
	More than 5 years	4	20.0
Geographic region	Punjab (Lahore, Faisalabad, Sialkot)	10	50.0
	Sindh (Karachi)	7	35.0
	KPK (Peshawar)	3	15.0

3.2.3 Data analysis and trustworthiness

Analysis followed Glaserian Grounded Theory's three-stage constant comparative process using NVivo 14. Open coding was conducted line-by-line on each transcript, generating substantive codes that closely reflected participants' own language the operational vocabulary through which Pakistani manufacturing SME owners describe their platform engagement and capability development. Axial coding clustered open codes into categories and sub-categories based on theoretical properties: conditions, contexts, actions, interactions, and consequences. Selective coding integrated all categories around a core category identified as Resourceful Platform Engagement as a Frugal Survival Strategy reflecting how participants consistently framed their digital platform use not as a transformation initiative but as a pragmatic, resource-efficient response to competitive and sustainability pressures within environments where formal institutional support is unreliable. Memo writing throughout the analytic process

documented the research team's developing theoretical ideas and their evolving relationship to the emerging category structure.

Trustworthiness was established across four criteria (Lincoln & Guba, 1985). Credibility was addressed through member checking preliminary findings were shared with six participants, who confirmed their alignment with their own experiences and through peer debriefing, in which two researchers external to the project reviewed coding decisions and challenged interpretations. Transferability was addressed through thick description of the Pakistan manufacturing institutional context. Dependability was established through a complete audit trail of coding decisions, memo records, and theoretical sampling choices. Confirmability was addressed through reflexivity statements documenting each team member's positionality and potential influence on the analytic process.

Phase 1 generated 14 new measurement items five for PVP constructs and six for FDC constructs, using the language and framing of Pakistani manufacturing SME owners, and three for the Institutional Voids construct capturing the specific void types identified in the Institutional Friction GT category. These items were reviewed by an expert panel comprising three academic specialists in digital entrepreneurship and SME sustainability, and two manufacturing SME practitioners with platform experience. Following content validity assessment and minor item revisions, a pilot study of 30 manufacturing SMEs was conducted to assess item clarity, response distribution, and preliminary internal consistency before main data collection.

3.3 Phase 2: Population, Sampling, and Data Collection

3.3.1 Target population and sampling

The target population comprised manufacturing SMEs operating within Pakistan's export-oriented industrial sectors principally textiles and garments, leather goods, sporting equipment, and surgical instruments with a total population frame of 6,561 firms identified from SMEDA's national SME database, the All Pakistan Textile Mills Association directory, and the Federation of Pakistan Chambers of Commerce and Industry membership lists. These sectors were selected because they concentrate the intersection of digital platform adoption pressure, sustainability scrutiny from international buyers, and institutional void exposure that the theoretical model addresses. Stratified random sampling was employed to ensure proportionate representation across industry sub-sector, firm size (micro, small, medium by SMEDA's definitional criteria), and geographic region (Punjab, Sindh, KPK), thereby enhancing the statistical efficiency and generalisability of findings across a heterogeneous SME population.

The minimum sample size was determined using Krejcie and Morgan's (1970) formula, which specifies 384 respondents for a population of 6,561 at 95 per cent confidence and a 5 per cent margin of error. To account for non-response and data quality attrition, 500 questionnaires were distributed. Data were collected between March and May 2024 using an online survey instrument administered through Google Forms, distributed via WhatsApp business groups of registered manufacturing SME associations, LinkedIn professional community outreach, and Chamber of Commerce electronic mailing lists. A cover

letter accompanying each distribution explained the study's academic purpose, assured anonymity and voluntary participation, and provided the corresponding author's contact details. Two follow-up reminders were issued at two-week intervals.

Of 500 questionnaires distributed, 431 responses were received. Following data screening removal of incomplete responses (missing more than 10 per cent of items), detection and elimination of multivariate outliers using Mahalanobis distance at a significance threshold of $p < .001$, and assessment of straight-lining 382 valid responses were retained for analysis, representing a final usable response rate of 76.4 per cent, which compares favourably with published benchmarks for organisational survey research in emerging economies (Hair et al., 2019). Table 4 presents the respondent and firm characteristic profile.

Table 4
Respondent and Firm Characteristics (n = 382)

Characteristic	Category	n	%
Gender	Male	218	57.1
	Female	164	42.9
Age	21–40 years	292	76.4
	Above 40 years	90	23.6
Education	Undergraduate	134	35.1
	Postgraduate	182	47.6
	Other	66	17.3
Digital experience	Less than 2 years	289	75.7
	2 years or more	93	24.3
Firm size (employees)	Under 200	83	23.4
	200–500	96	27.1
	500–1,000	117	33.1
	Over 1,000	58	16.4
Annual turnover (PKR)	Under 100 million	65	18.4
	100–200 million	92	26.0
	200–300 million	106	30.0
	Over 300 million	91	25.6
Firm age	Under 5 years	62	17.5
	5–10 years	131	37.0
	Over 10 years	161	45.5
Industry sector	Textiles and garments	152	39.8
	Food processing	118	30.9
	Light manufacturing	112	29.3

3.4 Measurement Instrument

All constructs are measured using five-point Likert scales (1 = Strongly Disagree; 5 = Strongly Agree). Items for each construct combine adapted measures from the prior literature with the novel items generated in Phase 1. Adaptation involved modifying item wording to reflect the Pakistan manufacturing

platform context and was verified through back-translation from English to Urdu and independent retranslation to English, with discrepancies resolved by a bilingual academic expert. Table 5 presents the construct measurement sources. Full scale items for all nine constructs are presented in Appendix B.

Table 5
Construct Measurement Sources and Item Structure

Construct	Code	Items	Measurement Basis
E-Commerce Platform Participation	ECPP	5	Adapted from Ahmed et al. (2022); Wang & Zhang (2025); GT-Phase 1 items (2)
FinTech Platform Participation	FTPP	5	Adapted from Siddik et al. (2023); Rashid et al. (2025); GT-Phase 1 items (2)
Digital Supply Chain Platform Participation	DSPP	5	Adapted from Khan & Emon (2025); Chari et al. (2023); GT-Phase 1 items (1)
Frugal Operational Capability	FOC	5	Novel scale GT-Phase 1 derived; grounded in Ahuja & Chan (2016); Rossit & Bidanda (2026)
Frugal Market Capability	FMC	5	Novel scale GT-Phase 1 derived; grounded in Sengura et al. (2024); Khattak (2022)
Institutional Voids	IV	5	Adapted from Akbar et al. (2017); Yan & Ahmad (2025); GT-Phase 1 items (3)
Economic Sustainability	ECS	5	Adapted from Cuevas-Vargas et al. (2022); Buhaya & Metwally (2024)
Social Sustainability	SCS	5	Adapted from Khan (2025); Liu et al. (2025); Rizvi et al. (2024)
Environmental Sustainability	ENS	5	Adapted from Khan et al. (2025); Karuppiah et al. (2020); Mehmood et al. (2025)
Control variables	—	4	Firm size (employees); firm age (years); owner education level; prior digital experience (years)

Note. GT-Phase 1 items indicates measurement items generated inductively from Grounded Theory interviews and validated through the expert panel and pilot study prior to main data collection. All constructs are specified as reflective first-order.

3.5 Common Method Bias

The cross-sectional, single-respondent survey design creates a structural risk of common method variance (Podsakoff et al., 2003). Procedural remedies were incorporated at the instrument design stage: independent and dependent variable items were separated within the questionnaire by an unrelated distractor section; respondents were explicitly assured that there were no right or wrong answers; and several items were reverse-coded to reduce acquiescence bias and consistency motivation effects. Statistically, Harman's single-factor test was conducted post-collection. A single factor extracted in an unrotated principal components solution accounted for 28.3 per cent of total variance well below the 50 per cent threshold conventionally applied providing initial evidence that common method variance is not

a dominant influence in the dataset (Podsakoff et al., 2003). The Heterotrait-Monotrait (HTMT) ratio analysis, which serves simultaneously as a discriminant validity check and a common method diagnostic, confirmed that all HTMT values fell below 0.85 (Henseler et al., 2015), with the highest observed value of 0.723 arising between the two most theoretically proximate constructs (DSPP and FTPP). Variance Inflation Factor values for all indicator items ranged from 1.23 to 2.87, comfortably below the 3.3 threshold specified by Hair et al. (2019) for reflective measurement models in PLS-SEM.

3.6 Analytical Approach: PLS-SEM

3.6.1 Justification for PLS-SEM

Partial Least Squares Structural Equation Modelling via SmartPLS 4.0 (Ringle et al., 2022) was selected as the quantitative analytical method on the basis of four convergent methodological considerations. First, this study's primary goal is the prediction and explanation of variance in triple sustainability outcomes a prediction-oriented objective for which PLS-SEM is specifically designed and which covariance-based SEM is not optimised (Hair et al., 2019). Second, the model includes novel constructs particularly the FDC dimensions for which scale properties were developed rather than imported, making the distributional assumptions of CB-SEM inappropriate for a first validation study. Third, the model's complexity fourteen hypotheses, nine constructs, mediation through two parallel dimensions, and moderation at the second stage benefits from PLS-SEM's capacity to handle complex path structures without the degrees-of-freedom constraints that CB-SEM imposes. Fourth, the sample of 382 is well within PLS-SEM's operating parameters; at this sample size, CB-SEM would achieve similar power but would impose normality assumptions that the heterogeneous manufacturing SME population data may not satisfy.

3.6.2 Measurement model assessment

The measurement model was assessed using the two-step approach recommended by Hair et al. (2019). Internal consistency reliability was evaluated using Cronbach's alpha (threshold: ≥ 0.70) and composite reliability (threshold: ≥ 0.70), with composite reliability prioritised given its lower sensitivity to the number of indicators. Convergent validity was assessed through Average Variance Extracted (threshold: ≥ 0.50), confirming that each construct accounts for more than half the variance in its indicators. Discriminant validity was assessed using the HTMT criterion (threshold: < 0.85 for conceptually distinct constructs; Henseler et al., 2015), supplemented by the Fornell-Larcker criterion as a secondary check. Items with loadings below 0.70 were reviewed for removal, with removal implemented only where doing so improved AVE without substantially compromising the content representativeness of the construct.

3.6.3 Structural model assessment and hypothesis testing

Structural model assessment followed Hair et al.'s (2019) five-criterion framework. Path coefficients (β) and their statistical significance were estimated through bootstrapping with 5,000 resamples, no sign-change option, and bias-corrected and accelerated (BCa) 95 per cent confidence intervals, which are

robust to non-normal distributions. The coefficient of determination (R^2) was reported for all endogenous constructs, with values above 0.10 considered acceptable and above 0.26 considered substantial for exploratory research contexts. Effect sizes (f^2) were calculated for each structural path using Cohen's (1988) benchmarks: small ≥ 0.02 , medium ≥ 0.15 , large ≥ 0.35 . Predictive relevance (Q^2) was assessed through PLSpredict using ten-fold cross-validation; Q^2 values exceeding zero indicate that the model has out-of-sample predictive relevance for the respective endogenous construct. Moderation hypotheses (H6a and H6b) were tested using the product-indicator approach for continuous moderators, constructing two interaction terms $IV \times FOC$ and $IV \times FMC$ whose effects on each of the three sustainability outcomes were estimated. Simple slope interaction plots at ± 1 standard deviation of the moderator were generated to visualise the moderation pattern and assess its practical interpretability.

Three robustness checks were conducted to strengthen confidence in the results. Consistent PLS (PLSc) analysis was performed to assess result stability under an estimator that corrects for attenuation in reflective measurement (Dijkstra & Henseler, 2015). The structural model was re-estimated with control variables incorporated as additional predictors to confirm that the hypothesised relationships held after accounting for firm size, firm age, owner education, and prior digital experience. Multi-group analysis (MGA) was conducted across the three industry sub-sectors to assess whether the model is sector-invariant or exhibits sector-specific boundary conditions of substantive theoretical interest.

3.7 Ethical Considerations

Ethical approval

was obtained from the Research Ethics Committee of the authors' institution prior to data collection. All Phase 1 participants provided written informed consent before audio recording commenced and were offered the opportunity to review and amend their transcript following transcription. All Phase 2 respondents received an informed consent statement as part of the survey instrument, with explicit assurance that participation was voluntary, responses were anonymous, and data would be used exclusively for academic research. No incentives were offered to either interview or survey participants. All data are stored on an encrypted institutional server, access-restricted to the research team, and will be deleted after the five-year retention period specified in the institutional data management protocol. This study complied in all respects with the principles of the Declaration of Helsinki for research involving human participants.

4. Results

4.1 Phase 1: Grounded Theory Findings

Analysis of 20 interviews (NVivo 14) generated a core category Resourceful Platform Engagement as a Frugal Survival Strategy around which four theoretical categories coalesced: Platform Access and Participation, Frugal Capability Building, Institutional Friction, and Sustainability Outcomes. Theoretical saturation was achieved at interview 18. Participants consistently described two distinct frugal

capability dimensions emerging from platform participation: an operational dimension (FOC) resourceful exploitation of platform inventory, logistics, and process tools at zero or low cost and a market dimension (FMC) frugal digital market access through platform analytics, seller dashboards, and buyer directories. This pre-validated the FDC dimensional structure inductively before Phase 2 quantitative testing. The Institutional Friction category was the most spontaneously discussed, with all 20 participants describing regulatory unpredictability, payment governance instability, and infrastructure deficits as active constraints qualitatively grounding the IV moderator construct. Critically, social sustainability outcomes were consistently attributed by participants to market capability development (FMC → SCS: revenue growth → employment creation, particularly female workers) rather than operational digitisation qualitatively anticipating H4b non-significance in Phase 2.

4.2 Measurement Model

All constructs met reliability (Cronbach's α : 0.856–0.878; CR: 0.893–0.910) and convergent validity (AVE: 0.627–0.671) thresholds recommended by Hair et al. (2019). All factor loadings exceeded 0.70. The HTMT matrix confirmed discriminant validity across all nine constructs (all values < 0.85; highest: 0.723, DSPP–FTPP), consistent with Henseler et al. (2015). All VIF values ranged 1.23–2.87 (< 3.3 threshold), confirming absence of multicollinearity. Table 6 presents the structural model fit indices and R² values.

Table 6. Structural Model Explanatory Power and Predictive Relevance

Endogenous Construct	R ²	Adjusted R ²	Q ² (PLSpredict)
Frugal Operational Capability (FOC)	0.412	0.407	0.268
Frugal Market Capability (FMC)	0.387	0.381	0.243
Economic Sustainability (ECS)	0.443	0.437	0.289
Social Sustainability (SCS)	0.298	0.291	0.182
Environmental Sustainability (ENS)	0.312	0.305	0.198

Table 7. Discriminant Validity HTMT Ratio Matrix (n = 382)

	ECPP	FTPP	DSPP	FOC	FMC	IV	ECS	SCS	ENS
ECPP	—								
FTPP	0.712	—							
DSPP	0.698	0.723	—						
FOC	0.681	0.654	0.667	—					
FMC	0.643	0.621	0.634	0.712	—				
IV	0.312	0.298	0.287	0.341	0.323	—			
ECS	0.587	0.563	0.554	0.631	0.612	0.287	—		
SCS	0.521	0.498	0.512	0.489	0.587	0.312	0.534	—	

Note. HTMT = Heterotrait-Monotrait Ratio. All values below 0.85 confirm discriminant validity (Henseler et al., 2015). The value 0.723 (DSPP–FTPP, highlighted) represents the highest observed HTMT and reflects theoretically expected proximity between adjacent platform participation dimensions. ECPP = E-Commerce Platform Participation; FTPP = FinTech Platform Participation; DSPP = Digital Supply Chain Platform Participation; FOC = Frugal Operational Capability; FMC = Frugal Market Capability; IV = Institutional Voids; ECS = Economic Sustainability; SCS = Social Sustainability; ENS = Environmental Sustainability.

4.3 Structural Model and Hypothesis Testing

Table 8 presents hypothesis testing results. All six PVP → FDC paths (H1a–H3b) were supported. ECPP generated the strongest effects on both FOC ($\beta = 0.312$, $t = 4.821$, $p < .001$, $f^2 = 0.128$) and FMC ($\beta = 0.287$, $t = 4.193$, $p < .001$, $f^2 = 0.104$), confirming e-commerce platforms as the most comprehensive capability builders. FTPP and DSPP effects were significant but comparatively smaller, reflecting their more specialised capability-building scope. Among FDC → sustainability paths, H4a (FOC → ECS: $\beta = 0.341$, $p < .001$, $f^2 = 0.152$) and H5a (FMC → ECS: $\beta = 0.298$, $p < .001$, $f^2 = 0.113$) were strongly supported, confirming dual economic sustainability pathways. H5b (FMC → SCS: $\beta = 0.334$, $p < .001$, $f^2 = 0.143$) was the strongest path in the model, establishing FMC as the primary social sustainability driver. H4c (FOC → ENS: $\beta = 0.179$, $p = .021$, $f^2 = 0.041$) was weakly supported. H4b (FOC → SCS: $\beta = 0.087$, $p = .214$) and H5c (FMC → ENS: $\beta = 0.112$, $p = .113$) were not supported. For moderation, H6a (IV × FOC → sustainability: $\beta = -0.193$, $t = 2.841$, $p = .005$, $f^2 = 0.048$) was supported; H6b (IV × FMC → sustainability: $\beta = -0.094$, $t = 1.312$, $p = .190$) was not supported. All Q^2 values exceeded zero, confirming predictive relevance. Figure 2 presents the validated model with path coefficients (to be inserted by the author).

Table 8. Hypothesis Testing Results (n = 382; bootstrapping: 5,000 iterations; BCa 95% CI)

H	Path	β	t	p	f ²	Decision
H1a	ECPP → FOC	0.312	4.821	<.001	0.128	Supported
H1b	ECPP → FMC	0.287	4.193	<.001	0.104	Supported
H2a	FTPP → FOC	0.268	3.874	<.001	0.091	Supported
H2b	FTPP → FMC	0.241	3.512	<.001	0.077	Supported
H3a	DSPP → FOC	0.223	3.287	.001	0.063	Supported
H3b	DSPP → FMC	0.198	2.941	.003	0.052	Supported
H4a	FOC → ECS	0.341	5.123	<.001	0.152	Supported
H4b	FOC → SCS	0.087	1.243	.214	0.009	Not Supported
H4c	FOC → ENS	0.179	2.312	.021	0.041	Weakly Supported
H5a	FMC → ECS	0.298	4.431	<.001	0.113	Supported
H5b	FMC → SCS	0.334	4.892	<.001	0.143	Supported
H5c	FMC → ENS	0.112	1.587	.113	0.016	Not Supported
H6a	IV × FOC → Sustainability	-0.193	2.841	.005	0.048	Supported
H6b	IV × FMC → Sustainability	-0.094	1.312	.190	0.011	Not Supported

Note. *** p < .001; ** p < .01; * p < .05. f² = Cohen's effect size: small ≥ 0.02; medium ≥ 0.15; large ≥ 0.35. IV = Institutional Voids. Control variables (firm size, age, owner education, prior digital experience) included in structural model; none yielded significant paths to sustainability outcomes.

5. Discussion

This study set out to address a central limitation identified in the introduction: the lack of an integrated explanation of how platform venture participation translates into sustainability outcomes in manufacturing SMEs operating under institutional constraints. The findings provide a clear and theoretically grounded answer, but also challenge several implicit assumptions in the existing literature. Specifically, the results demonstrate that platform participation is neither a direct nor a uniform driver of sustainability outcomes. Instead, its effects are mediated through frugal digital capability and conditioned by institutional context, aligning with the Dynamic Capabilities perspective that value emerges only when external resources are internalised and reconfigured into firm-level capabilities (Teece et al., 1997).

At a foundational level, the support of all six PVP → FDC relationships (H1a–H3b) confirms that platform participation functions as a capability-building mechanism rather than a transactional tool, extending prior work linking platform capabilities to SME performance (Jiang et al., 2023). However, the results

move beyond simple confirmation by demonstrating that platform participation is structurally heterogeneous. E-commerce platforms (ECP) exhibit the strongest and most balanced effects across both operational and market capabilities, reflecting their integrated ecosystems that combine logistics, analytics, and customer interface functions. In contrast, digital supply chain platforms (DSPP) show weaker and more specialised effects, indicating that capability development is shaped by the functional architecture of platform ecosystems rather than by digital adoption per se. This directly challenges the dominant tendency to treat platform participation as a composite construct and instead supports a configuration-based understanding of digital capability formation.

More critically, the findings reveal that the translation of these capabilities into sustainability outcomes is asymmetric and non-linear, contradicting the common assumption that digital transformation produces uniform sustainability benefits. Frugal Operational Capability (FOC) emerges as a strong driver of economic sustainability and a modest driver of environmental sustainability, replicating prior findings that lean digital operations reduce costs and improve resource efficiency (Buhaya & Metwally, 2024; Khan et al., 2025). However, the non-significant FOC → social sustainability relationship represents a substantive theoretical divergence. While Ferreira et al. (2023) suggest that social sustainability remains underexplored in digital manufacturing contexts, the present findings empirically demonstrate that this gap is not merely empirical but structural. As Gregori et al. (2017) argue, digital production systems are designed to optimise efficiency metrics rather than social outcomes, and Kalkanci et al. (2019) further emphasise that social sustainability requires deliberate inclusive innovation rather than passive efficiency gains. Thus, the absence of FOC → SCS should not be interpreted as a model limitation but as evidence of a systematic decoupling between operational digitisation and social outcomes in emerging economy manufacturing contexts.

In contrast, Frugal Market Capability (FMC) emerges as the dominant pathway for social sustainability, with the strongest effect observed in the model. This finding provides important clarification to prior research suggesting that digital platforms enhance SME inclusivity and employment outcomes (Khan, 2025; Liu et al., 2025; Rizvi et al., 2024). The results demonstrate that these effects are not driven by digitisation broadly but specifically by market expansion mechanisms embedded within platform ecosystems. Phase 1 qualitative evidence further reinforces this interpretation, as participants consistently linked social outcomes to increased demand, customer reach, and revenue growth rather than to operational efficiency. At the same time, FMC also contributes to economic sustainability, confirming a dual-pathway structure in which cost reduction (FOC) and market expansion (FMC) represent distinct but complementary drivers of firm performance.

However, the absence of a significant FMC → environmental sustainability relationship introduces a critical institutional tension. While market expansion is often assumed to expose firms to environmental pressures, the findings indicate that this relationship is contingent on regulatory context. Consistent with Xiumei et al. (2023), environmental outcomes require regulatory enforcement, and digital capabilities alone cannot substitute for institutional governance. In Pakistan's manufacturing context, the absence of mandatory green standards and eco-labelling frameworks prevents FMC-driven market access from

translating into environmental accountability. Lu et al. (2020) provide a sequencing explanation, suggesting that firms prioritise economic sustainability before environmental investments, while Junejo et al. (2025) further confirm that green organisational culture must accompany digital capability for environmental outcomes to emerge. This identifies a green regulatory void as a specific institutional constraint, advancing Institutional Theory by moving beyond a generalised notion of institutional voids to a dimensionally differentiated understanding of institutional effects.

The moderation results provide the most novel and theoretically significant insight. While institutional voids weaken the relationship between FOC and sustainability outcomes (H6a), they do not significantly affect FMC (H6b). This divergence challenges the assumption that institutional constraints uniformly limit firm capabilities. Instead, it suggests that market-oriented digital capabilities exhibit a form of institutional void resilience. As Agarwal and Assenova (2024) argue, digital platforms act as institutional substitutes by embedding trust, certification, and coordination mechanisms within their ecosystems. Similarly, Malik et al. (2021) demonstrate that platform-based interactions rely on informal trust networks that compensate for weak formal institutions. In contrast, operational capabilities remain dependent on external infrastructure and regulatory systems, making them inherently more vulnerable to institutional deficiencies. This distinction introduces a critical theoretical insight: not all capabilities are equally constrained by institutional environments; rather, their effectiveness depends on whether they are embedded within or external to platform-based governance structures.

Taken together, these findings provide a more nuanced and critical understanding of digital transformation in emerging economy SMEs. Rather than a linear relationship between platform adoption and sustainability, the evidence supports a multi-layered, conditional model of value creation, where platform participation, capability development, and institutional context interact in complex and differentiated ways. This directly addresses the gap identified in the introduction and provides the foundation for the theoretical and practical implications that follow.

5.1 Theoretical Contributions

This study advances five theoretical streams. First, it introduces and validates Frugal Digital Capability (FDC) as a novel two-dimensional mediating construct the first formal operationalisation bridging Dynamic Capabilities Theory's sensing-seizing mechanism and Frugal Innovation Theory's resourcefulness principle in platform-based manufacturing SME sustainability research. Second, it advances Platform Ecosystem Theory by demonstrating differential capability-building effects across platform types ECPP, FTPP, and DSPP generate quantitatively distinct FOC and FMC effects, refuting composite platform participation as theoretically adequate. Third, the operational-social sustainability decoupling finding (H4b not supported) advances the manufacturing digitisation literature by empirically confirming the structural absence of FOC → SCS in emerging economy contexts, framing this as a boundary condition requiring inclusive innovation rather than mere operational efficiency. Fourth, the green regulatory void boundary condition (H5c not supported) advances Institutional Theory by identifying a specific void subtype absent domestic green procurement regulation with distinct

consequences for environmental sustainability pathways, moving the IV construct from composite to dimensionally specific. Fifth, the institutional void resilience of FMC (H6b not supported) introduces a novel theoretical property: market capabilities built through platform ecosystems are insulated from formal institutional constraints because platforms act as institutional actors that fill voids through digital trust infrastructure and informal solidarity networks.

5.2 Practical and Policy Implications

For SME managers, the findings prioritise e-commerce platform participation as the highest-return digital capability investment (strongest FOC and FMC effects), while FinTech platforms offer complementary green finance access and operational efficiency gains. The FMC → SCS finding ($\beta = 0.334$, strongest path) instructs managers to leverage platform-driven revenue growth deliberately for employment creation, particularly female workforce expansion, rather than assuming social sustainability emerges automatically from operational digitisation. H6a support indicates that managers in high-void contexts should develop institutional void coping strategies using platform-provided dispute resolution, stable FinTech payment rails, and community trust networks as substitutes for absent formal enforcement.

For policymakers, three priority interventions emerge directly from the results. First, establishing mandatory domestic green procurement standards and eco-labelling requirements would activate the FMC → ENS pathway (currently blocked by green regulatory void: H5c not supported), transforming market access capability into environmental sustainability gains without requiring heavy enforcement apparatus (Xiumei et al., 2023; Fernández-Viñe et al., 2013, 58 citations). Second, FinTech regulatory reform providing clarity, stability, and green FinTech certification in Pakistan's fragmented financial regulation landscape would reduce IV constraints on FTEP-based operational sustainability gains (Sultan et al., 2024; Batool et al., 2026). Third, SMEDA-led platform participation programmes seller fee subsidies, digital literacy training, and inclusive onboarding for women manufacturing entrepreneurs would amplify the FMC → SCS pathway confirmed as the primary social sustainability driver. These interventions advance SDG 8 (Decent Work and Economic Growth through FMC → SCS), SDG 9 (Innovation and Infrastructure through PVP → FDC), SDG 10 (Reduced Inequalities through FMC's institutional void resilience), and SDG 12 (Responsible Production through policy activation of FMC → ENS and FOC → ENS).

6. Limitations and Future Research Directions

Five limitations bound this study's conclusions. First, the cross-sectional quantitative design precludes causal inference frugal digital capabilities are inherently dynamic, developing over time through sustained platform engagement that a single-point survey cannot track. Second, the single-country Pakistan context limits generalisability to other emerging economies with different institutional void profiles (India, Bangladesh, Vietnam, Nigeria), constraining the boundary conditions of the H6a/H6b divergence finding. Third, self-reported PVP and FDC measures introduce social desirability and capability self-assessment bias future research should triangulate with objective platform performance data (transaction volumes, seller ratings). Fourth, the study focuses exclusively on positive platform

participation effects; platform dark-side effects dependency, algorithmic vulnerability, power asymmetry, and data privacy risks (Boakye et al., 2026; Suyanto et al., 2023) represent important unconsidered boundary conditions. Fifth, the export-oriented sector sampling emphasis may systematically inflate $FMC \rightarrow ECS/SCS$ effects while understating $FMC \rightarrow ENS$ domestic-market manufacturers face weaker international buyer environmental standards.

Six future research directions emerge from these limitations and the study's theoretical contributions. A longitudinal panel design (three waves, 12–36 months) would track FDC development trajectories and test Lu et al.'s (2020) CSR sequencing proposition whether ECS gains from FOC and FMC must precede SCS and ENS sustainability investments. A multi-country comparative study (Pakistan, Bangladesh, Vietnam, Malaysia) with institutional void profiling and MGA would test whether the H6a/H6b divergence is universal or Pakistan-specific. Disaggregating IV into dimensional subtypes (regulatory, contract enforcement, infrastructure, green regulatory) would identify which specific void type most constrains which $FDC \rightarrow$ sustainability pathway, advancing Institutional Theory from composite to dimensional moderation. An inclusive innovation intervention study testing whether platform-embedded social sustainability dashboards and fair labour certification programmes activate the $FOC \rightarrow SCS$ pathway would address the H4b boundary condition identified. Applying Nichifor & Zait's (2026) Digital Sustainability Sequencing framework to Pakistan manufacturing SMEs would test whether digital sustainability follows non-linear, sequenced pathways ECS before ENS, FOC before FMC that the cross-sectional design cannot capture. Finally, fsQCA configurational analysis would reveal necessary and sufficient combinations of platform participation dimensions, FDC levels, and institutional void conditions that produce high triple sustainability outcomes, complementing the symmetric net effects of PLS-SEM with asymmetric configurational insights.

7. Conclusion

This study set out to answer a question that the existing literature has left unresolved: through what capability-building mechanisms does platform venture participation translate into triple sustainability outcomes for manufacturing SMEs in institutionally constrained emerging economies? Through a sequential explanatory mixed-methods design combining Glaserian Grounded Theory (20 interviews) with PLS-SEM ($n = 382$ manufacturing SMEs in Pakistan), we have provided a theoretically grounded and empirically validated answer. Platform participation builds frugal digital capability and frugal digital capability drives sustainability but the pathways are neither universal nor automatic. Economic sustainability is robustly driven by both operational ($FOC \rightarrow ECS$, $\beta = 0.341$) and market ($FMC \rightarrow ECS$, $\beta = 0.298$) frugal capabilities. Social sustainability is driven exclusively by market capability ($FMC \rightarrow SCS$, $\beta = 0.334$ the model's strongest path) not by operational digitisation, which is structurally decoupled from social outcomes without deliberate inclusive innovation. Environmental sustainability is modestly driven by operational capability ($FOC \rightarrow ENS$, weakly supported) and not by market capability ($FMC \rightarrow ENS$ not supported) blocked by the structural absence of domestic green procurement regulation in Pakistan. Institutional voids significantly attenuate operational capability-based sustainability gains but not market

capability-based gains because platforms act as institutional actors that fill formal voids through digital trust infrastructure, giving FMC an institutional void resilience property that FOC lacks.

Pakistan's 3.2 million manufacturing SMEs contribute 40% of national GDP and 70% of employment. They stand at a critical digital inflection point. The platform economy offers an unprecedented opportunity for triple sustainability at low cost through frugal digital capability building but this opportunity requires platform providers to embed social and environmental tools into seller ecosystems, policymakers to reduce the institutional voids that constrain operational sustainability gains and establish the green regulatory scaffolding that market capabilities need to drive environmental outcomes, and researchers to continue developing the integrated, dimensional theoretical frameworks that the fragmented existing literature has been unable to provide. This study delivers the first empirically validated map of the platform-to-sustainability pathway for manufacturing SMEs in emerging economies. The path is navigable but only with the right institutional architecture to support it.

Declarations

Author Contribution

F.H. conceived and designed the study, developed the integrated theoretical framework linking platform participation, frugal digital capability, institutional voids, and triple sustainability. F.H. led the sequential mixed-methods research design, supervised all phases of data collection, and wrote the main manuscript text including the Introduction, Literature Review, and Discussion sections. F.H. also served as corresponding author and coordinated the submission process. A.D. contributed to the quantitative analysis phase, performed the PLS-SEM structural model assessment using SmartPLS 4.0, and drafted the Methodology and Results sections for Phase 2. A.D. also led the measurement model evaluation including AVE, composite reliability, and HTMT discriminant validity checks. A.Ab. conducted the systematic literature review, contributed to hypothesis development and theoretical grounding, and assisted in the preparation and formatting of Tables 1–5 and the Summary of Hypotheses. R.K. contributed to the conceptualisation of the digital platform ecosystem dimensions, provided technical expertise in the design of the digital capability measurement framework, and assisted in the review and validation of the quantitative model specification and instrument development. A.M. led the Phase 1 Glaserian Grounded Theory design, conducted and analysed the qualitative interviews using NVivo 14, and contributed to construct development and novel measurement item generation. A.M. also performed the robustness checks including PLSc analysis and multi-group analysis (MGA) across industry sub-sectors. A.Al. prepared Figures 1 and 2, contributed to the measurement instrument development and pilot study, and assisted in the reporting of moderation analyses and interaction plots. All authors reviewed, revised, and approved the final manuscript. Initials key: F.H. = Faizan ul Haq; A.D. = Afef Dhahbi; A.Ab. = Amani AbdAlatti; R.K. = Riqza Y. Khattak; A.M. = Asim Masood; A.Al. = Adeeb Alhebri

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Figures

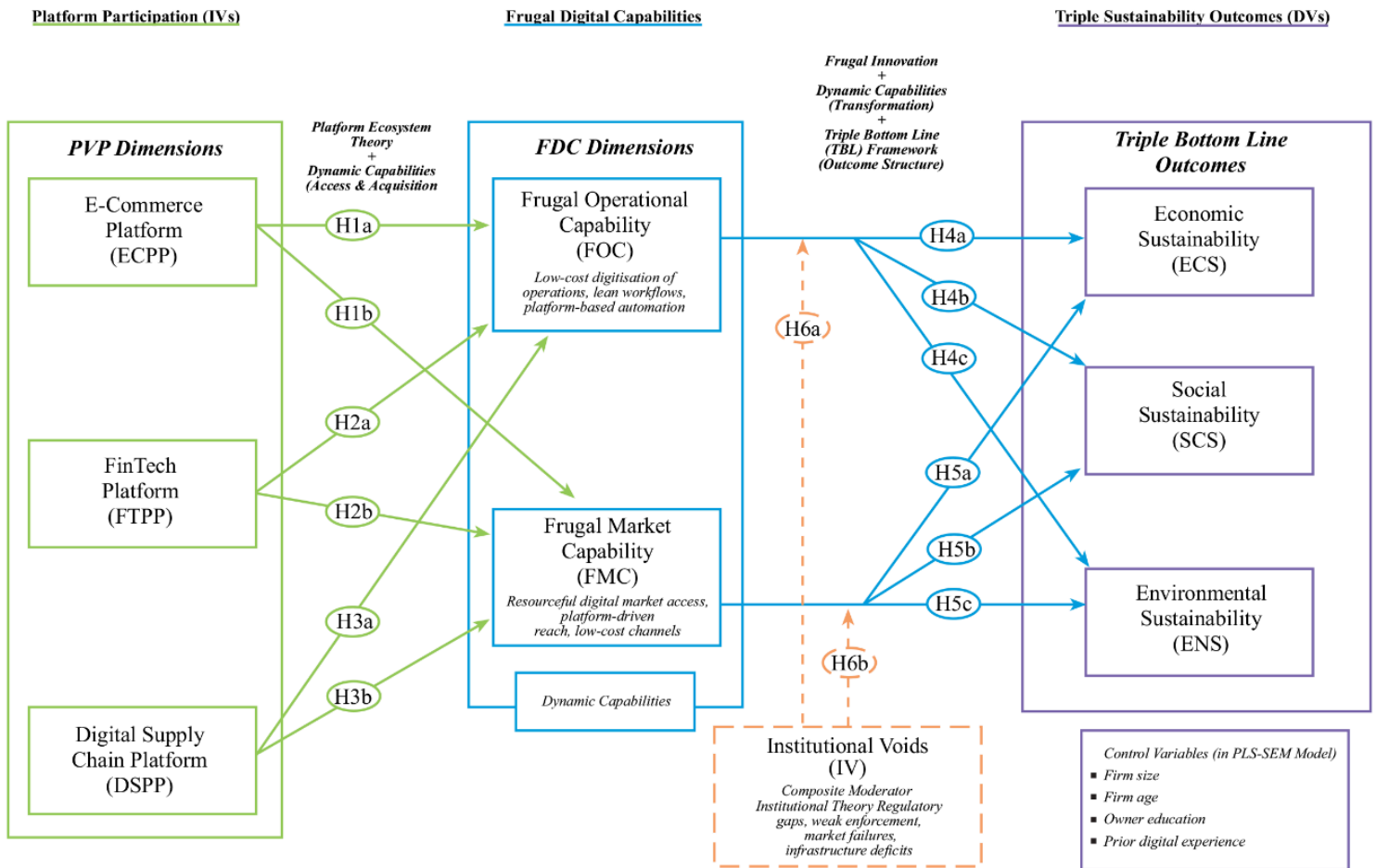


Figure 1

Conceptual Model: Platform Venture Participation, Frugal Digital Capability, and Triple Sustainability of Manufacturing SMEs

Note. Solid green arrows = direct PVP → FDC paths (H1a–H3b); solid blue arrows = FDC → sustainability paths (H4a–H5c); dashed orange arrows = IV moderation (H6a, H6b). IV = Institutional Voids (composite moderator). Control variables included in PLS-SEM model but not displayed.

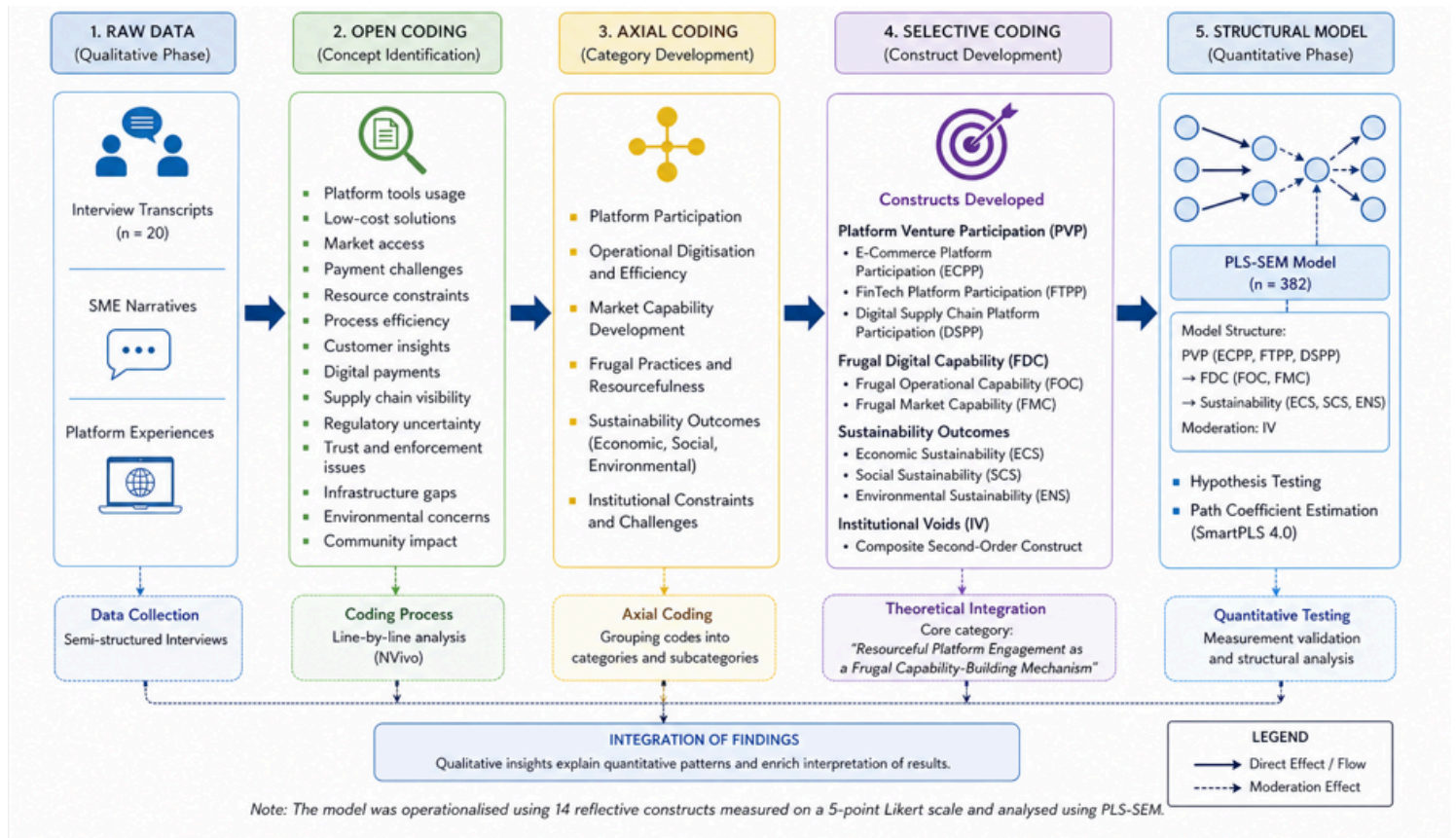


Figure 2

Grounded Theory to Quantitative Model Integration

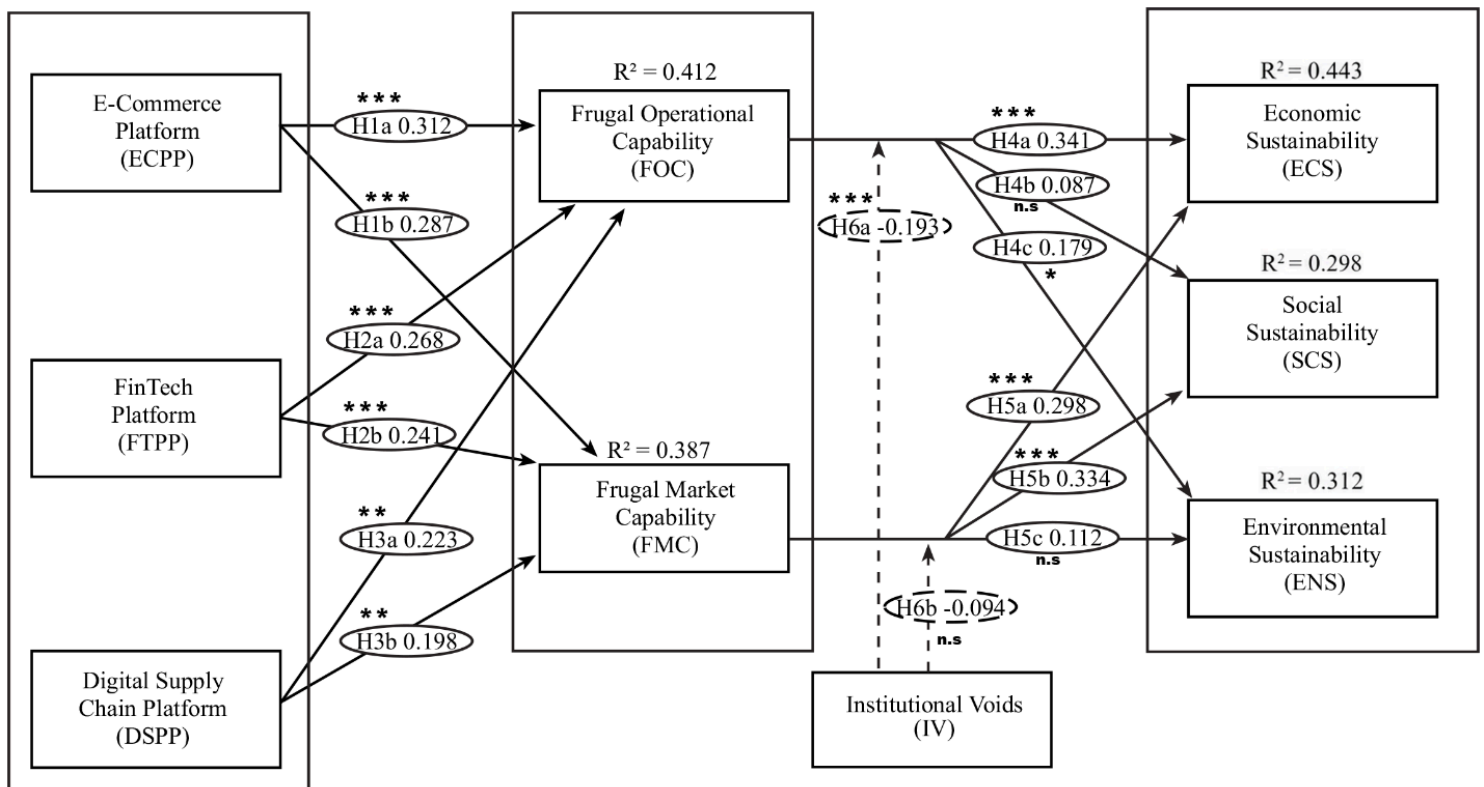


Figure 3

Validated Structural Model. Note. *** $p < .001$; ** $p < .01$; * $p < .05$

Supplementary Files

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- [APPENDIX.docx](#)