A Digital Transformation Model for Wood Waste Craft SMEs: Enhancing Value Chain Integration and Export Readiness in Bali, Indonesia

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Abstract. Small and medium-size enterprises (SMEs) engaged in wood waste craft production contribute significantly to the creative economy and sustainable resource utilization. However, many handicraft-based SMEs in developing countries face challenges related to limited digital adoption, weak value chain integration, and insufficient export readiness. This study contributes a context-specific and practically applicable digital transformation framework that integrates value chain management, sustainability-oriented traceability, and export readiness for wood waste craft SMEs. This applied qualitative research was conducted in Gianyar regency, Bali Indonesia, involving selected SMEs and relevant industry stakeholders. Data were collected through field observations, structured interviews, document analysis, and focus group discussions (FGDs) to identify digital transformation needs, value chain gaps, and export requirements. The findings reveal significant challenges in production documentation, quality control, raw material traceability, marketing, and export management activities. In response, this study proposes an integrated digital transformation model encompassing digital production management, quality assurance, traceability systems, digital documentation, and digital market access. The model demonstrates potential to improve operational transparency, product consistency, compliance with sustainability standards, and international competitiveness. This study contributes a context-specific digital transformation framework to support the sustainable development and export readiness of wood waste craft SMEs.

Keywords: Digital Transformation, Export Readiness, Sustainable Creative Economy, Value Chain Integration, Wood Waste Craft SMEs

1 Introduction

Small and medium-sized enterprises (SMEs) contribute significantly to economic development by creating employment opportunities, encouraging entrepreneurship, and strengthening local and global value chains (Beck et al., 2005; Enaifoghe, 2024; OECD, 2017; Radic, 2020). SMEs, in Indonesia, significantly contribute to national economic resilience and represent a major source of employment and gross domestic product (Bank Indonesia, 2020; Kementerian Koperasi dan UKM, 2021). Bali is internationally recognized for its tourism, cultural heritage, and creative industries. Among various

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creative sectors, wood waste craft SMEs represent a unique sustainable business practice that transforms discarded wood materials into products with economic and artistic value. This practice supports circular economy principles by reducing waste, maximizing resource efficiency, and creating additional economic opportunities for local communities (Ahmed et al., 2022; Geissdoerfer et al., 2017; Rizos et al., 2016).

In Gianyar Regency, wood waste craft production is not merely an economic activity but also reflects Balinese local wisdom that emphasizes harmony between humans, nature, and culture, consistent with the philosophy of Tri Hita Karana. The utilization of recycled wood materials demonstrates community efforts to preserve environmental sustainability while maintaining traditional craftsmanship inherited across generations. Therefore, digital transformation should strengthen rather than replace these local values by improving product traceability, sustainability documentation, and global market accessibility.

Despite their economic and environmental potential, wood waste craft SMEs continue to face challenges in production management, product quality consistency, and international market competitiveness. Many enterprises still rely on manual operational systems, informal quality assessment, and limited production documentation. These conditions hinder product standardization, sustainable sourcing verification, and compliance with international buyer requirements (Hai et al., 2016; Munawar & Munawar, 2022; Tambunan, 2019). As international markets increasingly demand transparency, traceability, and consistent product quality, these limitations highlight the need for integrated management systems supported by digital technologies. Consequently, SMEs are leveraging digital transformation as a strategic approach to strengthen their competitiveness and export readiness.

Digital transformation has become a strategic approach to improving SME competitiveness through the integration of digital technologies into business processes, decision-making, and value chain activities (Bharadwaj et al., 2013; Li et al., 2018; Vial, 2019). Technologies such as digital inventory systems, production monitoring, quality documentation, traceability platforms, and digital marketing provide opportunities for SMEs to improve efficiency, transparency, and access to international markets (Limsarun, 2015; Yousaf et al., 2021).

From a value chain perspective, competitiveness is influenced by the ability of SMEs to manage interconnected activities from raw material sourcing, production processes, quality control, and distribution to final consumers (Kaplinsky & Morris, 2001; Porter, 1985). Digital integration across these activities can facilitate value chain upgrading and strengthen export readiness by improving documentation, product reliability, and compliance with international standards (Gereffi et al., 2005; Leonidou et al., 2002).

Previous studies have extensively examined digital transformation, SME development, and value chain upgrading. Accordingly, there is a need for an applied digital transformation framework that not only supports digital adoption but also strengthens value chain integration and export readiness within the context of craft-based SMEs utilizing recycled wood materials. Although previous studies have examined digital transformation, value chain upgrading, and SME competitiveness independently, limited research has developed an integrated digital transformation model that simultaneously addresses value chain integration, sustainability-oriented

traceability, and export readiness for wood waste craft SMEs in developing countries (Hendriyana et al., 2025; Munawar & Munawar, 2022). Therefore, this study addresses this research gap by developing a context-specific digital transformation model for wood waste craft SMEs in Gianyar Regency, Bali.

Overall, the reviewed literature indicates that digital transformation, value chain integration, and export readiness are closely interconnected. However, previous studies have rarely integrated these three dimensions into a practical implementation framework specifically designed for wood waste craft SMEs. This gap provides the foundation for developing the proposed digital transformation model.

Accordingly, this study addresses the identified research gap by developing an applied digital transformation model that integrates value chain activities and export readiness within the context of wood waste craft SMEs. Unlike previous studies that primarily examine digital adoption or SME competitiveness separately, this study proposes an integrated framework tailored to the operational characteristics of craft-based SMEs utilizing recycled wood materials.

The objective of this study is to develop and evaluate an integrated digital transformation model that supports production efficiency, quality assurance, traceability, and international market accessibility. The proposed model contributes theoretically by integrating digital transformation, value chain improvement, and export readiness into a practical framework.

2 Methodology

2.1 Research Design

This study employed an applied qualitative research approach to develop and evaluate a practical digital transformation model for wood waste craft SMEs. An applied qualitative approach was selected because it emphasizes solving real-world industrial problems while generating practical solutions that can be implemented by SMEs (Babbie, 2020; Creswell & Creswell, 2018; Miles et al., 2020). The research was conducted in Gianyar Regency, Bali, Indonesia, one of the major centers of wood waste craft industries. Purposive sampling was employed to select five key informants representing wood waste craft SMEs and relevant stakeholders. The informants were selected based on their experience in production management, business operations, digital adoption, and export activities to ensure the relevance and richness of the information obtained.

2.2 Data Collection

Data were collected through field observations, semi-structured interviews, document analysis, and focus group discussions (FGDs). These complementary methods enabled data triangulation and provided a comprehensive understanding of existing business conditions, digital capabilities, value chain challenges, and export readiness. To enhance the credibility and trustworthiness of the findings, information obtained from

interviews was cross-checked with field observations, supporting documents, and discussions with stakeholders. Data collection continued until thematic saturation was achieved, where no substantial new information emerged (Bowen, 2009; Denzin, 2017; Flick, 2018; Krueger & Casey, 2014; Kvale & Brinkmann, 2015). To ensure the credibility of the findings, triangulation was applied by comparing information obtained from interviews, field observations, document analysis, and focus group discussions. This approach enhanced the validity and consistency of the qualitative data.

2.3 Data Analysis

The collected data were analyzed using thematic analysis integrated with a value chain perspective. Interview transcripts, field notes, and supporting documents were first subjected to open coding to identify recurring concepts related to digital transformation practices and operational challenges. Similar codes were then grouped into broader themes representing the digital gaps experienced by SMEs. Subsequently, these themes were analyzed using Porter's value chain framework to identify critical areas requiring digital intervention across resource management, production, quality control, export compliance, and market access. The analytical process served as the basis for developing the proposed digital transformation model, which was subsequently refined through discussions with participating SMEs and stakeholders.

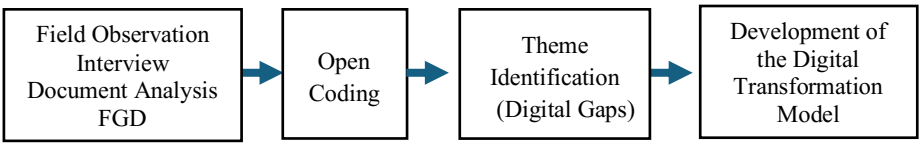


Figure 1. Framework of Research Data Analysis

The collected data were analyzed using thematic analysis integrated with Porter's value chain framework. Interview transcripts, field notes, and supporting documents were first subjected to open coding to identify recurring concepts related to digital transformation practices and operational challenges. The resulting codes were then grouped into broader themes representing digital gaps across SME operations. These themes were subsequently interpreted using a value chain perspective to identify critical areas requiring digital intervention. Finally, the synthesized findings were used to formulate the proposed digital transformation model, which was refined through expert feedback and discussions with participating SMEs. The preliminary model was subsequently reviewed through discussions with participating SMEs and relevant stakeholders to evaluate its practicality, feasibility, and applicability before the final model was established.

3 Result and Discussion

3.1 Existing Conditions, Digital Gaps, and Export Readiness Challenges of Wood Waste Craft SMEs

An assessment of existing business practices indicates that wood waste craft SMEs in Gianyar Regency continue to operate through traditional craftsmanship and manual operational systems. This approach contributes to the uniqueness and cultural value of the products; however, it also limits production efficiency, scalability, and the establishment of systematic documentation mechanisms (Hai et al., 2016; Hendriyana et al., 2025). Field observations and interviews indicate that most participating SMEs continue to rely on handwritten production records and manual inventory management. None of the participating SMEs had implemented an integrated digital system for documenting raw material sourcing, production processes, product specifications, labor allocation, and production outputs. This finding indicates that operational information remains fragmented across business functions, limiting managers' ability to monitor performance, evaluate productivity, and make evidence-based business decisions. Consequently, data availability for performance evaluation and strategic decision-making remains inadequate (Li et al., 2018).

Interviews with the five participating SMEs consistently revealed that none had established standardized digital quality control procedures. Product quality assessment was performed visually by experienced artisans without documented inspection criteria. Consequently, production quality varied across batches, making it difficult to ensure consistency required by international buyers. Product evaluation is generally based on the experience of individual artisans rather than documented quality assurance procedures. This situation leads to inconsistency in product quality and creates challenges in meeting the expectations of international buyers who demand standardized products and transparent production processes (Humphrey & Schmitz, 2002; Nadvi, 2008). Interview results further revealed that product inspection was primarily based on artisans' experience rather than documented quality standards, resulting in variations in product consistency and production records. An interview participant stated that product quality assessment still depends largely on individual experience rather than standardized procedures. Interview findings indicated that all participating SMEs relied primarily on manual production records and conventional inventory management, while none had implemented an integrated digital documentation system. Participants also emphasized that product quality assessment was predominantly based on artisans' experience rather than standardized digital documentation, resulting in inconsistencies across production batches.

From a sustainability perspective, traceability of wood waste materials remains insufficient. Many SMEs have not implemented documentation systems that record the origin, type, and utilization of recycled wood materials. In international markets, especially those emphasizing sustainable and environmentally responsible products, transparent traceability has become increasingly important as evidence of responsible resource management and circular economy practices (Ahmed et al., 2022; Geissdoerfer et al., 2017; Rizos et al., 2016).

In marketing activities, SMEs have adopted basic digital tools such as social media and online communication platforms. Nevertheless, digital utilization remains fragmented because marketing activities are not integrated with inventory management, production planning, quality documentation, and customer relationship management. This fragmentation reduces the strategic benefits of digital transformation in strengthening the overall SME value chain (Bharadwaj et al., 2013; Yousaf et al., 2021).

These findings demonstrate that the main challenge faced by wood waste craft SMEs is not merely the lack of digital technology adoption but the absence of an integrated digital system that connects all stages of the value chain. Therefore, digital transformation should be designed as a comprehensive strategy that integrates production efficiency, quality assurance, sustainability documentation, and market accessibility (Teece, 2018; Vial, 2019).

Interview findings indicate that all participating SMEs relied on manual record-keeping for production and inventory management. Furthermore, none had implemented an integrated digital system for documenting raw material sourcing, production activities, and product quality.

Table 1. Key Findings of Existing Conditions and Digital Gaps

Value Chain Activity	Existing Practice	Digital Gap	Impact on Export Readiness
Raw material sourcing	Manual recording	No traceability	Difficult to prove sustainable sourcing
Production	Manual scheduling	No production monitoring	Low production efficiency
Quality control	Visual inspection	No digital QC records	Inconsistent product quality
Documentation	Paper-based	No digital documentation	Difficult to meet export requirements
Marketing	Social media only	No CRM or analytics	Limited international market reach

As summarized in Table 1, digital gaps are evident across all primary value chain activities. These gaps collectively reduce operational efficiency, hinder compliance with international standards, and limit SMEs' readiness to participate in global markets. Therefore, digital transformation should be implemented as an integrated business strategy rather than as isolated technological initiatives. The digital gaps identified in Table 1 indicates that weaknesses occur throughout the SME value chain rather than within isolated business functions. Consequently, improving export readiness requires an integrated digital transformation strategy encompassing resource management, production, quality assurance, documentation, and market access.

Table 2. Interview Summary

Informant	Main Findings
SME 1	Manual inventory
SME 2	No traceability
SME 3	No export documentation
SME 4	Manual QC
SME 5	Limited digital marketing

3.2 Value Chain Challenges and Export Readiness Issues

The value chain analysis demonstrates that export readiness depends not only on downstream marketing activities but also on upstream traceability and internal production management. Consequently, digital transformation should encompass the entire business process rather than focusing solely on digital marketing or online promotion (Kaplinsky, 2004; Kaplinsky & Morris, 2001). The value chain analysis further indicates that export readiness depends not only on downstream marketing capabilities but also on the integration of upstream traceability and internal production management. Consequently, strengthening internal digital capabilities represents a prerequisite for improving international competitiveness.

Within internal production activities, the lack of standardized operating procedures (SOPs), digital production records, and systematic quality control limits production consistency and operational improvement. These limitations reduce the ability of SMEs to satisfy international market expectations concerning quality reliability and production transparency (Gereffi et al., 2005; Humphrey & Schmitz, 2002). In downstream activities, marketing and export management remain underdeveloped. Although digital marketing through social media has been adopted, many SMEs still lack integrated digital systems for customer management, product documentation, export compliance, and market analytics. Consequently, opportunities to enter higher-value international markets remain limited (Leonidou et al., 2002; Munawar & Munawar, 2022).

Export readiness is also constrained by inadequate documentation of production processes, product specifications, sustainability practices, and quality assurance procedures. These elements are increasingly important in international trade, where buyers require transparency, consistency, and evidence of compliance with environmental and product standards (Cavusgil & Zou, 1994; Nadvi, 2008). Therefore, strengthening export readiness requires not only market expansion strategies but also improvements in internal operational systems supported by appropriate digital technologies. These findings indicate that export readiness is influenced not only by external market access but also by the maturity of internal operational systems. SMEs with limited production documentation and traceability encounter greater difficulties in complying with international buyer requirements. Therefore, strengthening internal digital capabilities represents a prerequisite for sustainable participation in global value chains.

3.3 Integrated Digital Transformation Model and Its Implications

Based on the empirical findings and value chain analysis, this study proposes an integrated digital transformation model specifically designed for wood waste craft SMEs. The model differs from previous general digital adoption approaches because it integrates digital technologies with value chain improvement, sustainability requirements, and export readiness. Therefore, the model represents the main contribution of this study by providing a practical transformation framework suitable

for resource-constrained craft SMEs in developing countries (Li et al., 2018; Munawar & Munawar, 2022). The proposed model consists of five interconnected components:

Digital Raw Material Management and Traceability. Digital inventory systems are utilized to document the source, classification, and utilization of wood waste materials. The implementation of digital traceability supports sustainable resource management and strengthens evidence of environmental responsibility required in global markets (Ahmed et al., 2022; Geissdoerfer et al., 2017).

Digital Production Management. Production activities are supported through digital recording of production schedules, material consumption, labor involvement, production capacity, and product output. Such systems improve operational monitoring, efficiency, and data-based decision-making (Li et al., 2018).

Digital Quality Control and Product Documentation. Digital quality management enables SMEs to establish standard operating procedures (SOPs), document inspection results, maintain product specifications, and ensure product consistency. These aspects are essential for improving customer confidence and fulfilling international quality expectations (Hai et al., 2016; Humphrey & Schmitz, 2002).

Digital Export Documentation and Compliance Management. Digital documentation systems facilitate the management of product information, sustainability records, packaging standards, certifications, and export-related documents. Improved documentation increases transparency and supports SME readiness to participate in international markets (Leonidou et al., 2002; Nadvi, 2008).

Digital Marketing and Global Market Access. The final component focuses on the utilization of websites, e-commerce platforms, social media, and customer data management systems to increase market visibility and strengthen communication with international buyers. Digital market integration allows SMEs to expand business opportunities and improve global competitiveness (Bharadwaj et al., 2013; Yousaf et al., 2021). The proposed model follows three implementation principles: simplicity, affordability, and adaptability. These principles ensure that digital transformation can be gradually implemented according to the financial capacity, technological readiness, and human resource capabilities of SMEs.

The proposed model also aligns with the principles of Balinese local wisdom, particularly the philosophy of Tri Hita Karana, which emphasizes harmonious relationships among humans (pawongan), nature (palemahan), and spiritual-cultural values (parhyangan). The use of recycled wood materials reflects environmental responsibility through waste reduction and resource conservation, while digital traceability provides transparent evidence of sustainable sourcing practices.

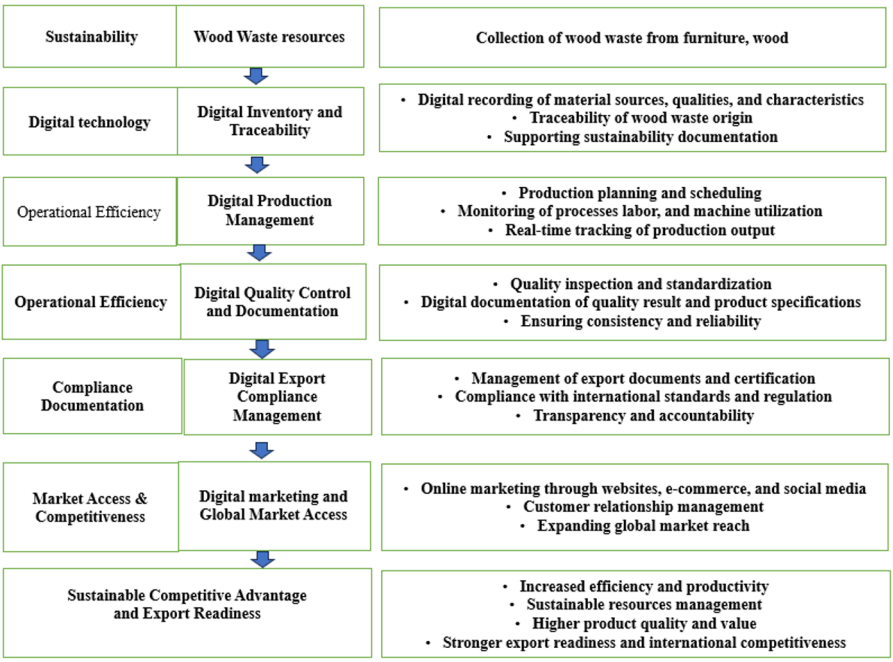


Figure 2. The Proposed Digital Transformation Model for Wood Waste Craft SMEs

Figure 2 illustrates the proposed digital transformation model developed from the empirical findings of this study. The model demonstrates that digital transformation should be implemented sequentially across resource management, production, quality assurance, export compliance, and market development to strengthen value chain integration and improve export readiness. Unlike previous studies that primarily discuss digital technology adoption, this model integrates sustainability, local wisdom, traceability, and export-oriented capabilities into a comprehensive framework specifically designed for wood waste craft SMEs.

Compared with previous studies that primarily focus on digital technology adoption or value chain upgrading independently, the proposed model integrates digital transformation, sustainability-oriented traceability, and export readiness into a single implementation framework. This integration represents the principal novelty of the study and provides a practical roadmap that can be adapted by craft-based SMEs in developing countries.

The proposed model can also serve as a practical reference for government agencies and SME development institutions in designing digital empowerment programs that support sustainable industrial development. Beyond addressing the operational challenges identified in this study, the proposed model also offers broader theoretical and practical contributions.

Practical Implications of the Proposed Model. The proposed model provides a practical roadmap for SMEs seeking to improve operational efficiency, sustainability

compliance, and international competitiveness. Furthermore, the model can support government agencies and SME development institutions in designing targeted digital capacity-building programs and export facilitation initiatives.

From a theoretical perspective, this study extends the digital transformation literature by demonstrating that value chain integration and export readiness should be treated as complementary dimensions of SME digitalization. Rather than emphasizing technology adoption alone, the proposed model highlights the strategic integration of digital inventory, production management, quality assurance, traceability, export compliance, and digital marketing into a unified framework.

4 Conclusion

This This study developed an integrated digital transformation model to strengthen value chain performance and enhance export readiness among wood waste craft SMEs in Gianyar Regency, Bali. The findings indicate that limited digital integration, inadequate quality control documentation, weak traceability systems, and insufficient export documentation remain the main barriers to SME competitiveness. To address these challenges, the proposed model integrates digital inventory and traceability, production management, quality assurance, export compliance, and digital marketing into a practical framework characterized by simplicity, affordability, and adaptability. The study contributes to the digital transformation literature by integrating value chain improvement and export readiness into a context-specific model while providing a practical reference for SMEs, government agencies, and supporting institutions in designing digital empowerment programs.

This study is limited to selected wood waste craft SMEs in Gianyar Regency and a limited-scale model evaluation. Future research should validate the proposed model across broader SME sectors and geographical contexts using quantitative or mixed-method approaches, while exploring advanced technologies such as the Internet of Things (IoT), artificial intelligence (AI), and blockchain to further enhance traceability and operational performance. Overall, the proposed model demonstrates that digital transformation is a strategic enabler of sustainable competitiveness and international market readiness rather than merely the adoption of digital technologies.

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