

## Inhibiting factors in digital supply chain implementation: Technology, organization, and environment framework study of the stilt-house industry in Tomohon City

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### ABSTRACT

Digital transformation has reshaped supply chain management, yet adoption among small, traditional enterprises remains uneven. This study analyzes the factors inhibiting Digital Supply Chain (DSC) implementation among stilt-house (rumah panggung) producers in Tomohon City, a wood-based craft industry of cultural significance in North Sulawesi. A qualitative exploratory case study was analyzed through the Technology-Organization-Environment (TOE) framework. Data came from eight informants (four owners, two employees, one timber supplier, one customer), selected purposively, through participant observation, semi-structured interviews, and documentation, and were analyzed with the Miles–Huberman–Saldaña interactive model, with source and technique triangulation. DSC implementation remains simple and not integrated: electric machinery in production, smartphones in marketing, and phone calls and WhatsApp in procurement operate as isolated applications. Barriers appear in all three TOE contexts: cost, limited electrical infrastructure, and unavailable equipment (technology); comfort with conventional systems despite adequate basic competence (organization); and supplier distance and unmet expectations of government support (environment). Informants consistently reported benefits from the technology in use, so barriers constrain the depth and integration of adoption rather than negate its value. The case also suggests, as an interpretation, that some manual work (e.g., hand-carving) persists as valued craft practice rather than an unmet digital need, qualifying deficit-based readings of traditional industries.

**Keywords:** digital supply chain; inhibiting factors; Technology-Organization-Environment (TOE); traditional craft industry; qualitative case study

**JEL Classification:** L23; L73

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### 1. Introduction

Digital transformation has reshaped supply chain management across sectors,

including small and medium enterprises. A Digital Supply Chain (DSC) integrates digital technology into supply-chain

activities to improve efficiency, transparency, and the speed of information flow among business actors (Khan et al., 2023), supports real-time information exchange and resilience (Elock and Break, 2023), and is considered able to enhance MSME competitiveness (Zainurrafiqi and Gazali, 2024). Deral et al. (2024) found, however, that financial, organizational, human-resource, technological, and data-management barriers keep digital transformation from running optimally.

DSC implementation in MSMEs and traditional industries continues to face limited resources, low digital literacy, insufficient organizational readiness, high implementation cost, and concern about system complexity (Setiawan and Wijayanti, 2024; Putri et al., 2025). Permadi (2025) and Sitompul et al. (2025) likewise point to digital infrastructure, literacy, financing, and policy support as decisive.

The stilt-house (rumah panggung) industry in Tomohon City is a traditional industry of cultural and economic importance in North Sulawesi. Production spans timber procurement, production by skilled craftsmen, and marketing and distribution, but most of this activity remains conventional, with manual record-keeping and communication that is not digitally integrated.

Preliminary observation showed that procurement, production, and distribution rely on experience and face-to-face communication; material waste persists because no system supports material planning or inventory control; marketing depends on word of mouth and repeat customers; and orders, stock, and customer data are recorded in simple notebooks. As Table 1 shows, production is concentrated in a few historically established centers, with Woloan Satu holding the largest share.

**Table 1. Stilt-house producer distribution in Tomohon City**

| Producing Area    | Number of Producers |
|-------------------|---------------------|
| Kamasi            | 15                  |
| Taratara Tiga     | 3                   |
| Woloan Satu       | 47                  |
| Woloan Satu Utara | 18                  |
| Woloan Dua        | 10                  |
| Kakaskasen Dua    | 1                   |
| Woloan Tiga       | 2                   |
| Kayawu            | 1                   |
| Kakaskasen        | 1                   |
| Kolongan          | 1                   |

*Source: Primary data, processed (2026)*

Digital platforms could strengthen competitiveness and the monitoring of stock and production in this industry (Minasa et al., 2024), yet this potential has not been realized owing to the absence of an integrated system and limited capacity to use digital technology fully.

Barriers are not technological alone. In the Technology-Organization-Environment (TOE) perspective, adoption depends on technological readiness, organizational conditions, and external support such as government policy (Soeprapto et al., 2026), and Indonesian MSMEs face low digital readiness amid a business environment that does not yet fully support digitalization (Purnomo and Purwandari, 2024).

Most DSC-barrier research addresses MSMEs broadly. TOE has been applied to craft-adjacent settings: Soeprapto et al. (2026) examine TOE readiness, ambidextrous capabilities, and resilience in craft SMEs, a readiness-and-performance question rather than one about what holds back digital supply-chain implementation, and Dafitri and Daryani (2025) apply a TOE-based qualitative framework to culinary MSMEs. This study differs in three ways: its setting is a culturally embedded wood-craft industry; it draws on owners, employees, a supplier, and a

customer along one chain; and it distinguishes manual work retained as valued craft practice (such as hand-carving) from manual work retained for lack of a digital alternative, a distinction that deficit-based framings (manual as backward, digital as progress) tend to obscure.

Three research questions guide the study: (1) how is DSC currently implemented among stilt-house business actors in Tomohon City, including the perceived benefits of the technology in use (treated as an emergent theme rather than a TOE construct); (2) which technical and non-technical factors inhibit implementation; and (3) how do these factors inhibit its success.

## **2. Literature review**

### **Supply chain management and digital supply chain**

Supply Chain Management (SCM) is the strategic coordination of business functions within and across firms to improve the long-term performance of firms and the chain as a whole (Win et al., 2025), integrating suppliers, factories, and warehouses so that products reach customers at the right quantity and time at minimum system cost (Gunawan and Wahyuni, 2024). Concepts such as Just-In-Time and Vendor-Managed Inventory depend on real-time information exchange (Saputra et al., 2025; Petropoulos et al., 2026), and SCM is commonly structured into upstream, internal, and downstream components (Nasirly et al., 2024).

A DSC develops and integrates supply-chain processes with information technology, such as big data analytics, blockchain, and the Internet of Things, to accelerate and simplify the flow of information, products, and services (Agusfiano et al., 2023). A key benefit is supply-chain visibility (Barratt and Oke, 2007), of which the digital supply-chain twin is one manifestation (Ivanov and Dolgui, 2021); He et al. (2024) add faster

response to market change, smoother upstream-to-downstream coordination, better demand forecasting, and greater trust among partners.

### **Technology-Organization-Environment (TOE) framework**

The TOE framework of Tornatzky and Fleischer holds that adoption of innovation depends on technical capability, organizational readiness, and a supportive external environment (Baker, 2012; Tornatzky and Fleischer, 1990, as cited in Rachmawaty et al., 2025). The technology context covers complexity, compatibility, relative advantage, and readiness (Petropoulos et al., 2026); the organization context covers management support, structure, human resources, and culture, with top management the principal architect of SME adoption decisions (Faiz et al., 2024); and the environment context covers competitive pressure, government policy, market conditions, and infrastructure support (Bilad et al., 2026). The contexts interact, so organizations must balance infrastructure against external pressures (Soeprapto et al., 2026).

### **Prior empirical studies**

Prior studies, largely qualitative, identify consistent barriers. Cahyadi et al. (2023), in a survey of 120 MSMEs in Denpasar, found that technology, environment, management, organization, knowledge, human-resource, and financial factors jointly shape digital-adoption readiness. Putri et al. (2025) found low digital literacy, limited awareness of benefits, limited capital, and comfort with traditional methods in a non-adopting MSME; Aisyah et al. (2023) identified IT personnel, strategy, and leadership commitment as success factors and scarce skilled IT staff as the main barrier; and Frediansyah and Tricahyono (2023) found limited human resources, high cost, inadequate infrastructure, and low literacy. Endey et al. (2025) found that information

technology improved administrative efficiency and coordination in supply-chain management, though integration with external platforms remained a challenge.

Internationally, Pourmorshed and Durst (2022) found limited digital competence, resistance to change, high cost, and weak inter-actor integration to be the main barriers in European SMEs' digital supply chains; Butt et al. (2025) and Butt and Alghababsheh (2025) reported technological limitations, high investment cost, unclear regulation, and low human-resource and organizational readiness. Dafitri and Daryani (2025) found digital literacy dominant in culinary MSMEs; Febriana et al. (2025) found largely manual, experience-based operations in tofu MSMEs; and Hartono et al. (2025) found low literacy, limited infrastructure, and high cost in a roof-tile MSME.

Nearly all of these studies address MSMEs in general rather than a traditional, culturally embedded wood-craft industry with an independently managed, non-integrated supply chain. This study addresses that gap through a TOE lens and asks whether a craft context changes how manual work should be read in barrier analyses.

## Research propositions

Five propositions guided data collection and analysis:

**Proposition 1:** DSC implementation in the stilt-house industry has not yet run optimally, given conventional operating systems, manual record-keeping, and traditional marketing (Putri et al., 2025; Permadi, 2025).

**Proposition 2:** DSC implementation is influenced by inhibiting factors from the technology, organization, and environment dimensions (Tornatzky & Fleischer, 1990, as cited in Rachmawaty et al., 2025).

**Proposition 3:** The technology factor (infrastructure, system integration, ease of use, investment cost, data security) inhibits DSC implementation (Deral et al., 2024).

**Proposition 4:** The organization factor (human-resource competence, owner commitment, readiness, culture, financial capability) inhibits DSC implementation (Simorangkir et al., 2025; Cahyadi et al., 2023).

**Proposition 5:** The environment factor (government support, supplier relationships and distance, market conditions) inhibits DSC implementation (Sitompul et al., 2025; Permadi, 2025; Bilad et al., 2026).

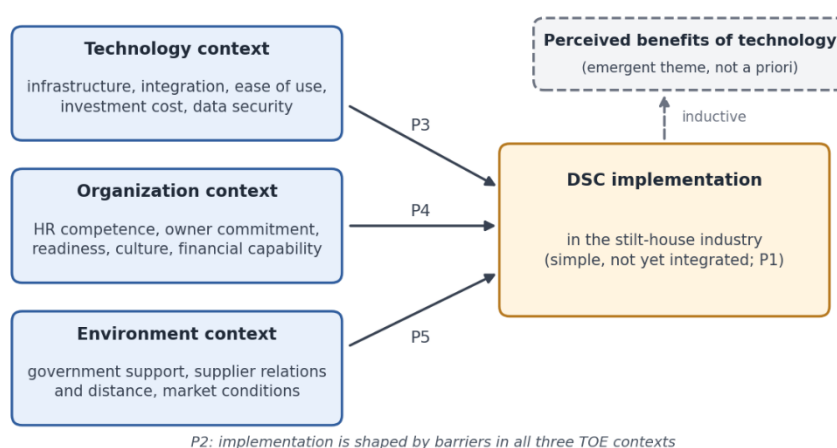


**Figure 1. Research framework: TOE contexts and DSC implementation**

### 3. Research method

This study uses a qualitative, exploratory case-study design to understand in depth the factors inhibiting DSC implementation in the stilt-house industry, a unique entity with cultural and traditional elements (Sugiyono, 2023; Paparini et al., 2021). Fieldwork took place in Woloan, West Tomohon District, Tomohon City, from May 2026. The four Woloan areas account for 77 of the 99 mapped producers (about 78 percent; Table 1), so the findings describe the Woloan-based segment of the industry rather than every producer in Tomohon City.

Purposive sampling (Sugiyono, 2023) selected informants in four categories: owners (key informants on decisions, supply-chain management, and technology adoption), employees (day-to-day procurement, production, and distribution), the raw-material supplier (timber procurement and external factors), and the customer (ordering and the end of the chain). Eight informants were included (Table 2); the owners' businesses have operated for 2, 20, 20, and 25 years. The single supplier and customer are treated as single-informant perspectives. The number of informants was determined by data saturation, the point at which additional informants no longer yielded significant new information.

Primary data (collected directly) and secondary data (existing sources) were gathered (Sholihin and Anggraini, 2021; Adiwijaya et al., 2024) through passive participant observation, semi-structured interviews guided by a protocol, and documentation (Sugiyono, 2023). Credibility was established through source

triangulation (across owners, employees, and other informants) and technique triangulation (across observation, interviews, and documents) (Sugiyono, 2023; Mili et al., 2026).

Data were analyzed with the interactive model of Miles, Huberman, and Saldaña (as presented in Sugiyono, 2023): data collection, data condensation, data display, and conclusion drawing and verification, iterated throughout fieldwork. The three TOE contexts served as a priori categories; one further theme, the perceived benefits of the technology in use, emerged inductively during condensation and is reported separately.

### 4. Result and discussion

#### General description of the research object

The stilt-house industry is a traditional craft industry centered in Woloan, producing houses of distinctive Minahasan character that carry cultural value and economic potential; production is generally independent, by owners with family members and skilled labor. The process runs from timber procurement through processing, fabrication, and assembly to marketing and delivery, linking suppliers, workers, and customers in one flow of materials, information, and products. DSC implementation is at an early stage: digital technology is used in some activities but is not integrated, and its extent varies across business actors.

#### Informant profile

Eight informants in four categories participated (Table 2); they are numbered 1 to 8 in table order, and quotations carry this number.

**Table 2. Informant classification**

| Code               | Name | Role            | Notes                         |
|--------------------|------|-----------------|-------------------------------|
| PP1 / Informant 1  | Ne   | Owner           | 25 years running the business |
| PP2 / Informant 2  | Fi   | Owner           | 20 years running the business |
| PP3 / Informant 3  | Ys   | Owner           | 2 years running the business  |
| PP4 / Informant 4  | Ye   | Owner           | 20 years running the business |
| KRY1 / Informant 5 | Fi   | Employee        | 1 year employed               |
| KRY2 / Informant 6 | Yp   | Employee        | 1 year employed               |
| PL1 / Informant 7  | Ka   | Customer        | Individual customer           |
| SP1 / Informant 8  | Ri   | Timber supplier | 15 years in the trade         |

*Source: Primary data, processed (2026)*

### Current condition of DSC implementation

Technology use is underway but simple. The technologies most often mentioned were electric machinery in production and smartphones in marketing; production is faster, though tasks such as carving remain manual.

*"For construction and assembly, about 90 percent already uses technology such as electric machinery, while about 10 percent is still done manually."*

— PP1 / Informant 1, Stilt-House Business Owner

*"For marketing, we are already assisted by advanced technology such as smartphones, but for the production of the stilt house itself, we generally still use traditional technology and manual methods."*

— PP4 / Informant 4, Stilt-House Business Owner

No digital system connects procurement, production, marketing, inventory, and distribution. Supplier Roni (Informant 8) reported that owners order timber by phone and WhatsApp, which eases communication across considerable distance: "Ordering raw wood materials only uses the WhatsApp application and phone calls." This is simple communication-application use, not an

integrated procurement system. The customer, Khansa (Informant 7), learned of the stilt house through family and ordered directly at the Woloan site, describing service, quality, and delivery as good; in this one account, ordering remained direct and in person.

### Technology factor

The technology factor emerged as a central finding. The clearest barriers were limited availability of technology, supporting infrastructure, and the cost of more advanced technology; the technology in use helps but has not eliminated manual work.

*"There still is [a gap], such as a profiling machine that we don't have yet."*

— PP1 / Informant 1, Stilt-House Business Owner

Yohanes cited electrical infrastructure as a barrier, as his business has run for only two years, and noted that technology use was limited by cost.

*"I face an obstacle in applying technology, namely supporting technology infrastructure (electrical infrastructure)."*

— PP3 / Informant 3, Stilt-House Business Owner

Not every informant reported a technology barrier: employee Feri (KRY1) and, according to interview summaries,

owners Ferdi (PP2) and Yopie (PP4) reported no difficulty or significant barriers, considering current technology applied to its fullest. Perceptions of barriers thus differ with need, business condition, and desired technology level.

Business age may matter: the only explicit mention of electrical infrastructure came from Yohanes (PP3), whose business is two years old, whereas among the three owners with 20 to 25 years in business, Nonnie (PP1) cited an equipment gap and the others no significant barriers. With four owners this is a candidate explanation, not a tested pattern.

### Organization factor

Competence in using existing technology was generally not experienced as a barrier: Nonnie, Ferdi, Yohanes, and Yopie reported that they and their workers understand the technology used, and employees Feri and Yosep reported no difficulty, Yosep citing the planing and cutting machines.

A habit-based barrier was also evident. Yohanes reported not yet using other technology because he is comfortable with the conventional system, suggesting that the ability to use available technology is fairly strong but readiness to move to newer technology has not yet formed.

*"There is no other technology I intend to use yet, because I am still used to, or already comfortable with, the conventional system."*

— PP3 / Informant 3, Stilt-House  
Business Owner

Technology operation remains internal: Nonnie identified employees as primary operators, while Yohanes and Yopie reported that owners and employees both operate it, so scaling to more complex technology would require corresponding competence.

These findings align with Simorangkir et al. (2025) on organizational readiness and resistance to change.

### Environment factor

Two matters emerged: the need for government support and the supplier relationship. Nonnie hoped for government funding for technology development in her business.

*"My hope is to receive funding from the government for technology development for my stilt-house business."*

— PP1 / Informant 1, Stilt-House  
Business Owner

Owners and the timber supplier communicate by phone and WhatsApp; Roni assessed the communication as running well and the technology as very helpful given the distance, though collecting or delivering materials still involves long travel time.

The external environment is therefore not only a source of barriers: the partnership supports smooth procurement, while distance and the unclear form of current government support are the more visible barriers (the transcripts contain only an expressed hope for support, so availability cannot be concluded). Competitive pressure and market conditions did not emerge as salient themes, so this case speaks only to government support and supplier relationships within the environment context.

### Perceived benefits and the form of barrier influence

This theme was not anticipated by the a priori propositions; it emerged inductively during data condensation. Despite the barriers, informants described the technology in use as beneficial: Nonnie said it speeds up construction and shortens working time, Ferdi said it eases work from raw material to finished product, Feri reported faster working time, and Yosep a reduced workload.

*"That technology is very helpful, such as speeding up the construction of the stilt house and shortening the working time."*

— PP1 / Informant 1, Stilt-House Business Owner

Barriers therefore constrain further escalation rather than negate existing benefit, through three patterns: cost limits acquiring additional technology; limited electrical infrastructure constrains use in still-developing businesses; and habituation to conventional systems means some owners do not feel a need for more. Adoption thus develops gradually rather than becoming integrated across the supply chain.

### Informants' expectations for technology implementation

Informants want to upgrade technology to differing degrees: Nonnie hoped for government funding and more advanced technology, including robotics; Ferdi, Feri, Yosep, and Yopie hoped for more advanced technology; Yohanes emphasized smooth operation of the business. Openness to improvement must be matched to each business's capacity and needs.

### Findings summary

Table 3 summarizes the findings across the three TOE contexts and the emergent theme of perceived benefits; in sum, DSC implementation remains simple and not integrated, and a gap persists between the technology in use and the technology aspired to.

**Table 3. Summary of findings on inhibiting factors**

| Context                             | Main Finding                                                                                            | Form of Barrier/Support                                                                                               |
|-------------------------------------|---------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------|
| Technology                          | Electric machinery used in production; smartphones for marketing; phone/WhatsApp for procurement.       | Cost of additional technology, electrical infrastructure, technology not yet available, some manual processes remain. |
| Organization                        | Owners and employees are generally able to use the technology available.                                | Habituation to and comfort with the conventional system can inhibit adoption of new technology.                       |
| Environment                         | Supplier communication is good and technology helps given distance; hope for government support exists. | Supplier distance affects travel time; government funding support remains an unmet expectation.                       |
| Perceived benefits (emergent theme) | Technology speeds up work, eases tasks, and reduces workload.                                           | Benefits are already felt, but not all supply-chain activities are yet digitally integrated.                          |

*Source: Primary data, processed (2026)*

### Discussion

#### DSC implementation in the stilt-house industry

The industry has adopted technology in several supply-chain activities, but this is not yet a fully integrated DSC. Digitalization is gradual and follows felt

needs, consistent with Tompunu et al. (2023) on WhatsApp and social media as marketing tools and Endey et al. (2025) on information technology easing coordination while integration remains a challenge, and echoing Simorangkir et al. (2025), who found that SMEs adapt

through incremental digitization matched to operational needs.

### **Barriers under the TOE framework**

The clearest barriers lie in the technology context (cost, electrical infrastructure, equipment availability), consistent with Deral et al. (2024). The organization context departs from the general-MSME literature, which often finds low digital literacy dominant (Dafitri and Daryani, 2025; Putri et al., 2025): here owners and employees reported adequate basic competence, and the barrier was habituation to conventional systems. In a craft industry where skills are built through long practice, the binding constraint is the perceived need to change rather than knowing how to use technology, so training and mentorship (Mintardjo et al., 2026) matter mainly for readiness to adopt more complex technology. In the environment context, the expectation of government support is consistent with Raintung et al. (2026) and Sitompul et al. (2025). Unlike Pourmorshed and Durst (2022), who report weak integration between actors, supplier communication here runs smoothly; the constraint is distance. Not every context constrains adoption equally: basic competence with available technology supports rather than inhibits implementation.

### **Form of influence on implementation success**

The barriers' influence is visible in the capacity to expand and maximize technology use: cost prevents acquiring equipment such as a profiling machine, and limited electrical infrastructure constrains early-stage businesses (Deral et al., 2024); habituation shows that barriers also reflect organizational readiness to change, consistent with Cahyadi et al. (2023). Where technology is available, informants experienced faster work and easier communication (Endey et al., 2025).

Inhibiting factors thus constrain the depth, breadth, and continuity of implementation rather than eliminate its benefit.

### **Manual work as craft value versus manual work as digital deficit**

Nonnie estimated that about 10 percent of construction and assembly is still manual, Yohanes noted that some parts are done by hand, and carving remains manual even where electric machinery is used extensively. MSME digitalization research often reads manual work as a deficit. Here, however, the technology gaps informants named concern missing machinery and electrical infrastructure, and none of the reported excerpts presents the remaining manual tasks as a problem. This is consistent with reading hand-carving as a retained craft practice rather than an unmet digital need; it is the authors' interpretation, not an informant statement. If sustained, programs that treat all manual work as a digitalization target risk misreading what craft producers value; support is better directed at order and stock recording, procurement, and marketing than at production steps that define the craft.

### **Synthesis**

DSC implementation success is not determined by owning tools alone; it also depends on capacity to provide infrastructure and financing, readiness to change, and relationships with external parties, reinforcing Cahyadi et al. (2023) and Deral et al. (2024) and supporting TOE as a framework for DSC implementation. It also suggests a boundary condition: in a traditional-craft context, what producers regard as worth keeping manual may need to be assessed alongside the three TOE contexts before manual work is read as a barrier.

## **5. Conclusion**

This study shows that Digital Supply Chain (DSC) implementation among stilt-

house producers in Woloan, Tomohon City, is underway but simple and not integrated: electric machinery in production, smartphones in marketing, and phone calls and WhatsApp in procurement have sped up work and eased communication, while part of the process, notably carving, remains manual. Under the TOE framework, the technology barriers are cost, electrical infrastructure, and equipment availability; in the organization context basic competence is relatively adequate but habituation to the conventional system is the main barrier; and in the environment context supplier distance is an obstacle while government support remains an unmet hope. These barriers constrain the depth and integration of adoption rather than erase the benefit of the technology already in use. Theoretically, the study extends TOE research to a culturally embedded craft industry, showing that the contexts operate with unequal force, and suggests, as a proposition for further testing from a single case, a boundary condition: heritage value may need to be assessed alongside the three contexts before manual work is read as a barrier.

Practically, the Tomohon City Government is expected to provide financing assistance, facilitate technology procurement, improve electricity infrastructure, and offer training and mentorship on digital technology for marketing, record-keeping, material management, and communication, while owners are encouraged to expand technology use gradually according to need and capacity, starting with simple tools such as smartphones, WhatsApp, and record-keeping applications, and to involve employees in training. Three limitations apply: the study is a single case bounded to Woloan (about 78 percent of mapped producers) and excludes other centers such as Kamasi; the small informant pool (eight, with one supplier and one customer) means upstream and

downstream claims rest on single accounts and the association between business age and barriers could not be tested; and as a qualitative case study it does not support statistical generalization. Future research could add informants and locations, stratify owners by business age, test the craft-value interpretation directly with craftsmen, and compare businesses of different scale.

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