

7th International Conference on Industry of the Future and Smart Manufacturing  
(former International Conference on Industry 4.0 and Smart Manufacturing)

## Investigating Barriers to Supply Chain Visibility and Implications for Transparency in Nigeria

Funlade T. Sunmola<sup>a,\*</sup>, Uje D. Apeji<sup>b</sup>

<sup>a</sup>*School of Physics, Engineering, and Computer Science, University of Hertfordshire, Hatfield, UK*

<sup>b</sup>*Department of Business and Law, Southampton Solent University, Southampton, UK*

---

### Abstract

In an era where supply chain resilience has become essential, achieving visibility remains challenging for enterprises in developing economies like Nigeria. This study investigates the primary barriers to supply chain visibility (SCV) in Nigeria and their implications for transparency. The research design employed draws on survey data from 204 supply chain professionals across diverse industries in Nigeria. The analysis was structured using the Context, People, Process, and Technology (CPPT) framework. The findings reveal that the most significant barriers are not necessarily technological in nature but are rooted in contextual and institutional conditions. Poor transport infrastructure, regulatory and customs delays, and unreliable power supply emerged as the top three obstacles. There is a perceived negative relationship between these barriers and firms' ability to achieve transparency, underscoring how operational opacity undermines stakeholder trust. The study also highlights the possible mediating role context plays, that is, for example, technological adoption enhances visibility only when supported by reliable infrastructure and efficient processes. This research empirically validates and extends the CPPT framework by demonstrating that, context and process form the foundation on which people and technology can operate effectively. Practically, it offers policymakers insights into the critical role of infrastructural and institutional reforms in enabling visible and transparent supply chains.

© 2025 The Authors. Published by Elsevier B.V.

This is an open access article under the CC BY-NC-ND license (<https://creativecommons.org/licenses/by-nc-nd/4.0>)

Peer-review under responsibility of the scientific committee of the 7th International Conference on Industry of the Future and Smart Manufacturing (former International Conference on Industry 4.0 and Smart Manufacturing)

**Keywords:** Supply Chain Visibility; Transparency; Developing Economies; Barriers; CPPT Framework.

---

---

\* Corresponding author.

E-mail address: [f.sunmola@herts.ac.uk](mailto:f.sunmola@herts.ac.uk)

## 1. Introduction

Global supply chains have been reshaped by successive disruptions from pandemics to geopolitical shocks pushing supply chain visibility (SCV) from not only a source of competitive advantage but also a strategic necessity for resilience, efficiency, and sustainability [1]–[4]. In this paper, the following definition of SCV is adopted: SCV is the extent to which relevant, timely, and accurate information about orders, inventory, shipments, and process events is accessible across organisational and network boundaries [2], [3]. Visibility can be distinguished from transparency i.e. the deliberate disclosure of selected information to external stakeholders for accountability and legitimacy [5], [6]. Essentially, while in supply chains, visibility is an internal capability that enables sensing, coordination, and control, transparency is more outward-facing choice that is often conditioned by governance, risk, and stakeholder expectations [5], [6]. Companies are increasingly embracing supply chain visibility, driven by the belief that transparency among stakeholders can unlock significant performance improvements. Leading sustainable organisations, for instance, set themselves apart by continuously improving visibility while ethically sourcing, innovating, distributing their products and transitioning towards full transparency. Despite its appeal, achieving the desired level of visibility is often difficult. It requires managing complex risks such as supply disruptions and delays, demand volatility, and compliance issues, as well as the potential loss of suppliers and customers.

Achieving end-to-end visibility remains particularly challenging in developing economies, like Nigeria. Supply chains often contend with infrastructural deficits (e.g., unreliable power and transport networks), institutional voids (e.g., weak standards and enforcement), fragmented data architectures, and heightened supply and demand uncertainty conditions that foster informational opacity and impede synchronised decision-making [7], [8], [9]. Nigeria, Africa's largest economy and a major regional logistics hub offer a compelling context in which these constraints converge across formal and informal channels, multi-tier supplier networks, and last-mile distribution. Weak visibility capabilities can inflate operating costs, prolong lead times, amplify risk exposure, and undermine transparency initiatives meant to build stakeholder trust and demonstrate compliance [10], [11].

While managerial accounts frequently acknowledge these issues, empirical evidence that systematically identifies and categorises the dominant barriers to SCV in the Nigerian context is limited. Moreover, prior studies tend to examine visibility and transparency in isolation, leaving the mechanisms through which visibility shortfalls constrain transparency outcomes (e.g., the reliability and verifiability of disclosures) [12]. Addressing these gaps, this study centers on the following. The aim of this study is to investigate the primary barriers to achieving supply chain visibility and to determine the implications for attaining transparency within key commercial sectors in Nigeria. The following two research questions were addressed.

**RQ1:** What are the dominant barriers (e.g., technological, infrastructural, regulatory, organizational) that prevent firms in Nigeria from achieving end-to-end supply chain visibility?

**RQ2:** How does a lack of supply chain visibility affect firms' ability to ensure and credibly demonstrate transparency to their stakeholders?

The paper proceeds as follows. Section 2 presents an overview of the literature on SCV and transparency, clarifying concepts and known barrier categories. Section 3 presents research design. Section 4 reports the findings on visibility barriers and their links to transparency outcomes. Section 5 discusses theoretical and managerial implications, and Section 6 concludes with contributions and avenues for future research.

## 2. Literature Review

Broadly, visibility in the supply chain is the extent to which actors within a supply chain have access to, or share, mutually benefiting information that is key and useful to their operations and supports decision making [2]. SCV enables firms to detect disruptions early and respond with agility, making it a prerequisite for resilience and responsiveness [1], [13]. Transparency, though closely related, is conceptually distinct. It involves the intentional disclosure of accurate and relevant information to stakeholders to promote trust, accountability, and legitimacy [14].

In essence, visibility represents the internal capacity of a firm to access and analyse supply chain data, while transparency is the external act of sharing that information with stakeholders. Without visibility of upstream and downstream activities, firms cannot credibly provide transparency in areas such as delivery timelines, sourcing practices, or sustainability compliance [15]. This extends beyond internal visibility and involves actively sharing information about the supply chain with external stakeholders, such as customers, investors, and the public. Transparency aims to build trust and accountability by making information accessible and understandable to those who have a vested interest in the company's operations.

### **2.1. The CPPT Framework for Analyzing Barriers**

To examine the barriers to SCV systematically, this study applies the Context–People–Process–Technology (CPPT) framework, which emphasises that organisational capabilities are shaped by the interaction of external conditions, human factors, workflows, and technology [16].

The context dimension represents the external environmental and institutional factors such as infrastructure, regulatory quality, policy stability, and logistics efficiency, all of which shape the feasibility of visibility initiatives. People refer to the human element including skills, leadership commitment, and collaboration necessary for effective information sharing and decision-making. Process represents the workflows, rules, and standard operating procedures that govern data exchange, while Technology is associated with the tools, platforms, and digital infrastructures (e.g., ERP, IoT, and blockchain systems) that enable real-time information capture and dissemination.

Research in developed economies frequently highlights technological integration and inter-firm collaboration (Technology and People) as primary enablers of SCV [17]. However, evidence from emerging and developing contexts shows that Context and Process frequently exert stronger influence. For instance, [16] demonstrated that overlooking contextual and process readiness often derails innovation and digital-adoption efforts. Similarly, [12] found that visibility in sustainable supply chains is primarily driven by contextual awareness, institutional alignment, and the integration of human and technological capacities within local environments.

Recent studies have further highlighted that context-awareness the ability of digital systems to sense and adapt to environmental conditions is critical for effective visibility management. Blockchain-based systems, when designed around local infrastructure and institutional realities, can provide auditable and secure data-sharing mechanisms that enhance both trust and transparency [30]. Despite the growing attention to SCV and transparency, there remains limited empirical work examining how contextual and process barriers interact to constrain visibility in developing economies.

### **2.2. Supply Chain Challenges in Developing Economies**

Empirical evidence demonstrates that developing countries face distinct structural challenges that constrain visibility. In Nigeria, poor transport infrastructure, limited digitalisation, weak institutional support, and the prevalence of informal markets create persistent opacity in supply chains [11], [18]. These deficits heighten uncertainty, which has long been identified as a primary impediment to visibility [12].

Recent systematic reviews confirm that SCV is a foundational element of sustainable and resilient supply chains, yet significant gaps exist in understanding how visibility can be implemented in complex, resource-constrained environments [19], [20]. Principles such as data accuracy, timeliness, and accessibility are frequently compromised in Nigeria, where infrastructural weaknesses and inconsistent regulatory oversight hinder the reliability of supply chain information [21], [22].

Moreover, collaboration among stakeholders an essential antecedent for transparency remains underdeveloped in the Nigerian context due to low trust, limited training, and weak inter-organisational linkages [23], [24]. While technologies such as IoT, blockchain, and AI offer promise, their adoption is slowed by high costs, insufficient

technical expertise, and regulatory uncertainty [25]. Thus, contextual and process barriers dominate, reinforcing the need for a framework such as CPPT to classify and address these challenges systematically. The dominant barriers to supply chain visibility identified are listed in Table 1.

**Table 1. Dominant Barriers to Supply Chain Visibility in Developing Economies.**

| Category                  | Specific Barrier              | Description/Impact of visibility                                                                                                                                                                                             | Examples from a Developing Economy Context                                                                                                                                    | Sources           |
|---------------------------|-------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------|
| Infrastructural           | Poor Transport Networks       | Unpredictable road conditions, poor congestion, and limited rail access lead to highly variable transit times. This creates “black holes” where goods cannot be reliably tracked, making accurate ETAs impossible.           | A truck carrying produce in rural Nigeria gets stuck for days on a washed-out road, an event completely invisible to the central planning system                              | [18], [38], [39]. |
|                           | Unreliable Power Supply       | Frequent power outages disrupt the operation of essential visibility hardware like servers, computers, barcode scanners, and warehouse management systems (WMS), causing gaps in data collection and transmission.           | A warehouse in Pakistan experiences a power cut, forcing staff to resort to manual, paper bases tracking for several hours, breaking the digital data trail                   |                   |
| Technological             | Low Technology Adoption       | A heavy reliance on manual processes (papers, ledgers, phone call, WhatsApp, Facebook messenger) instead of integrated digital systems. This creates information silos and prevents real-time data sharing between partners. | A distributor in Vietnam communicates inventory levels to a manufacturer via a weekly phone call, making it impossible for manufacturer to see daily stock fluctuations       | [39], [40].       |
|                           | Limited & Costly Internet     | Poor or non-existent connectivity, especially in rural areas, prevents the use of cloud-based systems and real-time tracking devices (e.g., GPS, IOT sensors)                                                                | A farming cooperative in rural Kenya cannot afford to install GPS trackers in its fleet, relying on periodic driver check in calls for location updates                       |                   |
| Financial                 | High Cost of Technology       | The significant upfront investment required for hardware (RFID, GPS) and software (ERP, WMS) is often prohibitive for the many small and medium-sized Enterprises (SMEs) that form the backbone of these economies           | A small trucking company in Brazil cannot afford to install GPS trackers in its fleet, relying on periodic driver check-in calls for location updates.                        | [39], [41].       |
| Human Capital             | Shortage of Skilled Personnel | A lack of locally available talent trained to implement, manage, and analyse data from sophisticated supply chain technologies. This leads to underutilization of any technology that is acquired                            | A company in Ethiopia invests in a n advanced analytics platforms but struggles to find data scientist to leverage its capabilities for demand forecasting                    | [39], [42].       |
| Regulatory & political    | Comple Customs & bureaucracy  | Opaque, multi-step, paper-intensive customs procedures create delays and total loss of visibility once goods reach borders/ports.                                                                                            | A shipment at Port of Lagos is held in customs for an unknown duration due to paperwork issues, with no digital status updates available to the owner.                        | [24], [39], [43]. |
|                           | Security Risks & theft        | High rates of cargo theft/hijacking force companies to be secretive about routes and schedules, the opposite of transparency. Visibility is intentionally limited to mitigate risks.                                         | A company transporting high-value electronics in South Africa uses unmarked vehicles and avoids real-time route sharing to prevent crime syndicates from targeting shipments. |                   |
| Organizational & Cultural | Lack of Trust & Data Sharing  | Deep reluctance among supply chain partners to share sensitive information (inventory levels, production schedules,                                                                                                          | A major retailer in Indonesia refuses to share POS (point-of-                                                                                                                 |                   |

|                                                                     |                                                                       |             |
|---------------------------------------------------------------------|-----------------------------------------------------------------------|-------------|
| sales data) for fear of losing a competitive/negotiating advantage. | sale) data with suppliers, causing the bullwhip effect and stockouts. | [44], [45]. |
|---------------------------------------------------------------------|-----------------------------------------------------------------------|-------------|

### 3. Methodology

This study adopted a quantitative, cross-sectional survey design to gather perceptions of supply chain visibility (SCV) barriers among professionals in Nigeria. A survey method was deemed appropriate for identifying, ranking, and generalising perceived challenges across diverse industries and organisational sizes [26]. The cross-sectional design enabled the collection of data at a single point in time, offering insights into the current state of SCV and its link to transparency outcomes. The methodological steps adopted is shown in Figure 1.

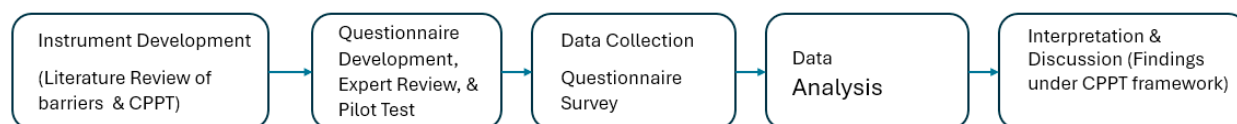


Figure 1: Methodology Flow Diagram

#### 3.1. Instrument Development

The survey questionnaire and a followed up semi-structured interview was developed based on barriers identified in the literature and structured around the Context–People–Process–Technology (CPPT) framework. For this paper, two relevant questions were asked: a) In your view, what are the main difficulties/barriers in attaining supply chain visibility? and b) Can you elaborate on your assessment of the current level of visibility for your supply chain, and does a lack of visibility directly impact on the ability of firms to ensure and demonstrate transparency to their stakeholders? 18 predefined barriers, which respondents rated on a 5-point Likert scale (1 = Not a Barrier, 5 = Very Significant Barrier). Questions also measured perceived impact on transparency (e.g., “Our firm’s ability to provide customers with accurate delivery times is... Excellent/Poor”), alongside demographic and organisational data. To ensure content validity, the instrument was reviewed in a pilot test with ten senior supply chain academics and practitioners who reviewed the instrument for clarity, relevance, and cultural appropriateness. Feedback improved the reliability of scales, simplified wording and structure, and aligned terminology with Nigerian industry standards, in line with best practices for survey design. These improvements strengthened both content validity and construct reliability, ensuring that each item accurately reflected its intended CPPT dimension.

#### 3.2. Sampling and Data Collection

A purposive sampling strategy was employed to target professionals with relevant expertise in logistics, procurement, and supply chain management. The survey was distributed via professional networks such as LinkedIn and the Chartered Institute of Logistics and Transport (CILT) Nigeria. This approach ensured that respondents had the necessary experience to provide informed responses. A total of 204 valid responses were collected, representing a response rate of approximately 35%. This rate is consistent with similar supply chain survey-based studies in developing contexts [27].

The respondents represented a diverse cross-section of Nigeria’s supply chain sector. Approximately 65% were based in Lagos, reflecting its role as the country’s logistics and commercial hub. Industry representation was broad, with strong participation from manufacturing (44%), retail (42%), fast-moving consumer goods (45%), pharmaceuticals (41%), agribusiness (43%), and logistics (44%). Firm size was balanced: 45% of respondents were employed in small and medium-sized enterprises (SMEs) (fewer than 250 employees), while 55% represented large corporations. Most respondents (78%) held middle or senior management positions, and the average industry experience was 12.5 years, ensuring that the sample reflected informed managerial perspectives.

### 3.3. Data Analysis

Survey responses were analysed using SPSS v28. To address RQ1, descriptive statistics (means, standard deviations) were used to rank the perceived barriers. The 18 individual barriers were subsequently aggregated into their CPPT categories to assess the relative significance of each domain. To address RQ2, Pearson correlation analysis was applied to test the relationship between the severity of visibility barriers and firms perceived ability to achieve and demonstrate transparency. Statistical significance was set at  $p < 0.05$ , consistent with conventional standards for social science research [28].

## 4. Findings and Analysis

The first research question explored the most significant barriers preventing Nigerian firms from attaining end-to-end SCV. Table 2 and Figure 1 presents the 18 barriers assessed by respondents, ranked by their mean score.

Table 2. Ranking of Perceived Barriers to Supply Chain Visibility in Nigeria (n = 204).

| Rank | Barrier                                        | Mean (out of 5) | Std. Dev. | CPPT Category |
|------|------------------------------------------------|-----------------|-----------|---------------|
| 1    | Poor transport infrastructure                  | 4.58            | 0.61      | Context       |
| 2    | Regulatory & customs delays                    | 4.45            | 0.75      | Process       |
| 3    | Unreliable power supply                        | 4.39            | 0.82      | Context       |
| 4    | Security risks and theft                       | 4.15            | 0.95      | Context       |
| 5    | Complex bureaucracy                            | 4.08            | 0.88      | Process       |
| 6    | High cost of technology                        | 3.82            | 1.05      | Context       |
| 7    | Lack of trust between partners                 | 3.65            | 1.12      | People        |
| 8    | Shortage of skilled personnel                  | 3.41            | 1.20      | People        |
| 9    | Low technology adoption                        | 3.33            | 1.15      | Technology    |
| 10   | Poor integration across supply chain functions | 3.29            | 1.08      | Process       |
| 11   | Misaligned incentives across partners          | 3.25            | 1.07      | People        |
| 12   | Weak leadership commitment                     | 3.22            | 1.09      | People        |
| 13   | Underdeveloped regulatory frameworks           | 3.19            | 1.14      | Context       |
| 14   | Absence of standardised data protocols         | 3.15            | 1.02      | Process       |
| 15   | Political instability and policy volatility    | 3.13            | 1.21      | Context       |
| 16   | Weak contract enforcement                      | 3.09            | 1.18      | Process       |
| 17   | Data fragmentation across systems              | 3.05            | 1.04      | Technology    |
| 18   | Resistance to organisational change            | 2.98            | 1.17      | People        |

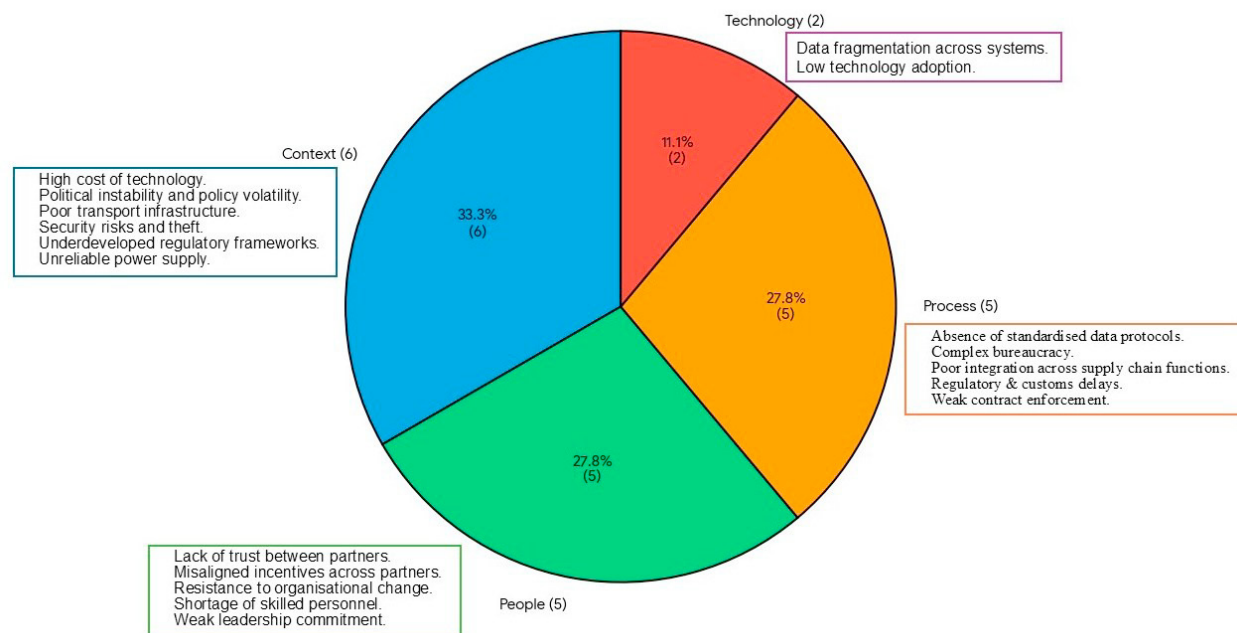


Figure 2: CPPT perceived barriers distribution

The findings reveal that the most critical barriers can be contextual and process-driven rather than technological. Three of the top four barriers poor transport infrastructure, unreliable power supply, and security risks reflect Nigeria's infrastructural and institutional environment. These systemic deficits create an environment of uncertainty and operational unpredictability, eroding firms' ability to track and coordinate supply chain flows. Process-related challenges compound these issues. Regulatory delays, complex bureaucracy, and the absence of standardised data protocols create "institutional voids" where visibility is lost. Respondents noted that customs procedures and trade administration remain largely manual and unpredictable, further amplifying uncertainty.

In contrast, barriers associated with People (e.g., lack of trust, misaligned incentives, and limited skills) and Technology (e.g., low adoption, data fragmentation) were rated lower on average, although still significant. The relative ranking suggests that firms recognise technology as an enabler but perceive contextual and regulatory constraints as the binding bottlenecks.

The aggregated CPPT categories highlights a clear hierarchy. The mean score for Process barriers (4.27) and Context barriers (4.24) far exceeded those of People (3.53) and Technology (3.33). This pattern demonstrates that, in Nigeria, advanced tools and training initiatives cannot fully address SCV gaps unless the structural and institutional environment is improved. These results align with earlier studies emphasising that infrastructural deficits, bureaucratic inefficiencies, and weak institutions are the primary obstacles to SCV in emerging markets [10], [12], [18]. In this regard, Nigeria's case illustrates that visibility shortfalls are arguably less about the absence of digital technologies and more about the systemic environment in which those technologies are deployed.

Despite widespread discourse on digital transformation, the survey findings show that "Low Technology Adoption" ranked only ninth among the 18 barriers. This suggests that the primary issue is not firms' unwillingness to adopt technology but rather the contextual realities that undermine its value. As one respondent observed: "What is the use of a multi-million Naira tracking system when the truck is stuck on a single road for three days or held at a checkpoint for no clear reason?"

This insight reflects a core finding: contextual and process failures neutralise technological solutions. Further analysis confirmed that while technology adoption was positively associated with visibility, its effect was significantly diminished in the presence of severe infrastructural barriers. This indicates a mediating relationship, where technology enhances visibility only when supported by a baseline of infrastructural and procedural stability. In other words, technology can amplify efficiency in contexts where physical infrastructure, regulatory systems, and workflows are reliable. Where these foundations are absent as is common in Nigeria the marginal returns on technology investments are limited. This explains why advanced tools such as IoT, blockchain, and ERP systems remain underutilized: they cannot overcome systemic opacity generated by infrastructural deficits, bureaucratic inefficiencies, and institutional weaknesses [29], [30], [31].

The perceived relationship between top barriers and key transparency metrics, including accurate delivery communication, shipment status updates, and product provenance assurance revealed a possible negative correlation between dominant barriers and transparency outcomes. The following results were obtained, poor transport infrastructure was correlated with reduced ability to provide accurate delivery times, regulatory and customs delays were correlated with reduced ability to communicate shipment status to partners, and security risks correlated with firms' reluctance to share route information openly.

These results demonstrate that visibility deficits directly constrain transparency. The “fog” of unpredictable infrastructure, opaque regulatory processes, and security threats prevents firms from reliably sharing operational information with external stakeholders. In some cases, firms deliberately withhold information, for example, route data to avoid compounding risks such as theft or hijacking. The consequences are severe: firms face customer dissatisfaction, strained partner relationships, and reputational risks from being unable to verify claims about delivery performance, ethical sourcing, or sustainability compliance. These findings reinforce the argument that transparency is fundamentally dependent on visibility [32], [33]. Without reliable visibility, transparency commitments risk being performative rather than actionable, undermining trust and competitiveness.

## 5. Discussion and Implications

This study's findings provide important theoretical, managerial, and policy insights into the barriers preventing effective supply chain visibility (SCV) in Nigeria. The empirical results demonstrate that Context and Process barriers dominate, while People and Technology barriers, though important, may not be as dominant given the barriers investigated. To elaborate on these results, the CPPT framework is applied as shown in Table 3.

Table 3. Discussion of Findings within the CPPT Framework

| Framework Category                  | Specific Barrier                                                             | Impact on Visibility within the Framework                                                                                                                                                                                                            |
|-------------------------------------|------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Context (The Operating Environment) | Poor Physical Infrastructure (Transport & Power)                             | The external physical environment is inherently unreliable. This unpredictability means that no matter how good the internal processes or technology are, visibility is consistently lost due to external, uncontrollable disruptions.               |
|                                     | Adverse Economic Climate (High Tech Costs & Limited Finance)                 | The market and financial environment restrict the firm's ability to invest. The economic context dictates what is feasible, often preventing the acquisition of technology needed to improve visibility, particularly for SMEs.                      |
|                                     | Volatile Socio-Political Landscape (Security Risks, Corruption, Instability) | The external social and political world is high-risk. This environment introduces unpredictable events (e.g., theft, informal demands) that actively break the formal data chain and work against the principles of transparency and predictability. |



|                            |                                                                                   |                                                                                                                                                                                                                                                     |
|----------------------------|-----------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| People (The Human Element) | Skills and Capability Gaps (Shortage of Skilled Personnel & Low Digital Literacy) | The workforce is not equipped to leverage visibility tools. Even with the best technology, a lack of human expertise leads to incorrect data entry, system underutilization, and an inability to analyse the data that is collected.                |
|                            | Cultural and Relational Barriers (Lack of Trust & Resistance to Change)           | The human mindset and inter-organisational politics create intentional information silos. A culture of mistrust or inertia means people are unwilling to share data or adopt new, transparent ways of working, regardless of the systems available. |
| Process (The Workflows)    | Inefficient & Opaque Procedures (Complex Customs & Bureaucracy)                   | Key supply chain workflows are fundamentally flawed "black boxes." Visibility is lost because the mandated processes, especially at borders, are inherently slow, manual, and not designed for transparency.                                        |
|                            | Lack of Standardisation (Manual Processes & Inconsistent Data Formats)            | The absence of agreed-upon rules for executing tasks and recording data makes aggregation impossible. Without a standard process, information from different partners is incompatible, preventing a single, clear view of the supply chain.         |
| Technology (The Tools)     | Inadequate Technological Infrastructure (Low Tech Adoption & Poor Connectivity)   | The foundational tools to capture, process, and transmit data are either absent or ineffective. The lack of appropriate hardware, software, and reliable internet means the technical capacity for real-time visibility does not exist.             |

The dominance of contextual barriers such as poor infrastructure, unreliable power supply, and security risks demonstrates that the operating environment is the primary source of opacity for Nigerian firms. In such settings, managers are often less concerned with acquiring advanced technological solutions than with ensuring that trucks can pass through roads safely or that warehouses will remain powered [15], [18]. This confirms previous research on the salience of environmental and institutional risks in developing economies, while also offering a clearer hierarchy of concerns that have not been systematically documented in prior work [34], [35].

Process barriers, particularly customs inefficiencies and bureaucratic complexity, were also found to significantly disrupt visibility. These challenges are not failures of individual firms but reflect systemic weaknesses in institutional design. Processes that are opaque and fragmented act as “black boxes” where information is lost, compounding the effects of infrastructural deficiencies [36], [37]. However, barriers related to people, such as skills shortages and resistance to change, and those related to technology, such as limited adoption and poor connectivity, were ranked lower. This should not be interpreted as a sign of irrelevance. Rather, it reflects the sequencing of priorities: firms are unable to focus on advanced workforce skills or digital integration when basic operations are undermined by systemic uncertainty in the environment and processes. It is widely argued that the human element plays a salient role in operational integrity. For instance, even when clear standards are in place, their implementation can be compromised by corrupt individuals.

From a theoretical perspective, the findings validate the CPPT framework’s relevance for analysing SCV in emerging markets, but they also suggest the need for rebalancing its dimensions. Instead of treating context, people, process, and technology as equal pillars, the Nigerian case illustrates that context and process provide the foundation upon which people and technology can operate effectively [18]. This reframing contributes to SCV theory by highlighting the mediating role of external conditions: even the most sophisticated tools or well-trained personnel cannot compensate for persistent infrastructural and institutional opacity [12].

The managerial implications of these findings are equally significant. For firms, the evidence indicates that effective visibility strategies must begin with managing the environment in which operations are embedded. This requires building resilience against infrastructural unpredictability, finding ways to navigate regulatory and customs

inefficiencies, and deploying technologies that are robust and context-appropriate rather than overly complex. Technology adoption in this context is less about acquiring advanced systems and more about ensuring that chosen tools can function reliably despite infrastructural and institutional weaknesses.

For policymakers, the study underscores the interdependence of private sector efficiency and public sector performance. Supply chain visibility is not merely an internal managerial challenge but one that is shaped by state-led investment in transport and energy infrastructure, as well as the efficiency of customs and regulatory institutions. Addressing these systemic issues is a prerequisite for enabling firms to achieve transparency and competitiveness in both domestic and international markets.

## 6. Conclusion

This paper set out to identify the dominant barriers to supply chain visibility in Nigeria and to examine their implications for achieving transparency. The findings demonstrate that there is a perception that contextual and process-related barriers such as poor infrastructure, unreliable power, security risks, and bureaucratic inefficiencies may exert a greater influence than people- or technology-related factors. These systemic weaknesses can generate a state of operational opacity that directly undermines the ability of supply chains to communicate accurately and reliably with stakeholders. In turn, this erodes trust, damages competitiveness, and constrains efforts to meet growing demands for transparency in areas such as delivery reliability, ethical sourcing, and sustainability compliance.

The paper's primary contribution lies in the assessment of visibility barriers and their interpretation through the CPPT framework. The research demonstrates that in developing economies, the path toward "smart" and visible supply chains may not necessarily always begin with digital sophistication but with addressing the physical and institutional foundations of supply chain operations. The study extends existing knowledge by suggesting a re-weighting of the CPPT framework: context and process form the base on which people and technology can effectively operate. Practically, the results provide managers and policymakers with a potential roadmap to prioritise interventions. For managers, this means investing in resilience against infrastructural unpredictability and bureaucratic inefficiencies before largely pursuing advanced technologies. For policymakers, it highlights the need to improve transport and energy infrastructure and streamline customs and regulatory systems as prerequisites for private sector efficiency. This research underscores that achieving visibility and transparency in Nigeria requires first clearing the fog at its source as highlighted in the clear hierarchy of challenges. Only then can technology and human capital fulfil their potential in delivering supply chains that are not only efficient but also credible and accountable.

This study has several limitations that inform future research directions. First, the data employed in this study is based on the perceptions of supply chain professionals, not on objective performance metrics. Second, the cross-sectional design offers only a snapshot in time, preventing analysis of trends. Third, the use of LinkedIn and professional networks may introduce sampling bias, with an overrepresentation of respondents from Lagos. Finally, the sampling may not fully represent Nigeria's diversity. Future research could address these gaps. Longitudinal studies are needed to track how visibility barriers evolve, while qualitative case studies could uncover the specific strategies firms use to overcome them. Furthermore, comparative studies across other African economies would help determine which challenges are unique to Nigeria versus those that are continent-wide.

## References

- [1] Dey, S. (2023). Surviving major disruptions: Building supply chain resilience and visibility through rapid information flow and real-time insights at the "edge". *Sustainable Manufacturing and Service Economics*, 2, 100008.
- [2] M. Barratt and A. Oke, (2007) "Antecedents of supply chain visibility in retail supply chains: A resource-based theory perspective. *Journal of Operations Management*, 25(6): 1217-1233. <https://doi.org/10.1016/j.jom.2007.01.003>.
- [3] A. Caridi, A. Crippa, A. Perego, A. Sianesi, and A. Tumino, (2010) "Do virtuality and complexity affect supply chain visibility?" *International Journal of Production Economics*, 127 (2): 372–383

- [4] F. Sunmola, P. Burgess, A. Tan, J. Chanchaichujit, S. Balasubramania, and M. Mahmud, (2023) “Prioritising Visibility Influencing Factors in Supply Chains for Resilience,” *Procedia Computer Science*, 217, pp1589–1598, doi: <https://doi.org/10.1016/j.procs.2022.12.359>.
- [5] Nilsson, F., Göransson, M., & Båth, K. (2019). Models and technologies for the enhancement of transparency and visibility in food supply chains. *Sustainable Food Supply Chains*.
- [6] Nie, W., Alem Fonseca, M., Tsolakis, N., Belligan, M., & Kumar, M. (2023). Tackling supply chain ‘blind spots’ via end-to-end visibility, traceability, and transparency: Conceptualising the role publicly data and big data analytics. *Scoping Review Paper*.
- [7] Hara, L., Guirguis, R., Hummel, K., & Villanueva, M. (2017). More than bar codes: integrating global standards-based bar code technology into national health information systems in Ethiopia and Pakistan to increase end-to-end supply chain visibility. *Global Health: Science and Practice*, 5(4): 678-685.
- [8] Ooi, T. K., Hsieh, C. H., Wang, S. M., & Huang, Y. K. (2025). Orchestrating agile omnichannel supply chain planning through big data analytics and end-to-end visibility. *The Asian Journal of Shipping and Logistics*.
- [9] Ivanov, D. (2021). Digital supply chain management and technology to enhance resilience by building and using end-to-end visibility during the COVID-19 pandemic. *IEEE Transactions on Engineering Management*, 71, 10485-10495.
- [10] Ottih, C., Cussen, K., & Mustafa, M. (2018). Building strong health supply chain systems: the visibility and analytics network approach to improving the Nigeria immunisation supply chain. *BMJ Health & Care Informatics*, 25(4).
- [11] Olutuase, V. O., Iwu-Jaja, C. J., Akuoko, C. P., Adewuyi, E. O., & Khanal, V. (2022). Medicines and vaccines supply chains challenges in Nigeria: a scoping review. *BMC Public Health*, 22(1), 11.
- [12] Apeji, U. D., & Sunmola, F. T. (2023). Sustainable supply chain visibility assessment and proposals for improvements using fuzzy logic. *Journal of Modelling in Management*, 18(3), 701-726.
- [13] Baah, C., Opoku Agyeman, D., Acquah, I. S. K., Agyabeng-Mensah, Y., Afum, E., Issau, K., ... & Faibil, D. (2022). Effect of information sharing in supply chains: understanding the roles of supply chain visibility, agility, collaboration on supply chain performance. *Benchmarking: An International Journal*, 29(2): 434-455.
- [14] Morgan, T. R., Gabler, C. B., & Manhart, P. S. (2023). Supply chain transparency: theoretical perspectives for future research. *The International Journal of Logistics Management*, 34(5), 1422-1445.
- [15] Essien, A., Chukwukelu, G. O., Kazantsev, N., & Subramanian, N. (2024). Unveiling the factors influencing transparency and traceability in agri-food supply chains: an interconnected framework. *Supply Chain Management: An International Journal*, 29(3), 602-619.
- [16] Sunmola, F. T., & Javahernia, A. (2021). Manufacturing process innovation deployment readiness from an extended people, process, and technology framework viewpoint. *Procedia Manufacturing*, 55, 409-416.
- [17] Kalaiarasan, R., Olhager, J., Agrawal, T. K., & Wiktorsson, M. (2022). The ABCDE of supply chain visibility: A systematic literature review and framework. *International Journal of Production Economics*, 248.
- [18] Oyedijo, A., Adams, K., & Koukpaki, S. (2021). Supply chain management systems in Africa: Insights from Nigeria. In *Business in Africa in the era of digital technology: Essays in honour of Professor William Darley* (pp. 121-140). Cham: Springer International Publishing.
- [19] Khan, T., Emon, M. M. H., & Rahman, M. A. (2024). A systematic review on exploring the influence of Industry 4.0 technologies to enhance supply chain visibility and operational efficiency. *Review of Business and Economics Studies*, 12(3), 6-27.
- [20] Emon, M. M. H., & Khan, T. (2024). Unlocking sustainability through supply chain visibility: Insights from the manufacturing sector of Bangladesh. *Brazilian Journal of Operations & Production Management*, 21(4), 10-14488.
- [21] Sunmola, F. T., & Apeji, U. D. (2024). Modelling supply chain visibility: a framework with considerations for manufacturing and business. *Journal of Manufacturing Technology Management*, 35(7), 1354-1374.
- [22] Sarley, D., Mahmud, M., Idris, J., Osunkiyesi, M., Dibosa-Osador, O., Okebukola, P., & Wiwa, O. (2017). Transforming vaccines supply chains in Nigeria. *Vaccine*, 35(17), 2167-2174.
- [23] Ezeh, F. S., Ogeawuchi, J. C., Abayomi, A. A., & Aderemi, O. Advances in Blockchain and IoT Integration for Real-Time Supply Chain Visibility and Procurement Transparency.
- [24] Oyeyemi, B. B., John, A. O., & Awodola, M. (2025). Infrastructure and Regulatory Barriers to AI Supply Chain Systems in Nigeria vs. the US. *Engineering Science and Technology*, 6(4), 155-172.
- [25] Ejairu, E., Mhlango, N. Z., Odeyemi, O., Nwankwo, E. E., & Odunaiya, O. G. (2024). Blockchain in global supply chains: A comparative review of USA and African practices. *International Journal of Science and Research Archive*, 11(1), 2093-2100.
- [26] Balloun, J. L., Barrett, H., & Weinstein, A. (2021). One is not enough: The need for multiple respondents in survey research of organizations. *Journal of Modern Applied Statistical Methods*, 10(1), 287-299.
- [27] Nulty, D. D. (2008). The adequacy of response rates to online and paper surveys: what can be done?. *Assessment & evaluation in higher education*, 33(3), 301-314.
- [28] Field, A. (2024). *Discovering statistics using IBM SPSS statistics*. Sage publications limited.
- [29] Shava, E., & Mhlanga, D. (2023). Mitigating bureaucratic inefficiencies through blockchain technology in Africa. *Frontiers in Blockchain*, 6, 1053555.
- [30] Sunmola, F., & Lawrence, G. L. (2024). Key success factors for integration of blockchain and ERP systems: A systematic literature review. *Procedia Computer Science*, 232, 775-782.
- [31] Ezekwueme, A. E., Abel, C. E., & Dike, G. A. (2024). Efficiency of IoT Adoption and Supply Chain Optimization: An Empirical Evidence from Nigeria.

- [32] Gold, S., & Heikkurinen, P. (2018). Transparency fallacy: Unintended consequences of stakeholder claims on responsibility in supply chains. *Accounting, Auditing & Accountability Journal*, 31(1), 318-337.
- [33] Onuma, E. P. Multi-Tier Supplier Visibility and Ethical Sourcing: Leveraging Blockchain for Transparency in Complex Global Supply Chains.
- [34] Adarkwah, G. K., & Benito, G. R. (2023). Dealing with high-risk environments: Institutional-based tools to reduce political risk costs. *Journal of International Management*, 29(4), 101033.
- [35] Child, J., & Tsai, T. (2005). The dynamic between firms' environmental strategies and institutional constraints in emerging economies: Evidence from China and Taiwan. *Journal of Management studies*, 42(1), 95-125.
- [36] Nuruzzaman, M., Haque, A., & Shamsuddoha, M. (2023). BUREAUCRATIC BEHAVIOUR, AND ITS INFLUENCE TOWARDS COMPETITIVENESS–ANALYSING THE SUPPLY CHAIN OF BANGLADESHI CLOTHING INDUSTRY. *International Journal of Business and Society*, 24(1), 506-522.
- [37] Asamoah, K., Asare-Bediako, E., & Jacqueline, A. P. (2023). Effects of supply chain visibility on supply chain performance in Ghana health service: The case of Kumasi Metro Health directorate. *Open Journal of Business and Management*, 11(2), 437-463.
- [38] Ezenwa, A., Whiteing, A., Johnson, D., & Oledinma, A. (2020). Factors influencing information and communication technology diffusion in Nigeria's transport logistics industry: an exploratory study. *International Journal of Integrated Supply Management*, 13(2-3), 252-276.
- [39] Okunsanya, L., & Azmat, M. (2025, May). Unlocking Nigeria's potential: experts' opinion-based insights on the economic impact of logistics challenges. In *Supply Chain Forum: An International Journal* (pp. 1-15). Taylor & Francis.
- [40] Mishrif, A., Antimiani, A., & Khan, A. (2024). Examining the contribution of logistics and supply chain in boosting Oman's trade network. *Economies*, 12(3), 70.
- [41] Sibupiwa, M., & Qutieshat, A. (2025). Trade Facilitation and Firms: A Literature Review. *Studies in Business and Economics*, 20(1), 247-262.
- [42] Foroughi, A. (2021). Supply chain workforce training: addressing the digital skills gap. *Higher Education, Skills and Work-Based Learning*, 11(3), 683-696.
- [43] Ojadi, F. I., & Walters, J. (2015). Critical factors that impact on the efficiency of the Lagos seaports. *Journal of Transport and Supply Chain Management*, 9(1), 1-13.
- [44] Doetzer, M. (2020). The role of national culture on supply chain visibility: Lessons from Germany, Japan, and the USA. *International Journal of Production Economics*, 230, 107829.
- [45] Baah, C., Acquah, I. S. K., & Ofori, D. (2022). Exploring the influence of supply chain collaboration on supply chain visibility, stakeholder trust, environmental and financial performances: a partial least square approach. *Benchmarking: An International Journal*, 29(1), 172-193.