




SPECIAL FOCUS PAPER

AI-Augmented Mobile ESG Data Capture: A Conceptual Framework for Sustainable Procurement in Engineering and Construction

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ABSTRACT

The importance of environmental, social, and governance (ESG) in the procurement process of the engineering and construction industry cannot be overemphasized. However, supplier ESG reporting is still done in a traditional manner. This paper introduces a conceptual model that combines mobile-based data capture and analytics of artificial intelligence (AI) to support sustainability in construction and engineering. Digital technologies are the main devices for the real-time capture of ESG data in supplier ecosystems. The model demonstrates how managers, AI supporting them, can obtain ESG dashboards to enhance supplier selection, compliance with the procurement's sustainability criteria, and rational decision-making. Practical examples from the cement and steel supply chains are provided. The author's contribution stems from presenting the model in theory and practice, where its use brings ESG integration into the procurement processes in sustainable, transparent, and scalable supply chains.

KEYWORDS

artificial intelligence (AI), mobile technologies, sustainable procurement, supply chain transparency, engineering and construction

1 INTRODUCTION

Due to the rise of climate change issues, social inequities, and challenges of governance, concern on the world stage has increased on the issue of sustainability. This, in turn, has prompted an even greater demand from businesses to implement strong environmental, social, and governance (ESG) practices, and not just for the business's operations, but for the entire supply chain and beyond. In complex and resource-consuming industries such as engineering construction, the demand for the effective implementation of transparent and verifiable ESG practices is not only necessary but also crucial [1], [2].

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Digital transformation has enabled the implementation of mobile and digitized technologies to promote a transparent and traceable supply chain and to integrate and align for sustainable procurements of a business. These technologies give firms the ability to assess and manage the environmental and social impacts across their supply chains and networks, directly providing an answer to the accountability of firms and the governance on the social demand and regulatory pressure [2].

Integrating digital strategies into procurement practices enhances the advancement of sustainability. Such practices will enable the cooperation of all concerned players and balance economic efficiency with overall sustainability. For instance, circular procurement and the resource-efficient construction project lifecycle integrated sustainability during procurement activities [3]. Procurement managers track the environmental standards of suppliers using mobile-based applications, community well-being and the upholding of equitable labor [3].

This paper develops a conceptual framework on mobile-based ESG data capture in supplier networks for the engineering and construction sectors. In this industry, fragmented supply networks and adversarial contracting lead to the ineffective implementation of sustainability initiatives [4]. Mobile-based approaches to data collection promote a bottom-up, voluntary approach to transparency on how procurement goals are socially and environmentally aligned. This approach to data collection will allow construction firms to engage with sustainability in supplier procurement [5].

This framework aims to refine procurement performance indicators to include social value in addition to the traditional focus on cost and efficiency. This will enable value-based supplier selection and risk prevention strategies concerning ESG dimensions, including modern slavery, unsafe working conditions, and environmental harm [6]. Considering how constructing globally interconnected value chains traversing multiple sectors will involve the reimagining of the industry's global perception [7].

In relation to the conditions in Nigeria, the social construct of inclusive social sustainability becomes vital when addressing the issue of infrastructure delivery projects in relation to the principles of sustainable procurement [6]. Only through the procurement process will the challenges of health and safety, support to the employees, and the empowerment of the communities become integrated and achieve social and economic value. Previous research indicates barriers to progress, such as weak client commitment and a lack of understanding regarding the benefits of sustainability [7]. This framework attempts to resolve the complex problem of social assessment by embedding it in the procurement process.

Equally important is the need for a low-carbon transition in the development of infrastructure. Shifting to sustainable models that seek profit and balance long-term and social value to the environment dramatically changes the scope of negotiation and investment strategies [8]. It is therefore a tactical opportunity to capture ESG digital data in real-time to augment procurement choices and an operational necessity.

This paper fills gaps in the ongoing debates of operationalizing sustainability in construction procurement by demonstrating the use of mobile technologies to boost data collection and deepen accountability and transparency in supplier networks. Organizations can achieve the system's objective of closing the loop on sustainability promises by integrating ESG performance into procurement systems whose sustainable performance is promised to extend to the entire infrastructure life cycle [9]. Ultimately, the framework is designed to advocate responsive, protective sustainability procurement and to accelerate procurement that facilitates global sustainability transitions [7].

2 LITERATURE REVIEW

2.1 Sustainable procurement in engineering and construction

The negative impacts associated with resource consumption and depletion, alongside the overexploitation of the environment, place the engineering and construction industries at the top of the list for needing aggressive sustainable procurement policies and practices [9]. Such policies and practices will integrate systems-thinking approaches to the environmental, social, and economic impacts of the entire lifecycle of procured goods and services [7]. More specifically, sustainable procurement seeks to implement a set of criteria into the procurement processes that will fulfill environmental, social, and economic objectives in a resource-efficient, quality-enhanced, and cost-optimized manner on a whole-life basis [3]. This perspective shifts the argument from the procurement cost perspective to the entire lifecycle and societal value of the procurement, operational, end-of-life, and the rest of the world's socio-environmentally responsible materials, services, and construction sourced [4]. With increased knowledge and concern about socio- and ecological injustices, the construction industry has fallen behind others in the uptake of sustainable procurement [4]. Even with strong encouragement from the government and organizations to push for procurement policies that facilitate the procurement of green and sustainable construction, this blind spot remains persistent [3].

2.2 Digital transformation of procurement

The use of digital assets or resources within procurement processes marks a thorough/complete change as it goes beyond the adoption of technology, which requires a complete remodeling of the functions as commonly performed [8]. The COVID-19 global health crisis made it important for this digital transformation for the organizational framework [10]. By this, the old procurement process has been sidelined, and this has paved the way for the implementation of new digital systems by organizations such as private companies and government parastatals, making the market accessible [11]. Aside from the acquisition of technology, training and monitoring are required for company-wide adoption [10]. In Procurement, digital technologies encourage firms to compete in the global market [10].

2.3 Mobile technologies for supplier data capture

There is a rapid change in business activities because mobile devices are now used cross-functionally. There is improvement in the supplier data capture process. Smartphones and other mobile gadgets have increased supply chain flexibility [3]. The adoption of these tools enhances supply chain effectiveness [3]. This allows for effective supplier performance and accountability [3]. In the supply chain, mobile tools are also used for strategic partnerships aside from data capture [3]. For instance, mobile phone technologies improve the collection of employee feedback and work efficiency [12]. Adding mobile web services into supply chain processes improves the advantages of mobile devices for several components of the supply chain [11]. This new method supports continuous process improvement,

especially in facilities and manufacturing, where accurate information is necessary for operational cost efficiency [10] [3]. There can be improvement of supply chain adaptability and flexibility and adaptation to changing markets if we strategically deploy these technologies [11].

2.4 ESG data capture challenges in supplier networks

The rising focus on environmental, social, and governance issues has placed ESG-related sustainable supply chain management on the strategic agenda, demanding effective data capture systems [2]. In spite of the increased focus on ESG data issues, companies still face significant challenges in collecting and assimilating these data, especially from extended supply chains [12]. This is particularly the case with primary data collection on discrete scope 3 emissions, where data density is high, and with third-party data. The primary challenge of such transactions is the periphery associated with value addition [6], which argued that primary data collection from primary sources with such a dense network is beyond the reach of most organizations, hence the need for multiple collaborative synergies along the value chain. The polycentric nature of ESG, and the absence of a single governance structure and standard of reporting within and among organizations, becomes a data aggregator and validator block [6]. The ESG field, especially in terms of oversight in the supply chain, is still at its rudimentary stage and is characterized by many challenges; mainly, the opaque nature of many supply chains becomes a cloud on the horizon for effective primary data collection [1].

2.5 Research gap and contribution

In this section, there is an analysis on the gaps in the literature pertaining to mobile technology applications to improve supplier data visibility, as well as the contributions made to mitigate those gaps.

Though data visibility plays an essential role in streamlining decision-making processes within supply chains, especially with the spread of information and communication technology (ICT), research and a conceptual framework studying mobile-specific use for supplier data capture remain rudimentary [13]. More specifically, integration of emerging technologies such as Internet of Things (IoT), AI, blockchain, and radio frequency identification (RFID) with integration of technology advances visibility challenges in broad ways, but little to no emphasis is placed on mobile interfaces and acquisition of real-time data across a fragmented supplier ecosystem [13]. This is a substantial research gap because the mobile technology affordances of ubiquity and portability and embedded sensors can potentially capture detailed on-the-spot supplier information for data acquisition that more traditional systems would fail to get [13]. In addition, most literature that talks about the digital transformation of data and the expansion of supply chains remains fragmented and theoretical. It rarely discusses the actual use of mobile technologies within the frameworks for detailed supplier data capture. Studies have highlighted the need for improving ESG performance in technology [13]–[16]. However, not many resources adequately describe the efficiency of mobile data capture and the challenges that businesses have to overcome to implement the same in developing economies, particularly regarding mobile vendors [11].

Most academic research examining the relationship between Industry 4.0 technologies and supply chains omits the use of the net-zero supply chain and ESG (Environmental, Social, and Governance) outcomes in addition to how mobile technologies might facilitate these objectives through better data collection [1]. This gap relates to how mobile data collection fosters vendor collaboration, reduces supply chain risk, and streamlines operational activities within green supply chains.

3 MATERIALS AND METHODS

This research adopts a framework that combines the use of mobile technologies with sustainable practices in the engineering and construction sectors. The ‘whole’ in this instance is the ‘digitalization of ESG data collection within supplier networks.’

3.1 Research design and approach

This is an inductive study, which starts with the examination of secondary data on the management of ESG data and the role of mobile technology in supply chains. A thematic content review and analysis of the sector and sustainability documents and online resources revealed conceptual gaps. These gaps formed the basis for developing a mobile-driven framework for capturing ESG data in the engineering and construction supply chains.

3.2 Literature integration and theoretical grounding

The framework is based on distinct theories that provide structure and practicality. The stakeholder theory provides the normative basis by emphasizing the need to reconcile the interests of all supply chain stakeholders. Further supported by the resource-based view (RBV), which considers mobile technology and ESG data as strategically primary resources to be harnessed for sustained transparency and accountability for competitive advantage. Also, the integration of technology and the human-organization interface is guided by the sociotechnical systems theory and ensures that the integration of technology and the human-organization interface is guided by the ethical boundaries of procurement.

3.3 Data sources and analytical strategy

Secondary data chapters were derived from peer-reviewed journals; policy documents; international journals on compliance such as ISO 20400 on sustainable procurement; the global reporting initiative (GRI); and other standards on sustainability. The documents were thematically synthesized to identify the key recurring elements of supplier transparency, social value, digital traceability, and transparency and accountability. These elements were crucial in defining the proposed framework’s conceptual relationships.

3.4 Framework development process

Concept Identification – Literature-based research on key dimensions of sustainable procurement and digital data capture:

1. **Concept Integration** – Aligning the identified dimensions with mobile-based ESG performance metric data gap solutions
2. **Framework Synthesis** – Defining interconnections between constituent variables: supplier mobile engagement, mobile data collection, ESG performance indicators, and decision support

Contextual elements of engineering and construction procurement, particularly multi-tier supplier dependencies, subcontracting complexity, and regulatory compliance, were the focus of the current analysis, and their practical relevance to the industry served to contextualize the framework.

3.5 Validation and theoretical contribution

While this framework is conceptual, in later research phases it will be subjected to expert validation. Procurement specialists, sustainability managers, and digital transformation specialists will be engaged to evaluate the framework for industry relevance, completeness, and practicality. The anticipated theoretical contribution is to shed light on the systematic use of mobile technologies to operationalize the collection of ESG data to enhance sustainability performance within complex ecosystems of suppliers.

4 CONCEPTUAL FRAMEWORK FOR MOBILE-BASED ESG DATA CAPTURE IN SUPPLIER NETWORKS

4.1 Framework overview

The framework intends to create an optimally mobile construction engineering model that increases procurement sustainability through mobile ESG data collection. Practically every method of ESG data collection, outsourcing, or sustainability reporting relies on incomplete or out-of-date supplier data, meaning there is limited control and visibility throughout supply chains. The construction industry's tiered subcontractor frameworks mean there is no integrated real-time method to capture ESG data. The data collection problem is even more pronounced in construction because of issues such as dynamic labor, tiered subcontractor frameworks, and heavy material dependencies.

The framework is focused on sociotechnical systems theory, which appreciates the intersection of organizational partners in the achievement of sustainability goals, and stakeholder theory, which appreciates how organizational partners accomplish goals and stakeholder theory, which appreciates the intersection of partners of an organization in accomplishing sustainability goals. The framework of mobile technology shifts the focus from subcontractors to procurement managers to the real-time integration of operational decisions.

Furthermore, this integrated framework (see Figure 1) supports the resource-based view by emphasizing the organizational resources of digital data and

AI systems that automate procurement to drive ethically responsible competitive advantage procurement.

MOBILE-BASED ESG DATA CAPTURE FRAMEWORK

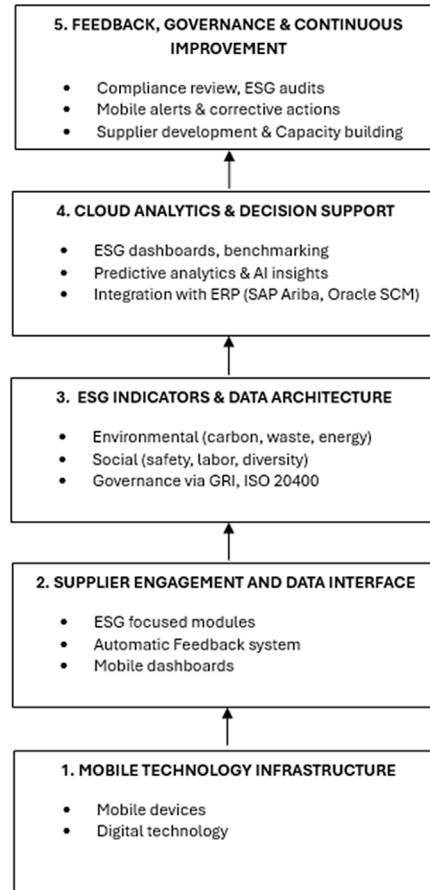


Fig. 1. Theoretical framework for mobile-based ESG data capture in supplier networks

Source: Constructed by authors.

4.2 Core components of the framework

To facilitate procurement and decentralize data collection, the Mobile-Based ESG Data Capture Framework employs five components that work in unison to achieve sustainability.

Mobile technology infrastructure. The framework is built on an advanced mobile technological system. This system covers the construction site and remote areas. The mobile system in use is composed of smart mobile devices. They are used to collect data on the various ESG indicators, which are environmental, social, and governance factors.

The mobile procedure helps suppliers to log and scan their performance data remotely. Tools such as geotagging and timestamping validate performance data.

Supplier engagement and data interface layer. This development has made it possible to engage with suppliers. The data interface layer aims to achieve a more positive engagement than just compliance. This is achieved by developing ESG-focused modules and embedding/immersing educational prompts in automated

feedback. Suppliers receive automated feedback on their performance and easily manage their ESG data.

This engagement layer also strengthens an overlooked aspect of construction procurement by mobilizing and softening lower-tier supplier requisitions to capture simplified ESG datasets via mobile dashboards. This improves the visibility of lower-tier suppliers while ensuring that the sustainability goals are maintained throughout the supply chain.

ESG indicators and data architecture. The ESG part of the framework is dedicated to the construction industry, setting benchmarks for measurable indicators. These include:

- **Environmental:** carbon intensity, recycling, resource efficiency, and renewable energy
- **Social:** safety, wage, occupational diversity, and community
- **Governance:** sustainable sourcing, compliance, anti-bribery

Data is collected through mobile applications and categorized in a central cloud system in accordance with the GRI, ISO 20400, and SDG taxonomy. This system integrates frameworks to enable analytics-based decision-making. Officers are capable of recognizing non-compliance and improvement opportunities in real time.

Cloud analytics and decision-support system. The framework is centered on a cloud platform that is capable of ESG analytics to provide models. While designed mostly as a mobile system, the added cloud analytics enable broader integrations with enterprise procurement systems (SAP Ariba and Oracle SCM). Suppliers' sustainability reports and regional benchmark comparisons and risk dashboards are accessible to procurement managers. Modules such as prediction and analytics are also available to forecast sustainability trends for proactive development and improvement activities.

This numerical decision support system turns ESG data or information from a list of items into a strategic, well-thought-out plan for supplier relationship management, organizational performance monitoring, and supervision.

Feedback, governance, and continuous improvement loop. Last but not least, procurement policies and strategies are supported with improved process insights or perceptions that are gained from data. The governance system that includes sustainability officers, project managers, and supplier representatives collaborates and analyzes ESG performance reports as well as prepares for improvement on the other hand.

Using mobile notifications, suppliers can take proactive improvement initiatives based on recommendations or corrective actions. With time, this builds up accountability and nurtures professional development, which leads to process improvement.

4.3 Expected outcomes and theoretical implications

The framework offers theoretical and practical significance.

The models on sustainable procurement already have a theoretical understanding of the sociotechnical interplay of mobile technology and supplier behavior. This one provides the function of decentralized, real-time data collection concerning stakeholder engagement and the internalization of sustainability principles within multi-tiered supply chains.

Practically, the organizations trying to digitalize low-cost procurement solutions, particularly in the developing world, will find the framework helpful for a big boost

in procurement. It shows that the journey toward sustainability entails dual control of supplier innovation as value co-creation.

Fundamentally, this positions mobile-based ESG data capture as a catalyst in sustainable procurement for engineering and construction.

4.4 Framework interactions

The interaction in the framework is circular and anchored on both qualitative and quantitative evidence. Supplier mobile interfaces upward from the ESG information system to the central data bank, where analytics modules construct a repository for data visualization. Procurement managers explain and give performance feedback on the same mobile ecosystem. This interaction closes the data collection and performance improvement loop.

This cycle improves procurement transparency and supplier participation. The model automatically integrates ESG compliance, focusing on everyday procurements and inter- and intra-department workflows, and embeds them culturally in responsible sourcing. Furthermore, the model's mobile-enabled approach improves the participation of small informal suppliers by lowering the unusually high integration infrastructure cost charged by complex enterprise unstructured systems.

4.5 Expected outcomes and theoretical implications

The theoretical and practical implications of the outlined framework are plentiful.

This approach helps enhance the existing parameters of sustainable procurement and offers a theory on the mobile technology suppliers' behavior and sociotechnical interaction. It models the extent to which real-time data collection improves stakeholder participation in the decentralization of siloed systems and the cross-institutionalization of sustainability norms in multi-tiered supply chains.

Practically, this approach assists entities on the emerging side of the economy, where the framework strategically helps them address cheap, high-impact digitalization tools within procurement systems. The framework also provides a bottom-up approach, where the pursuit of supplier-side governance systems is not regulated top-down, but instead is through grassroots innovation, aiming to sustain empowered suppliers through value co-creation.

This model also places mobile-based ESG data capture systems at the center of transformational change. It helps enhance the link between digitalization and responsible supply chain management in construction engineering to procurement works.

5 DISCUSSION AND IMPLICATIONS

5.1 Contextualizing the framework within sustainable procurement

The mobile-based ESG data capture framework provides a practical and scalable approach towards the enhancement of sustainable procurement within the engineering and construction sectors. This innovation aligns with the global shift towards the digital economy, as well as achieving more inclusive and transparent data collection through the redesigning of data collection as an interactive and bottom-up process implemented instead of a top-down compliance approach. It improves the

long-recognized issue of fragmented supplier data within sustainable multi-tier supply chain systems.

The construction sector is the backbone of infrastructural growth and development within developing countries, particularly in Africa. However, the construction sector continues to grapple with the problem of the lack of decentralized, sustainable compliance reporting systems. The mobile-based framework offers affordability and accessibility for construction supply chains through an inclusive approach to ESG data for all value chain suppliers. Low-level ESG indicator reporting is achievable through mobile devices, thus making real-time compliance monitoring possible.

This specific approach achieves sustainable data collection from any function within an organization. It allows organizations to expand transparency and traceability to lower supplier levels that are typically “black boxes.”

5.2 Advancing digital and mobile innovation in procurement

The use of mobile devices and apps in system processes is seen as another great advancement in the digitalization of procurement processes. While companies like SAP Ariba, Oracle SCM, and Jaggaer offer procurement-clinching systems and modules, these can be prohibitively costly and out of reach for many smaller entities. Mobile-based ESG solutions, on the other hand, offer such companies fit-for-purpose tools that are lightweight and agile for low-resource settings.

Some of the actual reporting analytics tools, such as geotagging, and QR code-based material traceability, have significantly improved “digital overtake,” which simply means letting go of old or outdated technologies to adopt modern solutions. In addition to this, mobile applications can work with data storage in cloud systems and government E-procurement systems to make sure that remote sustainability reporting is in line with the affected country or region.

Programmed ESG reporting works together with Industry, Innovation, and Infrastructure (SDG 9) and Responsible Consumption and Production (SDG 12).

5.3 Theoretical implications

The framework advances three major areas of supply chain and sustainability theory.

- Stakeholder Theory: This structure makes use of actual two-way communication flow within the supply chain. These days, suppliers are more focused on the value chain. This method of supplier engagement enables collaboration and togetherness on sustainability as well as securing operational efficacy and success.
- Sociotechnical Systems Theory: This framework shows how mobile technology interacts with people and achieves sustainable outcomes. The mobile app features are designed to facilitate supplier education and support supplier networks.
- Institutional Theory: The framework shows how to combine sustainability standards such as ISO 20400 and the principles of the UN Global Compact to capture and stream-record ESG procurement data in emerging or developing economies.

5.4 Managerial implications

The practicality of the proposed framework is diverse.

Enhanced supplier transparency and accountability. With the development of innovative technologies, suppliers' ESG compliance can be monitored progressively instead of at stipulated times, as this leads to prompt non-compliance resolution. These actions improve the resilience of the supply chain.

Streamlined sustainability reporting. By collecting ESG data automatically, the burden of reporting is reduced on the compliance team, even though there are still internal and regulatory policies to address.

Supplier development and capacity building. Suppliers on the lower-level tier can make use of mobile tools for independent training. This is because these suppliers often have limited resources to engage in fully developed training, so adopting these mobile tools will increase their productivity efficiently.

Policy and governmental adoption. Public procurement can implement or apply this framework for proper monitoring of its activities. For instance, they can include ESG compliance modules in the procurement portals, ensuring that every supplier bid is submitted in alignment with sustainability criteria put in place.

Strengthened buyer-supplier collaboration. Real-time feedback and mobile alerts encourage collaboration over corrective measures. Suppliers offer sustainability innovation, thus helping buyers develop solutions to waste and community engagement.

5.5 Application to the African construction context

In Africa, where infrastructure growth is a priority, poor monitoring and limited digital inclusion/usage have resulted in the underdevelopment of sustainable procurement. This framework is targeted to solve the problem of these infrastructural challenges.

The construction environment is prone/vulnerable to ESG issues, and mobile-based ESG captures procurement managers so that they can target certain on-site conditions, such as workplace safety, waste management, and community engagement, through digital records within a clear framework provided by contractors.

There is accountability in public and private projects, helping to eliminate the risk of greenwashing and data deception. Africa's rapid mobile adoption means, therefore, that the approach is aligned with the emerging trend of mobile-first, digital solutions.

Additionally, the framework supports the model's capacity to contribute towards the harmonization of ESG reporting on a regional basis, which supports the African Continental Free Trade Area's (AfCFTA) promotion of trade with equity and ethics. Incorporating the mobile ESG framework into regional procurement policies allows African governments to strengthen their positions in the global sustainable value chain.

5.6 Challenges and implementation considerations

While implementing this framework, there are issues that need to be considered.

- Supply Chain Gaps: Relying heavily on secondary data can lead to inaccuracies or mistakes, especially when the supplier is unreliable.
- Poor Change Management: The problems or challenges that have to do with adaptation are considered more challenging, especially in rural settings.
- Technology Management: A data governance structure should be in place.
- Corporate Silos: disregarding the global standards of transparency.

To address these issues, solutions must be tailored to stakeholders' interests and combine policy, infrastructure, and governance.

5.7 Summary of implications

The adoption of this framework is a major step in the right direction towards responsive and socially responsible procurement operations. In addition, the framework encompasses the entire sustainability reporting value chain, thereby unlocking the potential of bottom-of-the-pyramid suppliers and democratizing access to sustainable business practices.

The framework provides engineering and construction industries, particularly in developing economies eager for inclusive and responsible growth, with a transformative pathway through closing the digital divide and integrating sustainability into procurement operations.

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