

Integration of Sustainable Procurement and Circular Logistics into Project Delivery: A Framework for Environmental, Ethical, Social Standards, and Value Creation

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ABSTRACT

Project logistics is traditionally concerned with ensuring that materials, equipment, information and related services are available at the right location, time, quantity and cost. However, the increasing environmental, social and ethical consequences of project activities require logistics decisions to extend beyond conventional cost, time and quality considerations. Sustainable procurement provides an important mechanism through which project organizations can integrate environmental protection, responsible sourcing, social value and economic efficiency into project delivery.

Project logistics also influences cost, schedule, quality, resource consumption, emissions, waste, labour conditions and community outcomes. Yet sustainability is frequently managed as a reporting requirement rather than as an integrated project-delivery decision process. This conceptual article develops a Project Sustainability Integration Framework (PSIF) that connects sustainable procurement, circular logistics, ethical and social safeguards, performance measurement and continual improvement across the project lifecycle. The framework is organized around six stages: **Plan, Source, Move, Use and Recover, Measure, and Improve.**

The article adds an illustrative pilot scenario for a medium-scale public infrastructure project facing selected input-price inflation, intermittent supplier delays and limited supplier-level environmental data. The scenario demonstrates how proportionate procurement criteria, transport controls, circular-material actions, supplier screening and performance indicators can be operationalized without assuming sophisticated digital systems. The numerical values in the scenario are explicitly illustrative assumptions, not empirical findings.

The article also expands the discussion of SMEs and developing-economy contractors through phased implementation, low-cost data practices and risk-based controls. International reference points include ISO 20400:2017, ISO 14001:2026, ISO 26000:2010 and the UN Global Compact Ten Principles. The contribution is therefore a practical, testable conceptual framework rather than a claim of empirical validation.

The article argues that sustainability should not be treated as an additional reporting exercise after procurement decisions have been completed. Instead, sustainability considerations should influence project planning, supplier selection, logistics design, materials management, contract administration and performance evaluation. The proposed framework provides a practical structure for connecting procurement decisions with environmental, economic and social outcomes. It also highlights the importance of life-cycle thinking, supplier due diligence, circular resource management, measurable indicators, transparent reporting and continuous improvement. The article concludes that integrating sustainable procurement with project logistics can improve resource efficiency, supply-chain resilience, stakeholder confidence and long-term project value while reducing avoidable environmental and social risks.

Keywords: sustainable procurement; circular logistics; project delivery; green logistics; social sustainability; ethical sourcing; SMEs; PSIF

INTRODUCTION

Project delivery increasingly requires organizations to manage economic, environmental and social objectives simultaneously. Procurement decisions determine not only price and quality but also supplier practices, material choices, transport requirements, waste generation and opportunities for reuse or recovery. Logistics decisions similarly influence fuel use, emissions, congestion, packaging, delivery reliability and worker exposure to safety risks. Treating these activities separately can create trade-offs that become visible only after commitments have been made.

Project logistics represents an important component of successful project delivery because projects depend on the coordinated acquisition, transportation, storage, handling and deployment of materials, equipment, information and related services. In construction, infrastructure, energy, manufacturing, telecommunications and public-sector development, logistics may involve domestic and international procurement, multimodal transportation, customs clearance, warehousing, inventory management, equipment mobilization and final delivery to project locations.

Traditionally, project performance has been assessed primarily through the familiar dimensions of cost, time and quality. Although these dimensions remain important, they do not fully capture the wider consequences of project activities. A project may be delivered within budget and schedule while generating excessive waste, unnecessary transportation emissions, poor labour conditions, unethical supplier practices or negative impacts on surrounding communities.

The growing importance of sustainable development has therefore changed expectations regarding procurement and logistics. Organizations are increasingly required to consider not only what they purchase and how much they pay, but also how products are produced, how suppliers treat workers, how materials are transported, how resources are consumed and what happens to materials at the end of their useful life.

Sustainable procurement provides a strategic mechanism for addressing these issues. ISO 20400:2017 provides guidance for integrating sustainability into procurement processes and is intended for organizations of different sizes and activities as well as stakeholders affected by procurement decisions. ISO records that the standard was reviewed and confirmed in 2023 and remains current.

Environmental management is also relevant. ISO 14001:2026, published in April 2026, provides a framework for organizations to establish and improve environmental management and performance system.

Similarly, ISO 26000:2010 provides guidance on social responsibility, stakeholder engagement and communication of social-responsibility commitments and performance. Importantly, ISO 26000 is not a management-system standard and is not intended for certification.

The United Nations Global Compact provides another relevant framework through its Ten Principles covering human rights, labour, environment and anti-corruption, despite the availability of these frameworks, sustainability are still lacking in the organization procurement system

This article addresses the integration of proposing a Project Sustainability Integration Framework (PSIF) that connects sustainable procurement and project logistics throughout the project life cycle.

The article does not claim that PSIF has been empirically validated. Instead, its propose framework, the article identified three central improvement needs: practical validation under constraints such as cost inflation and disruption; substantially broader use of recent peer-reviewed literature; and clearer operational guidance for SMEs and contractors in developing-economy contexts. The present revision addresses those issues by retaining the lifecycle logic of PSIF while adding a conceptual numerical scenario, a more explicit implementation pathway, a stand-alone treatment of the UN Global Compact and a clearer distinction between

conceptual assumptions and empirical evidence that can be tested through future case studies, surveys, pilot projects or comparative implementation research.

LITERATURE REVIEW

Sustainable procurement and supply-chain resilience

Sustainable supply-chain research increasingly connects environmental and social objectives with resilience, continuity and long-term value. Recent review research on sustainable supply-chain resilience emphasizes the need to integrate economic goals with organizational, social and environmental dimensions rather than treating resilience as a purely operational issue. In project environments, this is particularly relevant because material shortages, price volatility and transport disruption can quickly affect cost and schedule.

Concept of Sustainable Project Logistics

Sustainable project logistics can be defined as the systematic integration of environmental, social, ethical and economic considerations into the planning and execution of project-related logistics activities. The concept extends conventional logistics thinking. Traditional logistics asks whether materials can be delivered at the required location and time at an acceptable cost. Sustainable project logistics additionally asks:

- Where were the materials sourced? and How were they produced?
- Were workers treated responsibly?
- How far must the materials travel?
- What environmental impacts arise from transportation?
- Can packaging be reused?
- Can materials be repaired or recovered?
- What happens to unused materials after project completion?
- Does the project generate value for local communities?
- Can sustainability performance be demonstrated with reliable evidence?

These questions demonstrate that sustainability is not a single activity. It is a cross-functional consideration extending from project conception to close-out.

Circular procurement and project logistics

The traditional linear economic and procurement model can be represented as:

Extract → Produce → Use → Dispose

Circular procurement thinking seeks to retain the value of products and materials for longer through approaches such as reduction, reuse, repair, refurbishment, remanufacturing and recycling. Project logistics is particularly suited to circular thinking because projects often generate temporary requirements and surplus materials, circular procurement shifts attention from one-time acquisition toward life-cycle value, including durability, repairability, reuse, refurbishment, take-back and recovery. A systematic review of circular procurement identifies procurement as an important entry point for translating circular-economy principles into organizational practice. In project logistics, circularity can be operationalized through returnable packaging, recovery of surplus materials, reuse of temporary works, reverse logistics and procurement specifications that recognize recycled or recovered inputs where technically appropriate. Circular procurement should therefore begin at specification stage rather than waiting until project completion.

Green logistics, project supply chains and Environmental Sustainability

Green logistics focuses on reducing the environmental impacts associated with logistics operations. Project logistics can create environmental impacts through transportation, warehousing, materials handling, packaging and equipment use

Green logistics includes transport consolidation, route planning, load optimization, fuel efficiency, lower-emission transport choices, packaging reduction and reverse logistics. Recent research on resilience and legality in civil-infrastructure supply chains supports an integrated approach in which cost, service, sustainability and disruption resilience are considered together rather than sequentially.

Social sustainability, Ethical Sourcing and Supply Chains management

Ethical sourcing refers to procurement practices that take account of the legal, social, environmental and ethical conduct of suppliers. Project supply chains can be complex where a project owner may have a direct contract with a main contractor while materials pass through several subcontractors, distributors and manufacturers. Consequently, ethical risks may occur beyond the immediate supplier while potential risks include: forced labour, child labour, unsafe working conditions, discrimination, corruption, conflicts of interest, fraudulent documentation, environmental violations, and exploitation of vulnerable communities.

The United Nations Global Compact's Ten Principles cover human rights, labour, environment and anti-corruption. Its principles include respect for internationally proclaimed human rights, elimination of forced and child labour, non-discrimination, environmental responsibility and action against corruption.

The anti-corruption principle specifically calls on businesses to work against corruption in all its forms, including bribery and extortion. These principles can inform supplier codes of conduct and due-diligence processes.

Human Rights, Labour and Social Responsibility

Sustainability extends beyond environmental protection. Workers involved in project logistics may include drivers, warehouse personnel, equipment operators, construction workers, subcontractors and other supply-chain employees. Responsible project logistics should therefore consider: occupational safety, fair treatment and appropriate working conditions, worker training, freedom from forced labour, non-discrimination, respect for human rights, and appropriate grievance mechanisms.

The UN Global Compact identifies human rights and labour as two of its four core areas.

ISO 26000:2010 provides guidance to organizations on social responsibility, including stakeholder identification and engagement and communication of social-responsibility performance. ISO also explicitly states that ISO 26000 is guidance rather than a certifiable management-system standard.

Social Value and Local Economic Development

Large projects can create significant economic and social opportunities.

Potential positive outcomes include: employment and local business development, skills development, infrastructure improvement, technology transfer, increased economic activity, and improved access to services.

However, projects can also generate negative impacts such as traffic disruption, pressure on local resources, displacement, environmental disturbance and unequal distribution of benefits.

Project logistics can contribute to social value by considering qualified local suppliers and service providers where this is compatible with technical requirements, procurement rules and value-for-money principles.

Local sourcing may also reduce transportation distances, but it should not be adopted automatically. Supplier capability, quality, reliability, cost, risk and sustainability performance must remain part of the decision.

Research Gap and Contribution

Existing sustainability frameworks provide valuable principles, but project teams still need an operational sequence linking procurement decisions to logistics execution, circular recovery, measurement and corrective action. The earlier conceptual review was appropriately identified to be lacking a practical application.

PSIF addresses this gap by presenting a six-stage lifecycle process and testing its logic through an illustrative scenario.

The contribution is deliberately framed as conceptual. It offers:

- An integrated lifecycle structure
- A set of measurable indicators
- Proportionate controls for constrained environments
- A pilot scenario that demonstrates how the framework could be applied and challenged in practice, these features provide a basis for future empirical validation.

Project Sustainability Integration Framework (PSIF)

PSIF embeds sustainability into ordinary project controls rather than creating a separate reporting exercise. The six stages are iterative and may be revisited when project conditions change.

1, PLAN Objectives, risks baseline stakeholders	2. SOURCES Specifications, criteria, contracts supplier	3. MOVE: Transport, consolidation, fuel, packaging
4. USE & RECOVER: Efficient use, reuse, reverse logistics	5.MEASURE: Indicators, evidence, supplier reporting	6, IMPROVE: Corrective action, learning, next cycle

Figure 1. PSIF lifecycle process flow. The arrows are conceptual: project teams can move backward when monitoring identifies a material risk or performance gap.

- **PLAN:** Define project sustainability objectives, legal and contractual requirements, material risks, stakeholder expectations and baseline indicators. Planning should distinguish mandatory requirements from voluntary enhancements so that scarce resources are directed toward material risks.
- **SOURCES:** Translate sustainability objectives into specifications, evaluation criteria and supplier questionnaires, contract clauses and delivery requirements. Criteria should be relevant, measurable and proportionate to the procurement value and risk.
- **MOVE:** Control the logistics stage through consolidated deliveries, route planning, appropriate vehicle utilization, packaging reduction, delivery scheduling and recording of basic transport information.
- **USE & RECOVER:** Use materials efficiently and establish procedures for segregation, return, reuse, repair, recycling or responsible disposal. Recovery should be considered during procurement planning rather than only after waste is generated.
- **MEASURE:** Use a small dashboard of indicators covering environmental, social, procurement and resilience performance. Evidence can include purchase records, delivery logs, supplier declarations, inspection records, incident reports and photographs where appropriate.
- **IMPROVE:** Review performance, investigate deviations, assign corrective actions and update specifications, supplier-management practices or logistics arrangements, improvement closes the feedback loop and makes sustainability part of normal project governance.



Fig 2. PSIF visual Illustrations shows the integration connectivity of the process

Conceptual Pilot Application: Medium-Scale Public Infrastructure Project

This article emphasis directly for the practical validation and application of PSIF to an illustrative concept as follow:

12-month medium-scale public infrastructure project in a resource-constrained developing-economy setting. The scenario is deliberately simple so that project teams can reproduce the logic with ordinary procurement and logistics records.

Scenario assumptions. Selected input prices are assumed to increase by 15%; some suppliers experience intermittent delivery delays; and supplier-level emissions information is incomplete. These are constructed assumptions for demonstration only. They are not observations from a real project and should not be interpreted as empirical evidence.

The project identifies cement/aggregates, electrical equipment, fuel/transport and subcontracted labour as higher-risk categories. The team therefore applies stronger controls to these categories while using lighter-touch requirements for low-risk purchases. This risk-based approach is intended to avoid imposing the same administrative burden on every supplier.

Indicator	Illustrative target	Evidence
Avoidable transport trips	10% reduction	Delivery log / trip register
Eligible packaging reusable/returnable	60%	Supplier records / site checks

Major surplus reviewed for reuse/recovery	100%	Surplus register
High-risk suppliers screened	100%	Supplier due-diligence file
Active subcontractors reporting safety performance	100%	Safety records
Critical items with contingency	At least 1 alternative	Approved supplier list

Table 1. Illustrative PSIF dashboard. Targets are scenario assumptions created to demonstrate operationalization; they are not empirical findings.

Under the inflation assumption, the project can compare total-cost implications rather than automatically selecting the cheapest unit price. For critical materials, a slightly higher purchase price may be assessed alongside delivery reliability, durability, transport requirements and recovery opportunities. Under disruption, the team can qualify

alternative sources, pre-agree substitution procedures and prioritize scarce materials according to schedule criticality.

Where emissions data are unavailable, the project can initially record distance, vehicle type, load and number of trips as proxy operational data while avoiding unsupported claims about exact carbon savings.

Managing Cost Inflation and Supply-Chain Disruptions

Cost inflation should be incorporated into risk registers, procurement planning and contract-management procedures. Useful responses include early market engagement, framework or call-off arrangements where permitted, realistic delivery schedules, approved alternative products, dual sourcing for critical items and transparent change-control mechanisms. The purpose is not to assume that every sustainability measure increases cost; rather, teams should examine total life-cycle value, risk exposure and operational consequences.

For disruptions, project teams can classify materials by criticality and lead time. Critical items may require alternative suppliers, minimum operational buffers or earlier ordering. Non-critical items can use ordinary replenishment procedures. Sustainability criteria should remain proportionate so that disruption-management actions do not unintentionally exclude capable local SMEs.

SME and Developing-Economy Implementation

A major implementation challenge is the assumption that sustainability requires expensive software, consultants or fully developed management systems. A phased approach is more realistic. ISO 14005:2019 specifically provides guidance for phased implementation of environmental management systems, including for SMEs.

The PSIF approach therefore proposes four maturity levels:

Level	Minimum practice	Low-cost evidence
. Basic control	Legal compliance, supplier screening, basic waste and safety records	Paper forms, spreadsheet, photographs
Managed control	Targets, supplier clauses, delivery and waste tracking	Shared spreadsheet, simple dashboard
Integrated control	Risk-based indicators linked to procurement and logistics decisions	Digital register, periodic review
Advanced practice	Life-cycle analysis, verified data, circular business models	Specialist systems / external assurance

Table 2. Phased implementation pathway for constrained contexts.

The key principle is proportionality. A small contractor should not be required to produce sophisticated life-cycle carbon calculations when the project cannot use or verify such data. Instead, it can begin with material traceability, delivery records, waste segregation, worker-safety records and supplier declarations, then increase sophistication as capability and project requirements grow.

Data Constraints, Verification and Greenwashing

Incomplete sustainability data can lead either to inaction or to unsupported claims. PSIF therefore distinguishes between measured data, supplier-declared information, proxy indicators and assumptions. Each dashboard indicator should identify its evidence source and confidence level.

Where data cannot be verified, project teams should avoid presenting estimates as measured environmental performance. Greenwashing risks can be reduced by requiring evidence for material sustainability claims, using consistent definitions, recording exceptions and applying targeted verification to high-risk claims. Independent assurance can be introduced where project value or risk justifies the cost.

Sustainability Performance Measurement and Indicators

A balanced dashboard can include indicators such as percentage of high-risk suppliers screened, percentage of deliveries consolidated, number of avoidable trips, packaging returned or reused, quantity of surplus materials recovered, worker-safety incidents, supplier corrective actions and disruption-response time. Indicators should be limited to measures that decision-makers can act upon. Performance measurement should combine leading indicators (for example, supplier screening and training completion) with lagging indicators (for example, incidents, waste and delivery failures). This allows teams to intervene before adverse outcomes become irreversible.

Sustainability must be measurable if organization are expected to demonstrate improvement.

Sustainability Area	Illustrative indicators
Transportation	Fuel/energy consumption per delivery

Logistics emissions	Estimated emissions associated with project logistics
Waste	Percentage of materials diverted from disposal
Packaging	Percentage of reusable/returnable/recyclable packaging
Local participation	Percentage of eligible expenditure awarded to local suppliers
Ethical sourcing	Percentage of relevant suppliers screened
Health and safety	Number/rate of logistics-related safety incidents
Circular economy	Percentage of materials reused, repaired or recovered
Compliance	Number of sustainability non-conformities identified/resolved
Training & Supplier performance	Percentage of relevant personnel trained & the suppliers meeting sustainability target

Table 3. Illustrate **Performance Measurement and Indicators**

The choice of indicators should reflect project-specific materiality and data availability organizations should avoid creating excessive reporting requirements that produce data without supporting meaningful decisions

Sustainable Tendering and Contract Management

Sustainability requirements should be incorporated into procurement documents in a way that is clear, measurable and consistent with applicable procurement rules.

- **Prequalification:** Suppliers can be assessed against environmental management, health & safety, ethical conduct, technical capability, financial capacity, labour practices, and previous performance.
- **Technical specifications:** Specifications may address, durability, energy efficiency, recycled or responsibly sourced materials, packaging, maintenance, repairability, and end-of-life requirements.
- **Evaluation:** Where permitted by the applicable procurement framework, sustainability criteria can form part of bid evaluation. The criteria should be relevant, objective, measurable, disclosed in advance, and applied consistently.
- **Contract conditions:** Contracts may include: sustainability targets, reporting requirements, audit rights, supplier conduct requirements, environmental obligations, labour requirements, corrective-action procedures and sanctions or remedies where appropriate.
- **Performance monitoring:** Supplier sustainability should be monitored throughout implementation rather than assessed only at award stage

Challenges to Sustainable Project Logistics

- **Initial cost concerns:** Some sustainable alternatives may have higher initial acquisition costs, however, procurement decisions should consider relevant life-cycle costs rather than focusing exclusively on purchase price.

- **Supplier capability:** Some suppliers may lack the systems and resources required to demonstrate sophisticated sustainability performance and organizations can respond through supplier development, training and proportionate requirements.
- **Data limitations:** Reliable sustainability information can be difficult to obtain. Standardized reporting templates, digital systems and evidence requirements can improve data quality.
- **Organizational resistance:** Employees may continue to prioritize lowest price and immediate delivery. Management commitment and professional training are therefore important.
- **Complex supply chains:** International supply chains can involve multiple legal and regulatory environments. Appropriate due diligence and contractual requirements can help manage these risks.
- **Green washing:** Suppliers may make sustainability claims that are difficult to verify. Procurement teams should therefore request appropriate evidence and avoid relying solely on marketing statements.

Implementation Strategy for Organizations

A practical implementation strategy can be organised into seven actions.

- **Establish sustainability governance;** Assign responsibilities to procurement, logistics, project management, environmental and other relevant personnel.
- **Identify material risks:** Focus resources on procurement and logistics categories with significant environmental, social or ethical risks.
- **Develop sustainable procurement criteria:** Translate sustainability objectives into measurable procurement requirements.
- **Strengthen supplier due diligence:** Assess suppliers according to relevant environmental, social and ethical risks.
- **Improve logistics efficiency:** Optimize transportation, inventory, packaging and warehousing.
- **Establish measurable KPIs:** Monitor performance and communicate results.
- **Create a continuous-improvement mechanism:** Use audits, lessons learned, stakeholder feedback and supplier performance information to improve future projects.

Implications for Procurement Professionals

The sustainability transition is changing the role of procurement professionals.

The procurement professional increasingly operates as a strategic value manager rather than simply a purchasing administrator.

This requires knowledge of sustainable procurement, life-cycle thinking, supplier risk, environmental management, circular economy principles, ethical sourcing, human rights, stakeholder management, contract performance, data management and sustainability reporting.

Professional development should therefore include sustainability competencies alongside traditional procurement skills.

For public procurement, sustainability must be implemented consistently with applicable procurement legislation, financial regulations, transparency requirements, competition principles and value-for-money objectives. Sustainability should enhance procurement integrity rather than become a mechanism for arbitrary supplier selection

Ethical, Social and Stakeholder Considerations

Stakeholders include, project owners, procurement professionals, contractors, suppliers, workers; regulators, host communities, local businesses, customers and civil-society organisations. Stakeholder engagement can help identify environmental and social concerns that may not be visible from procurement data alone.

A structured engagement process should include: stakeholder identification, assessment of stakeholder interests, appropriate consultation, communication of project information, feedback mechanisms, grievance management, response and follow-up. ISO 26000 specifically recognizes identifying and engaging stakeholders and communicating social-responsibility commitments and performance as relevant elements of social responsibility.

Social sustainability in supply chains concerns labour practices, human rights, health and safety, community impacts, inclusion and responsible business conduct. Ethical sourcing therefore requires more than supplier price comparison.

Proportionate supplier due diligence can include declarations, contractual clauses, screening of high-risk suppliers, grievance channels, worker-safety checks and targeted audits where risk justifies the cost

Ethical procurement requires fair treatment of suppliers, avoidance of conflicts of interest, transparent evaluation criteria and appropriate confidentiality. Social sustainability extends the focus to labour conditions, occupational safety, human rights and community effects. Stakeholder engagement should be proportionate to project impacts and should provide a mechanism for concerns to be raised and addressed.

UN Global Compact Principles

The UN Global Compact Ten Principles provide a complementary normative reference covering four areas: human rights, labour, environment and anti-corruption. In project procurement, the principles can be translated into supplier expectations, contractual commitments, risk screening, worker protections, environmental controls and anti-corruption requirements. The principles provide a broader responsible-business reference point.

Standards reporting, Transparency and Compliance

Reporting provides evidence of whether sustainability commitments are being implemented.

Effective sustainability reporting should be accurate, relevant, transparent, consistent; understandable, evidence-based, and proportionate.

Reporting should not be used merely for promotional purposes. Where performance is poor, responsible reporting should identify weaknesses and corrective actions.

ISO 20400:2017 provides guidance for sustainable procurement and can support the integration of sustainability considerations into procurement policy, strategy and processes. ISO 26000:2010 provides guidance on social responsibility and is not a certification standard. ISO 14001:2026 specifies requirements for environmental management systems and is the current edition published in April 2026.

The 2026 edition retains a systems approach and life-cycle perspective while updating the requirements. These standards should be treated as complementary rather than interchangeable.

For public-sector projects, these international references must also be aligned with applicable national procurement legislation, contract conditions, environmental requirements and project-specific rules. International standards do not automatically override statutory procurement requirements.

DISCUSSION

The revised PSIF model responds to the central implementation problem and identified steps on how to translate broad sustainability principles into project decisions. Its main operational proposition is that sustainability should follow the same lifecycle logic as procurement and logistics management. Planning establishes priorities; sourcing translates them into requirements; logistics executes them; recovery closes material loops; measurement provides evidence; and improvement feeds learning into the next cycle.

The illustrative scenario demonstrates that the framework can accommodate cost inflation, supplier delays and limited environmental data without requiring perfect information. However, the scenario does not demonstrate actual project performance. It only shows how a project team could structure decisions and evidence. Empirical testing remains necessary.

The framework also suggests that sustainability implementation should be risk-based and capability-sensitive. This is particularly important for SMEs and developing-economy contractors, for whom uniform documentation burdens may create unintended barriers to participation. Phased controls can preserve the core sustainability objective while allowing capability to develop over time.

CONCLUSION

This paper presents PSIF as a practical conceptual framework for integrating sustainable procurement and circular logistics into project delivery. The framework connects planning, sourcing, movement, use and recovery, measurement and improvement within one lifecycle. The added pilot scenario demonstrates how the approach could be applied under inflation, disruption and data constraints using proportionate controls and ordinary project records.

The framework should not be treated as empirically validated by this journal; future research should test PSIF through construction and infrastructure case studies, supplier surveys, longitudinal pilots and comparative studies across different institutional and economic settings. Research should examine whether implementation changes cost, schedule reliability, waste, emissions, supplier performance, worker outcomes and resilience, while also identifying

unintended effects such as supplier exclusion or excessive administrative burden.

LIMITATIONS AND FUTURE RESEARCH

The principal limitation is conceptual design. The numerical scenario is illustrative, not an observed case, and the proposed indicators have not been statistically validated. The framework may also require adaptation to different procurement laws, project types and organizational capabilities.

Future studies should develop validated measurement scales, collect project-level data, test causal relationships and compare PSIF implementation across public and private projects. Particular attention should be paid to SMEs, local suppliers, informal data environments and developing-economy institutional contexts.

Author Contributions

All authors contributed to the conceptual development, literature synthesis, framework refinement, review of the manuscript and approval of the final version. Individual contributions may be specified further by the authors in accordance with the journal's authorship policy.

Declaration

The authors declare no conflict of interest. The PSIF scenario is illustrative and was created for conceptual demonstration; it is not presented as an empirical case study or measured project outcome.

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