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THEFT AND VANDALISM IN INFRASTRUCTURE CONSTRUCTION: A REVIEW OF SUSTAINABILITY IMPACTS

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ABSTRACT

Infrastructure construction projects are complex and resource-intensive systems that significantly influence economic development, environmental sustainability, and societal well-being. Despite their importance, such projects remain highly vulnerable to operational risks, particularly theft and vandalism arising from inadequate site security. While existing research has extensively examined cost overruns and delays, limited attention has been given to the broader sustainability implications of security-related incidents, especially within developing economies. This study adopts a narrative literature review approach to examine how theft and vandalism influence the sustainability performance of infrastructure construction projects in developing countries. The review identifies key environmental, economic, and social impact pathways resulting from security breaches, drawing upon both international and Sri Lankan literature. Furthermore, the study synthesises mitigation strategies, including technological, managerial, contractual, and governance-based interventions. Based on these insights, a conceptual framework is developed to illustrate the relationship between infrastructure vulnerabilities, security risks, and sustainability degradation mechanisms. The findings highlight the importance of integrating security considerations into sustainability assessment practices to enhance the resilience and long-term performance of infrastructure projects. The study provides practical guidance for construction practitioners in developing more robust security and sustainability strategies and identifies avenues for further empirical research to validate and expand the proposed framework.

Keywords: *Infrastructure construction; Mitigation strategies; Security and Risk; Sustainability; Theft and Vandalism.*

1. INTRODUCTION

Theft and vandalism are common problems in the construction industry and include unauthorized removal of materials, equipment, and fuel or deliberate damage or destruction of project assets (Arthur-Aidoo et al., 2023). They do not occur as isolated incidents, but as systemic risks that have a serious impact on project performance (Armitage & Ekblom, 2019). Construction sites are easily identified as targets for opportunistic or organised theft and vandalism activities because of their open

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environment, temporary operation, and grouping of materials that are valuable to thieves and vandalism Arthur-Aidoo et al., 2023). Therefore, construction site theft costs the world significant amounts of money in addition to the cost of the stolen materials, due to project delays, disruption, and increased security costs (Arthur-Aidoo et al., 2023).

Theft and vandalism also have a negative effect on construction projects, as it can lead to decreased productivity, disruptions in the construction process, and unexpected resources lost, resulting in delayed projects and increased costs (Almashhour & Ojiako, 2025). The risks are especially high for infrastructure construction projects because of their size and complexity and exposure risks. Many infrastructure projects involve vast areas spread out over a large geographical area, and often there is a high demand for materials storage, which makes them more vulnerable to security threats than traditional construction projects (Arthur-Aidoo et al., 2023). In addition, these risks are heightened by the remote location of the projects and the lack of ongoing surveillance, especially outside of the operational hours (Arthur-Aidoo et al., 2023).Although this is a very vulnerable situation, theft and vandalism have received comparatively little attention in infrastructure projects, alongside other construction issues like cost overruns, procurement inefficiency and contractual disputes (Almashhour & Ojiako, 2025).There are also low levels of technological use, weak regulatory systems, fragmented governance and resource limitations that add to the vulnerability of these infrastructure construction projects to theft and vandalism, especially in less developed countries with less developed security management practices (Arthur-Aidoo et al., 2023; Foster et al., 2020). This means that security incidents have more significant operational and sustainability impacts in developing countries, as there are less institutional capacity and enforcement to address them.

Theft and vandalism also have implications beyond their impact on operations, for sustainability is now seen as a key aim in infrastructure development (Zhao et al., 2016). Environmentally, the loss of material requires replacement, which involves further extraction, manufacturing, and transportation, thus generating more embodied carbon (Kumanayake & Luo, 2018; Nawarathna et al., 2021; Rathnayake et al., 2022). On an economic side, the incidents result in financial instability and cost overruns, and on a social side, they cause delayed delivery of infrastructure and less confidence from stakeholders (Zhao et al., 2016).These inefficiencies are a further challenge to sustainable delivery of infrastructure and long-term development goals given the rapid expansion of infrastructure in developing countries like Sri Lanka, Nigeria and Malasiya where the achievement of these goals is hindered by governance and resource constraints (Foster et al., 2020). While research on construction sustainability and project risk management is plentiful, there is little research addressing the relationship between theft and vandalism and the performance of construction sustainability. The sustainability impacts of security-related incidents are not well discussed in the literature while there are other issues such as financial constraints, delays, productivity concerns, and general security risk management (Sivarajah, 2021; Dolage & Dasantha, 2022). Furthermore, previous research on construction security has focused primarily on technological and crime prevention solutions and in the context of developed countries (Armitage & Ekblom, 2019; Oliva et al., 2021). Hence, there is a big theoretical gap in dealing with construction site security risks and sustainability performance in the context of infrastructure project management.

Globally, theft and vandalism in construction projects tend to be more prevalent in developing regions such as parts of Africa, South Asia, and Latin America, where weak regulatory enforcement, informal markets for stolen materials, and limited technological adoption increase project vulnerabilities. In contrast, developed regions including North America and Western Europe generally experience comparatively lower levels of construction-related theft and vandalism due to stronger governance frameworks, advanced surveillance systems, and stricter security regulations (Arthur-Aidoo et al., 2023; Foster et al., 2020).Concurrently, there is a practical requirement to explore this issue in developing countries, where regulatory enforcement is weak, technological capability is limited, and institutional constraints make projects more vulnerable to theft and vandalism, while also intensifying the long-term environmental, economic, and social impacts of such incidents (Arthur-Aidoo et al., 2023; Foster et al., 2020).

Accordingly, this study aims to examine how theft and vandalism influence the sustainability performance of infrastructure construction projects in developing countries To achieve this aim, the study examines the critical vulnerabilities contributing to theft and vandalism, evaluates their environmental, economic, and social sustainability impacts, analyses mitigation strategies for sustainable security management, and develops a conceptual framework illustrating the relationship between construction site security risks and sustainability performance.

2. METHODOLOGY

The method used in this study is the narrative literature review method, which aims to review the literature to obtain the relationship between construction site security and construction site sustainability performance in infrastructure construction. In this study, the aim is to connect and interpret the knowledge from various disciplines, such as construction management, sustainability, and infrastructure governance, so the narrative approach is chosen instead of the systematic literature review in which the study selection and screening is strictly followed. This flexibility can be useful for a much more open and critical examination of ideas, especially when research is in its initial stages, with many studies that have different conceptual emphases and not much cohesion (Snyder, 2019).

Secondary data were gathered from various academic databases, especially Google Scholar, peer-reviewed journal papers, conference papers, institutional reports, relevant industry publications etc. Relevant literature was identified by following a structured keyword search using terms related to construction site security, theft and vandalism, sustainability performance, and mitigation strategies. The identified publications were subsequently screened to ensure their relevance to the research scope. The data were then analysed and critically synthesised to identify key themes and patterns within the context of developing countries.

3. REVIEW FINDINGS

The review findings are presented under three main headings: construction site security and vulnerabilities; impacts of theft and vandalism on sustainability aspects; and mitigation strategies for sustainable security management, followed by the development of a theoretical framework to summarise the key findings.

3.1 CONSTRUCTION SITE SECURITY AND VULNERABILITIES

Infrastructure construction sites, particularly within large-scale infrastructure projects, are widely recognised as highly vulnerable environments due to their temporary, dynamic, and spatially dispersed nature (Oliva et al., 2021). Unlike permanent facilities, construction sites operate under continuously changing conditions, where materials, equipment, and labour are frequently mobilised and demobilised, creating operational instability and exposure to risk (Szymański, 2017). This transient nature limits the effectiveness of traditional security systems and creates multiple points of exposure, making such sites particularly susceptible to theft and vandalism (Arthur-Aidoo et al., 2023). Furthermore, the authors argue that the absence of integrated security planning during the early stages of project development significantly increases the likelihood of security failures, as risk mitigation measures are often implemented reactively rather than proactively.

Empirical studies on construction site crime indicate that theft and vandalism are not merely opportunistic incidents but are often facilitated by systemic weaknesses in project management practices (Arthur-Aidoo et al., 2023). Moreover, the same authors identified several recurring vulnerabilities, including inadequate surveillance systems, insufficient lighting, lack of access control, and poor inventory management. These conditions create an enabling environment in which high-value materials such as steel reinforcement, copper cables, fuel, and mechanical components can be easily misappropriated (Oliva et al., 2021). Theft in construction sites typically occurs in multiple forms, including material theft, fuel siphoning, equipment component removal, and organised bulk material diversion, while vandalism may involve deliberate damage to machinery, storage facilities, or partially completed structures (Armitage & Ekblom, 2019). The high resale value, portability, and low traceability of construction materials further increase their attractiveness to organised theft networks, particularly in contexts where regulatory enforcement is weak (Armitage & Ekblom, 2019).

The vulnerability of theft and vandalism is significantly amplified in infrastructure construction projects due to their scale and operational complexity. Large project footprints, remote locations, and reliance on temporary storage facilities complicate the implementation of effective security measures and increase exposure to external threats (Oliva et al., 2021). In many infrastructure projects, materials are stored in open or semi-secured areas due to logistical constraints, which further elevates the risk of theft (Oliva et al., 2021). Additionally, the fragmentation of responsibilities across multiple contractors and subcontractors creates ambiguity in accountability, making it difficult to establish clear ownership and control over materials and assets. Dolage and Dasantha (2022), highlight that such coordination challenges are particularly prevalent in developing countries, where weak organisational structures and communication gaps contribute to inefficiencies and increased risk exposure.

Construction site security challenges are further intensified by institutional and governance limitations. Studies by Dolage and Dasantha (2022) and Sivarajah, (2021) demonstrate that project management practices in the local construction industry tend to prioritise cost and schedule performance, often at the expense of comprehensive risk management. As a result, security-related risks such as theft and vandalism are frequently underestimated and inadequately addressed. This issue is compounded by the absence of standardised guidelines or benchmarks for managing material losses, leading to inconsistencies in reporting and accountability. Consequently, theft-related losses often remain unquantified, masking their true impact on project performance.

Critically, existing literature on construction risk management has focused on macro-level risks such as cost overruns, design changes, and contractual disputes, while security-related risks remain underrepresented (Almashhour & Ojiako, 2025). Moreover, conceptualise construction risks as interconnected systems influencing project outcomes, yet their framework does not explicitly incorporate theft and vandalism as contributing factors. Similarly, Almashhour and Ojiako (2025) emphasises stakeholder-related risks and project complexity but does not integrate site security into the broader risk structure. This omission highlights a significant gap in current theoretical frameworks, suggesting that construction site security has not been adequately recognised as a critical component of project risk management.

Because of this exclusion of theft and vandalism from conventional risk frameworks limits the ability to fully understand their long-term impacts on environmental, economic, and social performance. In infrastructure projects, where material volumes and resource consumption are significantly higher, the consequences of theft-related losses extend beyond immediate financial impacts to include increased material waste, duplication of embodied carbon, and inefficiencies in resource utilisation (Kumanayake & Luo, 2018; Nawarathna et al., 2021). Therefore, integrating construction site security into sustainability and risk management frameworks is essential to achieve more comprehensive and effective project outcomes.

3.2 IMPACTS OF THEFT AND VANDALISM ON PROJECT SUSTAINABILITY

The impacts of theft and vandalism extend beyond immediate material loss and operational disruptions, influencing the broader sustainability performance of infrastructure construction projects (Arthur-Aidoo et al., 2023). Sustainability in this context is understood through its three interconnected dimensions environmental, economic, and social each of which is adversely affected by security-related incidents (Oliva et al., 2021). While existing research has primarily examined construction inefficiencies from a productivity and cost perspective, the implications of theft and vandalism on sustainability remain insufficiently explored (Szymański, 2017).

From an environmental perspective, material theft contributes to inefficient resource utilisation by necessitating the replacement of lost or damaged materials. This process involves additional extraction, manufacturing, and transportation activities, thereby increasing the overall environmental burden of the project. While traditional construction waste studies primarily focus on on-site inefficiencies, the role of theft-induced waste remains significantly underexplored (Szymański, 2017). A particularly important dimension of this issue is embodied carbon, which refers to the total greenhouse gas emissions associated with the lifecycle of construction materials (Nawarathna et al., 2021). Although existing literature has focused on material selection and lifecycle optimisation, the duplication of embodied carbon due to theft-related replacement cycles has received limited attention (Almashhour & Ojiako, 2025). Lifecycle assessment principles suggest that repeated material procurement directly increases carbon emissions, thereby undermining sustainability objectives. This indicates the major impact to the environmental sustainability which occurred due to security related inefficiencies (Zhao et al., 2016).

Building upon the environmental impacts, theft and vandalism also have significant economic implications that directly affect the financial sustainability of infrastructure projects. From an economic standpoint, these incidents introduce both direct and indirect financial burdens (Arthur-Aidoo et al., 2023). Direct impacts include the cost of replacing stolen materials and repairing damaged assets, while indirect impacts arise from inefficiencies in project execution. Falana et al. (2019) argue that even small-scale material losses can accumulate over time, significantly reducing contractor profitability. This issue is compounded by the fact that such losses are often not fully documented, leading to inaccuracies in cost estimation and financial reporting. Dolage and Dasantha (2022) highlight that unreliable cost data weakens financial control mechanisms, contributing to cost overruns. In addition, security-related incidents frequently cause project delays, which generate secondary financial impacts such as increased overhead costs, extended labour requirements, and idle time equipment. Almashhour and Ojiako (2025) emphasise that construction delays are the result of interconnected risk factors, suggesting that theft and vandalism should be considered as part of a broader network of risks influencing economic sustainability.

Beyond environmental and economic consequences, theft and vandalism also produce critical social impacts, particularly in infrastructure projects where outcomes are intricately linked to public service delivery. Infrastructure developments play a vital role in supporting community well-being, and delays caused by security incidents can postpone access to essential services such as transportation, energy, and water supply (Foster et al., 2020). Zhao et al. (2016) highlight the importance of stakeholder trust and governance in achieving sustainable infrastructure outcomes, noting that repeated disruptions can erode public confidence in project delivery systems. Therefore, theft and vandalism can disrupt social pillar in sustainability.

These challenges are further intensified by governance limitations and the absence of standardised benchmarks for acceptable material loss, which reduces accountability and allows security-related inefficiencies to persist (Emmanuella, 2019; Foster et al., 2020). Consequently, theft and vandalism contribute to environmental impacts through increased material waste and duplicated embodied carbon, economic losses in the form of cost overruns and resource inefficiencies, and social challenges such as reduced stakeholder trust and weakened institutional credibility. More broadly, in developing countries, these impacts are often amplified due to weaker regulatory frameworks, limited enforcement capacity, and resource constraints. As a result, security-related risks tend to have more severe and long-lasting implications on overall project sustainability and performance. To illustrate the interconnected impacts of theft and vandalism across all three sustainability dimensions, Table 1 presents key incident types, their immediate effects, and their environmental, economic, and social consequences within infrastructure construction projects.

Table 1: Sustainability impact pathways of theft and vandalism

Incident Type	Immediate Effect	Environmental Impact	Economic Impact	Social Impact	Reference
Steel theft	Re-purchase of materials	Increased embodied carbon	Additional material costs	Project delays affecting public services	[2],[3]
Fuel theft	Increased fuel consumption	Higher emissions	Increased operational costs	Reduced project efficiency	[1],[3]
Concrete vandalism	Demolition & rework	Waste generation	Labour and material rework cost	Delayed infrastructure delivery	[1]
Cable theft	Reinstallation	Resource depletion	Replacement and installation cost	Disruption to service provision	[2].[3]
Equipment damage	Repair/replacement	Additional resource use	Repair cost and downtime	Reduced productivity and trust	[1].[4]

(Arthur-Aidoo et al., 2023) [1]; (Nawarathna et al., 2021) [2]; (Oliva et al., 2021) [3]; (Foster et al., 2020) [4]

3.3 MITIGATION STRATEGIES FOR SUSTAINABLE SECURITY MANAGEMENT

Mitigating the impacts of theft and vandalism in infrastructure construction projects requires a comprehensive and integrated approach that extends beyond isolated security measures. As discussed in the previous section, security-related incidents affect environmental, economic, and social sustainability dimensions; therefore, mitigation strategies must be aligned with these broader sustainability objectives. The literature emphasises that effective security management should combine technological, managerial, contractual, and governance-based interventions to address the complex and interconnected nature of construction site risks (Fédération Internationale des Ingénieurs-Conseils [FIDIC], 1999; Zhao et al., 2016). However, the effectiveness of these strategies depends not only on their individual implementation but also on their integration within overall project management systems.

From an environmental sustainability perspective, technological interventions play a critical role in minimising material loss and reducing unnecessary resource consumption. Advanced tracking systems such as RFID and GPS enable real-time monitoring of materials and equipment, thereby reducing theft and preventing duplication of resource use (Wijerathna et al., 2024). Similarly, digital surveillance systems, including CCTV and sensor-based monitoring, enhance site visibility and act as deterrents to potential offenders. By preventing material loss, these technologies contribute directly to reducing embodied carbon and construction waste. However, their adoption is often constrained by high implementation costs and technical limitations, particularly in developing countries such as Sri Lanka, Nigeria and Malaysia, where resource availability and technological awareness remain limited (Oliva et al., 2021).

Managerial strategies further support environmental and economic sustainability by improving operational control and resource efficiency. Szymański (2017) highlights the importance of initiative-taking risk management practices such as site zoning, access control, and inventory audits, which help identify vulnerabilities and prevent security breaches. Secure storage practices and controlled access systems reduce material exposure, thereby minimising waste and associated environmental impacts. In addition, improved inventory management enhances cost control and reduces financial losses. However, the success of these strategies depends heavily on organisational commitment and the effectiveness of project leadership in enforcing security protocols (Armitage & Ekblom, 2019).

From an economic sustainability perspective, contractual mechanisms provide a structured approach to risk allocation and financial accountability. Standard forms of contract, such as those developed by FIDIC (1999) establish clear provisions for material ownership, liability, and risk transfer, which help reduce disputes and improve financial transparency. Almashhour and Ojiako (2025) emphasise that clear contractual arrangements enhance project performance by reducing uncertainty and strengthening stakeholder accountability. However, existing contractual frameworks often fail to explicitly address theft and vandalism, resulting in ambiguity and potential conflicts. Integrating security-specific clauses into contracts can therefore improve financial stability and support more effective management of sustainability-related risks (Zhao et al., 2016). At a broader level, governance and policy interventions are essential for addressing the social sustainability implications of theft and vandalism. Effective governance frameworks promote accountability, transparency, and stakeholder confidence in infrastructure projects (Zhao et al., 2016). In the absence of such frameworks, security-related losses are often normalised and inadequately addressed.

In developing countries, the effectiveness of mitigation strategies is strongly shaped by institutional, financial, and technical constraints that limit their consistent implementation across construction projects. Although technological solutions such as RFID tracking, GPS systems, and CCTV surveillance offer significant potential for reducing material loss and improving environmental performance, their adoption is often restricted by high initial investment costs and limited technical capacity within local construction organisations (Oliva et al., 2021; Wijerathna et al., 2024). Similarly, managerial, and contractual measures may exist in principle but are not always effectively enforced due to weak organisational structures and inconsistent regulatory oversight. Economically, these limitations make projects more vulnerable to cost overruns and financial instability, as even small-scale theft incidents can have amplified impacts in low-margin construction environments (Al-Hazim et al., 2017; Almashhour & Ojiako, 2025). From a social and governance perspective, the absence of standardised security benchmarks and weak enforcement mechanisms reduces accountability and allows variations in site security practices, which can undermine stakeholder confidence and public trust in infrastructure delivery (Arthur-Aidoo et al., 2023; Foster et al., 2020). As a result, while mitigation strategies are conceptually effective across environmental, economic, and social dimensions, their real-world performance in developing countries remains highly dependent on governance maturity and resource availability.

Lack of standardised guidelines and performance benchmarks for construction site security limits the ability of project stakeholders to monitor and control risks effectively (Arthur-Aidoo et al., 2023). Establishing national-level policies and reporting mechanisms can enhance accountability and improve public trust, thereby strengthening the social sustainability of infrastructure development (Foster et al., 2020). Despite the availability of these mitigation strategies, a critical limitation identified in the literature is their fragmented implementation (Almashhour & Ojiako, 2025). While technological, managerial, contractual, and governance approaches may be effective individually, their lack of integration reduces their overall impact. This highlights the need for a systems-based approach that aligns these strategies within a unified framework, enabling a coordinated response to security risks. Such integration not only enhances the effectiveness of security management but also directly contributes to sustainability outcomes by reducing material waste, improving cost efficiency, and strengthening governance structures. Table 2 illustrates how different mitigation strategies align with environmental, economic, and social sustainability objectives, providing a structured basis for their integration within the proposed conceptual framework.

Table 2: Mitigation strategies and sustainability outcomes

Strategy Type	**Example**	**Environmental Benefit**	**Economic Benefit**	**Social/Governance Benefit**	**References**
Technological	RFID, GPS tracking, CCTV	Reduces material loss and embodied carbon	Minimises replacement costs	Improve monitoring and site control	[3],[5]
Managerial	Secure storage, inventory audits, access control	Reduces waste and resource inefficiency	Improves cost control and reduces losses	Enhances accountability among workers	[4],[1]
Contractual	Risk allocation clauses, liability provisions	Indirectly reduces waste through accountability	Improves financial stability and reduces disputes	Clarify roles and responsibilities	[2]
Governance	National benchmarks, reporting systems	Supports sustainable resource management policies	Enhances transparency and financial oversight	Strengthens accountability and public trust	[6],[7]

(Armitage & Ekblom, 2019) [1]; (FIDIC, 1999) [2]; (Oliva et al., 2021) [3]; (Szymański, 2017) [4]; (Wijerathna et al., 2024) [5]; (Foster et al., 2020) [6]; (Zhao et al., 2016) [7]

3.4 CONCEPTUAL FRAMEWORK

The conceptual framework developed in this study presents construction site security as a dynamic and interrelated system rather than a simple linear cause and effect relationship. It integrates concepts from construction risk management, lifecycle assessment, and infrastructure governance to explain how theft and vandalism influence sustainability performance through multiple interconnected stages. The proposed framework is illustrated in Figure 1. The conceptual framework was developed by synthesising findings from Sections 3.1, 3.2, and 3.3 to establish the relationship between construction site vulnerabilities, theft and vandalism risks, sustainability impacts, and mitigation strategies. The framework integrates key themes identified in the literature to demonstrate how security-related incidents influence environmental, economic, and social sustainability performance in infrastructure construction projects in developing countries.

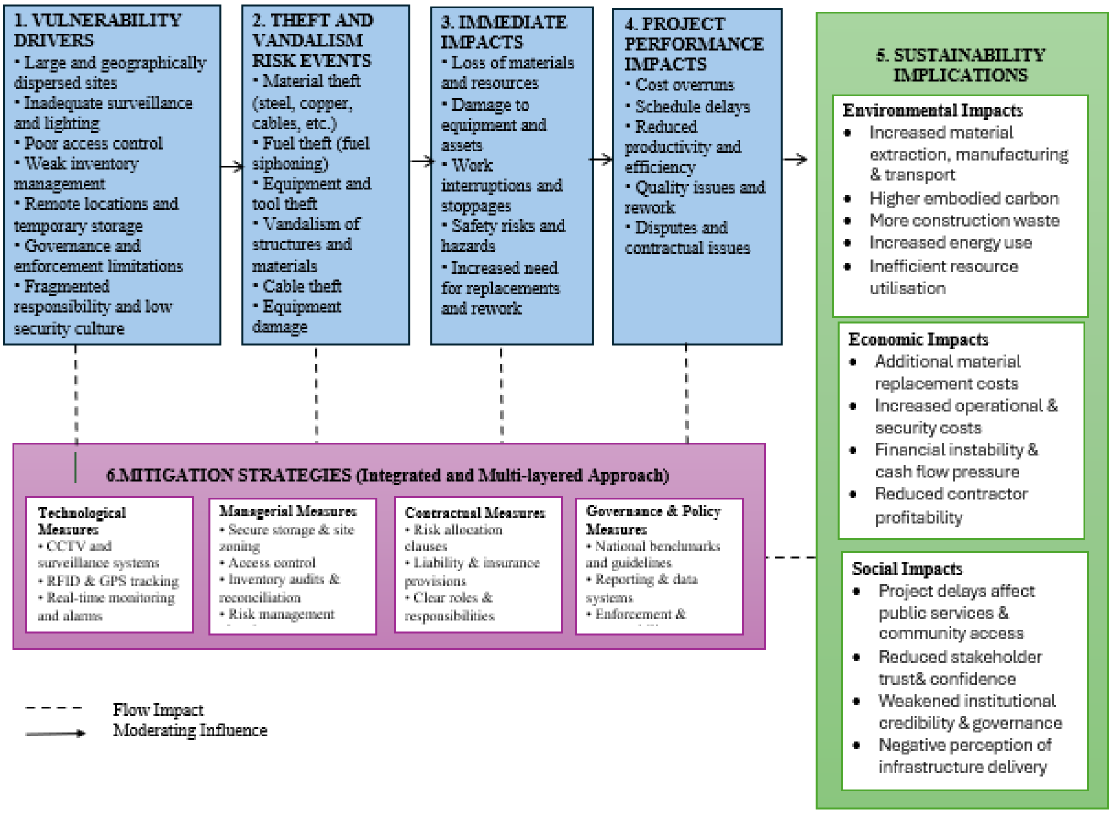

Figure 1: Conceptual framework

Initially, infrastructure project characteristics act as key vulnerability drivers, including large and geographically dispersed sites, temporary material storage, complex supply chains, and exposure to external environments. These conditions inherently increase susceptibility to security risks (Arthur-Aidoo et al., 2023). However, vulnerabilities alone do not directly result in risk events, as their impact depends on moderating factors such as governance quality, enforcement of security policies, contractor competence, and technological adoption. Weak governance and poor supervision amplify risks, while strong management practices mitigate them (Goh & Loosemore, 2017; Zhao et al., 2016). As a result of this interaction, vulnerabilities materialise into risk events such as theft and vandalism, marking the transition from potential exposure to actual project disruptions (Almashhour & Ojiako, 2025).

Following the occurrence of these risky events, projects experience immediate impacts, including material loss, equipment damage, work interruptions, and safety concerns. These direct effects disrupt site operations and reduce efficiency in the short term (Goh & Loosemore, 2017). Over time, such disruptions extend to broader project performance impacts, leading to cost overruns, schedule delays, productivity losses, and potential quality issues. This progression demonstrates that security incidents are not isolated problems but have significant implications for the overall success of construction projects (Almashhour & Ojiako, 2025). Beyond project performance, following impacts contribute to wider sustainability implications across environmental, economic, and social dimensions.

The framework explains that construction site security risks, such as theft and vandalism, generate interconnected impacts across the environmental, economic, and social dimensions of sustainability. Rather than occurring in isolation, these impacts emerge simultaneously and extend throughout the project lifecycle. Material losses contribute to increased embodied carbon and resource depletion, while financial losses, delays, and productivity reductions affect economic performance (Almashhour & Ojiako, 2025; Nawarathna et al., 2021). At the same time, disruptions to project delivery influence community access and reduce stakeholder trust and institutional credibility (Al-Hazim et al., 2017). The framework further highlights that these effects are cumulative, where repeated minor incidents can intensify long-term consequences through feedback within the project system, reinforcing the need to adopt a systems-thinking perspective (Al-Hazim et al., 2017).

To manage these interconnected impacts, the framework integrates a multi-layered mitigation approach embedded within the system itself. It emphasises that technological, managerial, contractual, and governance-based measures function as dynamic feedback mechanisms rather than isolated solutions. These strategies support continuous improvement by enabling better monitoring, informed decision-making, and strengthened accountability over time (FIDIC, 1999). In addition, the framework incorporates key performance indicators, such as incident frequency, material loss rates, carbon impacts, and delay durations, to support data-driven decision-making and performance evaluation (Nawarathna et al., 2021). This ensures that construction site security is proactively managed while enhancing overall sustainability performance.

Through this integrated approach, the framework demonstrates that construction site security is not an isolated issue but a critical factor affecting sustainable infrastructure development. It provides a comprehensive structure for understanding how security risks emerge, how they impact sustainability, and how they can be effectively managed through initiative-taking and feedback-driven strategies as presented in Figure 1.

3.5 IMPLICATIONS OF THE STUDY

This study provides important implications for both industry practice and future academic research by repositioning construction site security as a critical component of sustainable project performance rather than a purely operational concern. From an industry perspective, the conceptual framework offers a structured approach for project stakeholders including clients, contractors, and policymakers to better understand how theft and vandalism extend beyond immediate financial losses and influence long-term environmental, economic, and social outcomes. By identifying vulnerability drivers, impact pathways, and feedback-based mitigation strategies, the framework enables practitioners to adopt a more initiative-taking and integrated risk management approach. This can support improved decision-making in areas such as resource planning, security investment, and contract administration. Additionally, the framework highlights the importance of governance and institutional strength, suggesting that strengthening policy enforcement and accountability mechanisms can significantly reduce risk exposure in construction projects.

From a research perspective, this study contributes by bridging the gap between construction security management and sustainability assessment. It introduces a systems-based view that integrates risk events with lifecycle impacts and feedback mechanisms, providing a foundation for future empirical validation. Researchers can build upon this framework by evaluating the proposed relationships using case studies, quantitative modelling, or simulation techniques. Furthermore, the study opens new avenues for exploring cross-disciplinary approaches, particularly in areas such as digital construction technologies, smart monitoring systems, and sustainable infrastructure governance. Future research can also expand the framework by incorporating additional variables such as behavioural factors, regional differences, and emerging risks.

4. CONCLUSIONS AND FUTURE DIRECTIONS

This study examined how theft and vandalism influence the sustainability performance of infrastructure construction projects in developing countries on sustainability aspects through a narrative literature review approach. The findings demonstrate that security breaches are not merely operational issues but significant factors influencing environmental, economic, and social sustainability outcomes. The review highlights that theft and vandalism contribute to increased material waste, duplication of embodied carbon, financial instability, and reduced stakeholder trust. These impacts collectively undermine the sustainability performance of infrastructure projects, particularly in developing countries where governance and security mechanisms may be less robust. The study also emphasizes the importance of adopting integrated mitigation strategies that combine technological innovations, managerial practices, contractual frameworks, and policy interventions. The proposed conceptual framework provides a comprehensive understanding of how security risks interact with sustainability dimensions and offers a foundation for improving decision-making in infrastructure projects. Future research should focus on empirical validation of the framework, particularly in quantifying the environmental and economic impacts of theft-related losses. By incorporating security considerations into sustainability assessment models, infrastructure projects can achieve greater resilience, efficiency, and long-term value.

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