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Towards Sustainable Tramway Construction in Ali Mendjeli, Algeria: An Environmental and Social Management Plan

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Abstract

This study examines how the construction of the tramway has affected urban quality of life in Ali Mendjeli, Algeria, and develops a site-specific Environmental and Social Management Plan (ESMP) for impact mitigation. The research combined non-directive interviews (n=30), a structured questionnaire (346 valid responses), and Pareto analysis to identify the most critical disturbances experienced by residents, merchants, and users. The findings show that mobility, environmental nuisance, safety, communication, and local economic disruption were the dominant concerns, with access difficulty and lack of prior information emerging as major stressors. In response, the proposed ESMP organizes diagnosis, mitigation, stakeholder coordination, monitoring, and continuous improvement within an operational framework adapted to the Algerian context. The paper contributes a transferable management tool that places urban quality of life at the center of construction-site governance.

Keywords: ESMP; urban quality of life; tramway construction; impact mitigation; management tool.

1. Introduction

1.1 Background and Context

Urban construction projects, particularly large infrastructure developments, constitute necessary interventions for city modernization and economic development. However, these projects generate multidimensional impacts affecting residents' quality of life, including mobility disruption, environmental degradation, safety concerns, and economic consequences (Cuerdo-Vilches et al., 2020). In Algeria, the proliferation of new town developments and major infrastructure projects has intensified these challenges, particularly in emerging urban centers where construction occurs simultaneously with urban settlement patterns. Recent studies on tramway infrastructure also show that transport projects can reshape ecological performance and environmental quality in urban corridors, especially when greenery, surface treatment, and ecosystem functions are considered in design and implementation (Moroń et al., 2024; Major et al., 2023). The concept of quality of life (QoL) in urban environments encompasses objective indicators (infrastructure, environmental quality, mobility) and subjective dimensions (resident satisfaction, well-being, perception of urban space) (Türkoğlu et al., 2011). Construction activities directly influence both dimensions, creating temporary but significant disruptions that can persist for months or years. Despite growing awareness of sustainable construction principles, the management of construction site impacts on surrounding communities remains inadequately addressed in developing countries' regulatory frameworks. This multidimensional understanding of urban quality of life is consistent with recent debates that connect livability not only to infrastructure provision, but also to equity, sustainability, and the everyday experience of urban environments (Mouratidis, 2024; Sharifi, 2023).

1.2 Problem Statement and Research Gap

International standards such as ISO 14001:2015 provide environmental management system frameworks for construction organizations. However, these voluntary standards face critical limitations in the Algerian context: (1) they lack legally binding enforcement mechanisms within national legislation; (2) guidelines remain generic rather than context-specific; (3) social dimensions receive insufficient integration; and (4) certification objectives sometimes supersede genuine environmental protection (McGuire, 2014; Pesce et al., 2018).

Existing research extensively documents construction environmental impacts but offers limited operationalizable management tools adapted to specific national contexts. Previous studies focus predominantly on environmental dimensions while neglecting the holistic social-environmental-economic nexus fundamental to urban quality of life.

Moreover, few studies integrate resident perceptions with objective impact measurements to develop comprehensive mitigation strategies. Recent urban governance research similarly indicates that sustainability outcomes depend strongly on context-sensitive participation, communication, and stakeholder integration rather than on formal frameworks alone (Zheng et al., 2024)

1.3 Objectives and Hypotheses

This research addresses the following objectives:

1. Evaluate construction site impacts.
2. Identify priority construction site impact categories requiring immediate management intervention
3. Analyze ISO 14001 strengths and weaknesses within the Algerian construction context
4. Develop an Environmental and Social Management Plan (ESMP) adapted to Algerian regulatory frameworks and construction practices

Research Hypothesis: A context-specific Environmental and Social Management Plan (ESMP) provides a more effective framework than generic international standards for mitigating construction impacts on urban quality of life in Algerian new towns.

1.4 Significance and Structure of the research

This research contributes to urban construction management literature by: (1) providing empirical evidence of construction impact magnitudes on quality of life indicators; (2) demonstrating Pareto analysis application for prioritizing management interventions; (3) proposing a replicable ESMP framework adaptable to various construction project contexts; and (4) integrating legal compliance with practical operationalization.

The paper is structured as follows: Section 2 presents the materials and methods including study design, sampling, and analytical techniques; Section 3 reports quantitative and qualitative findings; Section 4 discusses results in relation to existing literature and proposes the ESMP framework; Section 5 concludes with implications and recommendations.

2. Materials and Methods

2.1 Study Design and Setting

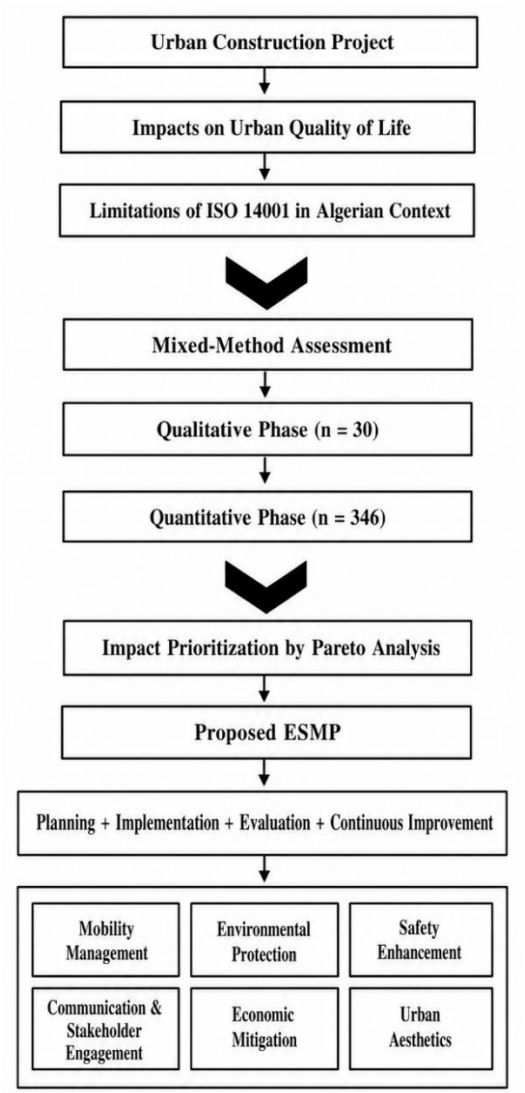

Figure 01. Structure of the Study (Developed by the Authors).

This research employed a sequential mixed-method design combining qualitative exploratory investigation with quantitative confirmatory assessment as shown in figure 01. The case study location was Ali Mendjeli New Town (Constantine, Algeria), an urban extension developed since 2000 to accommodate population overflow from Constantine city. The tramway construction project, spanning 10.3 km through the city center, was implemented by COSIDER (Algerian state construction enterprise) holding ISO 14001:2015 certification.
The study population comprised residents, merchants, employees, and regular users of Ali Mendjeli. The tramway route traversed residential neighborhoods, commercial districts, and public spaces, creating widespread disruption across multiple neighborhood units.

2.2 Participants and Sampling
Phase 1 – Qualitative (Non-Directive Interviews)
A purposive sample of 30 participants was selected to ensure diversity in demographic profiles, residential proximity to the construction site, and usage patterns. Interviews were conducted on-site along the construction corridor. The sample included residents (n=18), merchants (n=6), employees (n=4), and students (n=2), aged 20–67 years (mean = 40.3), with a gender split of 57% male and 43% female. This phase aimed to capture in-depth, lived experiences of construction-related disruptions.

Phase 2 – Quantitative (Structured Questionnaire)
Based on thematic content analysis of interview transcripts, a structured questionnaire was developed and administered to a convenience sample. Out of 400 distributed questionnaires, 346 were valid (86.5% response rate).

2.3 Data Collection Instruments
Non-Directive Interview Guide – Open-ended questions exploring lived experiences, perceptions, and evaluations of construction impacts on daily life. Key themes: mobility challenges, environmental concerns, safety perceptions, economic impacts, communication adequacy, and aesthetic degradation. Interviews lasted 15–30 minutes and were recorded in written format.

Structured Questionnaire – A 42-item instrument assessing six dimensions: (1) mobility and traffic (9 items), (2) urban aesthetics (3 items), (3) environment and safety (9 items), (4) economy (5 items), (5) communication (3 items), and (6) overall impact ranking. Response formats included Likert scales, binary choices, and multiple-selection items. Demographic variables and residential proximity indicators were also collected.

2.4 Data Analysis
Qualitative Analysis – Thematic content analysis of interview transcripts, organizing responses into six themes based on frequency of mention: mobility, urban aesthetics, parking, well-being, communication, and environment. Representative quotations were extracted to illustrate key findings.
Quantitative Analysis – Descriptive statistics (frequencies, percentages) computed using SPSS V22. Cross-tabulations examined relationships between demographic variables and perceived impacts.
Pareto Analysis – Impact frequencies from the overall ranking question were analyzed using the 80/20 principle to identify critical impact categories requiring prioritized intervention. Cumulative frequency distributions determined which categories contributed to 80% of the problems.

3. Results
3.1 Qualitative Themes from Interviews

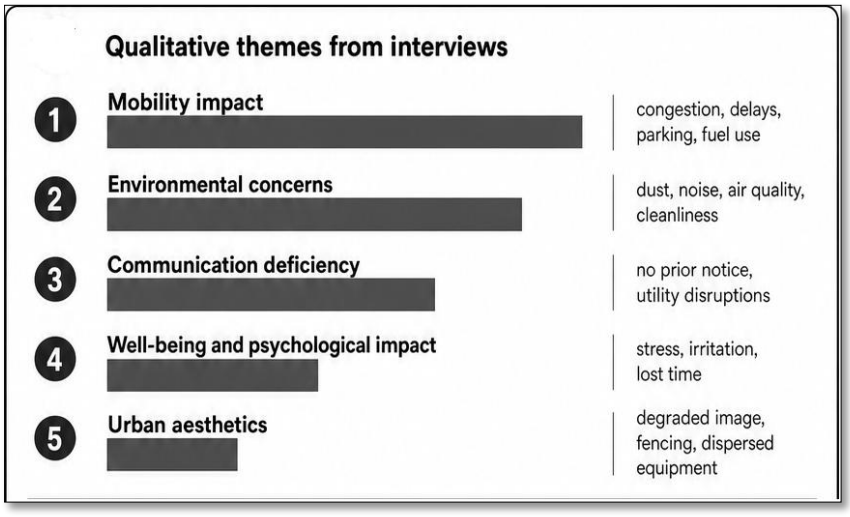

Figure 02. Qualitative Assessment of Construction-Related Impacts.

The qualitative findings as shown in figure 02 show that mobility impact was the most recurrent theme in the interviews, followed by environmental concerns and communication deficiency. Respondents mainly referred to traffic congestion, delays, parking difficulties, dust, noise, lack of prior notice, and utility disruptions, while psychological stress and urban aesthetics appeared as secondary but still meaningful dimensions of dissatisfaction. Overall, the interviews indicate that residents perceived the construction site not only as a physical disturbance but also as a source of daily inconvenience affecting comfort, time, and neighborhood image.

The quantitative results confirm the severity of the disturbances reported qualitatively, with the highest values recorded for difficult access to destinations (80.9%), no prior notification (78.3%), activity decrease among merchants (76.3%), delays reaching destinations (74.3%), and congestion (72.5%). Other important impacts included utility disruptions (67.0%), insufficient signage (60.1%), supply procurement difficulties (62.3%), air quality degradation (52.6%), and significant dust pollution (49.1%). These findings show that construction impacts were multidimensional, combining mobility constraints, communication failures, environmental nuisance, and economic losses.

3.2 Main Quantitative Disturbances

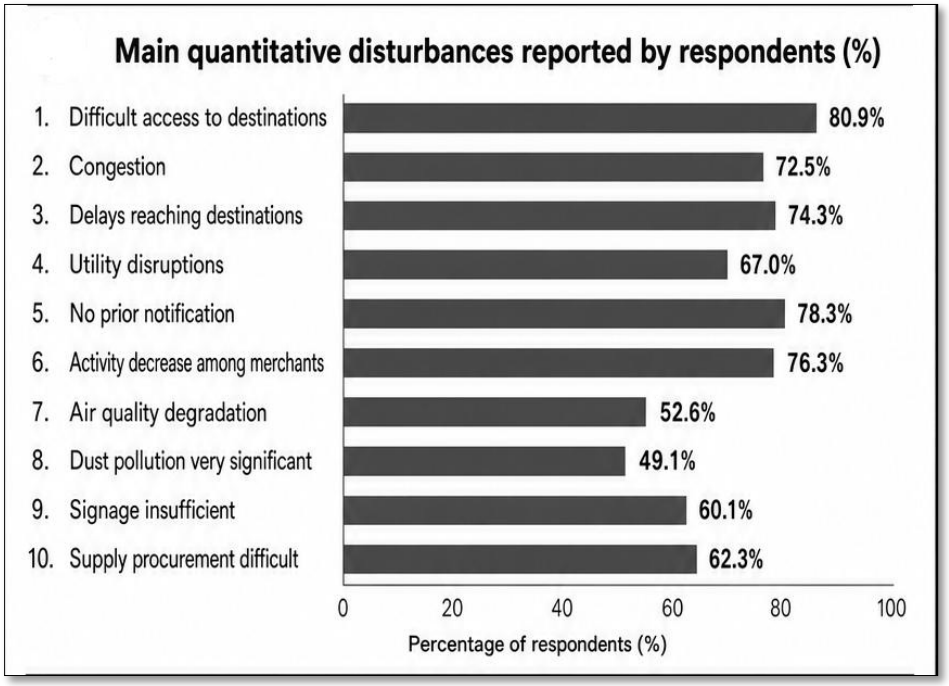

Figure 03. Quantitative assessment of Construction-Related Impacts.

The quantitative results in figure 03 confirm the severity of the disturbances reported qualitatively, with the highest values recorded for difficult access to destinations (80.9%), no prior notification (78.3%), activity decrease among merchants (76.3%), delays reaching destinations (74.3%), and congestion (72.5%). Other important impacts included utility disruptions (67.0%), insufficient signage (60.1%), supply procurement difficulties (62.3%), air quality degradation (52.6%), and significant dust pollution (49.1%). These findings show that construction impacts were multidimensional, combining mobility constraints, communication failures, environmental nuisance, and economic losses.

3.3 Prioritization of Impact Categories

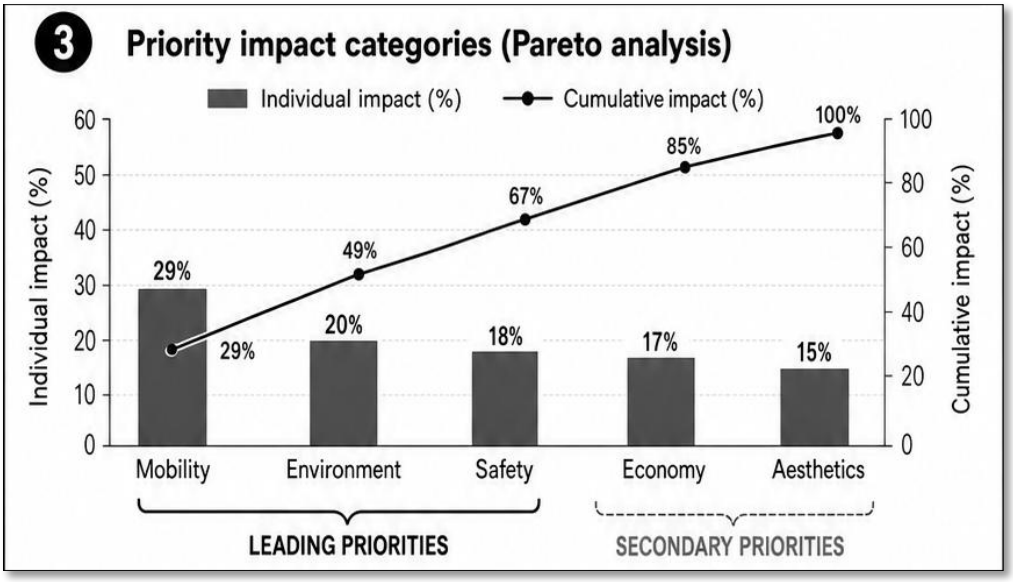

Figure 04. Impact Categories Using Pareto Analysis.

The Pareto analysis in figure 04 highlights mobility as the first priority impact category (29%), followed by environment (20%) and safety (18%), while economy (17%) and aesthetics (15%) formed secondary priorities. The cumulative curve shows that the first three categories accounted for 67% of total perceived impacts, which means that most management efforts should focus primarily on traffic, environmental control, and public safety. This result supports the argument that mitigation measures should target the most disruptive categories first in order to improve urban quality of life more efficiently during construction works.

4. Discussion

4.1 Interpretation of Key Findings

4.1.1 Mobility as Primary Impact

Mobility emerged as the predominant impact (29% in Pareto analysis, 72.5% experiencing congestion), consistent with infrastructure construction literature (Türkoğlu et al., 2011). The severity reflects the tramway's central urban location and inadequate traffic management planning. The 91.9% irritation rate demonstrates psychological well-being consequences extending beyond mere inconvenience. This finding is compatible with recent urban studies showing that movement conditions, safety, and the usability of public space are closely interconnected in determining how residents perceive everyday urban environments (Abdulla & Abdelmonem, 2023). Economic ramifications include fuel overconsumption (56.6%) and commercial supply chain disruption (62.3%), creating cascading effects throughout the urban economy.

The discrepancy between perceived severity (74.9% rating as "major") and actual mitigation efforts suggests systemic management deficiencies. Despite ISO 14001 certification, COSIDER's traffic management plan lacked key elements identified in international best practices: consultation with local authorities prior to construction, peak-hour construction activity restrictions, adequate detour signage, and pedestrian safety provisions.

4.1.2 Environmental Degradation

Environmental impacts ranked second (20%), with dust pollution affecting 49.1% significantly and noise considered unbearable by 43.4%. These findings align with construction environmental impact literature but reveal inadequate compliance with Algerian Decree No. 93-184 (July 27, 1993) regulating noise emissions. The 59.2% reporting insufficient cleanliness contradicts ISO 14001's environmental performance commitments. Perception-based urban studies also confirm that residents' evaluation of urban environments is strongly shaped by visible spatial disorder, design quality, and the coherence of the surrounding built setting (Ho et al., 2023).

Air quality degradation (52.6% confirmed) poses public health risks, particularly for vulnerable populations (children, elderly, individuals with respiratory conditions). The absence of Air Quality Monitoring Systems (AQMS) demonstrates reactive rather than proactive environmental management a fundamental ISO 14001 principle violation. These effects reinforce the view that liveability must be understood as a practical condition of daily urban life, shaped by housing, mobility, environmental comfort, and access to secure public space (Haruna et al., 2023).

4.1.3 Communication Failure

The communication deficit emerged as a cross-cutting exacerbating factor: 78.3% received no notification before utility disruptions, and 53.9% rated information dissemination as insufficient. This finding contradicts stakeholder engagement principles central to sustainable construction (McGuire, 2014). Despite 53.2% rating communication as "very important," systematic information channels were absent.

The communication gap reflects broader participation deficiencies in Algerian urban planning processes. Public consultation mechanisms, mandatory in international best practices, remain underdeveloped in local construction management frameworks.

4.1.4 Economic Consequences

Commercial activity impacts were substantial: 76.3% of merchants experienced revenue decline, with 7.9% facing business cessation. These findings demonstrate construction projects' economic externalities extending beyond project boundaries. The lack of compensation mechanisms or economic mitigation strategies indicates insufficient consideration of social sustainability dimensions.

More broadly, such impacts can be interpreted within an urban social-ecological-technological systems perspective, in which infrastructure disruptions affect not only environmental conditions but also governance capacity, social well-being, and urban resilience (Sharifi, 2023).

4.2 ISO 14001 Analysis: Strengths and Limitations

4.2.1 SWOT Analysis Findings

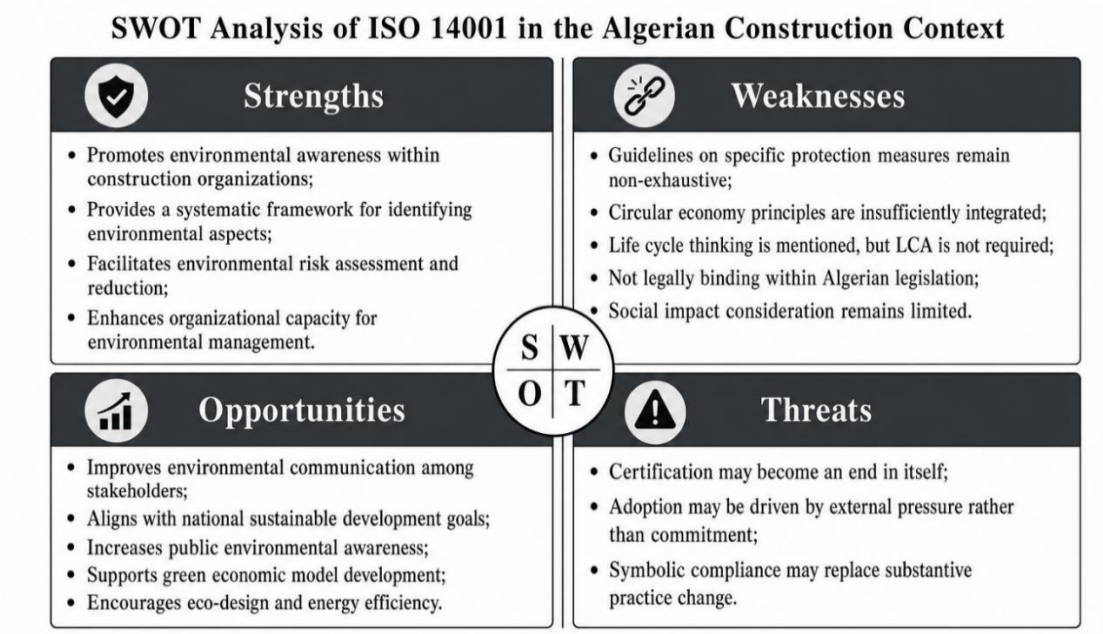

Figure 05. SWOT analysis.

The SWOT analysis in figure 05 was conducted to evaluate the relevance and limitations of ISO 14001 as an environmental management framework for construction projects in the Algerian context. While the standard offers clear organizational and environmental management benefits, its practical effectiveness remains constrained by generic guidance, weak legal enforceability, and limited integration of social dimensions. The analysis therefore helps identify the internal strengths and weaknesses of ISO 14001, as well as the external opportunities and threats that influence its implementation and real impact on construction site management.

4.2.2 ISO 14001 Limitations in Algerian Context

The fundamental limitation is ISO 14001's voluntary nature within Algerian legal frameworks. Without legal enforcement mechanisms, certification provides reputational benefits but lacks implementation accountability. This research demonstrates that ISO 14001-certified organizations may still generate significant negative impacts when certification prioritizes image over substantive practice.

Furthermore, ISO 14001's generic guidelines require contextualization for effective application. The standard's failure to mandate specific technologies, monitoring systems, or stakeholder engagement protocols creates implementation gaps, particularly in contexts lacking robust regulatory enforcement infrastructure.

4.3 Proposed Environmental and Social Management Plan (ESMP)
4.3.1 ESMP Conceptual Framework

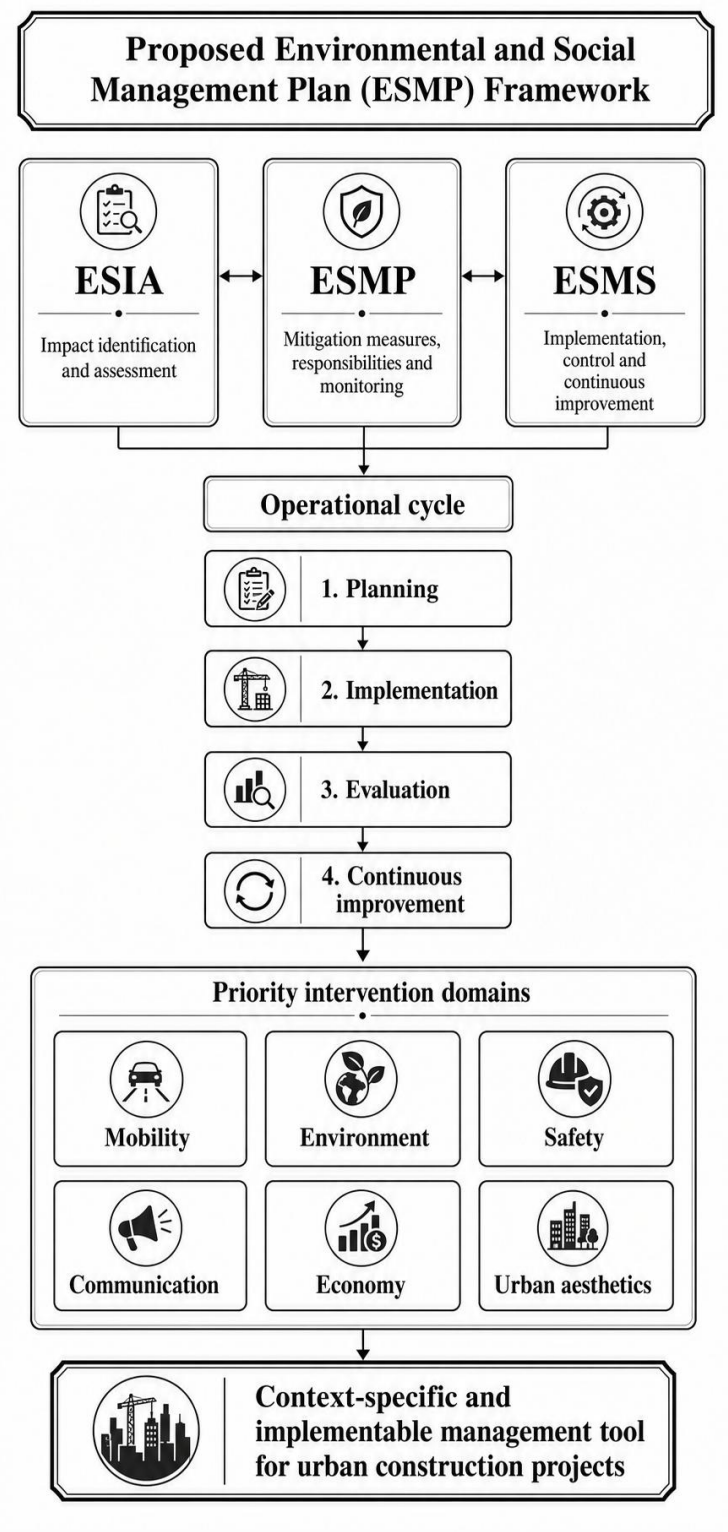

Figure 06. Proposed ESMP (Developed by the Author).

The proposed framework presents the Environmental and Social Management Plan as an integrated and operational system designed to overcome the limitations of ISO 14001 in the Algerian construction context. It is structured around three complementary components: Environmental and Social Impact Assessment, which identifies and evaluates impacts throughout the project lifecycle; the Environmental and Social Management Plan itself, which translates these impacts into mitigation measures, responsibilities, and monitoring procedures; and the Environmental and Social Management System, which ensures implementation, control, and continuous improvement.

The framework is operationalized through a four-phase cycle composed of planning, implementation, evaluation, and continuous improvement. This cycle is directly connected to the priority intervention domains identified by the empirical findings, namely mobility, environment, safety, communication, economy, and urban aesthetics, which emerged from the mixed-method assessment and Pareto prioritization. In this way, the framework transforms the main disturbances

observed in the Ali Mendjeli tramway project, such as congestion, dust pollution, lack of prior notification, and commercial disruption, into a context-specific and implementable management tool for urban construction projects.

Figure 06 presents the conceptual framework of the proposed Environmental and Social Management Plan (ESMP). The framework is structured around three interrelated components: the Environmental and Social Impact Assessment (ESIA), which identifies and evaluates potential project impacts; the Environmental and Social Management Plan (ESMP), which defines mitigation measures, responsibilities, and monitoring procedures; and the Environmental and Social Management System (ESMS), which ensures implementation, control, and continuous improvement. Together, these components form an integrated management structure that is operationalized through a four-phase cycle comprising planning, implementation, evaluation, and continuous improvement.

The framework is grounded in the empirical findings of the study. It targets the main priority domains identified in the case study, namely mobility, environment, safety, communication, economy, and urban aesthetics, thereby translating the observed construction-related impacts into a practical and context-adapted management model for improving urban quality of life during project execution.

Table 01: ESMP summary table.

Domain	Key impact	Core response	Lead actor	Review
Mobility	Congestion 72.5%; access difficulty 80.9%	Traffic management plan, signage, pedestrian access, parking	COSIDER + Traffic Police	Weekly
Environment	Dust 49.1%; air degradation 52.6%	Dust control, noise control, waste management, AQMS	COSIDER + Environment Directorate	Daily to monthly
Safety	Insufficient signage 60.1%	Fencing, audits, safe passages, training	COSIDER + HSE + Authorities	Daily/Weekly
Communication	No prior notification 78.3%	Meetings, notices, grievance system, liaison officer	COSIDER + Utilities	Monthly
Economy	Revenue decline 76.3%; supply difficulty 62.3%	Local jobs, access support, compensation, phased works	COSIDER + ANEM + Local office	Quarterly
Aesthetics	Poor landscape 63.0%	Better fencing, cleaning, screening, debris removal	COSIDER + Urban Planning	Weekly

Table 1 synthesizes the practical contribution of the proposed framework. It shows how each priority impact category identified in the study is translated into specific mitigation measures, assigned responsibilities, and monitoring procedures, thereby making the ESMP a context-specific and operational response to construction-related impacts on urban quality of life.

5. Conclusions

This study demonstrates that the impacts of urban construction works on residents' quality of life should be treated as a central dimension of project governance rather than as a temporary side effect of infrastructure delivery. By combining impact assessment, prioritization, and management design, the research shows that quality of life can be operationalized as a measurable and manageable component of construction sustainability.

The main theoretical contribution of the article lies in connecting construction management, environmental governance, and urban quality of life within a single analytical framework adapted to a developing-country context. It also advances the debate on voluntary standards by showing that ISO 14001, while useful as an organizational reference, remains insufficient when legal enforceability, social integration, and context-specific guidance are weak. In response, the proposed ESMP constitutes a conceptual advance because it translates broad sustainability principles into an implementable system structured around assessment, mitigation, monitoring, and continuous improvement.

From a policy and professional perspective, the study provides an applied framework that can support both regulatory reform and day-to-day project management. The findings support making ESMP preparation and implementation mandatory for major urban construction projects, strengthening compliance verification, institutionalizing stakeholder communication throughout the project cycle, and establishing independent monitoring and grievance mechanisms. For practitioners, the framework offers a practical roadmap for aligning contractor responsibilities, authority oversight, and community participation around clearly defined mitigation priorities and monitoring procedures.

More broadly, the article argues that sustainable urban development depends not only on what is built, but also on how projects are planned, communicated, supervised, and adjusted in relation to affected communities. The proposed ESMP

therefore represents more than a mitigation checklist: it provides a replicable governance model for shifting construction management from symbolic environmental commitment toward accountable, context-sensitive, and socially grounded practice.

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Conflicts of Interest
The author reports no conflicts of interest.

Data Availability Statement
The data supporting the findings of this study consist of anonymised interview notes, questionnaire responses, and derived analytical materials. These materials are available from the author on reasonable request, subject to ethical and confidentiality considerations related to participant privacy.

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