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Abstract
This study explores the integration of social equity and cultural indicators in sustainable road and highway infrastructure development in Ghana. Using a qualitative approach, semi-structured interviews were conducted with 14 professionals in the construction industry, including engineers, project managers, and consultants. The research aimed to uncover challenges and effective strategies in addressing social and cultural dimensions of infrastructure projects. Thematic analysis of interview data, facilitated by ATLAS.ti software, revealed three key areas of concern: community engagement and public participation, worker health and safety, and traffic congestion management. Findings indicate that while stakeholders recognize the importance of these factors, significant challenges persist in their practical implementation. These include mistrust between project implementers and communities, inadequate safety training and enforcement, and limited integration of cultural considerations in project planning. The study proposes a multifaceted approach to address these issues, emphasizing comprehensive impact assessments, culturally sensitive designs, and enhanced stakeholder engagement. This research contributes to the growing body of literature on sustainable infrastructure development in developing countries and provides actionable insights for policymakers and project managers to enhance the inclusivity and cultural sensitivity of future infrastructure projects in Ghana.

Keywords
Ghana, Road Construction, Sustainable infrastructure

1 Introduction

Infrastructure development, especially in the domain of roads and highways, has a crucial impact on promoting economic growth and enhancing quality of life. Nevertheless, the prosperity and long-term viability of these projects depend not only on their technical and economic feasibility, but also on their social and cultural suitability (Taherian et al., 2024). In Ghana, a nation undergoing rapid urbanization and infrastructural expansion, the incorporation of social justice and cultural factors into road and highway development has become increasingly crucial (Asumadu et al., 2023; Somanje et al., 2020). For instance, recent infrastructure projects have faced significant community resistance, with the 2023 Tema Port expansion and the ongoing Accra-Kumasi highway rehabilitation highlighting tensions between development goals and local community needs (Somanje et al., 2020). Recent research has emphasized the significance of social sustainability in infrastructure projects. Chen et al. (2024) contends that the use of development strategies that take into account cultural sensitivities can greatly improve the results of projects and foster more acceptance among communities. Agyekum et al. (2023) further stress the importance of ensuring fair and balanced involvement of all stakeholders at every stage of the project. Although these ideas are generally recognized, there is a lack of research on their practical application in the Ghanaian setting. The current body of literature identifies community engagement and public participation, improvement of workers' health and safety, and traffic management and congestion as the top three critical indicators of social equity and culture criteria for road and highway infrastructure development in Ghana (Dokyi, 2024).

Although infrastructure development fosters economic progress and enhances quality of life, attaining genuine sustainability necessitates a more holistic comprehension that transcends social and cultural appropriateness. Sustainability in infrastructure development encompasses multiple interconnected dimensions: environmental stewardship, economic viability, social equity, and cultural preservation (Hariram et al., 2023). These dimensions must be balanced and integrated, as excellence in one area does not automatically guarantee sustainable outcomes. For instance, while culturally sensitive project design and equitable stakeholder engagement are crucial, they must be complemented by environmental protection measures, economic feasibility, and long-term maintenance planning to achieve genuine sustainability (Onifade et al., 2024). In the Ghanaian context, sustainable infrastructure development demands particular attention to the interplay between these dimensions. The country's rapid urbanization and infrastructure expansion create complex challenges where environmental concerns, economic constraints, social equity considerations, and cultural preservation needs often compete for priority (Amponsah, 2021). Understanding sustainability as a multifaceted concept helps ensure that addressing social equity and cultural sensitivity, while necessary, is recognized as part of a broader framework for achieving truly sustainable outcomes.

Despite these insights, there remains a notable gap in understanding how social equity and cultural criteria are operationalized during project implementation and management in Ghanaian infrastructure projects. While quantitative studies have provided valuable data on project outcomes, there is a dearth of qualitative research exploring the in-depth experiences and perspectives of key stakeholders (Fuseini & Kemp, 2015). This gap limits our understanding of real-world challenges and effective strategies for integrating social and cultural dimensions into infrastructure development. This study aims to address this research gap by conducting a qualitative analysis of social equity and cultural indicators for sustainable road and highway infrastructure development in Ghana. The findings will be particularly relevant for ongoing and planned infrastructure projects under Ghana's 2024-2030 Infrastructure Development Plan.

2 Literature Review

Infrastructure development plays a crucial role in Ghana's economic and social growth. However, the integration of social equity and cultural considerations into road and highway projects remains a significant challenge (Kahangirwe & Vanclay, 2024; Porter, 2002). This review examines the current state of knowledge regarding social equity and cultural indicators in sustainable infrastructure development in Ghana, focusing on road and highway projects.

2.1 Conceptual Framework

The conceptual framework integrates social equity, cultural indicators, and sustainable development in Ghana;s infrastructure projects. Social equity ensures fair distribution of benefits and burdens across society (Clark et al., 2023; Dastgoshade et al., 2024), emphasizing inclusive growth and participatory decision-making (Gupta & Vegelin, 2016). However, implementation faces challenges including marginalization, mobility issues, and resettlement complications (Asiama et al., 2017; Brady & Hooper, 2019; Porter, 2002; Yakubu et al., 2021). While best practices include inclusive planning and fair compensation (Fuseini 2024; Grabowski et al., 2023), their effectiveness in rural Ghana remains understudied. Cultural indicators address local traditions and practices affected by infrastructure projects (Dansoh et al., 2020), supporting sustainable development's goal of meeting present needs without compromising future generations (Brundtland, 1987). Key challenges include inadequate cultural impact assessments and conflicts between modernisation and preservation (Adovor Tsikudo, 2023; Lawer, 2019). This highlights a critical gap in balancing cultural preservation with infrastructure development needs.

Sustainability in infrastructure construction necessitates a comprehensive understanding that transcends isolated elements like social equality or cultural preservation. While the Brundtland definition of sustainable development - meeting present needs without compromising future generations' abilities to meet their needs - provides a foundation, contemporary infrastructure development demands a more nuanced approach (Hariram et al., 2023). Sustainability encompasses three key dimensions that must be integrated and balanced:

- Environmental Sustainability: Ensuring infrastructure development minimizes ecological impacts, preserves biodiversity, and contributes to climate resilience.

- Economic Sustainability: Guaranteeing project viability through efficient resource use, life-cycle cost management, and long-term maintenance planning.

- Social and Cultural Sustainability: Promoting equitable access to infrastructure benefits, fair distribution of impacts, and inclusive decision-making processes, as well as preserving and respecting local traditions, values, and practices while accommodating modernization needs.

These dimensions are interdependent, and success in one area does not automatically ensure overall sustainability (Benites & Simões, 2021; Roseland, 2000). For instance, a project might achieve high levels of social equity and cultural sensitivity but still fall short of sustainability if it lacks environmental protection measures or economic viability. Therefore, while this study focuses on social equity and cultural indicators, these elements should be understood as necessary but not sufficient conditions for achieving sustainable outcomes in infrastructure development. The conceptual framework that follows examines how social equity and cultural indicators contribute to broader sustainability goals when properly integrated with other sustainability dimensions. This integration is particularly crucial in Ghana's context, where rapid development pressures often create tensions between immediate infrastructure needs and long-term sustainability considerations.

2.2 Integration of Conceptual Framework Concepts

Figure 1 shows the integration of social equity, cultural indicators, and sustainable development in infrastructure projects as a Venn diagram with three overlapping circles. This central area represents the ideal outcome of infrastructure projects that successfully balance the three elements. In Ghana, a nation characterized by its diverse ethnic landscape, with over 100 ethnic groups (Owusu & Agyei-Mensah, 2011) and facing developmental challenges such as regional disparities and rapid urbanization (Osei-Assibey, 2014; Somanje et al., 2020), an integrated approach to infrastructure development is crucial. This framework provides a comprehensive lens for evaluating Ghana's road and highway infrastructure projects, emphasizing the need for a holistic approach that considers technical, social, cultural, and sustainability aspects.

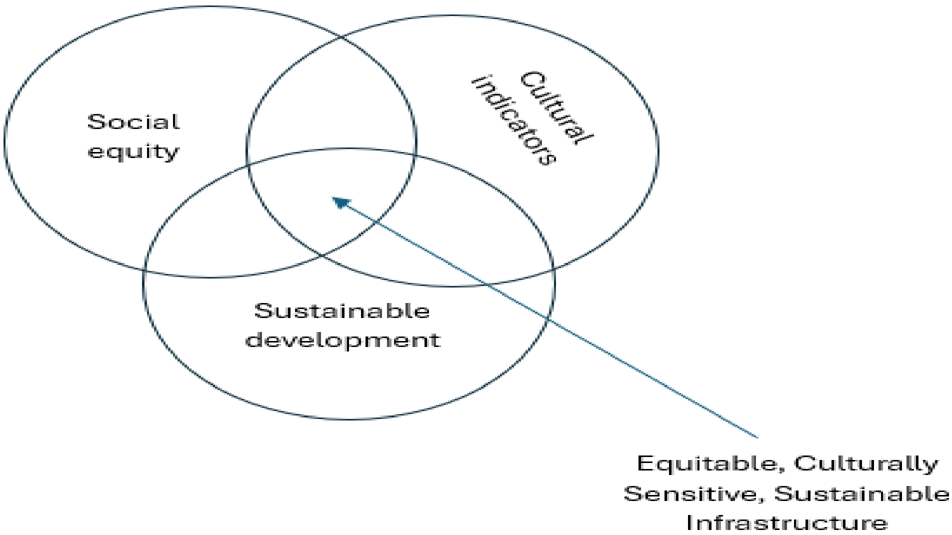

Figure 1: shows integration of social equity, cultural indicators, and sustainable development (Dokyi, 2024)

2.3 Community Engagement and Public Participation

Community engagement and public participation are crucial for successful road and highway infrastructure development in Ghana. While Barajei et al. (2023) emphasize external environmental factors and stakeholder involvement, and Damoah et al. (2022) highlight the importance of avoiding political interference, significant contradictions exist in the literature. Tengan and Aigbavboa (2017) report high initial stakeholder engagement but poor participation in monitoring and evaluation, indicating inconsistent involvement throughout project lifecycles. Additionally, disagreement exists regarding procurement-related factors' influence on project success. These contradictions in the literature reveal a critical need for more structured and sustained stakeholder involvement throughout all project phases. Addressing these inconsistencies and ensuring continuous community engagement is essential for enhancing project success and accountability in Ghana's infrastructure development (Barajei et al., 2023; Damoah et al., 2022; Tengan and Aigbavboa, 2017).

2.4 Improvement of Worker's Health and Safety

The literature identifies critical challenges and improvements needed in worker health and safety in Ghana's road infrastructure development. While technology is crucial for construction processes, its application in safety monitoring remains underutilised (Agyekum et al., 2022), with AI adoption hindered by lack of innovation culture and training (Mustapha et al., 2024). Key challenges include inadequate enforcement of safety legislation (Appiah, 2016), ergonomic injuries (Shah & Alqarni, 2018), and insufficient resources for OSH implementation (Wamalwa & Juster, 2022). Studies emphasise that effective OSH implementation improves worker performance (Handoko et al., 2020) and requires health hazard identification (Khan et al., 2023). However, obstacles persist due to organisational challenges (Baghdadi 2024), worker awareness gaps (Soares & Kurniawan, 2022), and company-perspective barriers (Kelly & Putra, 2024). The literature advocates for a holistic approach integrating technology, strengthened regulatory enforcement, and enhanced OSH measures to improve worker safety and project outcomes in Ghana's infrastructure development.

2.5 Traffic Management and Congestion

The literature presents contrasting views on traffic congestion management in Ghana’ s road infrastructure development. While intelligent transportation systems (ITS), GIS applications, and mixed-use urban planning can effectively reduce congestion (Subair et al., 2024; Wang & Zhang, 2024), and variable speed limits help alleviate congestion and emissions (Fang and Tettamanti, 2021), traditional solutions show limitations. Road expansion and increased capacity may unexpectedly worsen congestion (Subair et al., 2024; Mogridge, 1988). The literature emphasizes re-examining traditional highway planning from a sustainable development perspective (Liu et al., 2024), advocating for an integrated approach that combines ITS, GIS technology, and sustainable urban planning. However, such interventions require careful consideration of unintended consequences, highlighting the need for context-specific solutions in Ghana's infrastructure development (Liu et al., 2024; Wang & Zhang, 2024).

3 Research Methodology

This study adopts an interpretivist philosophical paradigm using qualitative methodology (Ryan 2018) to understand sustainability in Ghana's road and highway construction through participants’ experiences. Following an inductive reasoning approach (Clark and Creswell, 2008), the study employed thematic analysis to uncover patterns in participants’ perspectives (Krueger et al., 2024).

The sample comprised 14 professionals in road and highway construction, including engineers, consultants, contractors, environmentalists, and academics, with experience ranging from 10 to 24 years as highlighted in table 1. The study’s methodological rigor was established through a comprehensive validation framework. At the data collection stage, expert review validated interview questions (Bhalla et al., 2023), while standardised interview protocols ensured consistency (Campbell et al., 2013). During analysis, data triangulation using multiple sources (Natow, 2020) was complemented by member checking for credibility (Motulsky, 2021). The analysis process achieved an inter-rater reliability coefficient of 0.85 using Cohen's Kappa (Nili et al., 2020), while reflexive journaling throughout the research process addressed potential researcher bias (Olmos-Vega et al., 2023).

Table 1. Details of interviewee and their organizations

Participant	**Organisation Type**	**Position**	**Experience (years)**	**Interview Type**
P1	Academia	Senior Lecturer	10	Face-to-face
P2	Road Agencies	Project Manager	18	Face-to-face
P3	Ministry of Road and Highway	Principal Engineer	13	Face-to-face
P4	Road Agencies	Regional Manager	19	Phone
P5	Contractor	Project Manager	21	Face-to-face
P6	Road Agencies	Deputy Regional Manager	16	Face-to-face
P7	Road Agencies	Project Engineer	16	Phone
P8	Environmental Agencies	Deputy Director	24	Phone
P9	Road Agencies	Principal Engineer	12	Face-to-face

P10	Road Agencies	Regional Manager	20	Face-to-face
P11	Consultant	Project Manager	14	Face-to-face
P12	Road Agencies	Contract Manager	15	Face-to-face
P13	Consultant	Managing Director	18	Face-to-face
P14	Research Institute	Senior Researcher	15	Face-to-face

3.1 Data process and analysis

The study employed semi-structured interviews (Adeoye-Olatunde & Olenik, 2021) with 14 participants from Ghana's Greater Accra region, aligning with Creswell's (2007) recommended sample size of 12-30 participants for heterogeneous populations. Participants received information sheets, interview guides, and consent forms prior to recorded interviews.

The data analysis process followed an integrated approach where recorded interviews were first transcribed and edited for clarity. These transcripts were then processed through ATLAS.ti software, facilitating systematic qualitative analysis. The thematic analysis (Bingham 2023) proceeded as an iterative process, beginning with thorough review and familiarisation of interview content, followed by preliminary code development focusing on indicators' significance, implementation challenges, and strategies. These elements were systematically coded within ATLAS.ti, enabling comprehensive analysis of sustainable highway development themes and their interrelationships.

4 Findings and Discussion

The results were analysed and discussed using the themes extracted from the interview transcripts through the ATLAS.ti coding process. Thus, this section focuses on the demography of participants and social equity and cultural indicators in sustainable road and highway infrastructure development.

4.1 Demography of participants

The study participants represented diverse organisations within Ghana's road and highway infrastructure sectors, with road agencies comprising the largest group (seven participants, 50%), followed by consultants and academia/research (two participants each, 14.3%), and single representatives (7.1% each) from the Ministry of Road and Highway, contractor, and environmental agency. Position distribution reflected varied management levels: Project Managers and Engineers (five participants, 35.7%), regional managers and deputies (three participants, 21.4%), Principal Engineers and Senior Lecturers/Researchers (two participants each, 14.3%), and one each (7.1%) for Managing Director and Deputy Director positions. Participants possessed substantial industry experience (10-24 years), with the majority having over 15 years of experience. Following McDaniel et al. (1988), this extensive experience enhances the reliability of insights provided, as work experience correlates with job knowledge and information quality.

4.1.1 Community engagement and public participation

Community engagement and public participation in Ghana's road and highway infrastructure development presents a complex landscape of opportunities and challenges. Through semi-structured interviews with various stakeholders, this study reveals an in-depth understanding of the role and implementation of public participation in infrastructure projects. These findings highlight the critical importance of public participation in enhancing project acceptability, relevance, and sustainability. As one participant noted, *"They are concerned about the impact on their businesses and disruptions caused...The Land Valuation Board plays a crucial role in convincing them and addressing their concerns, showing them the benefits, they will gain" (P3)*. This observation aligns with the literature, particularly that of Barajei et al. (2023) and Tengan and Aigbavboa (2017), who highlight the significance of stakeholder involvement in project success.

However, the implementation of effective public participation poses significant challenges. A key issue is the lack of trust and communication between the project implementers and the public. As one participant explained, *"...one challenge with it is that sometimes there is mistrust and also lack of information from the contractors and even the road agencies. And sometimes too, another problem could be misinterpretation of information on the part of the public so if you give out an information, they misinterpret it" (P1),* presents an interesting contradiction to western-based stakeholder management theories. This mistrust and miscommunication can significantly undermine engagement. Political interference has become a major obstacle. One participant observed, *"In our budget for road construction, most of them because they are politically motivated and made, there is no proper coordination" (P11)*. This aligns with Damoah et al. (2022), who identify the absence of political interference as a critical success factor for projects, which presumes a baseline of institutional trust.

Resource constraints, both financial and temporal, frequently impede effective engagement. As one participant noted, *"financial constraints or other issues might limit the extent of stakeholder consultations" (P12)*. Time pressure also plays a crucial role, with another participant stating, *"When you have only two weeks to submit a proposal or feasibility report on a particular road, that is not enough time to engage the public" (P9)*. To address these challenges and move towards a truly integrated approach that balances social equity, cultural preservation, and sustainable development in Ghana's road and highway infrastructure projects, a multifaceted strategy emerges from the findings.

The core of this approach is the need for comprehensive impact assessments that go beyond traditional environmental and social studies to include thorough cultural impact evaluations. This holistic assessment would inform road designs that not only improve access for marginalized communities, but also respect sacred sites and traditional land-use patterns. Such an approach directly addresses the concern raised by one participant that *"at the inception of the project, sometimes we fail to take the needs of the people into consideration" (P9)*. Complementing this, the implementation of a benefit-sharing mechanism could reinvest project revenue into local cultural preservation and community development initiatives. This strategy responds to the observation that communities often demand immediate financial benefits, which can hinder ongoing engagement: *"they are demanding and the moment they see contractors they want to see money and that keeps them from not involving them anymore" (P10)*. To ensure different representations and effective communication, establishing a project steering committee with members from various ethnic groups, socioeconomic backgrounds, and sectors is crucial. This aligns with the recommendation that *"Ensuring that the right people represent the project and control how they communicate is important" (P5)*. Such a committee would be well-positioned to oversee enhanced education and awareness campaigns, improving the understanding of the value of public participation among both community members and project teams. These efforts should be underpinned by clear guidelines and frameworks for public participation, tailored to the Ghanaian context, and endorsed by relevant authorities. Simultaneously, building capacity within government agencies and project teams to manage participatory processes effectively is essential (Arkorful et al., 2023). This includes training in community engagement techniques and conflict resolution, and addressing the mistrust and communication issues highlighted by the participants.

To this end, leveraging technologies such as social media platforms and mobile applications (Ofori et al., 2023) can broaden outreach and facilitate more cost-effective engagement with a wider audience.

This approach can help mitigate both financial and temporal resource constraints, which often impede engagement. By implementing these interconnected strategies, Ghana can work towards a more inclusive, culturally sensitive, and sustainable approach to road and highway infrastructure development. This comprehensive approach not only addresses the challenges identified in this study, but also aligns with the literature's call for more consistent and effective stakeholder involvement throughout the project lifecycle.

4.1.2 Improvement of Worker's Health and Safety

The findings from semi-structured interviews with stakeholders in Ghana's construction industry reveal a complex landscape of worker health and safety issues in road and highway infrastructure development. The interviews unanimously emphasized the critical importance of health and safety measures in construction projects. However, they also highlighted significant gaps in implementation, including lax enforcement of safety regulations, inadequate worker training, and a general undervaluation of the role of safety. As one participant noted, *"We expect a certain level of compliance, but the reality is that many workers come from backgrounds where safety standards were not a priority. It is challenging to change their mindset and make them appreciate the importance of health and safety measures" (P13)*. This observation emphasizes the need for cultural transformation within the industry. The need for capacity building is evident, as highlighted by a participant: *"And there is also the need to enhance their capacity to do that. Not every engineer can do this risk assessment" (P1)*. This aligns with the literature's emphasis on the importance of worker awareness and knowledge of Occupational Safety and Health (OSH) (Soares & Kurniawan, 2022).

Financial constraints have emerged as a significant barrier to implementing robust safety measures, particularly for smaller firms. This is reflected in the literature, which identifies financial resources as key determinants of OSH implementation (Wamalwa & Juster, 2022). However, some positive practices are noted, such as the inclusion of safety provisions in contract documents: *"Yes, the contract documents include provisions for these issues. They cover things such as ensuring worker safety and providing insurance coverage for workers in case of accidents" (P12)*. To address the challenges in worker health and safety in Ghana's road and highway infrastructure development, a comprehensive and culturally sensitive approach is essential. The strategy integrates various elements to create a cohesive framework that balances social equity, cultural preservation, and sustainable development.

The core of this approach is to conduct comprehensive impact assessments that encompass cultural, environmental, and social dimensions. These assessments will inform the design of safety training programs that respect and incorporate local cultural norms while meeting international standards. As one participant emphasized, *"Now before any new worker or even a visitor gets to the site, there is the need for safety induction to also create the awareness for such person" (P1)*. This cultural sensitivity in safety protocols addresses the challenge highlighted by another participant: *"We expect a certain level of compliance, but the reality is that many of the workers come from backgrounds where safety standards were not a priority" (P13)*. Complementing these efforts, the implementation of a benefit-sharing mechanism would reinvest project revenue into local community development initiatives, including health and safety education programs. This aligns with the approach mentioned by a participant: "*This is how AFD does...Therefore, funding was provided as a part of the project. There are also charges or monies for the contractor to undertake these health and safety issues for workers" (P11)*. Such a mechanism would not only enhance safety measures but also contribute to broader community development.

To ensure different representations and effective implementation, establishing a project steering committee with members from various ethnic groups, socioeconomic backgrounds, and sectors is crucial. This committee oversees the implementation of safety measures, ensuring that they are culturally appropriate and effective. It would also address the need for enhanced capacity building, as highlighted by a participant: *"And there is also the need to enhance their capacity to do that. Not every engineer can do this risk assessment" (P1)*. Leveraging the technology to enhance safety monitoring and training is another key aspect of this integrated approach. This addresses the underutilization noted in the literature (Agyekum et al., 2022; Mustapha et al., 2024) and could include developing mobile apps for safety reporting in local languages, thus making safety measures more accessible and culturally relevant.

Strengthening regulatory enforcement while considering the local context is essential. As one participant noted, *"However, overall enforcement and implementation of safety measures can be improved, especially with stronger involvement from the regulatory agency" (P12)*. This improved enforcement should be coupled with efforts to foster a culture of safety that extends beyond the construction site, recognizing that *"For road construction, your stakeholder is not just the workers but the road users, pedestrians, drivers, and so forth" (P11)*. By implementing these interconnected strategies, Ghana can work towards a more holistic approach to worker health and safety in road and highway infrastructure development. This comprehensive strategy not only addresses immediate safety concerns, but also considers broader societal and cultural contexts, ensuring that infrastructure development truly serves the needs of various communities while promoting sustainability and social equity.

In view of this, improving worker health and safety in Ghana's road and highway infrastructure development requires a multifaceted approach that goes beyond regulatory compliance. This calls for a fundamental shift in industrial culture, enhanced capacity building, and the integration of safety considerations into every aspect of project planning and execution. By adopting this comprehensive strategy, Ghana can pave the way for safer, more equitable, and culturally sensitive infrastructure development that truly serves the needs of diverse communities.

4.1.3 Reduction of Traffic Congestion – Design/Construction/Operational Phases

The findings from semi-structured interviews with highway construction professionals in Ghana reveal a multifaceted approach to address traffic congestion across the design, construction, and operational phases of road and highway infrastructure development. The interviews highlighted the critical importance of strategic planning and innovative design in mitigating congestion. As one participant noted, *"You need incorporate all these things in your design decisions and put down measures that would curb people from taking the carriage way or the roadway space or the travel lanes" (P1)*. This aligns with the literature's emphasis on intelligent transportation systems (ITS) and mixed-use urban planning as effective strategies for reducing congestion (Subair et al., 2024). The application of traffic simulation models during the design phase has emerged as a key strategy (Qu et al., 2023), enabling the identification and preemptive addressing of potential congestion points. This approach is complemented by the integration of infrastructure features, such as roundabouts, bypasses, and dedicated bus lanes (Li et al., 2024), which are recognized for their potential to significantly enhance traffic flow.

During the construction phase, effective traffic management is crucial. As one participant emphasized, *"Regarding construction-related traffic congestion, it requires having a proper traffic management plan" (P12)*. This includes scheduling construction activities during off-peak hours, maintaining clear signage for diversions, and engaging in real-time communication with the public regarding ongoing work (Afrin & Yodo, 2020). Another participant highlighted the importance of skilled personnel: *"In my experience, some Flagmen may lack the necessary knowledge and skills to effectively control traffic. If we provide them with proper training, ... it would greatly help improve their performance" (P8)*. As projects transition to the operational phase, maintaining optimal traffic flow becomes paramount. The implementation of Intelligent Transportation Systems (ITS) stands out as a proactive approach to managing congestion (Cheng et al., 2020), emphasizing the value of technology in contemporary traffic management. This aligns with the recommendation of the literature for integrating ITS and GIS technologies into traffic management strategies (Wang & Zhang, 2024).

However, several challenges persist, including limited funding, slow technology adoption, and a lack of comprehensive data for planning and monitoring. Additionally, one participant insightfully remarked, *"In my opinion, the main cause of traffic congestion is poor land use planning. We haven't properly considered where to place settlements, commercial sectors, and how to efficiently move people around" (P12)*. This observation highlights the need for a holistic approach to urban planning and infrastructure development. To address these challenges and move towards a truly integrated approach that balances social equity, cultural preservation, and sustainable development, several interconnected strategies can be proposed, including comprehensive impact assessments that include cultural, environmental, and social dimensions alongside traditional traffic studies. This could involve evaluating how local cultural practices and land-use patterns influence traffic flow and developing culturally sensitive traffic management strategies. Design roads and transportation systems that improve access for marginalized communities while respecting sacred sites and traditional land use patterns. This approach aligns with the literature's call to re-examine traditional highway traffic planning from a sustainable development perspective (Liu et al., 2024).

Implement a benefit-sharing mechanism that reinvests project revenues in local cultural preservation and community development initiatives. This could include funding for public transportation improvements and non-motorized transport infrastructure, addressing both congestion and social equity concerns. Establish a distinct project steering committee with representatives from various ethnic groups, socioeconomic backgrounds, and sectors. This committee could oversee the integration of cultural considerations into traffic management strategies and ensure that congestion mitigation efforts do not disproportionately affect the vulnerable communities. Enhance capacity building among sector professionals to facilitate the effective implementation of innovative traffic management strategies. As one participant noted, *"Now there is the need during construction to train the flag men. They also play a critical role in reducing congestion" (P1)*. Foster public awareness and cooperation through targeted education campaigns. As highlighted by a participant, *"Firstly, implementing traffic warnings is essential to alert drivers about construction activities and potential congestion" (P7)*. By implementing these interconnected strategies, Ghana can work towards a more holistic approach to traffic congestion management in road and highway infrastructure development. This comprehensive strategy not only addresses immediate congestion concerns, but also considers the broader societal, cultural, and environmental contexts in which these projects operate.

Consequently, reducing traffic congestion on Ghana's road and highway infrastructure development requires a multifaceted approach that goes beyond traditional engineering solutions. This calls for a fundamental shift in urban planning, enhanced use of technology, and the integration of cultural and social considerations into every aspect of project planning and execution. By adopting this comprehensive strategy, Ghana can pave the way for more efficient, equitable, and culturally sensitive infrastructure development that truly serves the needs of its diverse communities, while promoting sustainable urban growth.

4.1.4 Research implications

This study's findings reveal critical implications for sustainable road and highway infrastructure development in Ghana. The research demonstrates the need to integrate social equity and cultural considerations into infrastructure projects in three key areas:

- First, stakeholder engagement requires culturally sensitive participation guidelines, supported by digital platforms and varied steering committees. The enhanced engagement framework guarantees the proper addressing of community needs and the preservation of cultural heritage.

- Second, health and safety practices must incorporate cultural considerations into training programmes and reporting systems. Mobile-based solutions in local languages can improve safety compliance while respecting cultural norms.

- Third, traffic management needs intelligent transportation systems that consider both technical requirements and local cultural practices. We should deploy real-time communication systems in culturally appropriate ways to effectively manage congestion.

These findings point to the need for a change in Ghana's infrastructure development strategy, emphasizing the achievement of technical excellence through social equity and cultural preservation. Future projects should adopt this integrated framework to ensure sustainable development that serves different communities while maintaining cultural heritage.

5 Conclusions and Further Research

This study explored social equity and cultural indicators in sustainable road and highway infrastructure development in Ghana through stakeholder perspectives. The findings reveal three key areas requiring attention: First, community engagement faces challenges including mistrust, political interference, and resource constraints *(P1, P11, P12)*, aligning with Damoah et al.'s (2022) findings on political interference in infrastructure projects. Second, worker health and safety show implementation gaps due to lax enforcement and inadequate training *(P13)*, supporting Agyekum et al.'s (2022) observations on safety challenges in Ghana's construction industry. Third, traffic congestion management requires strategic planning and innovative design *(P1)*, echoing Subair et al.'s (2024) emphasis on intelligent transportation systems.

The study recommends a multifaceted approach incorporating comprehensive impact assessments, culturally sensitive designs, and enhanced stakeholder engagement (Kahangirwe & Vanclay, 2024). This approach should balance social equity and cultural preservation while promoting sustainable development in infrastructure projects.

Despite the valuable findings of this study, several limitations should be acknowledged. Although the sample size of 14 participants provided in-depth insights, the study's qualitative design inherently limits the generalisability of the findings. The sample size did not encompass a comprehensive range of perspectives, such as those from community leadership, potentially leaving out critical grassroots viewpoints. Additionally, focusing solely on the Greater Accra region may limit the applicability of the findings to other regions, which could offer different insights. To address these limitations and deepen our understanding of social equity and cultural indicators in Ghana's infrastructure development, future research should adopt more comprehensive approaches. A mixed-methods strategy combining qualitative insights with quantitative data through nationwide surveys would provide more generalizable findings and help develop validated measurement scales for social equity and cultural indicators. Future research should consider evaluating the implementation outcomes of the proposed strategies across various regional contexts and aim to capture a broader array of stakeholder perspectives to enhance the comprehensiveness and applicability of sustainability initiatives.

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7 Ethics approval and consent to participate

The study was conducted in accordance with the Auckland University of Technology Human Ethics Guidelines and was approved by the AUT Ethics Committee (reference 22/327).

8 Consent for publication

Not Applicable

9 Competing Interests

No Potential conflict of interest was reported by the authors

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