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Editorial Article

Sustainable Infrastructure Systems: Bridging Transportation Efficiency, Structural Resilience, and Environmental Management

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Summary

Sustainable infrastructure has emerged as a central pillar in addressing the complex challenges associated with rapid urbanization, population growth, and climate variability. Modern civil engineering practice increasingly demands integrated solutions that not only enhance system performance but also balance environmental responsibility, user satisfaction, and long-term resilience. Within this context, the convergence of transportation efficiency, structural reliability, and environmental sustainability forms a critical foundation for future infrastructure development. This Volume 3, Number 1 (April 2026) brings together a diverse set of studies that collectively reflect the multidisciplinary nature of contemporary infrastructure research. Several contributions focus on transportation systems, highlighting the importance of data-driven approaches in optimizing operational performance and user experience. From traffic signal optimization using analytical models to service quality assessment of transport hubs such as ferry ports and passenger terminals, these studies emphasize the role of user-centered design and performance evaluation frameworks in improving mobility systems.

Bolaji et al. [1] investigate a practical approach to enhancing traffic operations at the Araromi intersection in Akure, Nigeria, where increasing urban growth and vehicle usage have led to notable congestion and inefficiencies. The primary objective of the study is to design an effective traffic signal system using Webster's model, with particular attention to locally observed traffic conditions rather than relying solely on generalized or technology-intensive solutions. Traffic data were obtained through field surveys conducted over two weeks during peak periods, capturing vehicle counts, classifications, and headway characteristics. These data were converted into passenger car units (PCU) and analyzed to estimate key parameters such as peak flow rate, saturation flow, total lost time, and critical flow ratios. Webster's analytical framework was then applied to determine the optimal signal cycle length and to allocate appropriate green, yellow, and red intervals for each phase. Findings indicate a peak hour volume of 6505 PCU and a peak flow rate of 6920 PCU/hr, with the west approach contributing the largest share of traffic demand (41%). The calculated critical flow ratio of 0.736 suggests that the intersection is operating within its capacity. The optimized design resulted in a cycle length of 110 seconds, with effective green times of 35, 32, and 28 seconds for the respective phases. Performance assessment shows volume-to-capacity ratios below one and a Level of Service (LOS) C, with average control delays of about 30 seconds per vehicle, indicating stable traffic conditions. In conclusion, the study confirms that applying Webster's model with site-specific data can improve traffic signal performance, reduce delays, and enhance overall efficiency. The proposed approach offers a practical reference for similar urban intersections facing comparable traffic challenges.

Alpina et al. [2] examine the service quality of Sinabang Ferry Port, a critical maritime gateway connecting Simeulue Island to mainland Sumatra, where increasing passenger demand highlights the need for systematic service evaluation. The study seeks to assess the port's service performance based on user satisfaction and to identify key service attributes that require priority improvement. Data were collected through questionnaires and interviews involving 156 respondents using the Sinabang–Calang route. Service quality was evaluated using the Importance Performance Analysis (IPA) framework across five SERVQUAL dimensions: tangibles, reliability, responsiveness, assurance, and empathy. Each attribute was measured using a Likert scale, and the level of suitability (LoS) was calculated to determine the gap between user expectations and actual performance. The findings indicate an average LoS value of 85.13%, suggesting that overall service performance has not fully met user expectations. Several attributes fall into the high-priority improvement category, particularly facilities for vulnerable users (such as persons with disabilities, pregnant women, and the elderly), clarity of port information including terminal layout and schedules, and the availability of security infrastructure such as CCTV. The IPA results further reveal that improvements are especially needed in the tangibles, reliability, and assurance dimensions. In summary, the study highlights a noticeable gap between perceived importance and actual service performance at Sinabang Ferry Port. Addressing critical service deficiencies through targeted and user-oriented strategies is essential to enhance passenger satisfaction, strengthen operational effectiveness, and support sustainable connectivity in remote island regions.

Abdul Aziz et al. [3] investigate the structural behaviour of a multi-storey reinforced concrete building under combined seismic and wind actions in Bangladesh, where rapid urbanization has increased the demand for resilient high-rise structures. The study aims to evaluate the response of a G+8 irregular building across four seismic zones using ETABS 2017, following the provisions of BNBC 2020, with particular focus on lateral load effects such as base shear,

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storey shear, displacement, drift, and torsional irregularity. A three-dimensional structural model was developed and analysed under dead, live, wind, and earthquake loads. Seismic parameters were assigned based on zone-specific coefficients, while wind loads were calculated according to exposure conditions and code-based wind speeds. The analysis compared structural responses under different load combinations (EQX, EQY, WX, WY) to identify governing design conditions. The results demonstrate that wind loads predominantly control the structural response, particularly in terms of storey shear, displacement, and drift. For instance, as illustrated in the storey shear plots on page 7, wind-induced forces reached approximately 45 Kip at the base, significantly exceeding seismic forces. Similarly, the displacement graphs on page 8 show that wind loads produced the largest lateral movements, with roof displacements approaching 8 inches. Although seismic base shear increased nearly threefold from Zone 1 to Zone 4, reflecting higher seismic intensity, its overall effect remained secondary to wind in governing serviceability. Finally, the study highlights that both seismic and wind loads are critical in structural design; however, wind effects dominate the lateral performance of mid-rise buildings in the studied context. It underscores the necessity of zone-specific and load-sensitive design strategies to ensure safety, serviceability, and resilience in Bangladesh's diverse environmental conditions.

Panjaitan et al. [4] explore the seismic behaviour of concentrically braced frame (CBF) systems by comparing two bracing configurations single IWF sections and double-channel sections under realistic cyclic loading conditions, acknowledging the critical role of braces in dissipating earthquake energy in seismically active regions. The study aims to evaluate whether alternative bracing geometries can enhance seismic performance, particularly in terms of strength, stiffness, and energy dissipation, when subjected to Random Variable Amplitude Loading (RVAL) that simulates irregular earthquake actions. A numerical approach was adopted using Abaqus software to model both bracing types with identical geometric properties but different cross-sectional characteristics. Two RVAL loading histories were applied to capture realistic tensile–compressive cyclic behaviour. The structural response was assessed through hysteretic curves, from which key parameters such as strength, stiffness, and dissipated energy were derived. The results indicate that double-channel bracing exhibits superior mechanical performance compared to the IWF section. From the hysteretic curves, the double-channel configuration produces wider and more stable loops, indicating better energy dissipation capacity. Strength and stiffness improvements of approximately 11–12% were observed, while dissipated energy increased modestly across both loading scenarios. Additionally, the study reveals that variations in displacement amplitude significantly influence structural response, with strength and energy following polynomial trends and stiffness exhibiting a power-law relationship.

Choe et al. [5] present a comprehensive numerical investigation into ground-borne vibrations affecting buildings adjacent to freight railway operations, a growing concern in urban environments with expanding rail infrastructure. The study aims to develop a robust predictive framework capable of capturing the complex interaction between train dynamics, track systems, soil media, and building responses, with a particular focus on freight trains characterized by higher axle loads and distinct dynamic behaviour. A coupled modelling strategy was adopted, integrating multi-body dynamics (SIMPACK) to simulate vehicle–track interaction and generate dynamic axle loads, with a three-dimensional finite element model (ANSYS) to represent soil–structure interaction. The model incorporates realistic features such as rail irregularities, nonlinear soil–foundation contact, and wave-absorbing boundary conditions. Vibration response was evaluated using the Vibration Acceleration Level (VAL), alongside parametric sensitivity analyses on train speed, soil properties, and distance from the track. Results show that vibration levels decrease significantly with distance, where VAL reduces by approximately 15 dB between 4 m and 20 m. The response plots further reveal that vibration distribution within buildings is non-uniform, with higher intensities observed at central floor regions. Additionally, the relationship between train speed and vibration is non-linear, indicating critical speed effects. Sensitivity analysis demonstrates that a ±20% variation in soil shear wave velocity can alter VAL by up to 3–5 dB, highlighting the importance of accurate geotechnical characterization. On the whole, the study confirms that coupled numerical modelling provides a reliable tool for assessing train-induced vibrations. It underscores the significance of distance, soil properties, and dynamic interaction effects in controlling vibration impact, and suggests that a buffer distance of approximately 20 m may be sufficient to maintain vibration levels within acceptable limits under the studied conditions.

Patrick et al. [6] investigate the spatial dynamics of air pollution and associated health risks in the industrial regions of Shah Alam and Petaling Jaya, Klang Valley, where rapid urbanization and industrial activities have intensified environmental and public health concerns. The study aims to analyse pollutant trends and map their spatial distribution using geospatial tools, while assessing the corresponding health impacts on residents in industrial zones. A mixed-method approach was employed, combining air quality data from Department of Environment (DOE) monitoring stations (2021–2023) with a questionnaire survey of 100 residents within a 10 km radius of industrial areas. Geographic Information System (GIS) techniques, including Inverse Distance Weighted (IDW) interpolation, were used to visualize pollutant distribution and correlate exposure levels with reported health symptoms. The results reveal spatial variability in pollutant concentrations across the study areas. The PM10 distribution exhibits higher coarse particulate concentrations, likely influenced by traffic density, while the PM2.5 shows elevated fine particulate levels in Shah Alam, linked to industrial emissions. Gaseous pollutants such as SO_2, NO_2, and O_3 are generally higher in Shah Alam, whereas CO levels are more pronounced in Petaling Jaya. Survey findings indicate that a majority of residents experience pollution-related symptoms intermittently, including respiratory discomfort, headaches, fatigue, and sleep disturbances. In brief, the study highlights a clear relationship between industrial air pollution patterns and localized health risks. It underscores the importance of GIS-based assessment for identifying pollution hotspots and supports the need for targeted mitigation strategies, stricter emission controls, and improved urban planning to enhance environmental sustainability and public health in rapidly developing industrial regions.

Sari et al. [7] evaluate the service quality of the Lueng Bata Type C passenger terminal in Banda Aceh, where increasing user demand has exposed significant gaps between service provision and user expectations. The study aims to assess terminal service performance from a user-oriented perspective and to identify priority areas for improvement using the Importance Performance Analysis (IPA) framework. Primary data were collected through structured questionnaires from 250 respondents, including passengers and other terminal users. Service attributes were assessed based on importance and performance using a Likert scale, and the Level of Suitability (LoS) was calculated to quantify the gap between expectations and actual service delivery. The IPA method was then applied to map service attributes into four strategic quadrants, facilitating targeted evaluation. The findings indicate an average LoS of 78.561%, suggesting that overall service performance does not fully meet user expectations. The Cartesian IPA diagram shows several critical attributes fall into Quadrant I (high importance–low performance), particularly the availability of service information and the clarity of evacuation routes. These deficiencies highlight weaknesses in both operational management and infrastructure readiness. Additionally, the mismatch between the terminal’s Type C classification and its actual role in handling intercity transport demand contributes to service inefficiencies and user dissatisfaction. Overall, the study underscores a substantial gap between perceived importance and actual service quality at the terminal. Addressing key deficiencies especially in information systems and safety infrastructure is essential to improve user satisfaction and operational reliability. The findings also emphasize the need for upgrading terminal classification and adopting more user-centered management strategies to ensure sustainable service improvement.

Taken together, the articles in this volume highlight the necessity of adopting integrated and multidisciplinary approaches in infrastructure research and practice. They demonstrate that effective solutions cannot be achieved through isolated analyses, but rather through the synthesis of transportation planning, structural engineering, and environmental assessment. Ultimately, this collection aims to contribute to the advancement of sustainable infrastructure by promoting innovative methodologies, evidence-based decision-making, and holistic perspectives that respond to the evolving needs of society.

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Conflicts of Interest

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Author Contributions

Reza Pahlevi Munirwan: writing, reviewing and editing. **Ramadhansyah Putra Jaya:** writing, reviewing and editing. **Aizat Mohd Taib:** writing, reviewing and editing.

Declaration of Generative AI and AI-Assisted Technologies in the Writing Process

During the preparation of this work, the authors used ChatGPT to enhance the clarity of the writing. After using the ChatGPT, the authors reviewed and edited the content as needed and take full responsibility for the publication's content.

References

[1] R. A. Bolaji, O. S. Aderinola, M. A. Oladipo, T. E. Oguntelure, and M. O. Abanire "Design of an Efficient Traffic Control Signal Using Webster's Model: A Case Study of Akure, Nigeria" Disaster in Civil Engineering and Architecture, vol. 3, no. 1, pp. 1-17, 2026, doi: http://dx.doi.org/10.70028/dcea.v3i1.70

[2] M. Alpina, Y. Darma, C. D. Refika, M. Mubarak, A. B. Dasopang, F. Mauladea, and S. Koting "Assessment of Service Quality of Sinabang Ferry Port Based on Sinabang - Calang Route Users' Perception" Disaster in Civil Engineering and Architecture, vol. 3, no. 1, pp. 18-30, 2026, doi: http://dx.doi.org/10.70028/dcea.v3i1.72

[3] M. Abdul Aziz, S. Rahman, A. Ghosh, M. H. M. Mazumdar, A. Haque, and F. K. Ovi "Structural Response of Concrete Buildings to Seismic and Wind Loads in Bangladesh Using ETABS and BNBC 2020" Disaster in Civil Engineering and Architecture, vol. 3, no. 1, pp. 31-44, 2026, doi: http://dx.doi.org/10.70028/dcea.v3i1.73

[4] A. Panjaitan, Y. Hayati, R. Asmaijar, and M. Shimizu "Seismic Performance of IWF and Double-channel Bracings in CBF Systems under Random Variable Amplitude Loading" Disaster in Civil Engineering and Architecture, vol. 3, no. 1, pp. 45-55, 2026, doi: http://dx.doi.org/10.70028/dcea.v3i1.74

[5] C. Choe, K. Jong, C. Choe, C. Kang, and D. Ko "A Numerical Study on the Environmental Vibration in Surrounding Buildings Induced by Freight Train Operations" Disaster in Civil Engineering and Architecture, vol. 3, no. 1, pp. 56-68, 2026, doi: http://dx.doi.org/10.70028/dcea.v3i1.75

[6] H. H. Patrick, S. Misbari, N. Aziz, V. Sao, and M. A. Adman "Geospatial Mapping of Air Pollution and Health Risks in the Klang Valley: Insights for Industrial Sustainability" Disaster in Civil Engineering and Architecture, vol. 3, no. 1, pp. 69-88, 2026, doi: http://dx.doi.org/10.70028/dcea.v3i1.78

[7] F. Sari, Y. Darma, M. Mubarak, and A. B. Dasopang "Assessing Service Quality of a Type C Passenger Terminal Using Importance–Performance Analysis: A User-Based Approach" Disaster in Civil Engineering and Architecture, vol. 3, no. 1, pp. 89-103, 2026, doi: http://dx.doi.org/10.70028/dcea.v3i1.85