Assessing the Institutional, Technological, and Financial Conditions for Deploying an Intelligent Transportation System (ITS) for Urban Traffic Management in Vietnam

Hai Binh NGUYEN [1,2]
[1]*Ministry of Construction, Vietnam*
[2]*University of Transport and Communications, Vietnam*

ABSTRACT : *This study assesses the institutional, technological and financial conditions for deploying an Intelligent Transportation System (ITS) for urban traffic management in Vietnam, with emphasis on AI cameras and centralised traffic operation centres. Drawing on a structured dataset of 436 survey responses, the study evaluates seven dimensions: institutional readiness, inter-agency coordination, technological readiness, financial feasibility, technology transfer readiness, social acceptance and expected system effectiveness. Descriptive statistics, reliability analysis, correlation analysis and multiple regression are employed. The findings show high perceived effectiveness and application potential, but also reveal persistent constraints related to institutional fragmentation, data-sharing mechanisms, life-cycle financing and technology transfer. The study proposes an integrated deployment framework linking legal harmonisation, open data architecture, sustainable financing and domestic technological capability.*

KEYWORDS - *Intelligent Transportation System; AI camera; urban traffic management; life-cycle financing, integrated framework*

I. INTRODUCTION

Urban traffic management in Vietnam is entering a critical transition from infrastructure-centred expansion to data-driven, real-time and institutionally coordinated governance. Large cities such as Hanoi and Ho Chi Minh City face recurring congestion, mixed traffic composition, uneven compliance behaviour, road safety risks and increasing pressure on public agencies to manage limited road capacity more efficiently. Conventional traffic management instruments, including fixed-time signal control, manual enforcement and fragmented camera monitoring, are no longer sufficient for cities whose travel demand, motorcycle density, logistics movement and digital service expectations are rising simultaneously.

An Intelligent Transportation System (ITS) offers a technically plausible response to this challenge. In a modern urban setting, ITS integrates sensing devices, AI cameras, traffic signal controllers, communication networks, databases, analytical algorithms and a centralised traffic operation centre to support real-time monitoring, incident detection, adaptive control, violation enforcement and strategic planning. ISO 14813-1 frames ITS architecture as an instrument for integrating services into a coherent reference architecture with interoperability and common data definitions [1]. This is particularly relevant to Vietnam, where many traffic surveillance, enforcement and urban management systems have been implemented separately rather than as components of a unified architecture.

Vietnam has also begun to establish a legal basis for smart traffic management. The 2024 Law on Roads and Decree No. 165/2024/ND-CP provide regulatory foundations for road infrastructure management and intelligent traffic-related systems [2]. At the local level, Ho Chi Minh City has invested in ITS, GIS-based infrastructure data management and AI-assisted traffic light adjustment

[3]. Hanoi has also moved towards AI-enabled monitoring and intelligent traffic control systems [4]. However, the mere presence of cameras, databases and control rooms does not guarantee an effective ITS. The practical performance of ITS depends on the institutional arrangements that govern data sharing, the technological architecture that enables interoperability, the financial model that sustains operation and maintenance, and the capacity of public agencies to control or at least audit core algorithms and data assets.

Therefore, this study examines the deployment conditions for ITS in Vietnam from a multi-dimensional perspective. It asks whether Vietnam's urban traffic management system is sufficiently ready, not only in terms of technological demand, but also in terms of institutional coordination, financial sustainability, technology transfer and social acceptance. Using 436 survey responses, the article develops an empirical assessment of ITS feasibility and identifies policy implications for staged deployment.

II. LITERATURE REVIEW

1. ITS as a socio-technical infrastructure for urban traffic management

ITS is not a single technology but a socio-technical infrastructure that combines information processing, communication, sensing, automation and organisational decision-making. ISO 14813-1 defines ITS service architecture in terms of service domains and service groups, emphasising interoperability, integration and common data definitions [1]. This architectural perspective is important because urban traffic management requires the coordination of heterogeneous data sources: video streams, vehicle counts, GPS traces, traffic signals, enforcement records, incident reports, public transport operations and road infrastructure inventories.

The International Transport Forum argues that congestion management should not be reduced to road expansion but should combine measurement, demand management, operational control and institutional strategy [5]. In this sense, ITS should be interpreted as an operational governance platform rather than a technology procurement package. It can support congestion monitoring, dynamic signal timing, emergency response, public information provision and post-event policy evaluation. The World Bank similarly treats ITS as a strategic digital transport segment that can enhance operational efficiency when institutional capacity and system integration are properly designed [6].

AI cameras are one of the most visible components of ITS. They can detect vehicle types, count flows, recognise licence plates, identify red-light running, monitor lane violations, detect incidents and support adaptive signal control. However, AI-enabled camera systems require high-quality visual data, stable communication links, computational infrastructure, model training, algorithmic validation and data protection rules. Recent research on deep reinforcement learning and AI-based traffic control suggests that data-driven traffic signal optimisation can improve traffic performance, but it also requires robust sensing coverage, scalable models and appropriate operational constraints [7], [8]. These conditions are not purely technical; they depend on funding, standards, data governance and institutional responsibility.

2. Institutional conditions and governance fragmentation

Institutional readiness is a decisive condition for ITS deployment. North's institutional theory defines institutions as formal and informal rules that structure interaction [9]. Applied to ITS, institutional readiness includes clear legal mandates, defined inter-agency responsibilities, procurement rules, data-sharing protocols, accountability mechanisms, enforcement procedures and dispute resolution. Without institutional clarity, ITS may generate more data but not necessarily better decisions.

The challenge is particularly significant in urban traffic management because responsibility is often distributed across transport departments, police agencies, local governments, infrastructure management units, public transport operators, technology vendors and emergency services. Data-driven transport systems also introduce privacy, cybersecurity and trust concerns. The ITF report on data-driven transport policy stresses that mobility data are increasingly generated through sensors and location-based technologies, and that their use raises privacy, trust and security questions [10]. Vietnam's legal environment has become more relevant to this issue with the Law on Personal Data Protection 2025, which took effect on 1 January 2026 and elevated personal data protection from decree-level regulation to statutory law [11]. Since AI cameras process images, licence plates, locations and behavioural traces, ITS deployment must comply with data minimisation, purpose limitation, storage control, access authorisation and auditability.

In Vietnam, Decree No. 151/2024/ND-CP provides rules for the road traffic order and safety database, including principles of centralised, unified database management and legal compliance in connection, sharing and use of traffic safety data [12]. This is relevant to ITS because urban traffic systems cannot operate effectively if traffic signal data, violation data, camera data and infrastructure data remain institutionally separated. The main institutional problem is therefore not the absence of all legal foundations, but the operationalisation of cross-agency data flows and real-time command authority.

2.3. Technological readiness and interoperability

Technological readiness refers to the ability of the urban traffic management system to collect, transmit, integrate, analyse and act upon data. A functioning ITS requires more than cameras. It needs a layered architecture consisting of field devices, communication networks, data platforms, analytical engines, control interfaces and feedback mechanisms. AI cameras provide perception; the traffic operation centre provides situational awareness; signal controllers and enforcement systems provide actuation; and data platforms provide memory and learning.

Interoperability is a recurring issue in ITS literature. ISO's reference architecture emphasises common definitions and integrated service domains because fragmented systems increase long-term integration costs [1]. This is directly relevant to Vietnam's cities, where different projects may be delivered by different vendors with non-uniform standards. A closed proprietary system may function at pilot scale but become costly when cities need to connect new intersections, new camera types, public transport systems or regional traffic management centres.

AI-based traffic management also requires contextual adaptation. Vietnamese urban traffic has a high proportion of motorcycles, frequent mixed-flow interactions, informal lane behaviour, curbside activity and complex intersection movements. Algorithms trained on more lane-disciplined traffic environments may not perform reliably without local calibration. Literature on deep learning for ITS highlights the potential of AI for signal control, perception and prediction, but also notes scalability, data quality and model generalisation as major challenges [7], [8], [13]. Thus, technological readiness should include not only equipment availability but also local model validation, cybersecurity, redundancy, system maintainability and capacity for continuous updating.

2.4. Financial feasibility and life-cycle cost

The financial condition for ITS deployment is often underestimated. Cities may focus on capital expenditure for cameras, servers, control rooms and software procurement, while underestimating operating expenditure for network connectivity, cloud or data-centre storage, model updating, software licences, staff training, cybersecurity, equipment replacement and technical support. This distinction is critical because ITS is not a static infrastructure asset; it is a continuously operating digital system.

The World Bank's transport digitalisation perspective indicates that ITS produces value through strategic segmentation, service integration and operational efficiency, but these benefits are conditional on implementation capability and sustainable investment [6]. For developing countries, the issue is not merely whether the initial project can be financed, but whether the system can be maintained after procurement. A camera that cannot be calibrated, a model that cannot be updated, or a database that cannot be integrated may become a stranded digital asset.

Financial feasibility should therefore be measured through life-cycle affordability. This includes capital expenditure, operating expenditure, maintenance expenditure and upgrade expenditure. Public investment may remain necessary for core regulatory functions, while public-private partnership or service-based procurement may be suitable for selected components such as data analytics, smart parking, traveller information and non-sensitive operational dashboards. However, vendor lock-in risk must be managed through open standards, data ownership clauses and technology transfer requirements.

2.5. Technology transfer, social acceptance and public trust

Technology transfer readiness is a core condition for Vietnam. If public agencies depend entirely on vendors for configuration, maintenance, algorithmic calibration and data extraction, the state may own the physical equipment but not the operational intelligence of the system. Effective technology transfer should include technical documentation, API access, data dictionaries, model audit procedures, staff training, cybersecurity protocols and the ability to re-train AI models using local datasets.

Social acceptance is also relevant. The Unified Theory of Acceptance and Use of Technology argues that performance expectancy, effort expectancy, facilitating conditions and social influence affect technology acceptance [14]. Although originally developed for information systems adoption, this logic is applicable to ITS because public acceptance depends on perceived effectiveness, procedural fairness, transparency and trust. Citizens may accept AI cameras if they believe that the system reduces congestion, improves safety and enforces rules fairly. Conversely, acceptance may decline if AI cameras are perceived as opaque surveillance tools or primarily as revenue-generating enforcement instruments.

2.6. Research gaps

Despite extensive literature on ITS architecture, AI traffic control and smart-city development, three gaps remain. First, many studies focus on technical performance, such as traffic prediction or signal optimisation, while giving less attention to institutional coordination, legal accountability and data-sharing mechanisms in developing-country contexts. Second, the financial dimension is frequently reduced to initial investment, whereas ITS requires life-cycle financing for operation, maintenance, cybersecurity and algorithmic renewal. Third, few Vietnam-focused studies empirically evaluate ITS feasibility through an integrated framework that combines institutional readiness, technological readiness, financial feasibility, technology transfer, social acceptance and expected effectiveness. This study addresses these gaps by using a 436-response dataset to quantify perceived readiness and identify the strongest predictors of ITS application potential in Vietnam.

III. METHODOLOGY

3.1. Research design and dataset

This study adopts a quantitative survey-based design supported by an institutional and socio-technical interpretation of ITS deployment. The dataset contains 436 valid responses. Respondents were classified by gender, age, education, occupation, city, dominant transport mode and perceived congestion exposure. The questionnaire used a five-point Likert scale, where 1 indicates strong disagreement and 5 indicates strong agreement.

The measurement model includes eight constructs. Institutional readiness (INS) measures legal clarity, policy support and regulatory preparedness. Coordination readiness (COO) captures inter-agency coordination, data sharing and operational command integration. Technological readiness (TEC) measures the availability and quality of AI cameras, communication networks, data platforms and interoperability. Financial feasibility (FIN) assesses investment capacity, operating expenditure, maintenance cost and financing mechanisms. Technology transfer readiness (TTR) measures domestic capability, vendor independence and knowledge transfer. Social acceptance (SOC) captures perceived fairness, privacy confidence and public willingness to accept AI-enabled monitoring. Expected effectiveness (EFF) evaluates anticipated improvements in congestion control, enforcement, safety, incident response and planning. Application potential (APP) is the dependent construct measuring overall feasibility of ITS deployment in Vietnam.

To ensure the data is suitable for exploratory social-science research, internal consistency is strictly assessed using Cronbach's alpha. A threshold value above 0.70 is utilized to signify acceptable framework reliability.

3.2. Feasibility index

To synthesise deployment readiness, the study defines an ITS Feasibility Index (IFI):

$$[IFI = w_1 INS + w_2 COO + w_3 TEC + w_4 FIN + w_5 TTR + w_6 SOC + w_7 EFF]$$

where (w_i) denotes the weight assigned to each dimension. In the baseline model, equal weights are applied:

$$\left[w_1 = w_2 = w_3 = w_4 = w_5 = w_6 = w_7 = \frac{1}{7}\right]$$

This index does not replace construct-level interpretation. Rather, it provides a compact indicator of overall readiness.

3.3. Regression model

To identify the conditions associated with perceived application potential, the following ordinary least squares model is estimated:

$$[APP_i = \beta_0 + \beta_1 INS_i + \beta_2 COO_i + \beta_3 TEC_i + \beta_4 FIN_i + \beta_5 TTR_i + \beta_6 SOC_i + \varepsilon_i]$$

where (APP_i) is the application potential score of respondent (i), the six explanatory variables represent deployment conditions, and (\varepsilon_i) is the error term. Expected effectiveness is not included as an explanatory variable in the main regression because it is conceptually close to the dependent variable and could inflate explanatory power. The model is therefore designed to identify the enabling conditions that shape perceived feasibility.

IV. RESULTS

4.1. Respondent profile

Table 1 presents the respondent structure. The sample is balanced by gender, with 52.1% male respondents and 46.3% female respondents. The largest age group is 25–34, accounting for 33.0% of the sample, followed by 35–44 at 23.9%. Respondents are relatively well educated: 57.1% hold a university degree and 24.1% hold postgraduate qualifications. This is appropriate for a study assessing an institutionally and technologically complex system.

Occupationally, the largest group consists of specialists in planning, research or consulting (23.2%), followed by engineering and technology respondents (20.6%), law-enforcement or traffic-control respondents (15.6%), public administration respondents (13.1%), transport operators (10.6%) and others (17.0%). City distribution is also relevant: Hanoi accounts for 31.0%, Ho Chi Minh City for 29.4%, Da Nang for 14.0% and Hai Phong for 10.8%. This distribution reflects the intended focus on large and medium-sized urban areas where ITS deployment is most urgent.

Traffic pressure is evident in the sample. A total of 63.6% of respondents report high or very high congestion exposure, while only 17.2% report low or very low congestion exposure. This strengthens the relevance of the dataset because the respondents are not evaluating ITS in abstract terms; they are responding in a context where congestion is a recognised urban problem.

4.2. Reliability of measurement scales

Table 1 reports the reliability results. Cronbach's alpha ranges from 0.767 to 0.823 across the eight constructs. All values exceed the common exploratory threshold of 0.70, indicating acceptable internal consistency. Financial feasibility has the highest alpha at 0.823, followed by social acceptance at 0.813, technology transfer readiness at 0.807, coordination readiness at 0.807 and institutional readiness at 0.806. The lowest value is expected effectiveness at 0.767, which remains acceptable.

Table 1. Reliability and descriptive statistics

Construct	Mean	Standard deviation	Cronbach's alpha
Institutional readiness	3.838	0.763	0.806
Coordination readiness	3.879	0.756	0.807
Technological readiness	3.953	0.747	0.797
Financial feasibility	3.790	0.806	0.823
Technology transfer readiness	4.047	0.730	0.807
Social acceptance	3.862	0.777	0.813
Expected effectiveness	4.141	0.676	0.767
Application potential	4.058	0.725	0.790

The descriptive results show a generally favourable assessment of ITS deployment. Expected effectiveness has the highest mean score at 4.141, suggesting that respondents believe ITS can improve traffic management, safety, enforcement and incident response. Application potential is also high at 4.058, indicating broad support for deployment. Technology transfer readiness is relatively high at 4.047, which may reflect confidence in Vietnam's growing digital and AI capacity. However, financial feasibility has the lowest score at 3.790, followed by institutional readiness at 3.838 and social acceptance at 3.862. These results suggest that respondents see ITS as necessary and effective, but remain cautious about the policy, funding and governance conditions required for sustainable implementation.

4.3. Construct-level interpretation

Table 2 presents the proportion of respondents with high readiness scores, defined as construct mean ≥4.0, and low readiness scores, defined as construct mean ≤2.5.

Table 2. High and low readiness by construct

Construct	Respondents scoring ≥4.0 (%)	Respondents scoring ≤2.5 (%)
Institutional readiness	50.2	6.4
Coordination readiness	53.4	4.1
Technological readiness	57.8	4.8
Financial feasibility	51.6	6.7
Technology transfer readiness	62.4	3.0
Social acceptance	51.6	5.7
Expected effectiveness	67.7	1.8
Application potential	65.4	4.6

The most positive result is expected effectiveness: 67.7% of respondents score it at 4.0 or above, while only 1.8% score it at 2.5 or below. This indicates strong confidence in the functional value of ITS. Respondents appear to believe that AI cameras and a centralised operation centre can reduce response time, improve enforcement, support signal optimisation and provide better data for policy design.

Application potential is also strong, with 65.4% of respondents scoring it at 4.0 or above. This suggests that ITS deployment is viewed as feasible in principle. Technology transfer readiness follows at 62.4%, implying that respondents believe Vietnam can gradually develop domestic capacity if deployment is accompanied by proper vendor management, training and knowledge transfer.

However, the institutional and financial dimensions are less robust. Only 50.2% of respondents rate institutional readiness at 4.0 or above, while 6.4% score it at or below 2.5. Financial feasibility records the highest low-score proportion at 6.7%. This confirms a central argument of this study: the main bottleneck is not the perceived usefulness of ITS, but the readiness of governance and financing mechanisms.

4.4. Correlation analysis

The correlation matrix in Table 4 shows strong positive relationships among all constructs. Application potential correlates most strongly with social acceptance (r = 0.835), institutional readiness (r = 0.816), financial feasibility (r = 0.816), expected effectiveness (r = 0.817), technological readiness (r = 0.808) and technology transfer readiness (r = 0.802). These values indicate that perceived feasibility is not determined by one isolated factor. Rather, respondents evaluate ITS deployment as an integrated institutional, technical, financial and social project.

Table 3. Correlation matrix

Construct	INS	COO	TEC	FIN	TTR	SOC	EFF	APP
INS	1.000	0.806	0.813	0.824	0.813	0.820	0.797	0.816
COO	0.806	1.000	0.781	0.797	0.805	0.812	0.789	0.776
TEC	0.813	0.781	1.000	0.825	0.804	0.803	0.803	0.808
FIN	0.824	0.797	0.825	1.000	0.810	0.835	0.838	0.816
TTR	0.813	0.805	0.804	0.810	1.000	0.804	0.805	0.802
SOC	0.820	0.812	0.803	0.835	0.804	1.000	0.821	0.835
EFF	0.797	0.789	0.803	0.838	0.805	0.821	1.000	0.817
APP	0.816	0.776	0.808	0.816	0.802	0.835	0.817	1.000

The high correlation between financial feasibility and expected effectiveness (r = 0.838) is noteworthy. It suggests that respondents who believe in stronger financing mechanisms also expect higher system effectiveness. This is logical because ITS effectiveness depends on continuous maintenance, reliable data transmission, software updating and operational staffing. Under-financed ITS systems may degrade quickly after installation.

The strong relationship between social acceptance and application potential (r = 0.835) is also important. It indicates that AI camera deployment must be accompanied by procedural transparency, privacy safeguards and fair enforcement mechanisms. If citizens perceive ITS as opaque surveillance, public resistance may weaken deployment legitimacy.

4.5. Regression results

Table 4 presents the multiple regression results. The model explains 78.3% of the variance in application potential ($R^2 = 0.783$; adjusted $R^2 = 0.780$). This is a strong explanatory level for survey-based social research, indicating that the selected conditions collectively provide a robust explanation of ITS feasibility perceptions.

Table 4. Regression results predicting ITS applicaton potential

Predictor	Unstan-dardised coefficient	Stan-dardised beta	p-value	Interpretation
Constant	0.517	—	<0.001	Baseline score
Institutional readiness	0.169	0.178	<0.001	Significant positive effect
Coordination readiness	0.037	0.038	0.399	Not significant
Technological readiness	0.167	0.172	<0.001	Significant positive effect
Financial feasibility	0.128	0.142	0.005	Significant positive effect
Technology transfer readiness	0.142	0.143	0.002	Significant positive effect
Social acceptance	0.267	0.286	<0.001	Strongest positive effect

The strongest predictor is social acceptance, with a standardised beta of 0.286. This means that public trust, perceived fairness, privacy confidence and willingness to accept AI-enabled monitoring are not secondary issues; they are central to implementation feasibility. The result is consistent with technology acceptance theory, which emphasises perceived value, facilitating conditions and social influence in shaping acceptance [14].

Institutional readiness is the second strongest predictor (β = 0.178), followed by technological readiness (β = 0.172), technology transfer readiness (β = 0.143) and financial feasibility (β = 0.142). These results confirm that ITS deployment in Vietnam requires a balanced policy package. It is insufficient to invest in AI cameras without legal clarity, technical interoperability, long-term financing and domestic capability building.

Coordination readiness is positively signed but statistically insignificant (β = 0.038; p = 0.399) when the other variables are included. This does not mean coordination is unimportant. Its bivariate correlation with application potential is high (r = 0.776). The insignificant regression coefficient likely reflects overlap with institutional readiness, technological readiness and social acceptance. In other words, coordination may operate through broader institutional and technological mechanisms rather than as an independent predictor in the model.

4.6. Synthesis of empirical findings

The empirical results support four conclusions. First, respondents strongly perceive ITS as effective and applicable. The high means for expected effectiveness and application potential demonstrate that the demand-side legitimacy of ITS is substantial. Second, institutional and financial readiness lag behind technological expectations. This gap is typical of digital infrastructure projects in which policy capacity and life-cycle financing are slower to develop than hardware procurement. Third, social acceptance is the most powerful predictor of perceived application potential. This highlights the need for transparent enforcement, accountable AI use and personal data safeguards. Fourth, technology transfer readiness is statistically significant, confirming that respondents do not view ITS as a simple import of foreign technology. They expect Vietnam to develop the ability to operate, audit, adapt and gradually localise core technical functions.

V. FIGURES AND TABLES

The findings show that ITS deployment in Vietnam should be understood as an institutional transformation rather than a camera installation programme. This is consistent with international ITS architecture principles, which emphasise integration, interoperability and service-domain coherence [1]. The high expected effectiveness score indicates that respondents recognise the value of AI cameras and centralised operation centres. However, the lower scores for institutional and financial conditions show that feasibility depends on governance maturity.

The strongest regression effect of social acceptance is a critical finding. AI cameras operate in public space, collect sensitive visual data and may support automated violation detection. Therefore, ITS must be designed around transparency, privacy protection and procedural accountability. The ITF has warned that sensor-generated and location-specific transport data raise privacy, trust and security concerns [10]. Vietnam’s personal data protection law reinforces this issue by creating a stronger legal framework for personal data processing [11]. For ITS, this means that data access logs, retention rules, encryption, authorised processing and citizen complaint mechanisms should be built into system design from the beginning.

Institutional readiness is also significant. Vietnam has made progress through the Law on Roads, Decree No. 165/2024/ND-CP and Decree No. 151/2024/ND-CP, but the implementation problem remains. Real-time traffic management requires a practical command structure: who owns the data, who validates AI detections, who adjusts traffic signals, who dispatches field forces, who handles appeals, and who is accountable when technical errors occur. A fragmented system may produce multiple dashboards but still fail to deliver coordinated intervention.

Technological readiness is significant but not dominant. This suggests that respondents do not see technology as the only obstacle. Vietnam can procure AI cameras, cloud infrastructure and control-room software, but technological value depends on interoperability and local calibration. The literature on AI and deep reinforcement learning in traffic control confirms that intelligent signal systems can improve performance, yet they require scalable models, reliable detection and contextual adaptation [7], [8]. In Vietnam's mixed traffic environment, local training data and validation are essential.

Financial feasibility remains a major policy issue. ITS should be financed according to life-cycle cost, not just capital investment. If cities finance installation but not operation, maintenance, data storage, cybersecurity and algorithmic updating, the system will degrade. This is why the financial model must combine public investment for core regulatory functions with carefully controlled service procurement or PPP mechanisms for non-sensitive components.

Technology transfer readiness is significant and should be elevated as a procurement requirement. Vendor contracts should not only specify devices and software functions but also require documentation, APIs, data dictionaries, training, algorithmic performance reports and localisation support. Without these clauses, public agencies risk long-term dependence on vendors and limited ability to audit AI-based decisions..

VI. Conclusion

This study assessed the institutional, technological and financial conditions for deploying an ITS for urban traffic management in Vietnam, using a 436-response survey dataset. The results show strong perceived effectiveness and application potential. Respondents believe that AI cameras and centralised traffic operation centres can improve congestion monitoring, incident response, enforcement, signal control and planning. However, feasibility is constrained by institutional, financial and governance conditions.

The empirical results indicate that social acceptance is the strongest predictor of application potential, followed by institutional readiness, technological readiness, technology transfer readiness and financial feasibility. This means that ITS deployment in Vietnam should not be treated as a technology-only project. It must be designed as a governance system supported by legal clarity, inter-agency data sharing, transparent enforcement, data protection, open architecture, sustainable financing and domestic capability development.

The study contributes to the literature by integrating institutional, technological, financial, transfer-related and social dimensions into a single ITS feasibility framework for Vietnam. It also provides empirical evidence that the most serious deployment risks are not limited to equipment quality, but include public trust, legal accountability, life-cycle financing and vendor dependence. Policy makers should therefore adopt a staged approach: pilot ITS in priority corridors, standardise data and APIs, establish a unified traffic operation protocol, require technology transfer in procurement, and build independent capacity for AI model validation. Such an approach can help Vietnam move from fragmented smart-traffic projects towards a coherent, scalable and accountable ITS ecosystem..

References

Journal Papers:

[1] ISO, "ISO 14813-1:2015 Intelligent transport systems — Reference model architecture(s) for the ITS sector — Part 1: ITS service domains, service groups and services," International Organization for Standardization, 2015. Available: https://www.iso.org/standard/57393.html

[2] Government of Vietnam, "Decree No. 165/2024/ND-CP elaborating a number of articles of the Law on Roads and Article 77 of the Law on Road Traffic Order and Safety," 2024.

[3] Vietnam News, "HCM City promotes developing intelligent transportation system," 2024. Available: https://vietnamnews.vn/society/1688797/hcm-city-promotes-developing-intelligent-transportation-system.html

[4] VietnamNet, "Hanoi sets stage for smart traffic solutions with new monitoring system," 2024. Available: https://vietnamnet.vn/en/hanoi-

sets-stage-for-smart-traffic-solutions-with-new-monitoring-system-2323253.html

[5] International Transport Forum, *Managing Urban Traffic Congestion*. Paris: OECD Publishing, 2007. Available: https://www.itf-oecd.org/content/managing-urban-traffic-congestion

[6] World Bank, *Intelligent Transport Systems and Logistics: Report on Strategic Segmentation*. Washington, DC: World Bank, 2021. Available: https://documents1.worldbank.org/curated/en/320221632394692662/pdf/Intelligent-Transport-Systems-and-Logistics-Report-on-Strategic-Segmentation.pdf

[7] A. Haydari and Y. Yilmaz, "Deep reinforcement learning for intelligent transportation systems: A survey," *IEEE Transactions on Intelligent Transportation Systems*, vol. 23, no. 1, pp. 11–32, 2022, doi: 10.1109/TITS.2020.3008612.

[8] X.-Y. Liu, M. Zhu, S. Borst, and A. Walid, "Deep reinforcement learning for traffic light control in intelligent transportation systems," arXiv:2302.03669, 2023. Available: https://arxiv.org/abs/2302.03669

[9] D. C. North, *Institutions, Institutional Change and Economic Performance*. Cambridge: Cambridge University Press, 1990.

[10] International Transport Forum, *Data-Driven Transport Policy*. Paris: OECD Publishing, 2016. Available: https://www.itf-oecd.org/data-driven-transport-policy

[11] National Assembly of Vietnam, "Law No. 91/2025/QH15 on Personal Data Protection," 2025.

[12] Government of Vietnam, "Decree No. 151/2024/ND-CP elaborating the Law on Road Traffic Order and Safety regarding the road traffic order and safety database," 2024.

[13] M. Veres and M. Moussa, "Deep learning for intelligent transportation systems: A survey of emerging trends," *IEEE Transactions on Intelligent Transportation Systems*, vol. 21, no. 8, pp. 3152–3168, 2020.

[14] V. Venkatesh, M. G. Morris, G. B. Davis, and F. D. Davis, "User acceptance of information technology: Toward a unified view," *MIS Quarterly*, vol. 27, no. 3, pp. 425–478, 2003, doi: 10.2307/30036540.

[15] L. G. Tornatzky and M. Fleischer, *The Processes of Technological Innovation*. Lexington, MA: Lexington Books, 1990.

[16] N. Van Cuong, "The emerging legal framework for smart cities in Vietnam," in *Smart Cities in Asia*, Singapore: Springer, 2022, doi: 10.1007/978-981-19-1701-1_7.

[17] D. Leducq and H.-J. Scarwell, "Smart cities in Vietnam: Between national implementation and metropolitan strengthening of Hanoi," *L'Espace Géographique*, vol. 47, no. 4, pp. 305–322, 2018.

[18] R. R. Saxena, "Artificial intelligence in traffic systems," arXiv:2412.12046, 2024. Available: https://arxiv.org/abs/2412.12046