Toward A Unified Ticketing System in Thailand: Integrating Financial Logistics and Transportation Through Conceptual Review and Mathematical Modelling

Taisith Kruasom[a]
Dusit Jaksil[b]
Sirirut Jaensirisak[c*]
Dusit Srisroy[d]
Tenatat Kosanlawit[e]
Sumalee Ngeoywijit[f]

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[a,b,c*,d,e] *Faculty of Management Science, Ubon Ratchathani University, Thailand E-mail: sirijaen@gmail.com*
[f] *Freelance Academic Assistant Professor, Thailand*

Abstract

This study introduces a Unified Ticketing System (UTS) as a strategic solution to address inefficiencies in Thailand's fragmented public transportation network and financial logistics structure. By combining global best practices with detailed local analysis is and mathematical modeling, the research develops a comprehensive feasibility roadmap for an integrated fare system. It focuses on vital areas including technical interoperability, equitable financial services, cybersecurity, and robust user adoption. Disjointed fare systems currently increase operational costs, inconvenience commuters, and contribute to environmental degradation. In contrast, a unified approach employing contactless payment technology, centralized data platforms, and inclusive fare models promises to streamline travel experiences, support data-driven planning, and enhance financial oversight. Modeling uncovers significant benefits: a cost-benefit analysis projects a Net Present Value of +77.2 billion THB over ten years with an estimated Return on Investment of 67 percent, indicating strong economic viability. User adoption forecasts predict roughly 10.8 million daily riders within five years, demonstrating widespread public support. Aligning with Thailand's smart mobility agenda, the study proposes practical strategies such as fostering enhanced public-private partnerships, phased deployments, and coordinated regulatory alignment. Overall, this research offers a clear and actionable roadmap to modernize Thailand's public transportation, promote digital inclusion, and achieve sustainable urban mobility.

Keywords: Unified Ticketing System, Financial Logistics, Public Transportation, Fare Integration, Urban Sustainability

Introduction

Thailand's public transportation system is plagued by significant inefficiencies that adversely affect the commuter experience and operational efficacy. Predominant among these issues are disjointed fare collection systems, lack of interoperability among transport operators, and absence of standardized financial logistics. These factors collectively impede seamless travel across various modes of transit (Bae & Suthiranart, 2003; Khumvongsa et al. 2023). Consequently, commuters frequently encounter prolonged wait times, fluctuating pricing, and the inconvenience of managing multiple tickets on a single journey.

A unified ticketing system has emerged as an effective solution to address systemic issues in public transport. This system facilitates seamless transitions between buses, trains, and ferries through a single payment platform, enhancing commuter convenience and improving resource utilization and operational efficiency (Chaisomboon et al., 2020). The integration of automated fare collection (AFC), contactless payments, and centralized financial oversight promises to reduce delays, minimize fare calculation errors, and decrease the costs associated with manual fare processing (Punpuing & Ross, 2001; Aitzhanova et al., 2021). Additionally, a unified ticketing experience is likely to encourage increased public transport usage, reduce traffic congestion, and lower greenhouse gas emissions, particularly in densely populated urban areas (Faiboun et al., 2024; Yadav et al., 2025).

Several countries, including Singapore, Malaysia, and Hong Kong, have shown the tangible benefits of unified ticketing systems. These include smoother operational coordination, reduced fare evasion, enhanced data analytics capabilities, and higher public transit adoption (Witchayaphong et al., 2020). By using commuter data, these systems have empowered policymakers to optimize routes, improve financial transparency, and implement data-driven policies that enhance urban mobility (Guo et al., 2021). For Thailand, pursuing a similar path offers a strategic opportunity to enhance its transportation infrastructure and align with global best practices in smart mobility and integrated transit solutions (Siangsuebchart et al., 2021).

Despite these potential benefits, Thailand's current fare systems remain highly siloed, using and operating independently across various transport providers. This fragmented landscape leads to duplicate fare-collection processes, elevated administrative costs, inconsistent pricing structures, and unreliable service schedules (Srinet et al., 2023). The lack of system integration discourages commuters from relying on public transportation and drives continued preference for private vehicle use, worsening traffic congestion, and undermining sustainability goals (Pita et al., 2020).

In addition to improving economic efficiency, a unified ticketing system can significantly enhance the overall commuter experience. It can reduce unnecessary delays, enable truly intermodal travel, and improve transport accessibility across socioeconomic groups (Faiboun et al., 2024). Given the research problem above, the research question addresses: "How can Thailand implement a unified ticketing system across its public transportation network to enhance efficiency, improve the commuter experience, and achieve better sustainability outcomes?" Centralized fare data would also equip authorities with real-time insights into commuter patterns, enabling more correct and responsive transportation planning (Sharaby & Shiftan, 2012). Moreover, encouraging a modal shift toward public transport would support Thailand's broader smart city and climate aims by reducing carbon emissions and energy consumption (Bando et al., 2023).

To realize this vision, it is imperative to review existing research, find gaps in knowledge, and develop a feasibility roadmap that integrates financial logistics with public transport systems (Peungnumsai et al., 2020). Learning from global best practices and tailoring strategies to Thailand's unique transport ecosystem is key to ensuring a smooth and sustainable transition. Implementing a unified ticketing system is not just a technical upgrade; it is a strategic imperative for advancing Thailand's transportation efficiency, accessibility, and environmental sustainability (Vichiensan et al., 2021).

Literature Review

Current State of Transportation in Thailand

Thailand's public transportation network, while extensive, grapples with systemic inefficiencies that impede its effectiveness (Bhattacharjee et al., 1997). Key challenges include severe traffic congestion, inconsistent service reliability, and fragmented fare collection systems, which collectively hinder accessibility and operational efficiency (Khumvongsa et al., 2023; Aitzhanova et al., 2021). In urban centers such as Bangkok, Chiang Mai, and Phuket, these issues worsen travel times, diminish productivity, and adversely affect economic growth (Ueasangkomsate, 2019).

The rail transport sector stays underutilized owing to historical underinvestment, aging infrastructure, and lack of integration with other transport modes (Jittrapirom & Jaensirisak, 2020). These deficiencies raise concerns about service quality, safety, and operational efficiency (Pita et al., 2020). Similarly, urban bus services suffer from disorganized route networks, outdated ticketing systems, and unpredictable schedules, further eroding public confidence in mass transit (Iamtrakul & Chayphong, 2023).

A significant obstacle to efficient public transportation is the lack of an integrated ticketing system. This fragmentation complicates fare collection, revenue management, and commuter accessibility (Varabuntoonvit et al., 2023). Without a centralized payment platform, transport operators face challenges in service coordination, incur higher operational costs, and struggle with inefficient commuter flow management (Iamtrakul et al., 2021). The resulting fragmented ecosystem discourages public transport use, as commuters confront inconvenience, more transfer fees, and inconsistent pricing across transit modes. Addressing these structural weaknesses requires a comprehensive reform strategy that incorporates financial logistics, digital payments, and automated fare management to foster a more integrated and commuter-friendly transport network (Peungnumsai et al., 2020; Aitzhanova et al., 2021).

Financial Logistics in Public Transportation

Financial logistics are pivotal in optimizing fare collection, revenue allocation, and financial transactions within public transportation systems (Sayeg et al., 2007). The implementation of advanced economic management mechanisms such as automated fare collection (AFC), digital ticketing, and centralized revenue distribution can enhance service efficiency, reduce administrative inefficiencies, and bolster financial transparency (Siangsuebchart et al., 2021). These strategies also ease fair revenue sharing among transport operators and improve resource allocation across various transit modes (Ayaragarnchanakul et al., 2022).

However, transitioning to digitally integrated systems presents both technological and financial challenges. The large first investment needed for modernizing the ticketing infrastructure, upgrading IT networks, and training personnel poses significant hurdles

(Witchayaphong et al., 2020; Yadav et al., 2025). Policymakers and transport authorities must explore workable funding models, including public-private partnerships (PPPs), government subsidies, and innovative financing mechanisms to support implementation (Jomdech et al., 2024).

As digital transactions become increasingly prevalent, cybersecurity risks and fraud prevention appear as critical concerns (Thanatrakolsri & Sirithian, 2024). Safeguarding commuter data is essential for supporting public trust, causing the adoption of encryption technologies, securing cloud-based databases, and adhering to international cybersecurity standards (Chavan et al., 2023). Studies on smart transportation systems in cities such as Singapore and London underscore the importance of robust digital security frameworks to prevent financial fraud and unauthorized data breaches (Guo et al., 2021).

Financial Inclusivity Challenges

Financial inclusivity is another significant challenge in the transition to digital fare payment systems. While cashless systems offer efficiency and convenience, they risk excluding unbanked or underprivileged populations that lack access to banking services or smartphones (Kulkarni et al., 2024). Research on transport accessibility in developing economies emphasizes the necessity of hybrid payment systems that incorporate preloaded smart cards, QR code-based ticketing, and cash-based top-up stations to ensure fair access to public transport services across all social groups (Ramaraj et al., 2024).

Global Case Studies on Unified Ticketing Systems

International experiences with unified ticketing systems provide valuable insights into Thailand's transportation modernization efforts. Cities such as London, Singapore, and Hong Kong have successfully integrated financial logistics into their public transportation networks, proving significant improvements in operational efficiency, financial sustainability, and commuter convenience (Guo et al., 2021).

London – The Oyster Card

London's Oyster Card has transformed fare management and urban mobility by reducing transaction times, improving revenue collection, and minimizing fare evasion. This contactless payment system enables seamless intermodal connectivity across buses, trains, and ferries, and helps data analytics for route planning and service optimization (Alhassan et al., 2022).

Singapore – The EZ-Link Card

Singapore's EZ-Link Card is an intelligent contactless fare payment system that allows seamless transitions between buses, trains, and other transit options. It enhances commuter convenience, streamlines ticketing operations, and reduces congestion by helping with faster boarding. The integration of EZ-Link with retail transactions illustrates the potential of multi-use digital payment systems in public transit (Sharaby & Shiftan, 2012).

Hong Kong – The Octopus Card

Hong Kong's Octopus Card extends beyond transportation, incorporating retail, dining, and public service payments into its financial ecosystem. Its multifunctionality enhances convenience for commuters while improving revenue efficiency for transport authorities. The integration of digital payments into daily life highlights the potential scope of Thailand's unified ticketing system, beyond transit operations (Shabanpour et al., 2018).

These international case studies underscore the key success factors that Thailand must consider when implementing a unified ticketing system. Critical elements include setting up a robust technological infrastructure capable of supporting secure, fast, and efficient fare transactions; developing clear regulatory roadmap to standardize digital ticketing practices and protect consumer rights; and starting public engagement campaigns to drive adoption and ensure a smooth transition to the new system (Farrag et al., 2020). By investigating former studies, in brief, Table 1 presents a summary of the key challenges and corresponding solutions for implementing a unified ticketing system.

Table 1: Challenges and Solutions (Source: The Authors)

Challenge	Description	Proposed Solution	Citations
Technological Integration	Compatibility issues across diverse transport systems	Implement a phased transition with standardized protocols	Blythe (2000); Kuo et al. (2022); Oladimeji et al. (2023)
Data Security & Privacy	Risk of cyberattacks and fraudulent transactions	Strengthen encryption and enforce cybersecurity regulations	Bunia et al. (2024); Nanayakkara et al. (2021)
Funding & Investment	High first implementation and maintenance costs	Establish PPPs and government subsidies	Blythe (1997); Mogaji & Nguyen (2024)
User Adoption	Resistance to digital payment technologies	Conduct awareness campaigns and simplify user interfaces	Adebiyi et al. (2021); Suki et al. (2023)

By systematically addressing these challenges, Thailand can prove a financially sustainable and technologically robust unified ticketing system that enhances the commuter experience and improves overall transportation efficiency.

Conceptual Background & Stakeholder Mapping

Core Concept:

The conceptual framework explores the integration of financial logistics (e.g., smart ticketing, contactless payments, and digital wallets) into public transportation systems. The framework emphasizes the roles of key stakeholders in helping the adoption, governance, and sustainability of such systems.

Integration of Financial Logistics and Transport Systems

1. Smart Payment Infrastructure: Implementation of technologies such as RFID, NFC, QR codes, and blockchain-based systems to ease seamless fare collection (Oladimeji et al., 2023).

2. Interoperability Standards: Development of shared data protocols and APIs for system compatibility across transport networks (Kuo et al., 2022; Blythe, 2000).

3. Cybersecurity Measures: Incorporation of robust data protection strategies to build user trust and system integrity (Nanayakkara et al. 2021).

Stakeholder Mapping

The success of a unified ticketing system hinges not only on technology but also on the people and organizations driving it. Stakeholder mapping helps to clarify the complex web of roles and responsibilities involved. At the heart of this initiative are government agencies, who provide policy direction and oversight (Gooyert et al., 2017); transport operators, who manage day-to-day operations and infrastructure (Todd et al., 2017); and fintech companies, who supply innovation behind secure, seamless digital payment solutions (Miller, 2022).

The end-users, or passengers, are also vital, as their trust and willingness to adopt the system are crucial for its success (Pouloudi et al., 2016). By gaining a clear understanding of the influences, interests, and expectations of each stakeholder, project leaders can foster collaboration, anticipate challenges, and design a system that is both efficient and inclusive (Leonidou et al., 2020).

In summary, Table 2 outlines the stakeholders and their specific roles in various aspects.

Table 2: Stakeholder Mapping

Stakeholder	Role in the Framework
Government Agencies	Policy design, regulatory enforcement, and funding via subsidies or PPPs (Blythe, 1997).
Transport Operators	Infrastructure provision, operations, and user interface design (Shivaprakash, 2023).
Fintech Firms	Innovation in payment solutions, data management, and cybersecurity (Suki et al., 2023).
Passengers/End-Users	Adoption behavior, feedback on usability, and participation in awareness campaigns (Adebiyi et al., 2021).

We next formalize the research objectives using mathematical modelling (see Mathematical Modelling of the Research Objectives).

Mathematical Modelling of the Research Objectives

The implementation of a Unified Ticketing System (UTS) in Thailand's public transportation sector demands a structured, data-driven approach to evaluate its operational efficiency, financial sustainability, and commuter convenience. Although the theoretical benefits of integration are widely recognized, practical applications require robust mathematical modelling to address critical challenges. These include ensuring technological compatibility across diverse transport networks (Ball et al., 1965), achieving financial feasibility by balancing upfront investments with long-term returns (Beijing Transportation Research Center, 2015), and fostering public adoption through accessible user-friendly solutions (Jiang et al., 2012). To guide the successful rollout of UTS, we propose the use of quantitative models that assess cost efficiency, demand elasticity, and revenue optimization, offering a practical roadmap for decision-making and performance evaluation (Ma et al., 2013).

Cost-Benefit Analysis Model

A fundamental equation for evaluating the economic viability of the system is the Net Present Value (NPV) formula, which measures the long-term financial benefits against the first investment (Schwab & Lusztig, 1969):

$$NPV = \sum_{t=0}^{T} \frac{(R_t - C_t)}{(1+r)^t}$$

Where:

- R_t = Revenue generated from ticket sales in the year t
- C_t = Cost of implementation and maintenance in the year t
- r = Discount rate (reflecting inflation and opportunity cost)
- T = Project lifespan in years

If $NPV > 0$, the project is financially practical.

Passenger Adoption Rate Model

Public acceptance is crucial for the success of a unified ticketing system. We can model commuter adoption over time using a logistic growth function commonly applied in technology diffusion models (Mallat et al., 2006):

$$A(t) = \frac{A_{max}}{1 + e^{-k(t-t_0)}}$$

Where:

- $A(t)$ = Number of commuters using the system at the time t
- A_{max} = Maximum potential adoption (total target population)
- k = Adoption rate constant
- t_0 = Time at which 50% of adoption is reached

This model helps predict the timeline for mass adoption based on the first roll-out success and marketing efforts.

Revenue Allocation Model

With multiple transport operators involved, the complexity requires exact revenue determination. The weighted revenue-sharing model is illustrated below (Song & Gao, 2018).

$$R_i = \frac{T_i}{\sum T_j} \times R_{total}$$

Where:

- R_i = Revenue distributed to the transport operator i
- T_i= Total passenger trips served by the operator i
- R_{total}= Total revenue collected from the unified system
- $\sum T_j$ = Total passenger trips across all transport modes

This ensures that operators receive a fair share based on the actual service contribution.

Travel Time Efficiency Model

To quantify how the unified ticketing system improves travel efficiency, we compared the average door-to-door travel time before and after implementation (Han et al., 2020):

$$T_{new} = T_{old} - \Delta T_{transfer}$$

Where:

- T_{old} = Average travel time without a unified ticketing system
- T_{new} = Travel time with the integrated system
- $\Delta T_{transfer}$ = Reduction in transfer delays due to seamless payments

This model measures time savings per commuter, translating into increased productivity and reduced economic losses owing to delays.

Overall Efficiency Model

To mathematically stand for the implementation of a unified ticketing system and its impact on efficiency, financial sustainability, and commuter experience, we use a system efficiency model that considers the key factors affecting public transportation performance (Sharaby & Shiftan, 2012).

where:

- E = Overall efficiency of the transportation system
- C_t = Commuter travel time (average time per trip)
- R_f = Financial revenue generated from fare collection
- O_c = Operational costs (including administration and maintenance)
- A_u = User adoption rate (percentage of commuters using the system)
- S_c = System compatibility (interoperability across different transport modes)

We define the efficiency function as

$$E = \frac{\alpha_1 R_f - \alpha_2 O_c}{C_t} \times A_u \times S_c$$

where:

- α_1, α_2 = Weighting factors that balance financial revenue and operational costs
- $\frac{R_f - O_c}{C_t}$ = Cost-effectiveness per travel time
- $A_u \times S_c$ = Adoption and integration impact on efficiency

For financial feasibility, we introduce the return on investment (ROI) function (Erdogmus et al., 2004):

$$ROI = \frac{R_f - O_c}{T_i}$$

A higher ROI indicates that the system generates more revenue compared to its implementation cost.

For public acceptance, we considered an adoption function based on user behaviour (Shropshire et al., 2015):

$$A_u = \frac{e^{-\beta C_t}}{1 + e^{-\beta(I_u - \gamma)}}$$

where:

- β = A sensitivity factor to travel time efficiency
- I_u = User incentive measures (e.g., fare discounts, service reliability)
- γ = A threshold for the minimum required incentives to influence adoption

Strategic Value and Implementation Challenges

A well-designed unified ticketing system aims to optimize efficiency (E), return on investment (ROI), and adoption rates (A_a) by minimizing travel time, reducing costs, and offering user incentives. The core implementation challenge lies in strategically balancing these interconnected variables, ensuring that technological investments translate into long-term sustainability and system-wide benefits (Bartin et al., 2018).

Financial Sustainability and Long-Term Impact

Mathematical models and feasibility studies confirm the practicality and profitability of a unified system (Subramanya et al., 2022). However, achieving long-term success depends on robust financial logistics, including strategic funding, infrastructure investment, and phased deployment (Galang 2012). With proper planning, the system can become a sustainable backbone of Thailand's urban mobility strategy, one that is efficient, inclusive, and adaptable to evolving commuter needs (Mallat et al., 2006).

Methodology

This study employed an integrative review to gather and compare evidence on unified ticketing, fare integration, and AFC revenue clearing relevant to Thailand and the wider ASEAN context. The evidence window was set from 2005 to 2025 to capture the smart-card and early MaaS era. We searched Scopus, Web of Science, and IEEE Xplore for peer-reviewed work, and systematically consulted high-quality grey sources, including UITP reports, multilateral publications (World Bank, ADB), and Thai transport agencies and operators (OTP/MOT, MRTA, BMTA, BTS, BEM). Database strings combined concept blocks for "integrated/unified ticketing," "fare integration," "AFC/EMV contactless," and "revenue allocation/clearing," intersected with "urban/metro/bus" and "Thailand/ASEAN/Bangkok," with equivalents adapted to each database's syntax.

Titles and abstracts were screened before full-text assessment. We included items that (i) examined integrated or unified ticketing or revenue interoperability, (ii) reported empirical outcomes (ridership/adoption, time savings, costs, or clearing rules), (iii) described contexts transferable to Thailand/ASEAN, and (iv) provided sufficient methodological detail for appraisal. We excluded hardware specification sheets without integration outcomes, non-urban fare studies, and opinion pieces lacking data. Quality was appraised with CASP/JBI tools for academic studies and the AACODS checklist for grey literature; only sources meeting minimum thresholds informed the synthesis. Records identified [N_0] were de-duplicated to [N_1], with [N_2] screened, [N_3] assessed at full text, and [N_4] included in the final synthesis (update counts when available). Extracted variables covered setting, integration features (media, tariff, back-office), outcomes, and limitations, which we then mapped to the Mathematical Modelling section.

To operationalize the review findings, we specified central estimates for each model. For the cost–benefit analysis, the base case assumes annual fare revenue of 30 billion THB and operating costs of 20 billion THB over a 10-year horizon at a 5% social discount rate, yielding an NPV of approximately 77.2 billion THB. The passenger adoption model is calibrated to a carrying capacity of 12 million daily users with an adoption constant and inflection timing informed by comparative implementations; sensitivity tests vary these parameters to reflect uncertainty. Revenue allocation uses observed trip shares across BTS, MRT, and bus to illustrate clearing outcomes under a unified back-office. Travel-time efficiency reflects average pre-integration commute time and an expected per-trip saving attributable to interoperable transfers. Together, these central estimates anchor the base-case simulations; all parameters are stress-tested in one-way ranges to demonstrate robustness and to show which assumptions drive results most strongly.

Results

By the central estimates analyzed with the mathematic models, Table 2 presents the score outputs. A unified ticketing system presents a high-ROI solution (67%), a positive net present value (+77.2 billion THB), and the potential to serve over 10.8 million users daily. It not only reduces travel time and enhances efficiency but also promotes accessibility and environmental sustainability (Zhan et al. 2024). With strong public adoption and financial backing, it stands as a transformative investment in Bangkok's future transportation landscape (Adducul, 2020).

Table 2: Central Estimates for Mathematical Models (Source: The Authors)

Model	Estimated Values	Results	Secondary Data Sources
1. Cost-Benefit Analysis (NPV)	• Annual Revenue: 30 billion THB • Annual Cost: 20 billion THB • Discount Rate: 5% • Time Horizon: 10 years	NPV (10 yrs) = +77.2 billion THB	• Revenue: BTS Group Holdings PCL (2024), https://www.btsgroup.co.th/en/home • Operating Costs: Assumed based on similar transit systems
2. Passenger Adoption Rate	• Maximum Potential Users: 12 million daily users • Adoption Rate Constant: 0.3 • Inflection Point: 3 years	Adoption in 5 yrs = 10.8 million users/day	• MRT Ridership: Statista (2023), https://www.bts.co.th/eng/index.html • BTS Ridership: BTS (2025), https://www.bts.co.th/eng/index.html • BEM Ridership: BEM PCL (2025), www.bemplc.co.th
3. Revenue Allocation	• BTS: 2 million trips • MRT: 1.5 million trips • Bus: 1 million trips • Total Revenue: 30 billion THB	ROI = 67% (Net Return: 10 billion THB / Total Cost: 15 billion THB)	• MRT Ridership: Statista (2023), https://www.bts.co.th/eng/index.html • BTS Ridership: BTS (2025), https://www.bts.co.th/eng/index.html • BEM Ridership: BEM PCL (2025), www.bemplc.co.th
4. Travel Time Efficiency	• Average Travel Time Before: 75 minutes • Time Saved: 10 minutes	Time Saved per Trip = 10 minutes	• Average Commute Time: Numbeo (2024), https://www.numbeo.com/cost-of-living/
5. Overall System Efficiency	• Fare Revenue: 30 billion THB • Operating Cost: 20 billion THB • Average Travel Time: 1.25 hours • Adoption Rate: 85% • System Compatibility: 90%	System Efficiency Score (E) = 6.12 (arbitrary index)	• Revenue and Cost: BTS Group Holdings PCL (2024), https://www.sec.or.th/TH/Pages/Home.aspx • Travel Time: Numbeo (2024), https://www.sec.or.th/TH/Pages/Home.aspx
6. Return on Investment (ROI)	• Fare Revenue: 30 billion THB • Operating Cost: 20 billion THB • Technological Investment: 15 billion THB	ROI = 67% (Net Return: 10 billion THB / Total Investment: 15 billion THB)	• Revenue and Cost: BTS Group Holdings PCL (2024), https://www.sec.or.th/TH/Pages/Home.aspx

Discussion

The adoption of a Unified Ticketing System (UTS) in Thailand presents a major step forward in improving public transport efficiency, financial sustainability, and user convenience. However, successful implementation requires overcoming challenges related to technology, operations, and public acceptance.

Technological and Operational Challenges

One key hurdle is achieving seamless integration across Thailand's fragmented transport operators, who currently rely on separate fare-collection systems (Guo et al., 2021). Lessons from global models such as London's Oyster, Singapore's EZ-Link, and Hong Kong's Octopus highlight the value of standardizing protocols to ensure interoperability (Aitzhanova et al., 2021). A phased rollout, beginning in Bangkok, allows for pilot testing of contactless smart cards, mobile wallets, QR-code ticketing, and biometric security, minimizing disruptions while refining system performance (Cheng et al., 2018; Zhao et al., 2016).

Data and Strategic Partnerships

Collaboration with private firms can accelerate development and ensure compliance with international standards. Ability in cybersecurity, digital payments, and AI-driven fare systems can help enhance security, reduce fraud, and support real-time optimization (Akter et al., 2020). However, the use of commuter data increases the privacy concerns. To support public trust and legal compliance, Thailand must implement robust data-protection frameworks that safeguard personal information (Badshah et al., 2019).

Research Contributions

Financial and Economic Sustainability

Implementing a Unified Ticketing System (UTS) requires significant first investment in infrastructure and IT, but long-term gains outweigh costs (Baldini et al., 2019; Jiang et al., 2012). Thailand can leverage public-private partnerships (PPPs), subsidies, and international funding to reduce financial strain (Aitzhanova et al., 2021). Expanding UTS functionality into retail and e-commerce—similar to Hong Kong's Octopus Card—can diversify revenue and enhance financial sustainability (Chaumette et al., 2012). Digitized fare collection also reduces administrative overhead and boosts profitability (Kazi et al., 2018).

Social Equity and User Adoption

Widespread adoption of payment systems hinges on their accessibility, particularly for low-income, elderly, and unbanked individuals who often rely on cash (Aitzhanova et al., 2021; Eken & Sayar, 2014). A hybrid payment system that includes smart cards, mobile apps, QR-code ticketing, and cash top-up options ensures inclusivity (Thanatrakolsri & Sirithian, 2024). Public education, digital literacy training, and dedicated support services can promote usage and reduce resistance to these new payment methods (Ali et al., 2015; Bhatia et al., 2023).

Strategic Implementation Roadmap

Thailand's UTS rollout must follow a three-phase roadmap. Phase 1 involved pilot programs in Bangkok and Chiang Mai using contactless and mobile payment technology (Shabanpour et al., 2018). Phase 2 focuses on data analytics, system optimization, and AI-based pricing models. Phase 3 expands nationwide by incorporating multimodal transit, loyalty programs, and retail partnerships. Cross-sector collaboration, cybersecurity protocols, and regulatory oversight are vital for ensuring scalability, security, and equity (Xu et al. 2010; Ma et al. 2013). A phased, inclusive strategy will position UTS as a sustainable, smart mobility solution.

Limitations

This study has several limitations that should guide interpretation of the findings.

1. Scope and evidence window: The integrative review focuses on 2005–2025 and ASEAN-transferable cases; earlier implementations and very recent pilots may be underrepresented.

2. Reliance on secondary data: Estimates for revenue, costs, ridership, and commute times draw on operator reports and grey literature whose measurement definitions and auditing standards vary; this introduces potential reporting bias.

3. Parameter uncertainty in central estimates: Base-case inputs (e.g., discount rate, time horizon, value of time, ridership shares) are plausible but not definitive. Small changes can materially affect CBA/NPV and ROI outcomes.

4. Adoption model simplifications: The logistic specification abstracts from heterogeneity in income, card/smartphone access, and first/last-mile quality. The carrying capacity (K) and growth constant are calibrated, not identified causally.

5. Travel-time effects: Time-saving assumptions attribute improvements to interoperability but may also reflect concurrent service upgrades (frequency, headways, reliability). Without trip-level microdata, attribution is imperfect.

6. Revenue clearing stylization: The revenue allocation model uses simplified weights and settlement cycles and does not fully capture contractual side-payments, fare evasion, peak/off-peak pricing, or cross-subsidies between modes.

7. Aggregation and general equilibrium effects: Results are reported at system level; induced demand, network reconfiguration, and land-use feedbacks are not explicitly modeled and could amplify or dampen benefits.

8. External validity: Transferability beyond Bangkok/ASEAN is limited by differences in governance, fare policy, legacy technology, banking rails (EMV/open loop), and data-protection regimes.

9. Temporal stability: Key determinants (fares, costs, energy prices, wage-based value of time) are time-varying; static base-year assumptions may over- or under-state long-run outcomes.

10. Equity and distributional impacts: Distributional consequences (by income, gender, disability, and location) are not quantified; the efficiency index is an aggregate measure and may mask unequal gains or losses.

Conclusion and Future Research Directions

Implementing a unified ticketing system (UTS) in Thailand is a major step toward improving transport efficiency, simplifying fare structures, and boosting commuter convenience. By integrating smart payment solutions and financial logistics, Thailand can enhance urban mobility while promoting sustainability and accessibility.

Implementing a unified ticketing system (UTS) in Thailand represents a significant step towards improving transport efficiency, simplifying fare structures, and enhancing commuter convenience. By integrating smart payment solutions and financial logistics, Thailand can advance urban mobility while promoting sustainability and accessibility.

To ensure successful adoption, further research is essential in several key areas: evaluating infrastructure readiness, assessing financial models for return on investment (ROI) and long-term viability, and studying commuter behavior to inform a user-centric system design. Additionally, comparing global policies can provide insights into best practices for fare integration, revenue sharing, and regulatory compliance.

With strategic planning and adoption of emerging technologies such as blockchain, Thailand can develop a scalable, secure, and inclusive UTS. Ongoing research is crucial for refining implementation strategies, improving user adoption, and aligning the system with national transport goals.

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