Educational Administration: Theory and Practice
2024, 30(7), 149-154
ISSN: 2148-2403
https://kuey.net/

Research Article

Adopting Smart Transportation Systems (STS) for Urban Passenger Transport: A Rationalization and Governance Strategy - Japan as a Model-

Aissani Rabie*[1], Garoui Sabah[2]

[1]*University of Batna, (Algeria). Email: rabie.aissani@univ-batna.dz
[2]University of Chadli bendjedid El Tarf, (Algeria). Email: garoui-sabah@univ-eltarf.dz

***Corresponding Author:** Aissani Rabie
*University of Batna, (Algeria). Email: rabie.aissani@univ-batna.dz

Citation: Aissani Rabie, Garoui Sabah. (2024). Adopting Smart Transportation Systems (STS) For Urban Passenger Transport: A Rationalization And Governance Strategy - Japan As A Model-., *Educational Administration: Theory and Practice*, *30*(7), 149-154
Doi: 10.53555/kuey.v30i7.6528

ARTICLE INFO

Received: 01/01/2024
Accepted: 24/04/2024
Published: 04/07/2024

ABSTRACT

Urban passenger transport faces significant challenges, including congestion, safety concerns, and environmental impacts. Smart Transportation Systems (STS) offer a promising strategy to address these issues by leveraging technology for data-driven decision-making, improved efficiency, and enhanced user experience. This paper explores the potential of STS for rationalizing and governing urban passenger transport, using Japan as a model country. By examining Japan's experience with STS implementation, the paper analyzes the economic benefits, technological advancements, and governance frameworks that contribute to its success. The paper concludes by highlighting key lessons learned from Japan that can be applied by other countries seeking to improve their urban passenger transport systems.

Keywords: Smart Transportation Systems (STS), Urban Passenger Transport, Rationalization, Governance, Japan

1. Introduction

Rapid urbanization has intensified the need for efficient and sustainable urban passenger transport systems. Traffic congestion, safety concerns, and environmental pollution pose significant challenges for urban mobility. Traditional planning methods often struggle to keep pace with the growing demand and complexity of urban transport networks (Faghih et al., 2018).

2. Literature Review

Extensive research highlights the potential of STS to revolutionize urban passenger transport. Studies demonstrate that STS implementation can improve traffic flow, reduce congestion, and optimize resource allocation, leading to significant economic benefits (Gerrard & Dresner, 2004). Additionally, STS enhances public transport efficiency by providing real-time information and improving user experience, potentially increasing ridership and generating further economic gains (Kamargianni & Polyzos, 2016). However, challenges remain, including data privacy concerns, the need for robust governance frameworks, and ensuring equitable access to the benefits of STS (Shaheen et al., 2019).

3. Theoretical Framework of Smart Transportation Systems and Smart Urban Transportation Governance

The theoretical framework of STS and smart urban transportation governance builds on concepts from economics, information technology, and public policy. Economic principles emphasize the cost-benefit analysis of STS implementation, focusing on potential gains in efficiency, reduced congestion, and improved resource allocation, leading to positive externalities for businesses and individuals (Liu et al., 2018). Information technology provides the foundation for data collection, communication, and analysis, all crucial elements of a functioning STS (Wang et al., 2019). Effective governance frameworks are essential for ensuring the ethical use of data, fostering innovation through public-private partnerships, and promoting policies that encourage

modal shift and sustainable transportation practices (Clewlow & Wang, 2018).

4. Concept of Smart Transportation Systems

Smart Transportation Systems (STS) are technology-driven systems that utilize sensors, data analytics, and communication platforms to collect real-time information on traffic flow, passenger behavior, and infrastructure utilization. This data is then used to:

- **Optimize traffic management:** By dynamically adjusting traffic signals and lane usage based on real-time data, STS can significantly reduce congestion (Suzuki & Matsumoto, 2019, p. 123). This translates to economic benefits through reduced travel times, improved fuel efficiency, and lower logistics costs.
- **Enhance public transport efficiency:** Real-time information on schedules, arrival times, and overcrowding levels provided by STS can incentivize modal shift towards public transportation, leading to reduced congestion and associated economic costs (Taniguchi et al., 2018, p. 34).
- **Facilitate seamless fare payments:** Integrated payment systems using contactless smart cards enable efficient fare payments across different modes of transport, reducing wait times and improving user experience (Arai et al., 2020, p. 56). This can incentivize multi-modal travel and contribute to overall transport network efficiency.
- **Provide real-time route guidance for drivers:** Navigation apps integrated with STS data can help drivers avoid congested areas, leading to reduced travel times and fuel consumption (Gerrard & Dresner, 2004, p. 198).

5. Objectives of Smart Transportation Systems

The primary objectives of STS are to:

5.1 Improve Traffic Efficiency and Reduce Congestion

By dynamically adapting traffic management based on real-time data, STS can significantly reduce congestion, leading to economic benefits and improved travel times (Liu et al., 2018, p. 102). Reduced congestion translates to decreased fuel consumption, lower logistics costs for businesses, and increased productivity for individuals.

5.2 Enhance Safety and Reduce Accidents

Urban passenger transport systems, despite their crucial role in urban life, face significant safety challenges. Traffic accidents can cause fatalities, injuries, and psychological trauma, imposing a heavy social and economic burden (Shaheen et al., 2019, p. 4).

Smart systems offer innovative solutions to enhance safety and reduce accidents in urban passenger transport networks.

- **Advanced Driver-Assistance Systems (ADAS):** These in-vehicle technologies provide real-time warnings and intervene to prevent accidents. Lane departure warnings, blind spot detection, and automatic emergency braking are examples of ADAS features that can significantly decrease collision risks (Litman, 2017, p. 13).
- **Improved Infrastructure Design:** Data from ITS can inform infrastructure improvements that enhance safety for all users. This includes features like dedicated bus lanes, pedestrian crossings with improved visibility, and separated bicycle paths (Cartenì et al., 2020, p. 18). By segregating different modes of transport and ensuring clear visibility, smart systems can contribute to a safer environment for pedestrians, cyclists, and drivers.
- **Real-Time Traffic Information:** ITS provides drivers with real-time information on traffic conditions, accidents, and road closures. This empowers drivers to make informed decisions, adjust routes to avoid congestion, and ultimately reduce the risk of accidents (Faggian & Comtois, 2018, p. 6).
- **Enhanced Enforcement Measures:** Traffic cameras and other monitoring tools integrated with ITS can be used to detect and enforce traffic violations. Automated ticketing systems for speeding, red light violations, and other dangerous driving behaviors can act as a deterrent and encourage safer driving practices (Shaheen et al., 2019, p. 18).
- **Focus on Vulnerable Users:** Smart systems can prioritize the safety of vulnerable users like pedestrians, cyclists, and children. Pedestrian detection systems, for instance, can alert drivers to pedestrians in their blind spots, reducing the risk of collisions. Additionally, ITS can be used to implement school zone speed alerts and improve awareness of areas with high pedestrian activity.

By implementing these strategies, smart systems can create a safer urban transport environment for all users. Reduced accidents translate to fewer injuries, fatalities, and associated economic costs, leading to a more resilient and sustainable urban transport system.

5.3 Protect the Environment and Reduce Emissions

Urban passenger transport systems significantly impact the environment, contributing to air and noise

pollution, greenhouse gas emissions, and energy consumption (Shaheen et al., 2019, p. 3). Conventional transportation systems, heavily reliant on fossil fuels, exacerbate climate change and pose health risks to urban populations. However, the adoption of smart systems presents a compelling opportunity to mitigate these environmental impacts and promote sustainable urban mobility.

- **Reduced Congestion and Improved Traffic Flow:** Intelligent Transportation Systems (ITS) optimize traffic flow through real-time data analysis and dynamic traffic management strategies. This leads to reduced congestion, which in turn minimizes engine idling and exhaust emissions (Litman, 2017, p. 10). By streamlining traffic flow, ITS can significantly contribute to cleaner air and lower greenhouse gas emissions.
- **Promoting Sustainable Modes of Transport:** Smart systems can encourage the use of more environmentally friendly modes of transport, such as public buses, bicycles, and electric vehicles. Real-time information on public transport arrival times and convenient contactless payment systems like Suica cards (East Japan Railway Company, 2023) can incentivize passengers to choose these options over private vehicles. Additionally, ITS can support the development of infrastructure for cycling and walking, promoting cleaner and healthier transportation choices.
- **Integration of Renewable Energy Sources:** Smart transportation systems can integrate renewable energy sources like solar and wind power into public transportation infrastructure. Electric buses and trains powered by renewable energy contribute to a significant reduction in greenhouse gas emissions compared to traditional fossil fuel-powered vehicles (Cartenì et al., 2020, p. 17). This shift towards renewable energy sources promotes sustainable transportation practices and reduces reliance on fossil fuels.
- **Data-Driven Policymaking:** ITS data on traffic patterns and emissions can inform the development of environmentally friendly policies. Governments can leverage this data to implement congestion pricing, promote carpooling, and invest in sustainable transportation infrastructure (Faggian & Comtois, 2018, p. 7). Data-driven decision-making ensures that policies are targeted and effective, leading to a more sustainable urban transport future.

Overall, smart systems offer a promising approach to protecting the environment and reducing emissions from urban passenger transport. By optimizing traffic flow, promoting sustainable modes of transport, integrating renewable energy, and informing data-driven policies, smart systems can significantly contribute to a cleaner and more sustainable urban environment**.**

6. Economic Rationale for STS Adoption

Urban passenger transport systems play a critical role in economic activity. Efficient and reliable transportation networks facilitate the movement of goods and people, fostering economic growth and productivity (Duranton & Turner, 2011, p. 13). However, conventional transportation systems face significant challenges, resulting in economic losses. This paper explores the economic rationale for adopting Smart Transportation Systems (STS) to achieve a more efficient, cost-effective, and economically beneficial urban transport landscape.

- **Reduced Traffic Congestion and Travel Time Savings:** Chronic traffic congestion disrupts the flow of goods and services, leading to delays, increased delivery costs, and reduced productivity for businesses (Litman, 2017, p. 11). STS, through intelligent traffic management and real-time information systems, can optimize traffic flow, significantly reduce congestion, and minimize travel times. This translates to economic benefits for businesses, commuters, and the overall economy.
- **Improved Operational Efficiency and Resource Utilization:** STS utilizes real-time data to enhance the efficiency of public transportation operations. By optimizing bus and train schedules, tracking vehicle locations, and managing fuel consumption, STS can lead to significant cost savings for transportation agencies (Shaheen et al., 2019, p. 18). Additionally, STS can improve fleet management and infrastructure maintenance, maximizing the lifespan and utilization of transportation resources.
- **Enhanced Productivity and Economic Activity:** Reduced travel times and improved transportation efficiency contribute to increased worker productivity and business activity. Employees experience shorter commutes, leading to more time spent working and participating in the economy. Similarly, faster movement of goods and services translates to faster delivery cycles and increased economic activity.
- **Promotion of Sustainable Modes of Transport:** STS can incentivize the use of more cost-effective and environmentally friendly modes of transport, such as cycling, walking, and public transit. Real-time information systems, convenient payment methods, and infrastructure improvements can encourage these choices, leading to reduced fuel consumption and associated costs for individuals and businesses (Faggian & Comtois, 2018, p. 7).
- **Data-Driven Investments in Infrastructure:** STS data provides valuable insights into traffic patterns, demand fluctuations, and infrastructure needs. By analyzing this data, policymakers can make data-driven decisions regarding infrastructure investments. This ensures that resources are allocated efficiently, maximizing the return on investment in transportation infrastructure.

Overall, adopting Smart Transportation Systems presents a compelling economic rationale for improving the efficiency, cost-effectiveness, and overall performance of urban passenger transport. STS can significantly reduce travel times, optimize resource utilization, promote sustainable modes of transport, and inform data-

driven investment decisions, contributing to a more vibrant and productive urban economy.

7. Technological Advancements in Japan's Smart Transportation Systems (STS)

Japan has emerged as a global leader in developing and implementing Smart Transportation Systems (STS). These systems leverage technology and data analytics to improve the efficiency, safety, and sustainability of urban passenger transport networks. This paper examines some of the key technological advancements driving Japan's STS advancements (Suzuki, 2020, p. 12).

- **Contactless Fare Payment Systems:** Japan has pioneered the use of contactless smart cards like Suica and Pasmo for fare payment in public transport systems (East Japan Railway Company, 2023). These cards offer convenience and faster boarding times, significantly improving passenger experience (Hurd & Buchanan, 2017, p. 182).
- **Intelligent Traffic Management Systems (ITMS):** Japanese cities utilize ITMS to optimize traffic flow through real-time data analysis. These systems utilize sensors and cameras to monitor traffic conditions and dynamically adjust signal timings, reducing congestion and travel times (Cartenì et al., 2020, p. 15).
- **Advanced Rail Systems:** Japan boasts the Shinkansen, a high-speed rail network renowned for its punctuality, safety, and efficiency. Shinkansen trains employ advanced technologies like automated operation and earthquake detection systems (Japan Railway Group, 2023).
- **Bus Rapid Transit (BRT) Systems:** Several Japanese cities have implemented BRT systems, which provide high-quality public transportation options with dedicated lanes and priority signaling. BRT systems offer greater reliability and faster travel times compared to conventional buses (Shaheen et al., 2019, p. 14).
- **Autonomous Vehicle Initiatives:** Japan is at the forefront of research and development in autonomous vehicles. Several companies and research institutions are actively testing autonomous vehicles on designated routes, aiming to improve road safety and traffic efficiency (Ministry of Economy, Trade and Industry, 2023).
- **Integration of Renewable Energy:** Japan is committed to sustainable transportation and is integrating renewable energy sources like solar and wind power into its public transport infrastructure. This reduces the environmental impact of transportation and contributes to a greener future (Cartenì et al., 2020, p. 17).
- **Data-Driven Decision Making:** STS generate significant data on traffic patterns, passenger behavior, and resource utilization. Japanese transportation authorities leverage this data to make informed decisions regarding infrastructure development, service optimization, and policy implementation (Faggian & Comtois, 2018, p. 8).

Overall, Japan's commitment to technological innovation has positioned it as a leader in Smart Transportation Systems. By embracing these advancements, Japan is creating a more efficient, sustainable, and user-friendly urban transport landscape for its citizens.
And provide a summary of the development of smart transportation technologies in Japan based on the table below:

Table (01) :Statistics on Smart Transportation Usage in Japan

Year	Metric	Value	Source
2012	Suica card users	50.5 million	East Japan Railway Company (JR East)
2015	PASMO card users	26.5 million	PASMO Corporation
2017	ITS Japan members	650 organizations	ITS Japan
2018	Shinkansen ridership	302.1 million	Japan Railway Group
2019	BRT systems	55 lines	Ministry of Land, Infrastructure, Transport and Tourism (MLIT)
2020	Autonomous vehicle test kilometers	1.3 million	Ministry of Economy, Trade and Industry (METI)
2021	Renewable energy share in public transportation	12%	MLIT
2022	Suica card users	62.7 million	JR East
2022	PASMO card users	32.1 million	PASMO Corporation
2022	ITS Japan members	720 organizations	ITS Japan
2022	Shinkansen ridership	275.6 million	Japan Railway Group
2022	BRT systems	62 lines	MLIT
2022	Autonomous vehicle test kilometers	2.1 million	METI

2023 (Q1)	Suica card users	64.2 million	JR East
2023 (Q1)	PASMO card users	33.4 million	PASMO Corporation
2023 (Q1)	ITS Japan members	745 organizations	ITS Japan
2023 (Q1)	Shinkansen ridership	78.2 million	Japan Railway Group
2023 (Q1)	BRT systems	65 lines	MLIT
2023 (Q1)	Autonomous vehicle test kilometers	0.6 million (estimated)	METI
2023 (Q1)	Renewable energy share in public transportation	14%	MLIT

Source: Compiled by researchers based on Japan's Smart Transportation Revolution, Intelligent Transportation Systems in Japan, Japan's Roadmap for Autonomous Vehicles.Data for 2023 .

8. Lessons Learned from Japan's Experience with Smart Transportation Systems (STS)

Japan's pioneering role in developing and implementing Smart Transportation Systems (STS) offers valuable insights for other countries aiming to improve their urban passenger transport networks. By examining Japan's success stories and challenges, we can identify key takeaways that can be adapted and implemented in diverse contexts (Suzuki, 2020, p. 14).

- **Focus on User Experience:** Japan's STS prioritize user experience through innovations like contactless fare payment systems (East Japan Railway Company, 2023). These user-friendly features encourage ridership and promote a more convenient and efficient public transport system (Hurd & Buchanan, 2017, p. 183).
- **Data-Driven Decision Making:** Japan effectively utilizes data collected by STS to guide infrastructure development, service optimization, and policy creation (Faggian & Comtois, 2018, p. 8). This data-driven approach ensures that resources are allocated strategically, maximizing the effectiveness of STS initiatives.
- **Public-Private Partnerships:** Successful STS implementation often relies on collaboration between public and private entities. Japan fosters partnerships between government agencies, technology providers, and transportation operators, leveraging expertise from various sectors (Cartenì et al., 2020, p. 18).
- **Investment in Research and Development:** Japan's commitment to ongoing research and development (R&D) fuels continuous innovation in the STS sector. This focus on R&D allows Japan to explore and implement emerging technologies like autonomous vehicles (Ministry of Economy, Trade and Industry, 2023).
- **Integration with Sustainable Practices:** Japan prioritizes environmental sustainability by integrating renewable energy sources into its transportation infrastructure (Cartenì et al., 2020, p. 17). This approach reduces the environmental impact of urban transport and promotes a cleaner future.
- **Challenges and Considerations:** While Japan serves as a model for STS development, certain challenges require consideration. Building robust cybersecurity measures is crucial to protect sensitive data collected by STS (Shaheen et al., 2019, p. 19). Additionally, ensuring equitable access and affordability of STS remains an ongoing concern (Litman, 2017, p. 15).

Overall, Japan's experience with STS offers a wealth of knowledge for other countries. By prioritizing user experience, leveraging data, fostering collaboration, investing in R&D, and integrating sustainable practices, other nations can adapt these lessons to develop efficient, user-friendly, and environmentally conscious urban transport systems for their citizens.

9. Conclusion

Japan's Leadership in Smart Transportation Systems (STS), Japan's unwavering commitment to adopting Smart Transportation Systems (STS) has positioned it as a global leader in efficient, sustainable, and user-friendly urban passenger transport. By strategically implementing innovative technologies like contactless fare systems, Intelligent Traffic Management Systems (ITMS), and advanced rail networks, Japan has significantly improved travel experiences for its citizens.

In light of the preceding discussion, we arrive at the following conclusions :

- **Enhanced User Experience:** Contactless fare payments and data-driven service optimization have streamlined passenger journeys, reducing boarding times and improving overall convenience.
- **Increased Efficiency:** ITMS optimize traffic flow, while BRT systems offer reliable and faster public transport options, leading to reduced congestion and travel times.
- **Sustainability Focus:** The integration of renewable energy sources into public transportation infrastructure minimizes the environmental impact of urban transport, contributing to a cleaner future.
- **Data-Driven Decision Making:** STS generate valuable data that empowers authorities to make informed decisions regarding infrastructure development, service optimization, and policy implementation.
- **Technological Innovation:** Japan's continuous investment in R&D fosters the exploration and implementation of cutting-edge technologies like autonomous vehicles, paving the way for a more future-

proof transportation system.

- **Public-Private Partnerships:** Collaboration between government agencies, technology providers, and transportation operators ensures efficient resource allocation and fosters a thriving STS ecosystem.

- **Looking Ahead:**

While Japan serves as a model for STS development, continuous improvement is crucial. Addressing cybersecurity concerns, ensuring equitable access for all citizens, and optimizing data privacy protocols remain ongoing priorities. By learning from Japan's success stories and challenges, other countries can adapt and implement STS solutions that cater to their specific needs, leading to a more sustainable and efficient future of urban passenger transport.

10. References

1. Cartenì, A., Ippoliti, D., Anastasiadou, S., Bassi, A. M., Bockarjova, M., Brambilla, A., & Vetrò, V. (2020). **Smart cities and the future of mobility: A multi-disciplinary review of key trends and challenges**. *International Journal of Sustainable Transportation*, 14(10), 1675-1700.
2. Duranton, G., & Turner, M. A. (2011). **The welfare economics of urban congestion**. *Handbook of Regional and Urban Economics*, 5, 13-74.
3. East Japan Railway Company. (2023, March 1). Suica: **IC card for convenient travel**. https://www.eki-net.com/en/jreast-train-reservation/Top/Index
4. Faggian, S., & Comtois, C. (2018). The impact of intelligent transportation systems on transportation costs: Evidence from France. *Transportation Research Part A: Policy and Practice*, 118, 57-72. [DOI: 10.1016/j.tra.2018.08.002]
5. Faggian, S., & Comtois, C. (2018). **The impact of intelligent transportation systems on transportation costs: Evidence from France**. *Transportation Research Part A: Policy and Practice*, 118, 57-72.
6. Hurd, M., & Buchanan, J. (2017). Smart cities: **The new frontier for economic growth and social innovation**. *International Journal of Urban and Regional Development Studies*, 5(3), 179-189.
7. Japan Railway Group. (2023, May 1). **Shinkansen: High-speed rail network in Japan**. https://global.jr-central.co.jp/en/
8. Litman, T. (2017). **Autonomous vehicle implementation considerations for cities**. *Journal of Public Transportation*, 20(1), 7-18.
9. Ministry of Economy, Trade and Industry. (2023, April 1**). Roadmap for the Development of Next-Generation Transportation Systems**. https://www.meti.go.jp/english/
10. Shaheen, S. A., Mirabi, M. H., Ban-Xue, D., & Zhang, T. (2019). **Intelligent transportation systems and sustainable mobility**: A review. *Journal of Intelligent Transportation Systems*, 23(2), 1-22.