IMPROVEMENT OF SMART MOBILITY IN PUBLIC TRANSPORTATION SYSTEM: A CASE STUDY OF INDIA'S KERALA STATE ROAD TRANSPORT CORPORATION (KSRTC)

Muhammed Rafnas KATTAYATTU PARAMBIL CHIRAKKAL, Vytautas Magnus University Agriculture Academy, Faculty of Bioeconomy Development, email: rafnas69@gmail.com

Summary

The article explores the challenges and solutions for implementing smart mobility in India's public transportation, focusing on the Kerala State Road Transport Corporation (KSRTC). It identifies factors influencing smart mobility adoption, including infrastructure limitations, affordability concerns, and cultural factors. Through a quantitative research method utilizing Google Forms, the study analyzes KSRTC's performance and gathers customer insights. The findings highlight a reliance on KSRTC, punctuality, and affordability challenges. Proposed solutions include advanced technologies, awareness campaigns, and collaborations. The article concludes that comprehensive development plans, technological investments, and government partnerships are vital for successful smart mobility integration in public transportation, emphasizing the need to address specific issues to enhance efficiency and competitiveness.

Keywords: smart mobility in public transportation, smart mobility, public transportation, KSRTC

Introduction

Transportation has significance in everyday life as it serves as the essential component facilitating the seamless movement of people and goods, playing an important role in enhancing economic activities, connecting communities, enabling access to education and healthcare, promoting social interactions, and contributing to the overall vibrancy and functionality of societies on a global scale (Berg and Ihlström, 2019). Subsequently, the transportation sector is adapting advanced technologies to enable smooth transportation. As per the researchers, smart mobility is a significant element employed in the transportation sector, which can increase the efficiency of transportation, enhance safety for travelers, increase accessibility, and create a more sustainable transportation system (Randell-Moon and Hynes, 2022; Kussl and Wald, 2023). Hence, applying smart mobility in transportation, especially in public transportation, will enhance the global transportation sector and it is significant to continue to invest in smart mobility technologies to get efficient, equitable, and environmentally friendly transportation systems that benefit everyone.

Subsequently, this article focuses on the ways through which the transportation sector can enhance the implementation of smart mobility in transportation, focusing on the case study of India's Kerala State Road Transport Corporation (KSRTC).

Research aim: to suggest possible solutions for improving smart mobility in India's public transportation system.

The following **objectives** have been set to achieve the aim:

1. To find out the factors affecting the implementation of smart mobility in the Indian public transportation system, focusing on the case study of KSRTC.
2. To suggest potential solutions to overcome the main challenges of implementing smart mobility in India's public transportation system, focusing on the case study of KSRTC.

Research object and methods

Research object: smart mobility in public transportation.

The primary research method is employed for the research aim and objectives. Empirical research on the improvement of smart mobility in the Indian public transportation system is done by conducting a case study of Kerala State Road Transport Corporation. The quantitative research method is utilized by conducting data collection through Google Forms. The Google Forms questionnaire incorporated both demographic inquiries and 12 research-specific questions, organized into four distinct themes including the current state of KSRTC, challenges in implementing smart mobility, solutions to enhance the smart mobility initiative, and the future of KSRTC. To ensure accuracy and simplicity in responses, close-ended questions were employed, and respondents were prompted to utilize a Likert scale ranging from 1 to 5 (1- strongly disagree, 2- disagree, 3- neutral, 4- agree, and 5- strongly agree). The Likert scale offered a standardized framework for quantitative analysis of 10 collected responses, allowing for a nuanced understanding of customer perceptions regarding various aspects of KSRTC's smart mobility initiatives.

Research results and discussion

Concept of smart mobility in public transportation

Smart mobility, an integral component of smart cities, plays a central role in the comprehensive framework by utilizing technology and data to enhance transportation systems, promoting sustainability and accessibility, reducing

congestion, and optimizing public transportation through advanced technologies and connectivity, thereby revolutionizing urban spaces (Bielińska-Dusza, Hamerska and Żak, 2021). Enhancing mobility as a service involves integrating connected autonomous vehicles, flexible transport services, shared autonomous vehicles, and free-floating E-mobility within the framework of smart mobility, encompassing electric mobility, demand-responsive transport, intelligent transport systems, shared transport, and autonomous vehicles (Butler, Yigitcanlar and Paz, 2020). That is, employing smart mobility in transportation helps enhance efficiency, reduce congestion, and promote sustainability by integrating advanced technologies such as connected autonomous vehicles, flexible transport services, shared autonomous vehicles, and free-floating E-mobility.

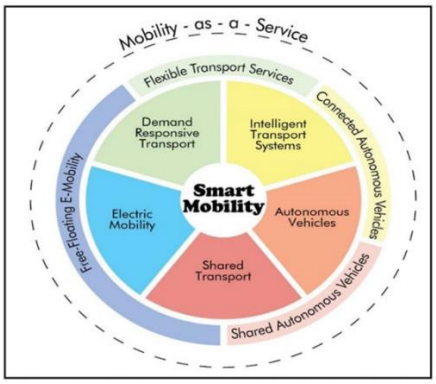

Fig. 1. Relationship between smart mobility methods (compiled by the author from Butler et al., 2020)

The performance of Kerala State Road Transportation Corporation (KSRTC)

The Kerala State Road Transport Corporation (KSRTC) has emerged as a commendable transportation organization, displaying impressive performance across various key performance indicators. Its commitment to providing efficient and widespread transportation services is evident through the extensive coverage it offers with 97 depots operating throughout the state (Kerala State Road Transportation, 2023). By strategically dividing the corporation into three divisions, KSRTC ensures effective management and operational efficiency, contributing to its overall success. The key statistics of KSRTC are mentioned below to understand the characteristics of KSRTC.

Table 1. Key statistics of KSRTC (Complied from KSRTC Website, 2023)

Network overview and capacity	Operational performance and financial data
Depots	97
Division	3
Vehicles	6241
Schedules	188
Daily scheduled service (km)	1422546
Routes	6389
Average passengers traveled by day (persons)	3.145 million
Average daily operating and non-operating income (crores/day)	6
Staffs	35002

Research result

A total of 10 responses from Google Forms are selected for the analysis of smart mobility in KSRTC. Google Forms were categorised into four themes and the analysis of the four themes are mentioned below.

Theme 1: Current State of KSRTC

In this theme, the Likert-scale analysis portrays a significant reliance on KSRTC for daily transportation needs, with concerns raised about punctuality and affordability. The majority of respondents rely on KSRTC, highlighting its significance in catering to daily commuting requirements. However, challenges are evident in punctuality and affordability, with perceived issues affecting the overall passenger experience.

Theme 2: Challenges of Implementing Smart Mobility in KSRTC

This theme delves into the perceived challenges of incorporating smart mobility in KSRTC. Respondents express a prevailing belief that KSRTC has not effectively implemented technological solutions, particularly in online ticketing and real-time information utilization. The findings underscore a need for improved technology integration to enhance public transportation services.

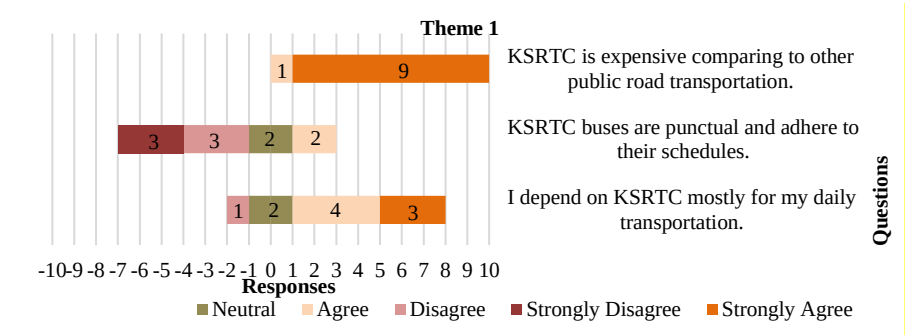

Fig. 2. Likert scale analysis of theme 1

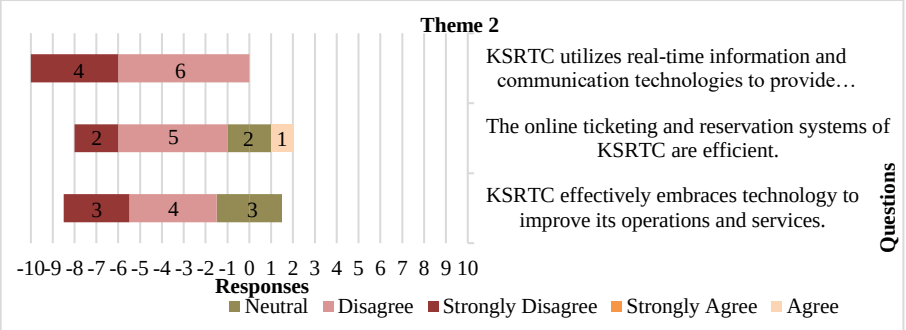

Fig. 3. Likert scale analysis of theme 2

Theme 3: Solutions for Implementing Smart Mobility in KSRTC

Here, the focus shifts to potential solutions for smart mobility implementation. Intelligent fleet management, mobile ticketing, and smart traffic management are suggested solutions, with varying degrees of customer agreement. Implementing these solutions is seen as crucial for enhancing overall efficiency and convenience in KSRTC.

Theme 4: Future of KSRTC

The final theme gauges customer opinions on the future of KSRTC. Recommendations to others are mixed, indicating areas for improvement. Environmental practices receive support, emphasizing the importance of sustainability. Adaptability to customer needs is acknowledged positively but highlights the necessity for KSRTC to enhance efficiency and meet evolving expectations for continued relevance. Overall, the theme underscores the need for addressing challenges and implementing forward-looking strategies for the sustained development of KSRTC.

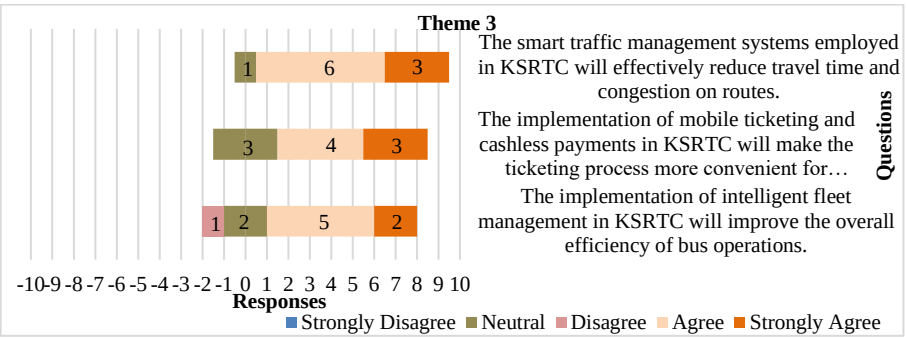

Fig. 4. Likert scale analysis of theme 3

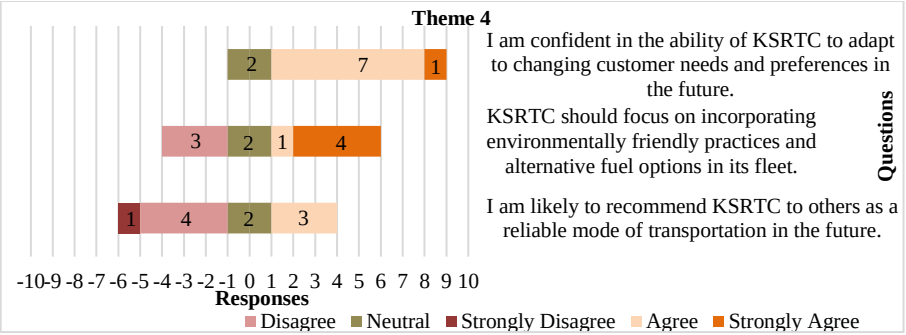

Fig. 5. Likert scale analysis of theme 4

Factors affecting the implementation of smart mobility in Indian public transportation

The implementation of smart mobility in Indian public transportation is a complex endeavor influenced by various factors that shape its trajectory and success. Understanding these factors is crucial for devising effective strategies and policies to foster the integration of smart mobility solutions. One of the foremost factors affecting the implementation of smart mobility in India is the existing infrastructure challenges (Garcia-Retuerta et al., 2021). The inadequacy of well-maintained roads, limited public transportation networks, and insufficient facilities for electric vehicles present substantial hurdles. Integrating smart mobility requires a robust infrastructure backbone, including charging stations for electric vehicles, high-speed internet connectivity, and smart traffic management systems. Addressing these infrastructure challenges is paramount for the successful adoption of smart mobility solutions. Affordability and accessibility are critical factors influencing the adoption of smart mobility in a diverse and economically stratified country like India (Hartawan et al., 2020). While the concept of smart mobility promises efficiency and convenience, the affordability of smart technologies, such as connected vehicles and intelligent transportation systems, poses a challenge. Ensuring that these solutions are accessible to a broader segment of the population, including economically disadvantaged communities, is essential for their widespread acceptance and impact. Cultural and behavioral factors play a significant role in the acceptance and usage of new technologies. India's diverse cultural landscape and the deeply ingrained habits related to transportation can impact the adoption of smart mobility. Encouraging a shift in mindset towards embracing shared mobility, electric vehicles, and digital platforms for transportation services requires targeted awareness campaigns and community engagement initiatives (Zhang et al., 2023).

The absence of a comprehensive regulatory framework tailored to smart mobility solutions hinders their effective implementation. Clear and supportive policies are essential to create an environment conducive to innovation and investment in the smart mobility sector (Hartawan et al., 2020). Policymakers must collaborate with industry stakeholders to establish guidelines that facilitate the integration of smart technologies while addressing safety, privacy, and ethical considerations. The level of technological readiness across different regions of India varies, posing a challenge to the uniform implementation of smart mobility solutions (Zhang et al., 2023). While urban centers may exhibit higher technological readiness, rural areas may lag. Bridging this technological divide is crucial to ensure that the benefits of smart mobility are extended to all citizens, irrespective of their geographic location. Smart mobility relies heavily on data collection, analysis, and connectivity. However, concerns regarding data security and privacy can impede the adoption of smart technologies (Garcia-Retuerta et al., 2021). Establishing robust data protection regulations and ensuring secure data handling practices are imperative to build trust among users and stakeholders. The integration of smart mobility solutions with existing public transportation systems poses a significant challenge. Coordinating and upgrading existing infrastructure and services to seamlessly incorporate smart technologies requires careful planning and execution. Compatibility issues, interoperability, and the need for retrofitting pose challenges that need to be addressed for successful integration.

Potential strategies for improving smart mobility in the case of KSRTC

India's public transportation system faces multifaceted challenges in implementing smart mobility, as highlighted in the empirical analysis focusing on the Kerala State Road Transport Corporation (KSRTC). The identified challenges include traditional operational frameworks, lack of awareness, deficient infrastructure, regulatory barriers, market competition, and affordability concerns. Effective solutions are essential to address these challenges and propel KSRTC towards a more efficient and competitive future in the dynamic landscape of smart mobility. To initiate a transformative shift towards smart mobility, KSRTC should develop a comprehensive development plan. The comprehensive development plan is essential for the smart mobility system to enhance the efficiency of public transportation (Zhang et al., 2023). This plan should focus on leveraging advanced technologies that enhance transportation services tailored to the specific needs of a diverse customer base. Investment in research and development is crucial to identify and implement innovative solutions that align with the unique operational context of KSRTC. This proactive approach ensures that the corporation stays ahead of the technological curve, providing efficient and tailored services to its customers.

Prioritizing and investing in advanced technologies form the core of smart mobility. Implementing Intelligent Transportation Systems, real-time tracking, data analytics, and user-friendly mobile applications can significantly improve service efficiency (Garcia-Retuerta et al., 2021). KSRTC should explore partnerships with technology providers, drawing inspiration from successful case studies in cities like Singapore and London. Collaborative efforts with established tech partners can accelerate the integration of cutting-edge solutions, placing KSRTC at the forefront of technological advancements in public transportation. Addressing the lack of awareness is pivotal for the successful implementation of smart mobility initiatives. KSRTC must launch comprehensive public awareness campaigns targeting both urban and rural populations. India is a country which has a significant distance between the urban and rural populations in development (Shamdasani, 2021). So, it is important to consider both urban and rural areas within India. These campaigns should highlight the benefits of smart mobility, encouraging increased usage and acceptance of new technologies. Emphasizing the advantages of cashless payments, mobile ticketing, and other smart transportation features through various communication channels can bridge the knowledge gap and foster greater public engagement.

KSRTC should actively seek collaborations with technology partners to leverage their expertise and resources for integrating intelligent fleet management, smart traffic management systems, and other innovative solutions (Garcia-Retuerta et al., 2021). Establishing long-term partnerships ensures ongoing technological support and updates, keeping KSRTC's systems at the cutting edge of innovation. Collaborative efforts with tech partners can enhance the corporation's technological capabilities and accelerate the implementation of smart mobility solutions. Advocacy for government support and funding is crucial to addressing infrastructure deficiencies hindering the seamless implementation of smart

mobility initiatives (Ponkshe and Pricing, 2020). KSRTC should collaborate with government agencies to align strategies and policies that promote sustainable and technologically advanced public transportation. A concerted effort with governmental bodies can result in the necessary financial and logistical support required for infrastructure upgrades, overcoming a significant barrier to smart mobility. Smart card accessibility poses challenges, particularly in catering to the diverse needs of both urban and rural populations. KSRTC should address these accessibility issues by developing inclusive solutions. Alternative payment methods and technologies that are more widely accessible should be considered to ensure that smart mobility benefits a broader segment of the population (Hartawan et al., 2020). By promoting inclusivity, KSRTC can enhance the reach and impact of its smart transportation initiatives. Establishing a robust monitoring and evaluation system is essential to track the effectiveness of implemented solutions. KSRTC should make data-driven adjustments as needed, ensuring continuous improvement and responsiveness to changing needs. Regularly soliciting feedback from both employees and customers creates a feedback loop that fosters a culture of continuous improvement (Neves, de Castro Neto and Aparicio, 2020). By consistently evaluating performance metrics, KSRTC can fine-tune its smart mobility initiatives for optimal efficiency and effectiveness.

Conclusions

1. The article outlines significant obstacles and possible solutions for improving smart mobility in India's public transport system, focusing on KSRTC. By examining the consequences of smart mobility inside KSRTC, it is clear that India needs to increase the scope of its smart mobility initiatives to improve the transportation industry more broadly.
2. The implementation of smart mobility in Indian public transportation is influenced by various factors, including: i) existing infrastructure challenges, ii) affordability, iii) accessibility, iv) cultural and behavioural factors, v) the absence of a comprehensive regulatory framework, vi) varying levels of technological readiness, vii) concerns regarding data security and privacy, and viii) challenges related to integration with existing public transportation systems.
3. To improve smart mobility in India's public transportation system, potential strategies include i) developing a comprehensive development plan enhancing advanced technologies, ii) investing in research and development, iii) prioritizing technologies such as Intelligent Transportation Systems, iv) launching comprehensive public awareness campaigns targeting both urban and rural populations, v) actively seeking collaborations with technology partners, vi) advocating for government support and vii) establishing a robust monitoring and evaluation system.

References

1. Berg, J., Ihlström, J. 2019. The importance of public transport for mobility and everyday activities among rural residents. *Social Sciences*, Vol. 8(2), 58.
2. Bielińska-Dusza, E., Hamerska, M., Żak, A. 2021. Sustainable mobility and the smart city: A vision of the city of the future: The case study of Cracow (Poland). *Energies*, Vol. 14(23), 7936.
3. Butler, L., Yigitcanlar, T., Paz, A. 2020. How can smart mobility innovations alleviate transportation disadvantage? Assembling a conceptual framework through a systematic review. *Applied Sciences*, Vol. 10(18), 6306.
4. Garcia-Retuerta, D., Chamoso, P., Hernández, G., Guzmán, A. S. R., Yigitcanlar, T., Corchado, J. M. 2021. An efficient management platform for developing smart cities: Solution for real-time and future crowd detection. *Electronics*, Vol. 10(7), 765.
5. Hartawan, M. S., Putra, A. S., Muktiono, A. 2020. Smart city concept for integrated citizen information smart card or ICISC in DKI Jakarta. *International Journal of Science, Technology & Management*, Vol. 1(4), p. 364-370.
6. Kerala State Road Transportation. 2023. Retrieved from https://www.keralartc.com/main.html
7. Kussl, S., Wald, A. 2023. Smart Mobility and its Implications for Road Infrastructure Provision: A Systematic Literature Review. *Sustainability*, Vol. 15(1), 210.
8. Neves, F. T., de Castro Neto, M., Aparicio, M. 2020. The impacts of open data initiatives on smart cities: A framework for evaluation and monitoring. *Cities*, Vol. 106, 102860.
9. Ponkshe, A., Pricing, C. 2020. Policymaking towards green mobility in India. *Transport*, Vol. 41(35.27), p. 30-49.
10. Randell-Moon, H. E. K., Hynes, D. 2022. 'Too smart': Infrastructuring the Internet through regional and rural smart policy in Australia. *Policy & Internet*, Vol. 14(1), p. 151-169.
11. Shamdasani, Y. 2021. Rural road infrastructure & agricultural production: Evidence from India. *Journal of Development Economics*, Vol. 152, 102686.
12. Zhang, J., Li, S., Wang, Y. 2023. Shaping a smart transportation system for sustainable value co-creation. *Information Systems Frontiers*, Vol. 25(1), p. 365-380.