Assessing the Role of Kochi Metro in Improving Public Transport Efficiency in Ernakulam

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DOI: https://doi.org/10.47772/IJRISS.2026.100500152

Received: 25 April 2026; Accepted: 01 May 2026; Published: 25 May 2026

ABSTRACT

This study examines the role of the Kochi Metro in improving public transport efficiency in Ernakulam, focusing on its impact on urban mobility, traffic conditions, and commuter behaviour. With rapid urbanization and increasing traffic congestion, the need for efficient and sustainable transportation systems has become critical. The research is based on both primary and secondary data, where primary data were collected from 302 respondents using structured questionnaires and online surveys, and secondary data were gathered from existing literature and reports. Statistical analysis, including ANOVA, was applied to evaluate variations in public perception. The findings reveal that the Kochi Metro has significantly improved travel convenience, safety, and overall transport efficiency, while its impact on reducing traffic congestion and dependence on private vehicles remains moderate. The study also indicates consistent satisfaction with ticketing systems and service quality among users, whereas perceptions of safety vary across different groups. Furthermore, differing opinions regarding future metro expansion highlight the need for better planning and communication. The study concludes that although the Kochi Metro enhances urban mobility, addressing issues such as last-mile connectivity, affordability, and awareness is essential to maximize its long-term effectiveness.

Keywords: Kochi Metro; Urban Transport Efficiency; Public Transportation; Urban Mobility; Infrastructure Development

INTRODUCTION

Urban transportation systems play a crucial role in supporting economic growth, improving mobility, and enhancing the quality of life in rapidly developing cities. Efficient public transport infrastructure reduces travel time, lowers transportation costs, and promotes sustainable urban development. In many growing metropolitan regions, metro rail systems have emerged as an effective strategy for addressing increasing traffic congestion, environmental concerns, and urban mobility challenges.

The city of Kochi in Kerala has experienced rapid economic and infrastructural growth over the past two decades. Major developments such as the expansion of Cochin International Airport, the growth of the IT hub at Kakkanad, and increasing commercial activities have significantly increased travel demand within the city. As a result, traffic congestion and transportation inefficiencies have become major challenges for urban mobility.

To address these challenges, Kochi Metro Rail Limited introduced the Kochi Metro in 2017 as a modern urban mass rapid transit system designed to improve connectivity between residential, commercial, and institutional areas while promoting environmentally sustainable transport. The system incorporates advanced signalling technology, integrated ticketing systems, and inclusive employment practices.

From a theoretical perspective, urban transport infrastructure contributes to economic productivity, improved accessibility, and sustainable urban development. Efficient transit systems encourage a shift from private vehicles to public transportation, thereby reducing congestion, fuel consumption, and environmental pollution. However, the effectiveness of metro systems also depends on factors such as commuter acceptance, service quality, accessibility, safety, and affordability.

This study therefore evaluates the impact of the Kochi Metro on public transport efficiency in Ernakulam by examining commuter perceptions, travel behavior, traffic conditions, and operational features of the metro system.

Significance Of the Study

The study's significance lies in providing valuable insights into whether the metro system effectively addresses traffic congestion in Kochi city. Understanding its impact can guide urban planners, policymakers, and stakeholders in making informed decisions regarding future transportation infrastructure development, potentially leading to more sustainable and efficient urban mobility solutions.

Statement of the Problem

Rapid urbanization in Kochi has resulted in increased traffic congestion, longer travel times, and higher environmental pollution. Despite the introduction of the Kochi Metro, concerns remain regarding its effectiveness in reducing congestion, improving accessibility, and influencing commuter behaviour. This study seeks to evaluate the overall impact of the metro system on public transport efficiency and identify key challenges affecting its performance.

Objectives

- To study how metro rail impacts the general public
- To study the effect of Metro on the traffic environment of the city.
- To analyse KMRL's forthcoming developments and offer suggestions for its advancement.
- To determine the most common way of ticketing payment.

LITERATURE REVIEW

Evolution of Metro in Kochi City

The metro in Kochi has been an impressive development. It began with planning and feasibility studies in the early 2000s, followed by the formation of Kochi Metro Rail Limited in 2011. Construction commenced in 2012, and the first phase, covering 13.4 km (about 8.33 mi), was inaugurated in 2017. Since then, expansions and improvements have continued, contributing to the city's transportation infrastructure and connectivity.

Literature Review

(**Singh**, **2020**) The study “India’s Shift from Mass Transit to Mobility as a Service (MaaS): Insights from Kochi” examines the city’s transition from traditional mass transit to a MaaS framework, integrating multiple transport modes into a unified, user-focused system. Focusing on post-Kochi Metro implementation, it highlights systemic changes such as regulatory restructuring, inclusion of informal transport services, and conflict management. Findings suggest that MaaS can enhance mobility management and service delivery, offering valuable lessons for other Indian cities pursuing integrated urban transport solutions.

(Shaheem, Shijil, & Sreelekshmi, 2022) The study by Shaheem, Shijil, and Sreelekshmi, titled “India’s Shift from Mass Transit to Mobility as a Service (MaaS): Insights from Kochi,” examines the city’s transition from traditional mass transit to a MaaS framework. The study focuses on post-Kochi Metro implementation and highlights systemic changes such as regulatory restructuring, inclusion of informal transport services, and conflict management. Findings suggest that MaaS can enhance mobility management and service delivery, offering valuable lessons for other Indian cities pursuing integrated urban transport solutions.

(P. & Wilson, 2020) The study *“Study on Critical Implementation Factors Influencing Kochi Metro Rail Project”* examines key factors affecting the progress and overall performance of the Kochi Metro Rail development. Set against rapid urbanization and growing travel demand in Kochi, the research identifies challenges such as project delays, coordination issues, resource allocation, and stakeholder influence. Using the

Relative Importance Index (RII) method, the study systematically prioritizes these factors, offering valuable insights for planners and policymakers involved in large-scale urban transport projects.

(Bhaskaran, Pappy, Rajeswaran, Suber, & Satheesh, 2023) A study by Bhaskaran, Pappy, Rajeswaran, Suber, and Satheesh examined strategies to optimize entry arrangements for increasing urban metro usage, focusing on the Kochi Metro and Vytila Mobility Hub. The study highlighted commuter hesitancy in adopting metro services and emphasized the need for targeted policy interventions. By analyzing fare structures and access strategies, it demonstrated how strategic measures can boost ridership and support sustainable urban mobility, providing key insights for urban transport planning and highlighting the importance of optimized entry arrangements in maximizing metro systems' contribution to urban development and connectivity.

(Sajeevan, E S, & Sunny, 2023) A study by Sajeevan E S and Sunny examined how the Kochi Metro addresses urban transportation challenges. It analyzed factors influencing commuter preference for metro travel, emphasizing the urgent need for efficient transport amid rapid population growth. The research highlights the project's focus on integration, sustainability, and innovation, demonstrating how strategic infrastructure initiatives can meet modern urban mobility needs and guide comprehensive, future-ready public transport planning in Kochi and similar cities.

(Winto, Chandran, Dilip, & Shyin, 2023) A study by Winto, Chandran, Dilip, and Shyin examined ways to improve accessibility in urban transit, focusing on the Kochi Metro. Using a survey of metro riders, the study assessed access to and from stations, developed an accessibility index, and proposed a mobile application to enhance commuter convenience. It highlighted challenges affecting commuter comfort and emphasized the role of land-use patterns, travel planning, and stakeholder engagement in creating more efficient, inclusive, and sustainable urban mobility.

(Rahim, Thomas, Baburajan, & Taleqani, 2022) A study by Rahim, Thomas, Baburajan, and Taleqani investigated factors influencing commuters' intentions to use metro services, focusing on the proposed Phase II of the Kochi Metro from JLN Stadium to Infopark. Using an ordered probit model, the study examined how attitudes, subjective norms, environmental factors, and commuter characteristics shape travel intentions. Key determinants included educational background, travel costs, and travel time. The research emphasizes incorporating these factors into predictive models to help planners and policymakers promote sustainable urban mobility.

(Kunnathully, 2021) The study examines commuter satisfaction with Kochi Metro Rail Ltd. (KMRL) and the factors influencing it. Conducted in Kochi, a densely populated city, the research highlights the need for efficient and reliable urban transport. Using a structured survey of 150 randomly selected residents, the study identifies key elements that affect commuter satisfaction and retention. Findings emphasize the importance of continuous evaluation and service improvement to enhance commuter experiences, making the metro a preferred mode of transport. The study provides valuable insights for KMRL to optimize its services and strengthen its role in Kochi's urban transportation network.

(Chathoth, 2024) The study "Perceived Discouragement of Metro Rail Transport in Enhancing Urban Mobility: A Study in Kochi" explored factors that deter potential users from adopting the Kochi Metro despite its benefits in reducing congestion and promoting cleaner transport. Surveys and interviews revealed positive perceptions, including improved traffic flow and environmental advantages, alongside barriers such as limited stations, inadequate feeder services, crowded trains, and higher ticket costs. The study recommends improving feeder networks, extending operating hours, increasing service frequency, and offering fare incentives to make the metro more accessible and attractive for daily commuters.

(Thomas & K, 2022) A study by Thomas and K examined the impact of the Kochi Metro on traffic and the environment. It explored how transportation infrastructure influences urban growth, showing that metro rail can reduce congestion and pollution. The study also highlighted challenges, such as increasing city-centre traffic and declining daily ridership, illustrating the complexity of urban transport issues. Overall, it provides valuable insights into the effectiveness of metro systems in improving mobility and promoting sustainable urban development in Kochi.

(. J., Tewari, & Bhagwat, 2021) The study "A Comparative Study of Perceptions of Safety in Metro Rail and Public Transport: The Case of Kochi" examined women commuters' safety perceptions across different public transport modes. Using an online survey, it found high incidences of perceived or experienced harassment, which influenced travel behaviour. Safety concerns varied by context—such as waiting areas, on-board travel, and night-time conditions—leading to behavioral changes like avoiding night travel, carrying protective items, or altering clothing. The study emphasizes that addressing safety is crucial for promoting equitable public transport use and reducing reliance on private vehicles.

RESEARCH METHODOLOGY

The study is based on both primary and secondary data. Primary data were collected from 302 respondents using structured questionnaires and online surveys. Secondary data were obtained from research articles, reports, and relevant publications.

A quantitative research approach was adopted to analyse the collected data. Statistical tools, including ANOVA, were used to identify variations in perceptions among different respondent groups.

Analysis and Interpretation

ANOVA

Table 1- Public Perception Toward Kochi Metro Phase I

ANOVA						
		Sum of Squares	df	Mean Square	F	Sig.
Would you be interested in volunteering or participating in awareness campaigns about Phase II?	Between Groups	2.490	4	.622	1.429	.224
	Within Groups	129.404	297	.436		
	Total	131.894	301			
What do you expect from metro stations in Phase II?	Between Groups	8.956	4	2.239	1.730	.143
	Within Groups	384.332	297	1.294		
	Total	393.288	301			
Do you believe Phase II will help in reducing pollution and fuel consumption?	Between Groups	3.676	4	.919	.727	.574
	Within Groups	375.556	297	1.264		
	Total	379.232	301			
How 2 do you think metro expansion to Kakkanad and Info park is for city development?	Between Groups	19.402	4	4.851	4.233	.002
	Within Groups	340.333	297	1.146		
	Total	359.735	301			
Are you 2 with the proposed station locations in Phase II (JLN Stadium to Infopark)?	Between Groups	7.636	4	1.909	1.699	.150
	Within Groups	333.742	297	1.124		
	Total	341.377	301			
Are you aware of the proposed Phase II expansion of the Kochi Metro?	Between Groups	3.927	4	.982	1.255	.288
	Within Groups	232.430	297	.783		
	Total	236.358	301			

Interpretation: The One-Way ANOVA test was conducted to determine whether significant differences exist among respondent groups regarding perceptions of Kochi Metro Phase II**.** The significance level was set at 0.05. The results show that most variables, including interest in awareness campaigns ($p = 0.224$), expectations regarding metro stations ($p = 0.143$), perceived environmental benefits ($p = 0.574$), support for proposed station locations ($p = 0.150$), and awareness of Phase II expansion ($p = 0.288$), do not show statistically significant differences among respondent groups ($p > 0.05$). This indicates that public perceptions toward these aspects are relatively consistent across different categories of respondents. However, a statistically significant difference was observed regarding perceptions of the metro expansion to Kakkanad and Infopark and its impact on city development ($p = 0.002$). This suggests that respondents hold differing views about the developmental implications of the expansion. Overall, the findings indicate that while most perceptions of Kochi Metro Phase

II remain uniform across groups, opinions regarding its role in urban development vary significantly. These results are consistent with (Saleh, Tithi, Sakib, Paul, Anwari, & Amin, 2023) who found that while general perceptions of transit expansion projects are broadly uniform across demographic groups, differences often emerge regarding economic and developmental impacts, reflecting varied priorities and concerns among respondents.

Table 2- Public Perception of Traffic Flow and Congestion Impact of Kochi Metro

ANOVA						
		Sum of Squares	df	Mean Square	F	Sig.
Do you believe the kochi metro has improved overall traffic flow in the city?	Between Groups	2.631	4	.658	.745	.562
	Within Groups	262.111	297	.883		
	Total	264.742	301			
Have you observed reduction in road congestion since the introduction of the Kochi metro?	Between Groups	4.199	4	1.050	.968	.426
	Within Groups	322.264	297	1.085		
	Total	326.464	301			

Interpretation: ANOVA results show that there are no significant differences among respondent groups regarding perceptions of traffic improvement and congestion reduction following the introduction of the Kochi Metro. Respondents held similar views on overall traffic flow improvements ($p = 0.562$, $F = 0.745$) and reduction in road congestion ($p = 0.426$), indicating minimal variation between groups. These findings suggest that the metro's impact on traffic conditions is perceived consistently across different categories of users, whether considered moderate, limited, or effective. These results are consistent with (Baum-Snow, Kahn, & Voith, 2005) who also observed that the introduction of urban transit systems tends to produce broadly similar perceptions of traffic improvement among diverse groups of city residents.

Table 3- Commuter Behaviour and Travel Pattern Changes After the Introduction of Kochi Metro.

ANOVA						
		Sum of Squares	df	Mean Square	F	Sig.
Have you personally shifted from using private vehicle to Kochi metro for travelling?	Between Groups	.010	1	.010	.009	.926
	Within Groups	340.100	300	1.134		
	Total	340.109	301			
How often do you use the kochi metro?	Between Groups	1.028	1	1.028	1.469	.226
	Within Groups	209.847	300	.699		
	Total	210.874	301			
Has the introduction of Kochi metro reduced your dependency on private vehicles for commuting?	Between Groups	.026	1	.026	.024	.877
	Within Groups	320.309	300	1.068		
	Total	320.334	301			
How has the Kochi metro affected your travel time during peak hours?	Between Groups	.878	1	.878	.739	.391
	Within Groups	356.410	300	1.188		
	Total	357.288	301			
Has the introduction of the Kochi metro influenced your decision to use public transportation more frequently?	Between Groups	.690	1	.690	.636	.426
	Within Groups	325.773	300	1.086		
	Total	326.464	301			

Interpretation: ANOVA analysis shows that the introduction of the Kochi Metro has influenced commuting behaviour in a generally uniform manner across respondent groups. There were no statistically significant differences in shifts from private vehicles ($p = 0.926$), frequency of metro usage ($p = 0.226$), reduction in private vehicle dependency ($p = 0.877$), perceptions of peak-hour travel time ($p = 0.391$), or encouragement of public transport use ($p = 0.426$). These results indicate that while the metro provides a viable alternative to private transport and promotes public transit, its behavioural impact—including changes in travel patterns and reliance on private vehicles—is relatively consistent across demographic categories, with minimal variation between groups. These results are in line with the study by (Cervero & Murakami, 2010) who also found that the

introduction of rapid transit systems generally produces similar commuting behaviour changes across different demographic groups, without significant variation in modal shift patterns.

Table 4- Ticketing Preferences and Smart Card Usage Experience in Kochi Metro

ANOVA						
		Sum of Squares	df	Mean Square	F	Sig.
Which type of pass or ticket do you use most frequently when travelling on metro?	Between Groups	1.604	1	1.604	1.529	.217
	Within Groups	314.756	300	1.049		
	Total	316.361	301			
What mode of ticketing do you primarily use while travelling on Kochi metro?	Between Groups	3.284	1	3.284	2.032	.155
	Within Groups	484.809	300	1.616		
	Total	488.093	301			
How would you rate the process of purchasing and recharging smart card or ticket at Kochi metro station?	Between Groups	.727	1	.727	.655	.419
	Within Groups	332.641	300	1.109		
	Total	333.368	301			
Have you faced any technical issues with smartcards, machines, or gates?	Between Groups	.041	1	.041	.043	.836
	Within Groups	283.314	300	.944		
	Total	283.354	301			

Interpretation: ANOVA analysis indicates that there are no statistically significant differences among respondent groups regarding ticketing preferences and smart card experiences in the Kochi Metro. No significant differences were found for the type of pass or ticket used most frequently ($p = 0.217$), mode of ticketing such as smart card or QR ticket ($p = 0.155$), rating of the purchasing and recharging process ($p = 0.419$), or experience of technical issues with smart cards or machines ($p = 0.836$). These results suggest that ticketing preferences, usability perceptions, and technical experiences are largely consistent across user groups, reflecting operational stability and widespread familiarity with the metro's ticketing system. This finding is consistent with (Blythe, 2004) who also noted that user experiences with standardized service systems tend to be uniform across different demographic and user categories.

Table 5- Safety Perception, Facilities, Communication, and Leisure Usage of Kochi Metro

ANOVA						
		Sum of Squares	df	Mean Square	F	Sig.
How safe and secure do you feel while traveling on Kochi metro trains and stations?	Between Groups	9.125	1	9.125	8.850	.003
	Within Groups	309.338	300	1.031		
	Total	318.464	301			
How are you with the parking facilities in metro stations?	Between Groups	.338	1	.338	.297	.586
	Within Groups	340.550	300	1.135		
	Total	340.887	301			
Are the announcements and signage in the stations/train clear and understandable?	Between Groups	.289	1	.289	.283	.595
	Within Groups	306.016	300	1.020		
	Total	306.305	301			
Would you be interested in using Kochi Metro for weekend leisure travel or tourism?	Between Groups	.668	1	.668	.614	.434
	Within Groups	326.432	300	1.088		
	Total	327.099	301			

Interpretation: A One-Way ANOVA test was conducted to examine whether significant differences exist among respondent groups regarding perceptions of safety, facilities, communication clarity, and leisure usage of the Kochi Metro. The significance level was set at 0.05. The results indicate a statistically significant difference in perceptions of safety and security while traveling ($p = 0.003 < 0.05$), suggesting that respondents differ in their feelings of safety when using the metro system. However, no statistically significant differences were observed in satisfaction with parking facilities ($p = 0.586$), clarity of announcements and signage ($p = 0.595$), or interest in using the metro for leisure or tourism purposes ($p = 0.434$), as all p-values are greater than 0.05. These

findings indicate that while safety perceptions vary among respondents, other operational aspects of the metro system are perceived relatively uniformly across different groups. This aligns with the study of (Owen & Levinson, 2015) who also reported that perceptions of transit safety significantly varied by demographic characteristics, while satisfaction with service information and general amenities tended to be more consistent among different rider groups.

CONCLUSION

Most service quality variables—such as facilities, announcements, and ticketing experience—showed no significant differences, indicating generally uniform positive perceptions among respondents. Safety and security perception was the only variable with a significant difference, suggesting that some groups feel less secure and highlighting the need for targeted safety improvements. Perceptions of traffic flow improvement, congestion reduction, dependence on private vehicles, and peak-hour travel time showed no significant differences, implying that while the Kochi Metro contributes to urban mobility, its impact on congestion is moderate and gradual across groups. Opinions on most upcoming projects were also similar; however, the expansion to Kakkanad and Infopark showed significant differences in perception, indicating a need for improved public communication, engagement, and awareness programs. Ticketing variables—including pass type, mode, smart card usage, and technical issues—showed no significant differences, suggesting that the ticketing system is efficient, widely adopted, and provides a consistent experience for all users.

FINDINGS

- The ANOVA results show that respondents across different groups have largely similar perceptions of Kochi Metro Phase II regarding awareness, environmental benefits, station expectations, volunteering interest, and support for proposed locations, with no statistically significant differences ($p > 0.05$). However, a significant difference ($p = 0.002$) was observed in perceptions of the metro expansion to Kakkanad and Infopark, indicating varying opinions among groups about its developmental impact on the city.
- The ANOVA findings show that there are no statistically significant differences among respondent groups regarding whether the Kochi Metro has improved overall traffic flow ($p = 0.562$) or reduced road congestion ($p = 0.426$), indicating that perceptions about its impact on city traffic conditions are largely uniform across all groups.
- The ANOVA results indicate that there are no statistically significant differences among respondent groups regarding behavioural changes after the introduction of the Kochi Metro (all p-values > 0.05), showing that shifts from private vehicles, frequency of metro usage, reduction in dependency on private transport, changes in peak-hour travel time, and increased public transport use are perceived similarly across all groups.
- The ANOVA results reveal that there are no statistically significant differences among respondent groups regarding ticket type preference ($p = 0.217$), mode of ticketing ($p = 0.155$), satisfaction with the purchasing and recharging process ($p = 0.419$), or experience of technical issues ($p = 0.836$), indicating that the ticketing system of the Kochi Metro is perceived and used uniformly across different user groups.
- The ANOVA findings show that perceptions of safety and security while traveling on the Kochi Metro differ significantly among respondent groups ($p = 0.003$), indicating varying levels of comfort across categories; however, perceptions regarding parking facilities ($p = 0.586$), clarity of announcements and signage ($p = 0.595$), and interest in weekend leisure use ($p = 0.434$) do not significantly differ, suggesting uniform opinions on these operational aspects.

CONCLUSION

This study evaluated the role of the Kochi Metro in enhancing public transport efficiency in Ernakulam by examining its impact on commuters, city traffic, upcoming developments, and ticketing systems. Findings show that the metro has a generally positive and consistent effect across different commuter groups, with uniform perceptions of service quality, usage patterns, behavioural changes, and ticketing convenience. While the shift

from private vehicles is not statistically significant, the metro is widely seen as a reliable and organized transport option. Its contribution to improved traffic flow and reduced congestion is recognized, though the effects are considered gradual rather than dramatic.

The study also provides insights on future expansion and operational efficiency of the Kochi Metro. While service-related aspects receive broad agreement, opinions vary regarding the developmental impact of Phase II toward Kakkanad and Infopark, reflecting different expectations about economic growth and urban development. Smart cards and digital payments are widely used and seen as convenient, demonstrating technological efficiency and system reliability. Overall, the findings confirm that Kochi Metro significantly strengthens public transport in Ernakulam, and with targeted improvements in safety, public communication, and integrated planning, its long-term contribution to sustainable urban mobility can be further enhanced.

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