

ORIGINAL RESEARCH PAPER

Gridlock gloom: A geographical analysis of commuters' perceptions on traffic congestion

A. Mukherjee^{1,2*}, A.K.M. Anwaruzzaman¹

¹ Department of Geography, Aliah University, Kolkata, India

² Department of Education, St. Xavier's College (Autonomous), Kolkata, India

ARTICLE INFO

Article History:

Received 20 February 2024

Revised 09 May 2024

Accepted 30 May 2024

Keywords:

Commuters

Kolkata Municipal Corporation

Garrett score

Relative Importance index

Traffic congestion

Travel time

ABSTRACT

BACKGROUND AND OBJECTIVES: One of the most challenging aspects of city living is traffic congestion. The multitude of vehicular modes and their sheer volume coupled with inadequate road infrastructure unable to keep up with the escalated travel demand of Kolkata is a major cause of concern. Recognizing the significant toll on commuters' time and health, the research aims to identify the root causes of congestion across fifteen selected Traffic Intersection Points, explore its multifaceted impacts on the environment, economy, and society, and propose solutions to alleviate this pressing issue effectively.

METHODS: This study employed a mixed-method approach. An on-site survey with 375 regular commuters in Kolkata was conducted, utilizing questionnaires and focus group discussions. The survey gathered data on travel patterns, socio-demographic information, and perceptions of traffic congestion. The Garrett Ranking method and Relative Importance Index (RII) were employed to evaluate the significance of various contributing factors, their impact on commuters, and potential solutions. Statistical analysis using Microsoft Excel and SPSS 26 complemented the data analysis, with cartographic visualizations providing spatial insights. Additionally, the Wilcoxon Signed-Rank Test validated the differences in travel times during congested and free-flowing traffic conditions.

FINDINGS: The results revealed that the commuters' average daily travel delay owing to congestion is approximately 17 minutes. Utilizing Garrett score ratings, the most significant obstacles to smooth traffic flow were identified as intersectional conflicts (66.19) and curbside parking (64.75). Following the same methodology, increased reliance on personalized vehicles (69.87) and encroached road space (64.3) were attributed to rush hour saturation, whereas political rallies (71.36) and demonstrations (59.74) contributed to unprecedented incidents. Work schedule disruptions and hearing anomalies were the most common offshoots of this hazard. Relative Importance Index (RII) scores highlighted the consensus among commuters emphasizing the economic, environmental, and social impact of congestion, with particular emphasis on enhanced fuel consumption (RII=1), decreased economic opportunities (RII=0.96), worsened pollution levels (RII=0.91), and reduced family time (RII=0.93). Congestion pricing (RII=0.88) and ride-sharing (RII=0.87) emerged as the most viable strategies to mitigate congestion. Furthermore, Garrett ratings indicated training of drivers (63.74) and road users (61.03) along with parking management (63.51) to be the most desired areas of improvisation suggested.

CONCLUSION: Implementing the 'Avoid, Shift, Improve' framework in conjunction with a 'people-first' mentality would encourage sustainable urban living by placing a premium on public transport, land use planning, and technological improvements to reduce traffic

DOI: [10.22034/IJHCUM.2024.04.05](https://doi.org/10.22034/IJHCUM.2024.04.05) congestion and enhance commuter well-being in Kolkata.



NUMBER OF REFERENCES

30



NUMBER OF FIGURES

12



NUMBER OF TABLES

8

*Corresponding Author:

Email: aratrika@sxccal.edu

Phone: +919836211776

ORCID: [0000-0003-1821-929X](https://orcid.org/0000-0003-1821-929X)

Note: Discussion period for this manuscript open until January 1, 2025 on IJHCUM website at the "Show Article."

INTRODUCTION

Transportation has historically functioned as a crucial intermediary, nurturing seamless connections between disparate regions and enabling the efficient flow of goods (Janic, 2017). Effective transport networks significantly enhance accessibility for individuals, promoting their interaction with various land-use activities within specified zones (Falcocchio & Levinson, 2015; Afrin & Yodo, 2020). However, the escalating demand for transportation services, spurred by the pervasive global urbanization trend, has led to an increasingly complex urban transportation landscape. The sheer volume and diversity of traffic flows, involving both resident and transient populations, pose significant challenges (Chakraborty & Gupta, 2015). The rapid growth of private vehicle ownership, rising population densities, and sometimes suboptimal management of public transportation infrastructure have created a scenario of constrained urban mobility (Rao & Rao, 2012). One of the most critical manifestations of these challenges is urban traffic congestion, a permeating issue that significantly disrupts urban life (Ali & Faraz, 2013). As traffic volume increases, each additional vehicle progressively hinders the movement of others, ultimately surpassing the maximum capacity of the roadway, and triggering congestion (OECD, 2007). Therefore, congestion can be defined as a temporal phenomenon characterized by an excess of vehicles attempting to utilize a route beyond its capacity to accommodate them, to maintain an acceptable service level Bull, 2003 (Bull, 2003; Rothenberg, 1985). In contrast to periods of lower demand, this discrepancy between the system's capacity and the transportation demand resulted in a pronounced increase in travel times (Ortzar & Willumsen, 2011; Bates *et al.*, 2001). Consequently, congestion not only elevates travel costs and man-hour losses but also harbors significant adverse implications for commuters' physical and psychological well-being, causing stress, frustration, and even health risks (Higgins *et al.*, 2017). Furthermore, inadequate road signage, encroachment by informal vendors, and inefficient traffic management exacerbate these issues. Within the context of mixed traffic comprising motorized and non-motorized means, particularly prevalent in developing countries, maneuverability is often compromised. This compromised maneuverability

triggers a domino effect of adverse environmental impacts including enhanced fuel consumption, heightened emissions of air pollutants, and amplified noise pollution, all of which contribute to escalating environmental costs (Fattah *et al.*, 2022). These combined socioeconomic and environmental impacts, threaten commuters' overall well-being in almost all metropolitan cities. The case of Kolkata, situated on the River Hooghly's eastern bank, exemplifying these challenges, is no exception. It is India's third-most populous metropolis and accommodates approximately 4,496,694 people (Chandramouli & General, 2011). The city's unplanned development expanding over an area of 206.08 square kilometers, poses formidable logistical challenges for the Kolkata Municipal Corporation (KMC), with traffic management being a key area of concern. The Ola Hyperdrive 2019 infographics, as reported by the Times of India in 2020, elucidate discernible differentials in the average traffic speed across India's principal urban centers, directly correlating it with the experienced congestion levels. Hyderabad emerges as the pre-eminent city in terms of traffic fluidity, boasting an average speed of 24.5 kilometers per hour (kmph), succeeded closely by Chennai (23.1 kmph) and Delhi (23.5 kmph). Mumbai and Bengaluru follow suit with relatively lower average speeds of 22.7 kmph and 21.2 kmph, respectively, while Kolkata exhibits the most sluggish pace of 19.4 kmph. Factors like infrastructure, population density, and urban planning initiatives may likely be attributed to such speed differences. With 21,825 people per square kilometer, Kolkata has a higher propensity to exacerbate its traffic woes in comparison to National Capital (7435 people per square kilometer), Bengaluru (11933 people per square kilometer), or Chennai (10,906 people per square kilometer). Besides, the intricate mix of transportation modes, ranging from modern automobiles to traditional hand-pulled rickshaws, operating within a limited road space of 7 percent of the total area, creates severe congestion (Pucher *et al.*, 2005). This phenomenon has its roots in the booming market of Light Motor Vehicles (LMV) within the city. Of particular note is the substantial density of cars (LMVs) in Kolkata, which is quantified at 432 cars per kilometer according to a 2022 report by the Times of India. This figure typifies how their proliferation contributes to the dynamics of congestion, even

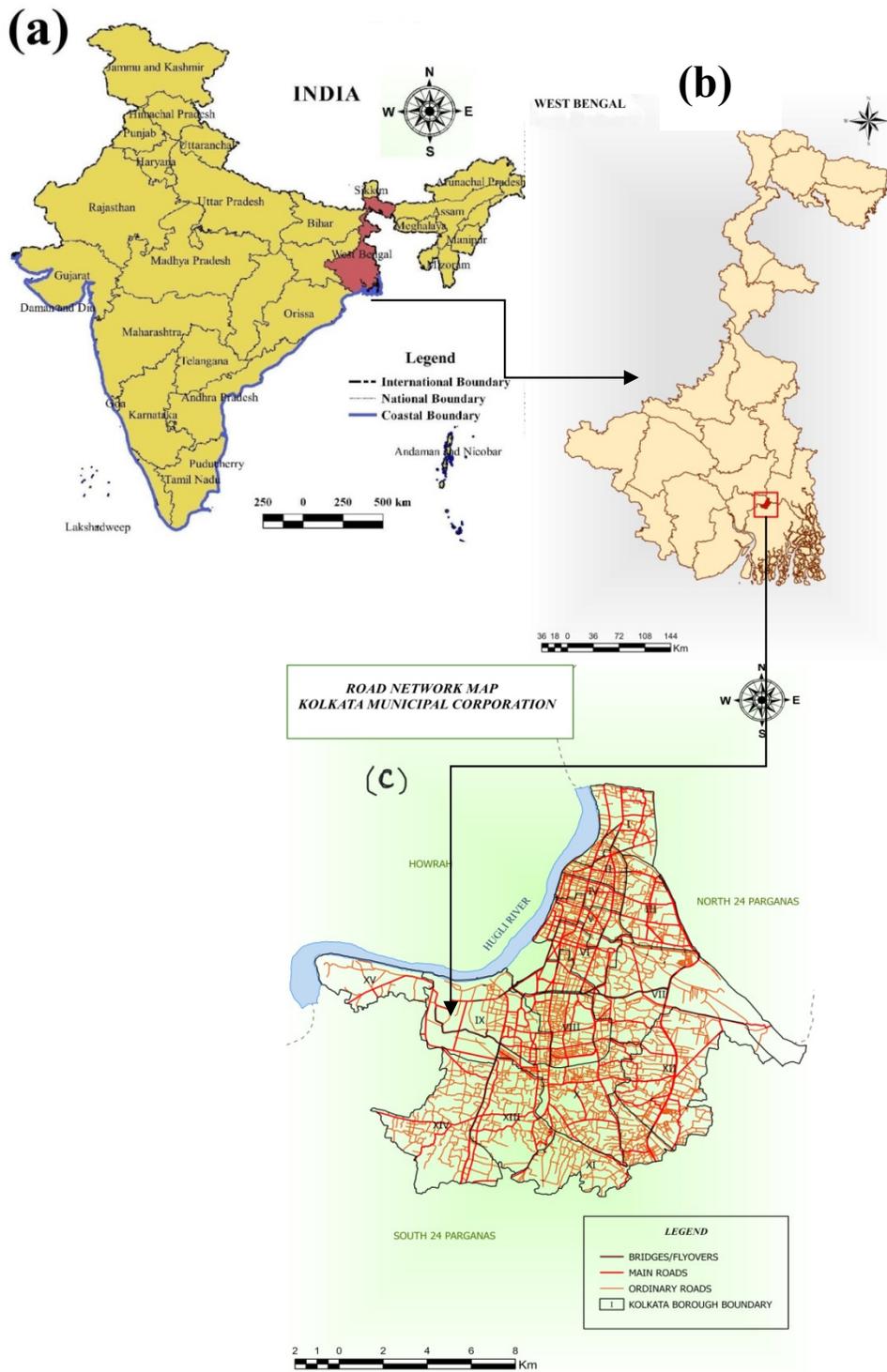


Fig. 1: Geographic location of the study area: a) India b) West Bengal c) Kolkata Municipal Corporation

surpassing Bengaluru (210 cars per kilometer). An exceptionally high vehicular density of 2448 vehicles per square kilometer, was reported by The Economic Times, in August 2023. Additionally, studies by the transport department, cited by the Times of India in 2021, indicate that the use of nearly 24 percent to 38 percent of carriageways for parking has plummeted the average traffic speed by 25 percent. The recorded average vehicular speed was 18.7 km/hr in 2022 and was considered to be the slowest of all 154 Indian cities studied by the National Bureau of Economic Research (Akbar, P. *et al.*, 2023). An analysis conducted by Mint on 300 arterial roads across six major metropolitan cities in 2019 further revealed that a 10-kilometer commute in Kolkata takes approximately 39 minutes, a 63% increase over the national average of 24 minutes. This extended commute time is a direct consequence of reduced vehicular speed on major roadways, with commuters experiencing an average daily delay of 15 minutes. These significant delays contribute to elevated fuel consumption and heightened stress levels among those commuting. The absence of rigorous research investigating commuters' perspectives on the multifaceted causes of congestion, and its subsequent socioeconomic impacts, hinders policymakers' efforts to develop effective mitigation strategies in Kolkata. This knowledge gap presents a significant obstacle to sustainable urban development, as unchecked traffic congestion has the potential to paralyze the municipal transportation system (Singh, S.K., 2012). Hence, understanding public perceptions and preferences is crucial for designing initiatives that resonate with commuters and encourage behavioral shifts toward congestion-reducing practices. By exploring commuter perceptions in two key domains—first, on nature and causes of traffic congestion along Kolkata's main roads—and second, assessing how congestion impacts commuters' time use, and overall being, the study attempts to fill the existing gap. Therefore the primary goal of this study is to learn more about commuters' perceptions on the prevailing causes and social-economic impacts of traffic congestion along the city's major thoroughfares. Addressing traffic congestion is essential to protect both environmental sustainability and the well-being of urban populations (Bigazzi & Clifton, 2015). Hence, by grasping commuter preferences and understanding the socioeconomic ramifications of congestion, this

research has the potential to shape policy development, offering evidence-based recommendations for initiatives that align with commuters' needs and priorities. It seeks to enrich the existing research by investigating the interplay of socioeconomic and psychological factors influencing commuters' receptiveness to congestion-alleviation measures. Through the analysis of these intricate dynamics, the research aims to provide practical recommendations and empirical understanding that can be extrapolated to similar congested urban environments fostering collaboration and knowledge exchange within the global urban planning community. Overall, in response to the critical challenge of traffic congestion, this study aims to comprehensively examine the relative importance of the key factors identified in causing and exacerbating traffic by employing ranking methodologies and statistical analysis to quantify the influence of each factor. In addition, drawing on the findings of the preceding analyses, the study tends to propose a set of actionable strategies geared towards alleviating this pressing issue and paving the way for a more efficient and sustainable urban transportation system. To achieve these objectives, an on-site research survey was conducted along the three most significant road stretches under the upkeep of Kolkata Municipal Corporation—namely Acharya Jagadish Chandra Bose Road (AJC Bose Road) and its continuation as Acharya Prafulla Chandra Road (APC Road), Central Avenue continuing till DeshapranSasmal Road passing through intermediary stretches of Ashutosh Mukherjee Road and Shyama Prasad Mukherjee Road and Eastern Metropolitan Bypass Corridor. Fifteen Traffic Intersection Points (TIPs) were strategically chosen (Fig. 2) from the aforementioned stretches for an in-depth analysis of commuter perspectives. The data collection period spanned from October 10, 2022, to December 20, 2022. The details of the TIPs (Table 1) are as follows:

MATERIALS AND METHODS

Data collection and survey design

This study delves into the complexities of traffic congestion in Kolkata, examining commuter perspectives on the challenges they face. To explore the complexities underlying urban gridlock in Kolkata and capture commuter narratives, this study employed a structured survey approach. The study focused on

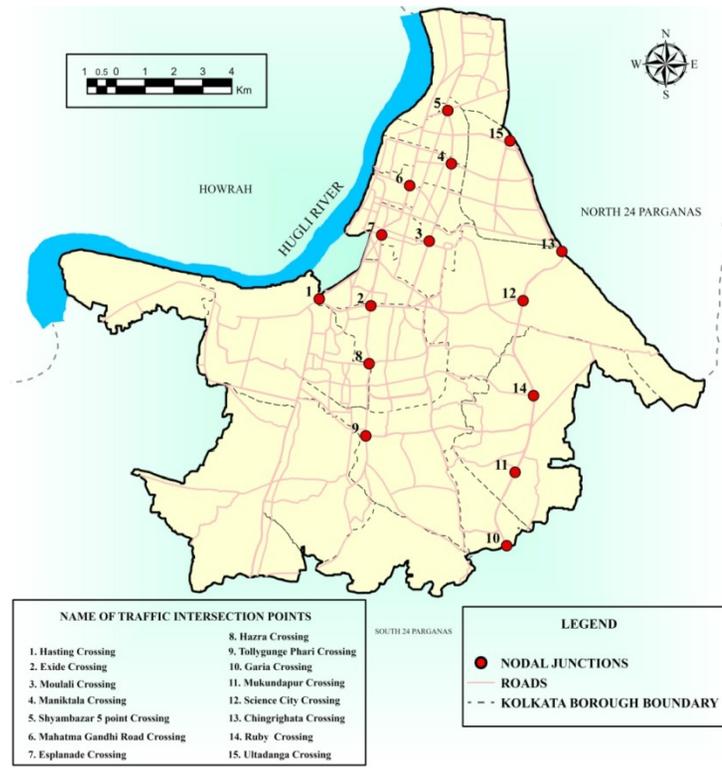


Fig.2: Location of the TIPs in the study area

Table 1: Details of the selected TIPs in KMC

Sl. no.	Nodes or names of the TIPs (Crossings)	Latitude	Longitude	Ward Number	Borough Number
1	Hastings Crossing	22°32'38" N	88°19'48" E	75	9
2	Chowringhee/Exide Crossing	22°32'30"N	88°20'50"E	63	7
3	Moulali Crossing	22°33'41"N	88°22'2"E	53	5
4	Maniktala Crossing	22°35'7"N	88°22'29"E	32	3
5	Shyambazar5 point Crossing	22°35'54"N	88°22'15"E	11	2
6	Mahatma Gandhi Road Crossing	22°34'43"N	88°21'38"E	23	4
7	Esplanade Crossing	22°33'48"N	88°21'4"E	46	6
8	Hazra Crossing	22°31'25"N	88°20'47"E	83	8
9	Tollygunge Phari Crossing	22°30'5"N	88°20'42"E	89	10
10	Garia Crossing	22°28'1"N	88°23'32"E	110	11
11	Mukundapur Crossing	22°29'23"N	88°23'43"E	109	12
12	Science City Crossing	22°32'34"N	88°23'55"E	64	7
13	Chingrighata Crossing	22°33'28"N	88°24'42"E	57	7
14	Ruby Crossing	22°30'48"N	88°24'6"E	107	12
15	Ultadanga Crossing	22°35'38"N	88°23'9"E	13	3

regular commuters who traversed the 15 identified TIPs for at least a year. A bilingual (English and Bengali) questionnaire was administered to a sample of 375 respondents (25 per junction) across three major thoroughfares. Purposive random sampling was employed to ensure the sample reflected a

diverse range of commuters using these intersections. Recognizing potential literacy variations, the survey was conducted as face-to-face interviews with diverse commuter groups. Before the interviews, participants were provided with a clear explanation of the study's overall purpose. Additionally, clear definitions were

offered for any technical terms or specific language used within the questionnaire. This ensured informed participation and the provision of accurate responses. The interviews explored commuters' understanding of the nature and causes of congestion and analyzed the consequences of congestion on their well-being in KMC. The selection of Kolkata (Figs. 1 and 2) as a research area on traffic congestion stems from its unique confluence of historical, infrastructural, and social factors that contribute to the problem. Rapid urbanization has outpaced the capacity of the city's colonial-era transportation infrastructure, resulting in Kolkata becoming one of the slowest cities globally in terms of traffic speed. Its ranking as sixth among the world's ten foremost slow cities, as divulged in 'Kolkata Now' in October 2023, speaks volumes about the daily struggles encountered by the commuters. Hence, to fulfill the objectives, a comprehensive understanding of commuter travel patterns and their responses to congested roads is crucial. By analyzing these factors, the study aims to illuminate the underlying causes and consequences of gridlock within KMC. Additionally, this knowledge would serve as a vital foundation for policymakers, encouraging them to develop targeted interventions to ensure better design and effective implementation of solutions to reduce traffic congestion.

Analytical framework

Data from each interview was organized in Microsoft Excel and subsequently imported into SPSS 26 for analysis. Based on their personal experiences, the respondents ranked factors contributing to the varying nature of congestion, perceived threats associated with congestion, and consequent perils affecting their well-being due to prolonged exposure. Descriptive statistics were employed to summarize the data using frequency and percentage distributions. Additionally, the Garrett Ranking Technique, a quantitative method, was utilized to analyze the rankings. This technique, developed by Henry Garrett in 1969, calculates a percentage score for each item based on individual rankings. The formula for calculating the percentage score is as stated below (Eq. 1)

$$\text{Percentage Score} = \frac{100(R_{ij} - 0.05)}{N_j}, \quad (1)$$

Where, R_{ij} = Rank of i^{th} item by the j^{th} individual,

and N_j = a number of items Ranked by a j^{th} individual. Building upon the data obtained from commuter rankings, the research utilized Garrett's Ranking Technique to convert the percentage positions into numerical scores from Garrett's Table (Garrett & Woodworth, 1973). For each factor contributing to congestion, perceived threats, and individual consequences, participants' scores were summed and averaged. Consequently, factors with higher average scores were deemed to hold greater significance allowing identification of the most critical issues associated with traffic congestion in Kolkata. Following the same ranking approach, participants were presented with various mitigation strategies from different bibliographic sources, deemed valuable by researchers and potentially significant to commuters. Utilizing the same formula as in the previous analysis, the score values helped to determine the areas of highest priority for addressing congestion-related concerns. To delve deeper into the analysis, the Likert Scale (Likert, 1961) was employed to allow respondents to rank the importance of both the perceived repercussions of congestion and the proposed mitigation strategies. Responses were collected on a 5-point scale, ranging from "Strongly Disagree" to "Strongly Agree" for assessing the severity of congestion effects, and "Very Helpful" to "Not at all helpful" for evaluating the suitability of proposed solutions. This ordinal data (ranked data) was then used to calculate ratios and the Relative Importance Index (RII) facilitating further analysis by quantifying the relative importance assigned to different factors (Sambasivan and Soon, 2007; Olojedeet al., 2017). The formulae for which is as follows (Eq.2)

$$\text{RII} = \frac{\sum W}{A * N}, \quad (2)$$

Where W = weights as assigned on the Likert scale by each respondent in a range from 1 to 5, A = Highest weight (here it is 5), and N = Total number in the sample. To assess the impact of congestion on travel times and to statistically determine whether travel times during Free-Flow (FF) and Congested Flow (CF) differed significantly, the Wilcoxon Signed-Rank Test for matched pairs was employed. This non-parametric test was chosen as it was suitable for analyzing paired data (travel times under different conditions for the same individuals), set at a significance level

Table 2: Socio-demographic profile of sample commuters in KMC (computed by the authors based on sample design)

Categories	Groups	No. of sample Respondents (n)	Percent of sample Respondents
Gender	Male	234	62.4
	Female	141	37.6
Age group (Years)	15-29	109	29.1
	30-44	152	40.5
	45-59	89	23.7
	60-74	25	6.7
Levels of Education	Primary	3	0.80
	Upper Primary	17	4.5
	Secondary	38	10.1
	Higher Secondary	60	16
	UG	149	39.7
	PG	98	26.1
	Ph.D	10	2.7
Income (INR)	≤25,000	206	54.9
	25001– 50,000	89	23.7
	50,001– 75,000	46	12.3
	75,001– 100,000	24	6.4
	Above 100,000	10	2.7

of 0.01 and offered an efficient alternative to the inapplicable t-test (Bagabaldoet al., 2017).

RESULTS AND DISCUSSION

Brief profile of sample respondents

This study delves into the socio-economic and demographic characteristics of 375 commuters in KMC, aiming to identify variations in their travel patterns and experiences. The analysis provides a nuanced understanding of the intricate relationship between socioeconomic factors and travel behavior. By dissecting these subtleties, the research enables a comprehensive analysis of the challenges faced by daily commuters, offering valuable insights for ensuing analysis.

The data (Table 2) reveals a well-dispersed sample across age groups (15-74 years) with gender distribution skewed towards males (62.4%). The highest representation is observed in the age group of 30-44 (40.53 percent) suggesting a focus on working professionals, followed by the other age groups of 15-29 years, 45-59 years, and 60-74 years. In terms of attainment of education, a significant portion of the commuters hold undergraduate degrees (26.33 percent), followed by those having higher secondary and postgraduate degrees (16.83 percent and 16 percent). Intriguingly, the income distribution highlighted a heterogeneous socio-economic spectrum where most respondents (54.9%)

earned less than 25,000 INR, followed by a gradual decrease in frequency with rising income brackets. The inclusion of commuters across diverse socio-economic backgrounds ensured a comprehensive analysis.

Travel characteristics

While exploring the travel characteristics of the commuters in KMC, diverse aspects of their daily transportation routines were revealed. Factors like modal preferences, average trip frequency, distance covered, and the time lost during commuting provided an extensive picture. With a mean value of 3.7 and a standard deviation of 1.59 (Table 3), the average daily trip frequency found among the sampled commuters stipulated moderate variability of travel patterns. This variation is likely linked to factors like lifestyles, employment patterns, and access to transportation. The mean value suggests that, on average, individuals in Kolkata make approximately 4 trips per day. Interestingly, gender disparities emerge, with men exhibiting a higher average trip frequency (3.99) compared to women (3.22), which could be attributed to occupational differences or job patterns influencing mobility needs.

A significant finding in Table 4 was respondents earning less than 25,000 INR (36 percent) tend to make fewer trips (average 2 trips), potentially due to financial constraints limiting non-essential travel.

Commuters' perceptions of traffic congestion

Table 3: Details of travel characteristics of the respondents

Travel Characteristics	n	Minimum	Maximum	Mean	Std. Deviation
Daily Average Trip Frequency	375	1	6	3.70 (4)	1.589
Average Distance traveled (kilometers)	375	2.0	22.0	7.683	3.9090
Average time lost (minutes)	375	3	40	16.41	6.492

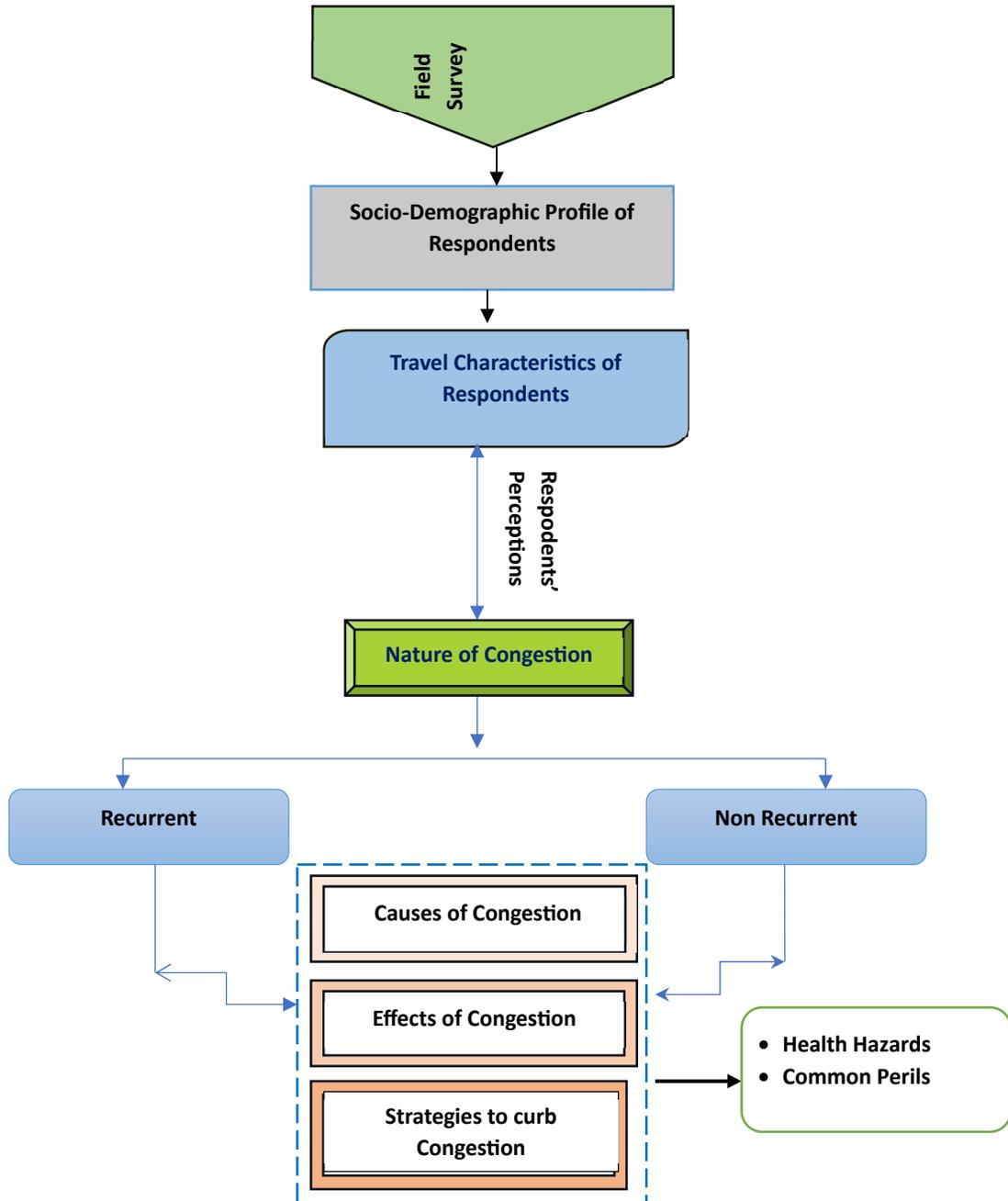


Fig. 3: Methodological flowchart

Conversely, higher income groups particularly those earning between 25000-49999 INR (37 percent) and 50000- 74999 INR (39 percent) exhibit a higher average trip frequency (average 4 trips) with significant portions falling into the 4-trip and 6-trip categories, suggesting greater travel flexibility.

An analysis of commuting distances revealed a significant variation among respondents in Table 3, with distances ranging from a mere 2 kilometers to a substantial 22 kilometers. The average distance traveled, at 7.68 kilometers, indicates a moderate commute for most respondents. Given the time and effort required to traverse longer distances, it became imperative to investigate the reciprocal relationship between the distances traveled and average trip frequency. Within an average distance of 10 kilometers travel, the lion's share of commuters (104 out of 139) undertook only 2 trips per day whereas people commuting between the range of 2 to 4 times a day exhibit a more varied distribution throughout several distance categories, with a significant fraction (103 out of 142) covering within 5-15 kilometers. Commuters who travel more frequently (4-6 trips) typically cover shorter distances (within 5 kilometers), which could exacerbate traffic congestion in places with high population densities,

whereas, those traveling beyond 20 kilometers find it difficult to take up more than 2 trips in a day. These findings are consistent with the notion of a free-flow traffic scenario, where fewer obstacles along the way result in reduced travel time, enabling commuters to reach their destinations more quickly (Maparu & Pandit, 2010). In the context of KMC, traffic flow often reaches saturation levels, leading to recurrent congestion, particularly during morning and evening rush hours, posing a major problem. The disparity in travel time between commuting under free flow conditions and congested flow conditions ranges from 3 to 40 minutes, with an average loss of 16.41 minutes and a standard deviation of 6.492 (Table 3). To analyze the paired observations of travel time in FF and CF conditions, the Wilcoxon Signed Rank Test was employed. This non-parametric test was deemed more appropriate due to the unmet assumptions of normality in the paired observations. The test yielded a highly significant p-value of 0.000, based on 375 matched sample observations, providing compelling evidence against the null hypothesis. The practical consequences of the results obtained from the Test highlight a statistically significant difference in trip times under the two flow conditions (FF and CF conditions). This was presented by the test statistic of

Table 4: Cross tabulation results between income groups to daily average trip frequency (computed by the authors)

			Daily average trip frequency					Total
			1	2	4	5	6	
Income groups (INR)	<25000	Count	14	60	84	0	48	206
		% within Income groups	6.8%	29.1%	40.8%	0.0%	23.3%	100.0%
		% of Total	3.7%	16.0%	22.4%	0.0%	12.8%	54.9%
	25000-49999	Count	0	33	33	4	19	89
		% within Income groups	0.0%	37.1%	37.1%	4.5%	21.3%	100.0%
		% of Total	0.0%	8.8%	8.8%	1.1%	5.1%	23.7%
	50000-74999	Count	0	9	18	4	15	46
		% within Income groups	0.0%	19.6%	39.1%	8.7%	32.6%	100.0%
		% of Total	0.0%	2.4%	4.8%	1.1%	4.0%	12.3%
	75000-99999	Count	0	20	0	0	4	24
		% within Income groups	0.0%	83.3%	0.0%	0.0%	16.7%	100.0%
		% of Total	0.0%	5.3%	0.0%	0.0%	1.1%	6.4%
	>99999	Count	0	3	7	0	0	10
		% within Income groups	0.0%	30.0%	70.0%	0.0%	0.0%	100.0%
		% of Total	0.0%	0.8%	1.9%	0.0%	0.0%	2.7%
Total		Count	14	125	142	8	86	375
		% within Income groups	3.7%	33.3%	37.9%	2.1%	22.9%	100.0%
		% of Total	3.7%	33.3%	37.9%	2.1%	22.9%	100.0%

70500 and the standardized test statistic of 16.894, derived by dividing the test statistic by the standard error (2086.502). It is interesting to note (Table 5) that, across all road conditions, the majority of respondents (34.7%) reported a loss of 10 and 19 minutes of travel time while commuting, followed by another 32% reporting a loss between 20 and 29 minutes. The data unmistakably shows a significant degree of variation in commuter travel times, influenced by factors such as the condition of roadways, transit choices, and infrastructure quality. The variations in the frequency of trips, travel distances, and the amount of time lost are a reflection of the reduced speed profile of the major thoroughfares of the city. This demonstrates the intricacy of the transportation network and its interplay in understanding the dynamics of traffic congestion.

Since the efficiency and caliber of road infrastructure greatly influence the flow of vehicles, the condition of roads emerges as a significant aspect to be considered. Analysis of surveyed commuters' opinions regarding the sampled road segments leading to selected TIPs within Kolkata reveals pertinent insights (Fig. 4). A substantial portion of

responses revealed that the majority of roads were either classified as 'Mixed' (35.20 percent) or 'Uneven or Bumpy' (30.13 percent). Together, these two make up 65.33 percent of the total, suggesting a significant proportion of the condition of the roads is to be believed subpar in their optimal levels of utilization and maintenance. Thus, the prevalence of slower-moving traffic inescapably raises the possibility of traffic jams. The fact that 19.20 percent of the commuters opined the roads to be 'full of potholes' insinuated an increased likelihood of road accidents and further deterioration of road infrastructure quality endorsing the intricate relationship between road condition, traffic congestion, and road safety in Kolkata.

Interestingly in Table 6, a substantial portion of sampled commuters comprising 9.3 percent and 14.4% of the sampled commuters, commuting between 5 to 10 kilometers, and within 5 kilometers, respectively, experienced uneven or bumpy roadways. Mixed road conditions, on the other hand, were reported to be encountered by 7.7%, 21.3%, and 35.2% of the commuters undertaking journeys for less than 5 kilometers distance, within 5–10 kilometers

Table 5: Cross tabulation results between the condition of the road to daily average journey time lost (minutes) (computed by the authors)

Condition of Road			Time lost in minutes (average)					Total
			<10	10-19	20-29	30-39	40-49	
Bumpy	Count		14	37	51	8	3	113
	% of Total		3.7%	9.9%	13.6%	2.1%	0.8%	30.1%
Mixed	Count		47	43	39	3	0	132
	% of Total		12.5%	11.5%	10.4%	0.8%	0.0%	35.2%
Pot-hole riddled	Count		25	25	22	0	0	72
	% of Total		6.7%	6.7%	5.9%	0.0%	0.0%	19.2%
Smooth	Count		17	25	8	8	0	58
	% of Total		4.5%	6.7%	2.1%	2.1%	0.0%	15.5%
Total	Count		103	130	120	19	3	375
	% of Total		27.5%	34.7%	32.0%	5.1%	0.8%	100.0%

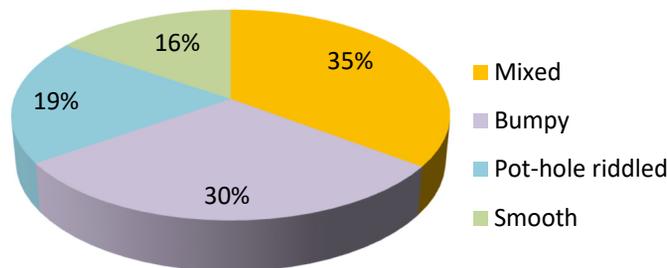


Fig.4: Condition of roads as perceived by commuters'(2022) (Source: Prepared by the authors based on field survey data, October-December, 2022)

Table 6: Cross-tabulation results between the condition of the road and to daily average journey time lost (minutes) (computed by the authors)

		Distance travelled in kilometers (average)					Total	
		<5	5-0.99	10-14.99	15-19.99	≥20		
Condition of Road	Bumpy	Count	35	54	12	12	0	113
		% of Total	9.3%	14.4%	3.2%	3.2%	0.0%	30.1%
	Mixed	Count	29	80	19	4	0	132
		% of Total	7.7%	21.3%	5.1%	1.1%	0.0%	35.2%
	Pot-hole riddled	Count	21	42	4	0	5	72
		% of Total	5.6%	11.2%	1.1%	0.0%	1.3%	19.2%
	Smooth	Count	18	36	4	0	0	58
		% of Total	4.8%	9.6%	1.1%	0.0%	0.0%	15.5%
Total		Count	103	212	39	16	5	375
		% of Total	27.5%	56.5%	10.4%	4.3%	1.3%	100.0%

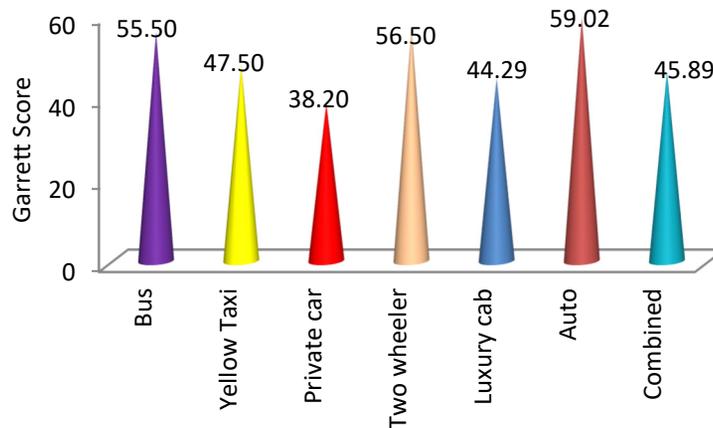


Fig. 5: Preferred daily mode of conveyance by commuters (2022) (Prepared by the authors based on field survey data, October-December, 2022)

and 10–15 kilometers distance respectively. The state of the roads not only affected the average trip distance but also significantly affected the amount of time lost when commuting. Due to different road conditions, the majority of respondents (35.2%) lost time, indicating a considerable level of discomfort. A time range between 10 to 19 minutes was cited to be wasted by the respondents (18%) traveling through mixed (11.2%), pothole-ridden (6.7%), and bumpy (9.9%) road conditions. Individuals navigating through these uneven road surfaces (13.6 percent) experienced a varied range of time losses, with the highest incidence occurring within the 20-29-minute timeframe. The mixed road conditions (10.4 percent), within the same timeframe, followed closely. Pothole-filled roads were a frequent occurrence for commuters (5.6%) covering fewer than 5 kilometers, which greatly increased their journey times. Conversely, smoother facilitated comparatively faster

travel times. Within the major TIPs of the KMC area, commuter mobility preferences and behaviors and mobility preferences are greatly influenced by the complex interaction between their income levels and the form of transportation they choose. The Garrett ratings (Eq. 1), which are allocated to each mode of transport and represent commuters favored or preferred daily means of conveyance, reflect this preference for various modes of travel (Fig. 5). With a Garrett score of 59.02, auto-rickshaws were the mode with the highest score among the others, followed by two-wheelers (56.5) and buses (55.5). This suggests that people have a noticeable preference for smaller, more agile auto-rickshaws, especially in crowded settings. Buses, despite being extensively used, face challenges in providing satisfactory services in coherence with increased demand and restricted maneuverability, thereby contributing to congestion. Nearly 27% of commuters with incomes below

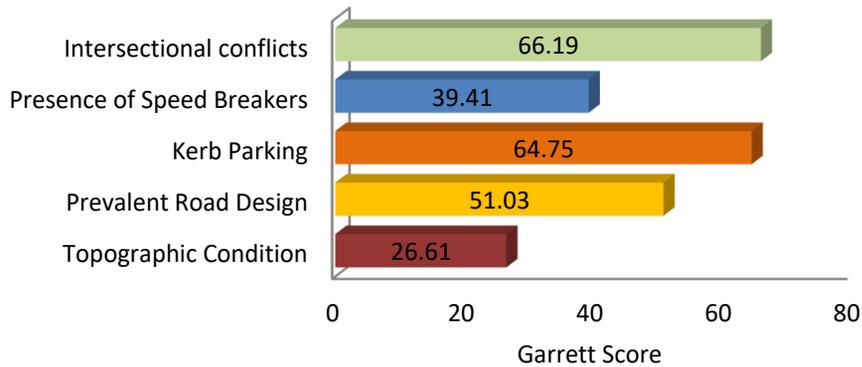


Fig. 6: Commuters' perception of dominant barriers affecting smooth traffic flow (2022) (Prepared by the authors based on field survey data, October-December, 2022)

50,000 INR and nearly 29percent of commuters with incomes below 25,000 INR select two-wheelers as their major mode of transportation for daily travel. For commuters in the same economic brackets, auto rickshaws appear to be the most convenient mode of transportation after buses. Depending on the financial situation, luxury taxis and private vehicles receive substantially lower Garrett ratings of 38.20 and 44.29 as mean scores, respectively, from the commuters, suggesting a lower degree of desire when traveling daily.

Rising travel demand necessitates an expansion of KMC's road infrastructure to accommodate the growing number of vehicles (Chakraborty, 2018). With the second-highest automobile ownership rate in India (61 cars per 1,000 residents), KMC experiences slower motorized traffic flow on major thoroughfares. The high density of automobiles has contributed to a chaotic mix of motorized and non-motorized transportation modes in the streetscape. An analysis of commuter perceptions on key barriers to TIPs along KMC's major road corridors reveals a clear hierarchy of hindrances (Fig. 6). The most significant barrier, with a mean Garrett score of 66.19 is intersectional conflicts, reinforcing the substantial impact of high total vehicular flow on the carrying capacity of the road. curb parking (64.75), acknowledging the detrimental effects of on-street parking on vehicle mobility follows next. Moreover, prevalent road design, with a mean score of 51.03, exhibits the adverse consequences of the haphazard development of city thoroughfares rooted

in colonial history, serving as a significant contributor to impediments in smooth vehicular flow. While the presence of speed breakers (ranked fourth with a score of 39.41) and topographic conditions (ranked fifth with a score of 26.61) are perceived as lesser obstacles, their impact on traffic flow can by no means be disregarded.

Causes of congestion

Traffic congestion, recurrent or non-recurrent, in KMC, arises from a complex interplay of factors that collectively impede the smooth flow of vehicular movement. Recurrent congestion, typically associated with rush hour commutes (8:30 AM - 11:00 AM and 4:30 PM - 7:30 PM), is primarily driven by an increase in the number of vehicles on the road that tends to obstruct the way of one another using the same road space at the same time. Non-recurrent congestion, on the other hand, involves less predictable, sporadic events such as car malfunctions, collisions, erratic behavior of individual drivers, road construction, adverse weather conditions, protests, and large gatherings that temporarily disrupt traffic flow and diminish road capacity (Falcocchio & Levinson, 2015; Chakraborty & Gupta, 2014). The commuter opinion poll results, (Fig. 7) demonstrated interesting trends about the factors contributing to this kind of phenomenon. Notably, the proliferation of personalized vehicles emerges as the most significant factor for recurrent congestion, as evidenced by its highest mean score (69.87). Both male (37%) and female (20%) commuters concur on its paramount

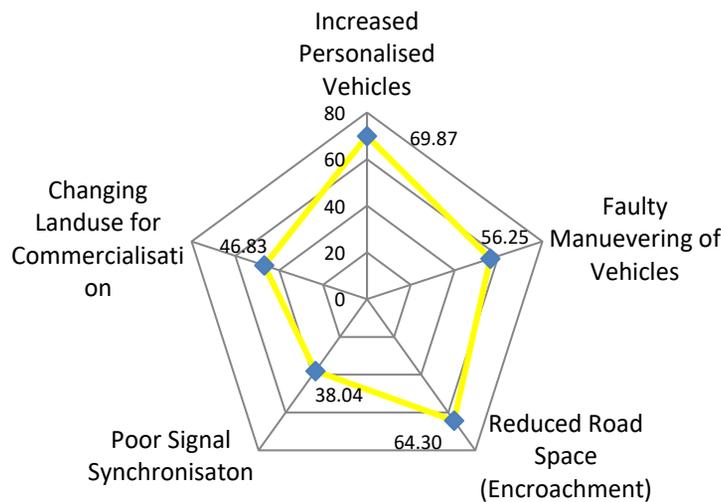


fig. 7: Commuters' perception of major factors leading to recurrent congestion (2022) (Prepared by the authors based on field survey data, October-December, 2022)

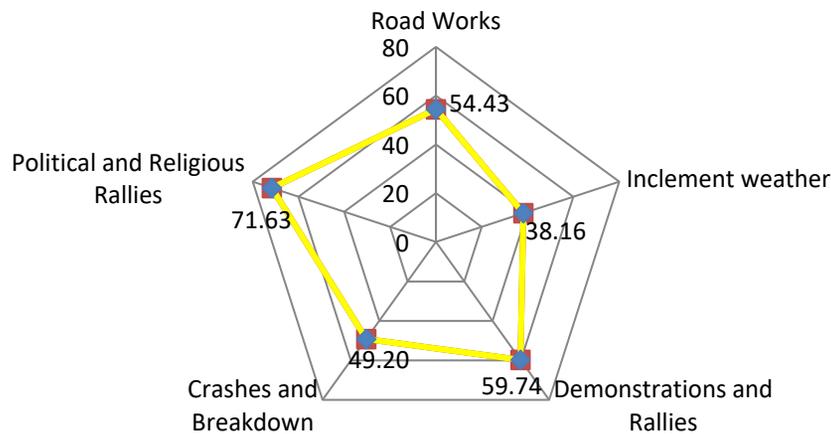


Fig. 8: Commuters' perception of major factors leading to non-recurrent congestion (2022) (Prepared by the authors based on field survey data, October-December,2022)

importance highlighting its significant effect on congestion. Limited road space due to encroachment by vendors and street hawkers (mean score 64.30) emerged as the second most concerning issue. Improper vehicle maneuvering (mean score 56.25) trailed by poor traffic signal synchronization (mean score 46.83), and land-use changes for commercial purposes (mean score 38.04) were perceived as additional contributors of recurrent congestion reflecting the multidimensional nature of their perceptions.

While comprehending the causes of irregular or

non-recurrent traffic congestion (Fig. 8) political and religious protests emerged as the most disruptive factor with the highest mean score, (71.63). This was closely followed by demonstrations and rallies (59.74). Road construction (54.43) collisions/breakdowns (49.20), and inclement weather (38.1) were ranked as third, fourth, and fifth, contributing factors respectively.

Commuters in Kolkata face a complex web of factors contributing to traffic congestion. Heavy traffic volumes, inadequate public transport options, and a strong preference for personal vehicles,

Table 7: RII on effects of congestion on commuters' perception (computed by the authors)

sl. no.	Major effects of congestion	RII score
1	Excess fuel consumption by car	1.00
2	Hinders availing opportunities	0.96
3	Reduces time spent with family	0.93
4	Enhances noise pollution	0.93
5	Wastes individuals' productive capacity	0.92
6	Enhances air pollution	0.89
7	Causes tension and sweating to reach a destination	0.87
8	Combative temperament and behavior	0.82
9	Restrains building social relationships	0.81
10	Impatient behavior on the road	0.80
11	Causes headaches and physical discomfort	0.73
12	Cause a sense of suffocation	0.68
13	Enhances the risk of accidents	0.65

particularly two-wheelers, all play a significant role in creating gridlock. The elevated Garrett score provides a quantitative measure of congestion severity. As the commuters navigate these challenges in the bustling urban environments, the ramifications of traffic congestion on their daily lives become readily apparent. Extended travel times, increased fuel consumption and heightened levels of stress and fatigue are all tangible consequences of disorderly traffic conditions (Ajayi & Olawole, 2018).

Effects of congestion

To understand the relative severity of various consequences arising from traffic congestion in Kolkata, a Relative Importance Index (RII) as indicated by Eq. 2 was employed. The results (Table 7) shed light on the significant implications perceived by commuters. Excess fuel consumption emerged as the most impactful consequence, with an RII score of 1.00. The stop-and-start nature of congested traffic significantly increases fuel consumption. Furthermore, prolonged idling and inefficient engine operation contribute to heightened levels of air and noise pollution, as evidenced by the high RII scores of 0.89 and 0.93, respectively. The upshots of congestion extend far beyond detrimental environmental impacts. Commuters highlighted a significant decrease in their ability to capitalize on various opportunities due to congestion, reflected in the high RII score of 0.96 for hindrance to availing opportunities. This unrealized potential leads to a decline or waste in individual productivity, underlined by the RII of 0.92. Additionally, the adverse psychological and social impacts of congestion

surfaced, with notably high mean scores assigned to reduced family time (0.93) and its consequential impact on creating social bonds (RII=0.81) suggesting a hindrance to social interaction. Impatience and irritable behavior (RII=0.82), emerged as significant repercussions both within family dynamics and on the road. The rush to reach destinations, leading to heightened tension and perspiration (RII=0.87), physical discomfort, including headaches (RII=0.73), and at times, an increased risk of accidents (RII=0.65), were also identified as significant health risks associated with congestion. The multi-faceted and interconnected nature of the effects of congestion, as mirrored through the findings emphasizes the urgent need for holistic and integrated approaches to address the problems stemming from urban traffic congestion in Kolkata.

A rigorous analysis was undertaken to explore the health hazards and safety risks associated with traffic congestion in Kolkata, both of which are considered integral aspects of the broader consequences experienced by commuters. This analysis aimed to rank these concerns based on their perceived severity from the commuters' perspective.

Common associated perils

Through Garrett ratings, the common hazards associated with TIPs are further substantiated by their causative elements (Fig. 9). The assessment pinpointed several serious risks that commuters plying through these junctions experience. The most impactful consequence, with a mean score of 71.49, is work schedule disruption. emphasizing its detrimental impact on individuals' productivity.

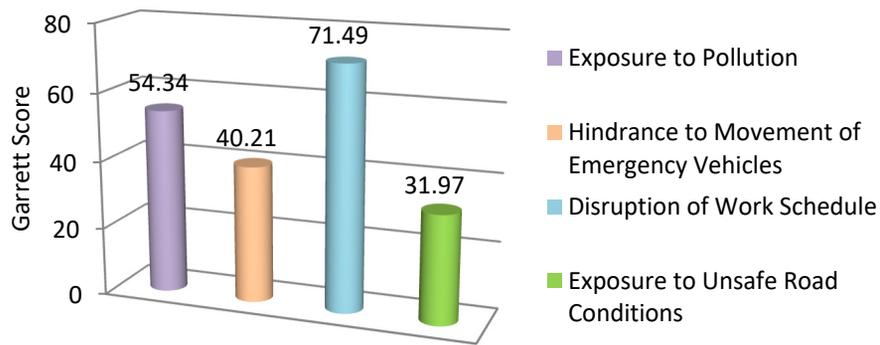


Fig. 9: Commuters' perception of common perils associated with traffic congestion (2022) (Source: Prepared by the authors based on field survey data, October-December, 2022)

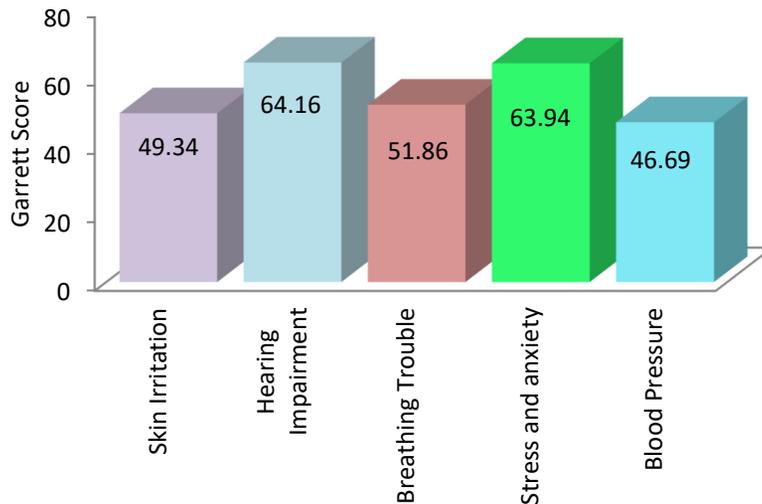


Fig. 10: Commuters' perception of common health hazards resulting from traffic congestion (2022) (Prepared by the authors based on field survey data, October-December, 2022)

Following closely and ranked second is the concern about exposure to pollution, reflected in a mean score of 54.34. This advocates a major concern for both deteriorating air quality and noise pollution caused by unrestrained honking. The hindrance to movement of emergency vehicles, scoring 40.21 was ranked third emphasizing the critical importance of maintaining efficient traffic flow to ensure prompt emergency response. Lastly, with a score of 31.97, exposure to hazardous road conditions may be linked to an increased likelihood of accidents, anxiety about reaching one's destination on time, increased fuel consumption by vehicles, and physical discomfort.

Health hazards

Commuters traversing crowded corridors face a spectrum of health risks (Anciaeset al., 2017). An analysis of perceived health hazards, utilizing Garrett scores, revealed a distinct hierarchy of concerns (Fig. 10). Topping the list with a mean score of 64.16 is hearing emerged as the most prominent health concern indicating a severe impact of traffic-related noise on commuters' well-being. Stress and anxiety come in second, with a mean score of 63.94, speaking volumes about the adverse mental health implications that congestion has on commuters' lives, at times, inhibiting the growth of social bonds and family

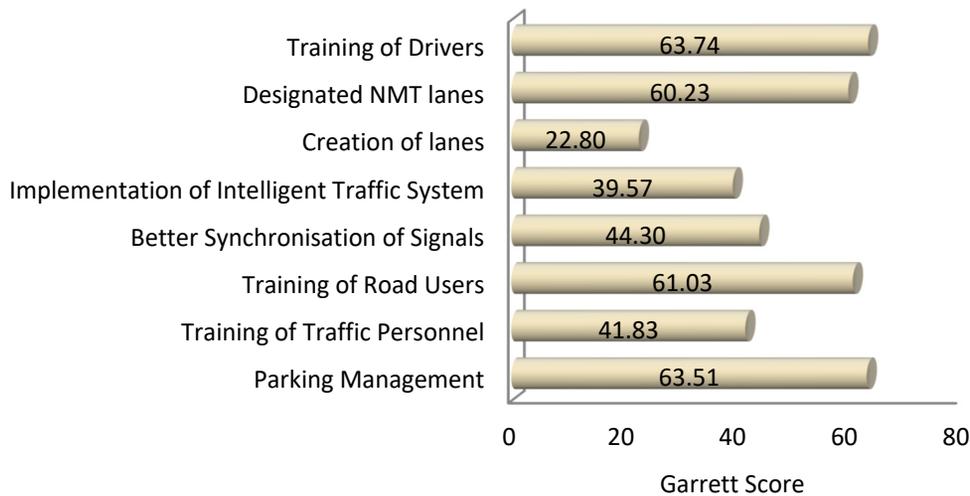


Fig. 11: Suggested areas of improvisation by commuters (2022) (Prepared by the authors based on field survey data, October-December, 2022)

ties. Breathing trouble and skin irritation with mean scores of 51.86 and 49.34 trials as third and fourth-ranked issues of health concern respectively. This hints towards prolonged exposure to environmental toxins and pollutants.

The cross-tabulation reveals distinct patterns in the relationship between health hazards and age concerning traffic congestion in Kolkata Municipal Corporation. Across various age groups, different health concerns emerge as predominant. Primarily, the threat of hearing anomaly looms large among commuters across all other age groups in nearly similar proportions (approximately 45 percent). For example, people between the ages of 15 and 29 are more susceptible to hearing impairment (47.7 percent) and stress and anxiety (45.9 percent) indicating that congestion has a substantial effect on their auditory and mental health. Meanwhile, those aged between 30-44 years are more prone to blood pressure issues, indicating a potential physiological response to the stressors associated with commuting. A wide age range seems to be affected by respiratory issues, with peaks seen in those between the ages of 15 to 29 and 45 to 59, suggesting a widespread risk to respiratory health at various phases of adulthood. Additionally, skin irritation is notable among commuters aged 30-44, potentially linked to prolonged exposure to environmental pollutants.

Recommended areas of improvisation and viable strategies

This more complex view of the perceived effects of congestion offers chances for focused interventions meant to improve overall passenger well-being while traveling across these vital intersections (Orru *et al.*, 2016). As prioritization of areas for improvement is crucial an analysis of the ranking of these areas would reveal insights into designing viable strategies as calculated by Garrett scores (Fig. 11). Foremost, with a mean score of 63.74, enhancing driver training emerges as a critical intervention, emphasizing the imperative of improving drivers' awareness and abilities to promote safe and effective traffic management. Parking management comes next, with a mean score of 63.51, favoring the importance of practical parking solutions at these crossings. Furthermore, with mean scores of 61.03 and 60.23, the introduction of road user education and the creation of lanes dedicated to Transportation (NMT) ranked third and fourth, respectively, indicating the necessity of improved infrastructure to guarantee the safety of pedestrians and cyclists. Subsequently, measures such as better signal synchronization (mean score 44.03), specialized training for traffic personnel (mean score 41.83), and the implementation of advanced traffic systems (mean score 39.57) were identified as areas for improvement. It's plausible

Table 8: Relative Importance Index on strategies to curb congestion by commuters' perception (computed by the authors)

Sl. no.	Strategies to curb congestion	RII score
1	Congestion charging	0.88
2	Ride-sharing	0.87
3	Wider lanes	0.85
4	Right of way for pedestrians	0.85
5	Route management	0.80
6	Improved public transport	0.78
7	Public-private partnership	0.76
8	Sustainable livable initiatives	0.72
9	Integrated corridor management	0.67
10	Commuter tax benefits	0.62

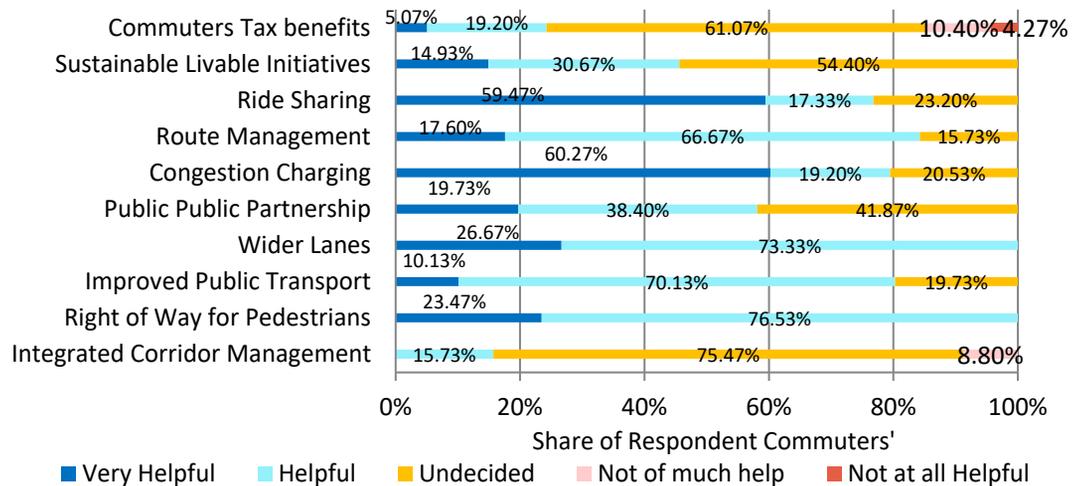


Fig. 12: Viability profile of strategies to curb congestion by commuters' perception (Prepared by the authors based on field survey data, October-December,2022)

that the undervaluation of operational benefits may stem from limited experience with supply-side improvement initiatives in urban settings like Kolkata.

To effectively tackle traffic congestion a diversified strategy that addresses previously identified areas for improvement is necessary. An analysis of commuter opinions on congestion relief measures using the RII (Table 8) reveals differential priorities (Anciaes et al., 2017). Congestion pricing has been recommended as the most practical approach, with a RII of 0.88. This demonstrates the perceived benefits of pricing mechanisms in discouraging driving during peak hours, thereby alleviating traffic congestion (Chakrabarty & Gupta, 2014). With a score of 0.87, ride-sharing indicates its potential as a significant decongestion strategy by maximizing vehicle

occupancy and reducing traffic volume. Additionally, prioritizing the pedestrian right of way and wider lanes, with an RII of 0.85, spells the importance of investing in pedestrian-friendly infrastructure. The provision for improved public transport and public-private partnerships, having RIIs of 0.78 and 0.76 respectively are next deemed crucial as a means to promote environmentally friendly modes of transport and collaborative approaches between government entities and private stakeholders to enhance transportation infrastructure and services. Conversely, the low ratings for integrated corridor management (RII=0.67) and commuter tax benefits (RII=0.62) reinstated that there was still a lack of awareness among the general public about supply-side management techniques.

CONCLUSION

In the context of the KMC and its struggle with traffic congestion, the scenario echoes a global trend observed in many of the cities of developing countries. Regrettably, like its counterparts, KMC has been emulating car-centric development patterns, exacerbating issues related to noise pollution, air pollution, greenhouse gas emissions, and accidents. The fact that the city still lacks a secure Non-Motorized Transportation infrastructure highlights the necessity of a paradigm change. The prioritized sequence of mean scores and ranks revealed in this study can serve as a crucial tool for policymakers and urban planners, aiding in the formulation of a comprehensive roadmap to understand commuters' priorities. To address the challenges, decision-makers must swiftly transit to a sustainable future, embracing strategies beyond the simplistic notion of 'building way out of congestion.' Instead, a dedicated and sustainable approach, informed by techniques like congestion pricing, ride-sharing programs, wider lanes, improved public transportation, and insights from developed nations' experiences with 'complete streets,' can offer more workable and long-lasting solutions to KMC's particular congestion issues. Implementing the 'Avoid, Shift, Improve' concept within KMC can offer a holistic approach to tackle urban transport difficulties and alleviate traffic congestion. By increasing accessibility and reducing journey distances, the 'Avoid' strategy—which combines land use and transportation planning, mixed-use development, and ICT utilization—can aid in minimizing needless travel. With a focus on public transportation and non-motorized options, the 'Shift' method encourages people to switch from owning private automobiles or motorcycles to more environmentally friendly modes of transportation. This approach advances a sustainable urban mobility paradigm by improving inter-city transit and putting travel demand management programs into place. The effective application of the 'Avoid' and 'Shift' techniques might greatly improve sustainable urban mobility and lessen traffic in a densely populated metropolis such as Kolkata. Complementing the previous strategies, the 'Improve' approach concentrates on technology improvements such as smart transportation systems, higher car efficiency requirements, and better fuel quality. Incremental advantages, while not immediately perceived,

do contribute to long-term improvements in the economy, environment, and society. In keeping with the suggestion made in the 'Bangkok 2020 Declaration' to implement a 'people-first' approach, KMC's initiatives should prioritize commuters' welfare first and promote sustainable urban life. A thorough and practical strategy to reduce traffic congestion and maintain the overall sustainability of urban transport in the area is provided by embracing a 'people-first' mindset in conjunction with the 'Avoid, Shift, Improve' framework.

AUTHOR CONTRIBUTIONS

A. Mukherjee performed the literature review, took samples for the study, analyzed and interpreted the data, prepared the manuscript text, and edited the manuscript. A K M Anwaruzzaman supervised and performed the corrections reviewed the article and controlled the results of the research.

ACKNOWLEDGEMENT

The authors express their heartfelt gratitude to the commuters who generously contributed their time to respond to the questionnaires at the surveyed Traffic Intersection Points. Their willingness to engage and participate, despite their hectic schedules, offered valuable insights for the study reflecting their commitment to improve the road traffic condition in Kolkata.

CONFLICT OF INTEREST

The author(s) declare no potential conflict of interest regarding the publication of this work. In addition, the ethical issues including plagiarism, informed consent, misconduct, data fabrication and, or falsification, double publication and, or submission, and redundancy have been completely witnessed by the authors.

OPEN ACCESS

©2024 The author(s). This article is licensed under a Creative Commons Attribution 4.0 International License, which permits use, sharing, adaptation, distribution, and reproduction in any medium or format, as long as you give appropriate credit to the original author(s) and the source, provide a link to the Creative Commons license, and indicate if changes were made. The images or other third-party material in this article are included in the article's Creative

Commons license unless indicated otherwise in a credit line to the material. If material is not included in the article's Creative Commons license and your intended use is not permitted by statutory regulation or exceeds the permitted use, you will need to obtain permission directly from the copyright holder. To view a copy of this license, visit:

<http://creativecommons.org/licenses/by/4.0/>

PUBLISHER'S NOTE

Tehran Urban Research & Planning Centre (TURPC) takes a neutral position about claims on disputed territories, place names, international boundaries, jurisdiction in published maps, and institutional affiliations. TURPC is committed to retracting the paper after it is published if it becomes apparent that there are serious problems in terms of research and publication ethics in its content (<https://www.ijhcum.net/journal/process?ethics>)

ABBREVIATIONS (NOMENCLATURE)

KMC	Kolkata Municipal Corporation
RII	Relative Importance Index
TIPs	Traffic Intersection Points
FF	Free-Flow
CF	Congested Flow
LMV	Light Motor Vehicles
Kmph	Kilometers per hour

REFERENCES

- Afrin, T.; Yodo, N., (2020). A survey of road traffic congestion measures towards a sustainable and resilient transportation system. *Sustainability*, 12(11): 46-60 (15 pages).
- Ajayi, F.; Olawole, M., (2018). Road Users' Perceptions of Causes and Effects of Traffic Congestion in Ile-Ife, Nigeria. *Ife Social Sciences Review*, 26(1): 114-127(14 pages).
- Akbar, P.; Couture, V.; Duranton, G.; Storeygard, A., (2023). Mobility and Congestion in Urban India. *Am. Econ. Rev.*, 113(4): 1083-1111 (29 pages).
- Ali, P. M.; Faraj, R. H., (2013). A traffic congestion problem and solutions: the road between Sawz Square and Shahidan Square in Koya city as a case study. *First International Symposium on Urban Development: Koya as a Case Study*, 77: 125-133(9 pages).
- Anciaes, P.; Metcalfe, P.; Heywood, C., (2017). Social impacts of road traffic: Perceptions and priorities of local residents. *Impact Assess. Project Appraisal*, 35(2): 172-183 (12 pages).
- Bagabaldo, A.; Añosa, J.; Gapusan, J.; Soriano, K.; Uy, F.; Bacero, R., (2017). Determining the Potential Effects of

- the Proposed Removal of South Provincial Buses along Epifanio de los Santos Avenue (EDSA) using Commuters' Perception. *J. East Asia Soc. Transp. Stud.*, 12: 489-504(16 pages).
- Bates, John.; John, P.; Peter, J.; Andrew, C., (2001). The Valuation of Reliability for Personal Travel. *Transp. Res.*, 37E (2): 191-229 (39 pages).
- Bigazzi, A.; Clifton, K., (2015). Modeling the effects of congestion on fuel economy for advanced power train vehicles. *Transp. Plann. Technol.*, 38(2): 149-161(13 pages).
- Bull, A.; (2003). *Traffic Congestion: The Problem and how to Deal with it*. Santiago, United Nations Publication.
- Chakrabartty, A.; Gupta, S., (2015). Estimation of congestion cost in the city of Kolkata—A case study. *Curr. Urban Stud.*, 3: 95–104(10 pages).
- Chakrabartty, A.; Gupta, S., (2014). Traffic Congestion in the Metropolitan City of Kolkata. *Curr. Journal of Infrastructure Development*, 6(1): 43–59 (17 pages).
- Chakraborty, S., (2018). *Traffic congestion in Dhaka city and its economic impact*. Dhaka, A H Development Publishing House.
- Chandramouli, C., General, R. (2011). *Census of India 2011: Provisional Population Totals*. New Delhi, Govt. of India.
- Falcochio, J.; Levinson, H., (2015). *Road traffic congestion: a concise guide*. New York, Springer International Publishing.
- Fattah, M.; Morshed, S.; Kafy, A., (2022). Insights into the socio-economic impacts of traffic congestion in the port and industrial areas of Chittagong city, Bangladesh. *Transp. Eng.*, 9, 100122-100133 (12 pages).
- Garrett, H.; Woodworth, R., (1973). *Statistics in psychology and education*. Bombay, Vakils, Feffer and Simons Private Ltd.
- Higgins, C.; Sweet, M.; Kanaroglou, P., (2018). All minutes are not equal: travel time and the effects of congestion on commute satisfaction in Canadian cities. *Transportation*, 45(5): 1249-1268(20 pages).
- Rao, A.; Rao, K., (2012). Measuring Urban Traffic Congestion—A Review. *Int. J. Transp. Eng.*, 2, 286-305(20 pages).
- Janic, M., (2017). *Transport systems: Modelling, planning, and evaluation*, Taylor and Francis Books Limited, U.K.
- Likert, R., (1961). *New patterns of management*. 1st edition. New York, McGraw-Hill.
- Maparu, T. S.; Pandit, D., (2010). A methodology for selection of bus rapid transit corridors: A case study of Kolkata. *Journal of Institute of Town Planners India*, 7(4): 21-36(16 pages).
- Memon, R. M.; Khiani, R. K.; Ali, S.; Mustafa, T.; Pasha, Y. N.; (2020). Traffic congestion issues, perceptions, experience and satisfaction of car drivers/owners on urban roads. *Mehran Univ. Research Journal Of Eng. & Techno.*, 39(3): 489-505 (17 pages).
- OECD., (2007). *Managing Urban Traffic Congestion: Summary Document*. Paris, OECD Publishing.
- Olojede, O.; Yoade, A.; Olufemi, B., (2017). Determinants of walking as an active travel mode in a Nigerian city. *J. Transp. Health*, 6: 327-334(8 pages).
- Orru, K.; Orru, H.; Maasikmets, M.; Hendrikson, R.; Ainsaar, M., (2016). Well-being and environmental quality: Does

- pollution affect life satisfaction?.Qual. Life Res., 25: 699-705(7 pages).
- Ortúzar, J de. D.; Willumsen, L. G., (2011). Modelling transport. 4thedition,West Sussex,John Wiley & Sons, Ltd.
- Pucher, J.; Korattyswaropam, N.; Mittal, N.; Ittyerah, N., (2005). Urban transport crisis in India. Case Stud. Transp. Policy Case Studies in., 12(3): 185-198(14 pages).
- Rothenberg, M. J., (1985). Urban congestion in the United States: what does the future hold.Institute of Transportation Engineers Journal., 55(7): 22-39 (18 pages).
- Sambasivan, M.; Soon, Y. W., (2007). Causes and effects of delays in Malaysian construction industry. Int. J. Project Manage., 25(5): 517-526 (10 pages).
- Singh, S. K., (2012). Urban transport in India: issues, challenges, and the way forward. EurTransp - Trasp Eur., 52(26 pages).

COPYRIGHTS

©2024 The author(s). This is an open access article distributed under the terms of the Creative Commons Attribution (CC BY 4.0), which permits unrestricted use, distribution, and reproduction in any medium, as long as the original authors and source are cited. No permission is required from the authors or the publishers.



HOW TO CITE THIS ARTICLE

Mukherjee, A.; Anwaruzzaman, A.K.M., (2024).Gridlock gloom: a geographical analysis of commuters' perceptions on traffic congestion. Int. J. Hum. Capital Urban Manage., 9(4): 617-636.

DOI: [10.22034/IJHCUM.2024.04.05](https://doi.org/10.22034/IJHCUM.2024.04.05)

URL: https://www.ijhcum.net/article_713480.html

