Traffic Operations and Capacity Analysis in India

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Abstract. This study highlights the concept of capacity analysis along with traffic operations in urban areas in India. First chapter indicates the introduction of this study through which research aims and objectives can be analysed properly. Moreover, research background and rationale of this study can be also highlighted in this chapter. The second chapter discusses the literature review due to which process of traffic operations and capacity analysis of vehicles can be analysed properly. Using model and theories of traffic flow can help in managing the complexities and issues in traffic management system in urban areas in India. The third chapter defines the research methodology through which tools and techniques regarding this research can be analysed successfully. Using philosophy, approach, design and data collection process, adequate information regarding traffic operations and capacity can be recognised properly.

1. Introduction
The significance of capacity analysis and traffic operations helps in identifying the traffic condition and structure in urban areas in India. The intent of this study is to comprehend the performance structure of vehicles regarding traffic operations in urban areas in India. This study discusses the capacity of vehicles and traffic operations in the context of mixed traffic conditions in India.

1.1. Research background
In India, the status of socio-economic structure and urbanisation have improved through which the capacity of vehicles increased at a rapid pace. The urbanisation level has enhanced from 17.29\% in 1951 to 31.6\% in 2011 and continued [1]. India is one of the fastest-growing countries all over the world through which the urban population has also increased at a rapid pace. Due to the growth of this population, the mixed traffic behaviour has also increased thus; the traffic management operators can face positive and negative impact due to this traffic situation. Most of the time, these operators have failed to manage the traffic situation that can lead to uncertain accidents. It can negatively impact on the population and violate the structure of mixed traffic operations.
1.2. Aims and objectives

1.2.1 Aims
The foremost aim of this study is to analyse the traffic operations and take adequate measures to handle the mixed traffic to reduce the complexities for the population of urban areas in India.

1.2.2 Objectives
- To analyse the structure of heavy traffic conditions in urban areas in India.
- To recognise the role of traffic management operators during handling mixed traffic situations in India.
- To analyse issues that have a negative impact on the population of urban areas in India.
- To recommend appropriate strategies to overcome these issues and manage heavy traffic situations in India.

1.3 Rationale
Traffic operations are one of the crucial factors for handling heavy traffic situations through which urban people can easily use urban roads without facing any accident or any other complexities. However, sometimes, due to the high capacity of traffic, the traffic management team has failed to maintain the structure of managing traffic conditions. It can negatively impact on the population of urban areas thus uncertain accidents in the street and roads in India can happen that can majorly affect the population. Due to lack of knowledge in understanding the traffic rules and other functions, the traffic management team has failed to handle the heavy traffic that can increase congestion and create delays in traffic.

1.4 Significance of the study
The significance of this study is to acknowledge the operations of traffic and analyse the vehicle capacity in the urban areas in India. Through the aid of several methods, vehicle capacity and other aspects regarding traffic can be analysed successfully that can be beneficial for managing the heavy traffic in India. Moreover, through this study, appropriate strategies for handling the complex situation regarding mixed traffic can be recognised through which uncertain accidents can be avoided. It can be beneficial for local people in urban areas in India.

1.5 Summary
From this chapter, aims and objectives of this study can be analysed properly through which strategies can be incorporated to handle the mixed or heavy traffic condition in urban areas in India. Moreover, issues in the traffic management system and the importance of adequate methods can be recognised to improve the quality of this study. It can help in improving knowledge about traffic condition and situation through which capacity of vehicles can be acknowledged.
2. Literature Review
The literature review helps in providing adequate information about the traffic operations and conditions of the mixed traffic situation in India. This section also discusses the intervention model and theory to analyse the process of handling the structure of mixed traffic in urban areas in India.

2.1 Conceptual Framework

![Conceptual Framework](Source: Created by author)

2.2 Features of mixed traffic operations
Mixed traffic operations are very helpful for managing the congestion and heavy traffic situation through which complexities in urban roads can be managed in India. There are several features of mixed traffic operations such as merge, diverse and weaving through which traffic conditions can be successfully maintained. In light of this, using the merging segment, the behaviour of a driver can be analysed properly through which mixed traffic situation can be understood properly [2]. It can be beneficial for urban areas in India through which complexities can be solved and improve the traffic situation. The diverse segment has mainly been used during repairing of roads that can guide the drivers to take a diversion from that repaired road to reduce the complexity natures. Through the aid of this segment, traffic congestion can be avoided.
through which efficiency in developing traffic operations can be managed successfully. It can be beneficial for mixed or heavy traffic in the urban roads in India thus, every driver can follow the diversion process to manage the congestion of traffic and improve the capacity of vehicles.

On the other hand, using the weaving segment, vehicles are required to change the lane according to the requirements of the traffic situation. In this way, uncertain accidents and congestion in traffic operations can be successfully managed. It can also be helpful for mixed traffic conditions through which issues and other negative aspects regarding the traffic situation can be managed properly [3]. It can be helpful for the population of urban areas through which traffic congestion and other negative aspects can be avoided. These segments can provide a structural way of organising the mixed traffic and managing the diversity of traffic and maintain the capacity flow of vehicles.

2.3 Analysing the capacity of vehicles in India

Passenger car units play an essential role in understanding the different types of vehicles through which capacity and frequency of vehicles can be understood properly. From this process, it has been acknowledged that there are four types of vehicles used in the urban areas in India. This includes four-wheelers, three-wheelers, two-wheelers and more than four-wheelers [4]. The frequency of these wheelers can be organised successfully through which complexities and other aspects regarding heavy or mixed traffic conditions can be organised properly. It can be helpful for maintaining the structure of traffic operations and reduce the issues regarding mixed traffic.

The traffic management team is needed to make initiative in analysing the traffic situation through which complexities and efficiency of traffic can be organised properly. Additionally, through the aid of PCU, proportionality of vehicles and traffic volume can be organised properly due to which vehicle type on the traffic stream can be identified properly [5]. It can be helpful for managing highway traffic and organising the different LOS services. It would give a significant way of managing the relationship between volume and speed of the four types of vehicles. It can directly impact on the PCU values through which traffic composition on six-lane and four-lane traffic can be managed properly.
2.4 Intervention model and theory

2.4.1 Traffic Simulation Model

Traffic simulation models describe the flow of cars according to the lane through which the capacity of vehicles and structure of lanes can be understood properly. Through the aid of this model, base and coop car following processes can be acknowledged through which conflict among cars within the mixed traffic can be analysed properly [7]. Thus, the traffic management team in the urban areas in India can take crucial measures to handle this traffic situation and manage the issues within the heavy traffic condition. On the other hand, lanes also play a key role in managing the capacity of vehicles using LC choice models. Through this model, drivers can select their individual lanes to decrease the congestion in traffic and manage the flow of traffic conditions. It can increase the gap among the vehicles in the heavy traffic condition that can decrease the rate of uncertain accidents within the urban areas in India.
2.4.2 Traffic flow theory

Traffic flow theory is mainly based on the two factors such as speed and volume through which free speed for vehicles can be successfully managed. If the volume of vehicles is low then the speed and accuracy of that vehicle can be increased. Through the aid of this theory, vehicle capacity and congestion processes in heavy traffic can be analysed properly [9]. Thus, the traffic management team is expected to set rules for limiting the speed in some areas where the population is very high in India. Through the limitation, drivers can follow the speed restriction and reduce the uncertain accidents that can be beneficial for urban people in India. Through the aid of this theory, the traffic management team can guide the vehicles to follow a specific lane and maintain the flow of managing all the segments of the mixed traffic situation. In this way, the traffic management process can be managed successfully and improve the traffic operations within the urban areas in India.

2.5 Impact of intervention model and theory

Intervention model and theory provide a way of handling the heavy traffic situation and improve the structure of the traffic management system. Through the aid of the traffic simulation model, car density and lane capacity can be analysed properly through which mixed traffic conditions can be maintained properly. In this manner, it can be beneficial for organising the structure of handling the traffic and improving the flow of traffic through which vehicle capacity and sustainability can be organised properly [6]. This model also guides the drivers to improve the flow of traffic operations that can give a favourable impact on the urban population in India.

Using traffic flow theory, volume capacity and speed of vehicles can be understood properly that can guide the traffic management team to take suitable measures to deal with those issues regarding traffic. It can provide a positive impact on social lifestyles for urban people due to the complexity of nature. It can help
in improving the process of speed circulations according to the volume of vehicles. Thus, drivers can follow a specific route for their driving in the urban areas in India.

2.6 Analysing the issues regarding traffic operations and overcoming strategies

Issues in traffic operations can slow the movement of traffic due to which congestion in vehicles and complexities in drivers in heavy traffic can be increased. Lack of proper infrastructure in the traffic management system can increase the congestion that can lead to fatal accidents. This can negatively impact the urban populations in India through which urban people have failed to cross the road in a secured manner [10]. On the other hand, due to lack of technological advancement process, the structure of performing TMS can be decreased that can negatively impact on the traffic operations.

In order to solve these issues, the traffic management team is required to modify the infrastructure with the help of traffic flow theory and traffic simulation model of their traffic management system. In this way, congestion and complexities among drivers can be solved. Additionally, the traffic management team can incorporate the latest traffic technologies to improve the conditions and operations of traffic due to which efficiency and quality in performance regarding traffic can be organised properly [11]. It can help in providing a favourable impact on the sustainability of traffic capacity and operations as well.

2.7 Gap of Literature

Level of transportation in Indian Traffic system cannot be incorporated within this study due to lack of time management. Moreover, the concept of traffic rules and regulations in Indian Traffic system cannot be included due to lack of adequate resources. Due to these gaps, the quality of this study can be decreased in a certain manner and also slow the progression of this study.

2.8 Summary

From this section, the capacity of the vehicles and traffic operations depending on the lane have been discussed through which structural performance regarding traffic management systems can be analysed. Using traffic flow theory and traffic simulation models, the relationship between speed and volume for a particular vehicle can be understood properly. Moreover, the interconnection between the lane and car simulation can be understood properly in this section.

3. Research Methodology

Research methodology defines the tools and techniques through which the structural way of managing data processing regarding the traffic management system can be organised. Using several methods, the impact of TMS on vehicle capacity and traffic operations can be analysed properly due to which research quality can be increased in a significant manner.
3.1 Research philosophy

Research philosophy defines the way of including practical information about the content of the research study through which the clarity of the research study can be managed properly. This includes four types like pragmatism, realism, interpretive and positivism [12]. Positivism philosophy has been used in this study to analyse the practical information about the traffic operations due to which mixed traffic conditions can be successfully analysed. This philosophy has also helped in understanding the capacity of vehicles in the urban areas in India through which the quality of this research can be maintained properly.

3.2 Research approach

Research approach helps in analysing the validity of the research content due to which specific information can be incorporated within the study. This contains three types such as abductive, deductive and inductive research approaches [13]. The deductive research approach has been incorporated within this study to convert the general information about the traffic management system to specific information about the traffic information system. It can help in improving the process of managing the structure of the traffic condition and deliver adequate information about the traffic rules and regulations regarding the situation in India.
3.3 Research design

![Image of research design]

**Figure 3.3.** Research design
(Source: 14)

Research design assists in establishing a general plan for selecting the appropriate method of data collection process through which essentiality of research can be structured. Primarily, the types of research design can be categorised in two types such as exploratory and conclusive [14]. Conclusive research design has been selected for this research for verifying the existing information about traffic operations and delivering accurate results about the capacity analysis in India. It can give a structural way of handling the heavy traffic situation due to which complexities can be decreased for urban drivers. Thus, they can easily operate their activities without facing any issues and maintain the flow of the traffic management system.

3.4 Data collection method

![Image of data collection method]

**Figure 3.4.** Data collection method
(Source: 15)

The data collection method is one of the essential methods in the research methodology through quality data that can be shared using several ways to manage the quality of a research study. This includes primary data collection and secondary data collection methods, depending on the way in which the data has been collected for the research [15]. Primary data collection method has been used in this study in the form of the site selection process through which accurate information about traffic situations can be incorporated. Using this method, this research study is capable of providing the data about vehicle categories, capacity and various others through which complexity nature can be organised properly.
3.5 Data analysis

Data analysis provides a way of performing data collection methods through which information structure can be successfully synchronised. Depending on the way the data has been collected, the process of analysing data also tends to differ, with the main two categories including qualitative and quantitative data analysis processes [16]. Qualitative data analysis has been used in this study to acknowledge the way of incorporating adequate information about the traffic condition and operations in urban areas in India. Using this method, quality information regarding traffic management systems can be maintained properly due to which the quality and efficiency of this research study can be organised properly.

3.6 Sampling size

Sampling size represents the quantity of research samples from which accurate and quality data can be gathered successfully. For the purpose of conducting this research, using a random probability sampling method, the sample of 51 respondents has been selected from the population of 151. The random simple probability method has been chosen since it allows the researchers to select research data in a random and unbiased manner, making the research outcomes fair and unbiased as well [17]. Thus, the viewpoints of these respondents have been gathered regarding the traffic conditions and operations. It can be helpful for incorporating various kinds of viewpoints through which positive and negative aspects regarding traffic management systems in urban areas in India have been analysed. It would help this research to deliver adequate data about the mixed traffic condition through which clarity and efficiency in research methods have been developed. It would give a structural way of handling more quality essential information to achieve the goals and objectives of this study.

3.7 Ethical consideration

Ethical consideration is required for the research study through which confidentiality and privacy of research participants can be maintained properly. Using the Data Protection Act 2018 (c.12), the security regarding collected data can be developed through which external members cannot access the database of this research. It can be beneficial for this research study by organising the structure of this research. On the other hand, privacy and other essential information regarding respondents can be organised properly. It can be helpful for them that they can execute their operations without facing any issues.

3.8 Summary

From this section, adequate tools and techniques have been used to manage the structure of this research through which the aims and objectives of this study can be reached. This section also delivers appropriate
ways of handling the data collection and data processing techniques to manage the clarity and confidentiality of this study.

4. Findings

4.1 Findings 1: Indian Roadways work under mixed Traffic conditions
Based on the data provided in the table, it can be stated that Indian Traffic systems have been observed to work under mixed traffic conditions. However, Apart from this, it can be stated that, movement of too many vehicles have been the main reason for commotion. In this context, it can be stated that vehicles maneuvering with different lane behavior results in traffic conditions that behave homogeneously. Moreover, this has usually been generated due to their static as well as dynamic behavior. Currently, it has been observed that traffic on the road rises rapidly, thus, pressurizing the road conditions. Hence, proper management of traffic has been observed to require better roads along with enhanced traffic management systems. Apart from this, with increase in population the pedestrian count has been observed to increase considerably. This has also resulted in Indian Traffic conditions to be homogeneous in nature. Utilizing public transport would reduce the count of vehicles on road as a result of which Traffic congestion can be reduced comparatively.

4.2 Findings 2: main reasons for traffic congestions
Traffic congestion can be considered as one of the main issues that hinders the construction of Quality roadways in India. This increases pressure on rest road networks as the traffic is diverted in most of the cases. More than 37.50 % of the participants within the research had agreed to the fact that too many cars on Indian Roads are the main reason for increased traffic conditions. Apart from this, an increase in the number of pedestrians on the roads disobey the traffic signals. This creates commotion as a result of which traffic congestion increases considerably. Roadways can be considered as one of the most commonly used modes of commuting for India after railways. However, the current infrastructure developments have been observed to be comparatively not catering the needs of common Indians. Utilizing public transport would reduce the count of vehicles on road as a result of which Traffic congestion can be reduced comparatively.

4.3 Findings 3: influential factors that impact Free Flow Speeds
Free flow speed can be classified as a term that can be used in order to describe the average speed of a motorist while crusading long distances. However, in case of India, this speed is comparatively low due to the adverse road condition of India. In accordance with the presentations of the table, it can be stated that Vehicle subclasses, Width of the road and quality of the roads have been identified as the main reason for low free flow speed. Maneuvering capacity of a vehicle can also be considered as a major parameter that influences free flow speed. Urban Arterial roadways have been associated with poor maintenance processes and it creates irregularities within roadways. The aforesaid factor can be reflected as the main reason that would initiate reductions in vehicle speed processes. In India, it has been observed that Vehicles change lanes without indication; this can also be considered as one of the major reasons that would help in reducing free flow speed of the vehicle.

4.4 Findings 4: role of urban planners of your city
Data in the table provided above helps in having a glance at the role of the urban planners within a city. In this context, it can be stated that more than 38% of the participants have been observed to be dissatisfied
with the role of urban planners. The achievement of rapid growth is expected to be achievable as well as sustainable and this has been observed to present formidable challenges to the urban planners. In most of the cases, it has been observed that the urban planners of a city are associated with corruption. This results in reduction of budgets that have been allocated for construction of Urban Arterial Road network construction. Qualities of roads have been observed to be reduced as a result of this. Besides this, it can be stated that construction of roads has also been associated with certain complications. Instance includes issues like legal conjugations and this hinders the process of creating quality Roadways in the country.

5. Conclusion

This study had aimed at analyzing the performance of urban arterial roads within India. Hence, the concepts of research onion had been deployed in order to accomplish the aims and objectives of the study. Positivism philosophy has been used in this study to analyses the situation of Indian mixed traffic and also helps in improving knowledge about services of urban arterial roads. This has been observed to be aided with the concepts of deductive analysis and descriptive designs. The study had implemented the concepts of mixed methods for framing the contents of the study. One major aspect of this study had been the data validity therefore both primary and secondary analysis has been implemented within the study accordingly. Survey is one of the means of data collection methods that have been used in the study. In order to be specific, Arterial roads form the major aspect of a city's infrastructure that makes the commute process easier as well as effective. However, the type of service provided by these roads has been observed to be problematic. Loads of Obstructions within Roads have resulted in decrease in speed of traffic, apart from this; the issues related to frequent braking has reduced the quality of Roads in India.

5.1 Future Scope

Arterial roads comprise majority of roads in India which connect major town centers in urban areas and have partial access at certain areas like weaving, diverge and merge segments. These roads generally allow movement of smaller vehicles like four wheelers, two wheelers and three wheelers and these roads have specified segments for allowing seamless flow of traffic. However, studies can be carried out within areas through which the performance of Urban Arterial Roads can be increased considerably. Roadways can be considered as one of the most commonly used modes of commuting for India after railways. This has been evident from the fact that most of the roadway transports in India are associated with cheap costs. However, the process of Widening the roads so that there is an increased PCU moving per hour. This can also be considered as one of the major areas of future research. The study also mentions that the Indian Traffic is not homogeneous in nature. However, the study fails in explaining the reason why the Indian Traffic is not Homogenous in Nature. Further Research can be carried out in this field so that the Indian Traffic can be made homogeneous in nature.

5.2 Recommendation

In accordance with the proceedings of the study, it can be stated that lack of maintenance is one of the main reasons that performance of a road is decreased. However, with increase in population has also resulted in increase in road traffic considerations. This in turn have been observed to make the process of maintenance more complex as a result of which the performance of the roadway is decreased considerably. As commented by Gore et al. (2019) road closure for maintenance during peak traffic can increase congestion
on road as a result of which mobility would be affected. Therefore, closing the road when traffic movement is low can be suggested to the urban planners within Major cities in India. Urban planners have been observed to construct roadways considering the Future expansion capacity of a city. Instances include the construction of Ring roads within Cities like Bangalore and Hyderabad. However, expansion as well as maintenance of Urban Arterial Roads has been observed to be avoided. Lack of Forecasting and Legal complications associated with Roadway construction has been observed to be some of the reason for the same. Hence, the Indian Government can be suggested to look into the matter and ensure proper allocation of funds for the same. Road closure for maintenance during peak traffic can increase congestion on road as a result of which mobility would be affected. However, for maintenance, roads would have to be closed. Road closure during low traffic mobility can be advisable.

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