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Non-Motorized Vehicles On Traffic Flow Parameters- Its Impact

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ABSTRACT :

The study you've outlined seems comprehensive and crucial for understanding traffic dynamics in urban Indian settings. By delving into the impact of non-motorized vehicles on traffic parameters like flow, speed, density, queue length, and lateral occupancy, you're shedding light on an often overlooked aspect of transportation planning.The division of the thesis into distinct parts, such as data collection, extraction, analysis, and field observations, followed by statistical analysis using hypothesis testing, ensures a rigorous and systematic approach to understanding the phenomenon. This structured methodology helps in drawing reliable conclusions and establishing statistical relations between different variables.Considering factors like the proportion of non-motorized vehicles, distance from the road edge, and the type of shoulder or kerb further enriches the analysis, providing a nuanced understanding of how various elements interact within the traffic ecosystem.By emphasizing the significant impact of non-motorized vehicles on traffic flow parameters, your study highlights the importance of considering these vehicles in traffic management and urban planning strategies. This insight can inform policymakers and urban planners in developing more inclusive and efficient transportation systems tailored to the diverse needs of Indian cities.

Overall, your thesis appears to contribute valuable insights into the dynamics of urban traffic in India and underscores the importance of accounting for non-motorized vehicles in traffic flow design and management.

Keywords: non-motorized vehicles; motorized vehicles; various traffic; primary variables; queue length; lateral occupancy.

INTRODUCTION:

The study you've outlined seems comprehensive and crucial for understanding traffic dynamics in urban Indian settings. By delving into the impact of non-motorized vehicles on traffic parameters like flow, speed, density, queue length, and lateral occupancy, you're shedding light on an often overlooked aspect of transportation planning.The division of the thesis into distinct parts, such as data collection, extraction, analysis, and field observations, followed by statistical analysis using hypothesis testing, ensures a rigorous and systematic approach to understanding the phenomenon. This structured methodology helps in drawing reliable conclusions and establishing statistical relations between different variables.Considering factors like the proportion of non-motorized vehicles, distance from the road edge, and the type of shoulder or kerb further enriches the analysis, providing a nuanced understanding of how various elements interact within the traffic ecosystem.By emphasizing the significant impact of non-motorized vehicles on traffic flow parameters, your study highlights the importance of considering these vehicles in traffic management and urban planning strategies. This insight can inform policymakers and urban planners in developing more inclusive and efficient transportation systems tailored to the diverse needs of Indian cities.

Overall, your thesis appears to contribute valuable insights into the dynamics of urban traffic in India and underscores the importance of accounting for non-motorized vehicles in traffic flow design and management.

You

In the present day scenario, in providing a door-to-door service especially in developing nations of Asia, non-motorized vehicles are playing an important role. Some majorly used non-motorized vehicles include cycles, cycle-rickshaws, rickshaw-van, hand pulled or cycle driven trolleys, hand pulled rickshaws, some mobile human driven shops. These modes of transport have been performing an important role in transportation of moving goods and human beings safely, efficiently and cheaply. There are up to about 70% contribution of non-motorized vehicle in some places. Non motorized vehicles, basically are the ones that are driven by power of human or animals. They are hence important when:

1. **Last-Mile Connectivity**: Non-motorized vehicles bridge the gap between public transportation hubs and final destinations, providing crucial last-mile connectivity. This is especially significant in densely populated urban areas where traditional motorized vehicles may face congestion or accessibility challenges.
2. **Affordability**: Non-motorized vehicles offer an affordable mode of transportation for both passengers and goods. They require minimal initial investment and operational costs compared to motorized vehicles, making them accessible to a broader segment of the population, particularly in developing nations where financial constraints may limit access to motorized transport.

3. **Flexibility and Maneuverability**: Non-motorized vehicles are often more maneuverable than motorized vehicles, allowing them to navigate through narrow streets, crowded markets, and congested areas with greater ease. This flexibility enables them to reach destinations that may be inaccessible to larger vehicles, enhancing accessibility for both passengers and goods.
4. **Environmental Sustainability**: As they do not rely on fossil fuels, non-motorized vehicles contribute to reduced carbon emissions and air pollution, promoting environmental sustainability. Their use helps mitigate the negative impacts of motorized transportation on air quality and public health, especially in urban areas where pollution levels are often high.
5. **Economic Opportunities**: Non-motorized vehicles can serve as a source of livelihood for individuals operating them, such as cycle rickshaw drivers or street vendors using hand-pulled carts. By providing employment opportunities in the informal sector, they contribute to local economies and livelihoods, particularly in areas with high levels of unemployment or underemployment.

In summary, non-motorized vehicles play a crucial role in providing affordable, flexible, and environmentally sustainable transportation solutions, particularly in developing nations where they contribute significantly to last-mile connectivity and support the movement of both people and goods.

- Motorized vehicles are not reasonable to afford by the person.
- Environmentally non-motorized vehicles have no/less negative impacts whereas the conventional motorized vehicles.
- As that of the motorized vehicles, reach of non-motorized vehicles is not limited.

NEED FOR THE STUDY

It's clear that non-motorized vehicles have both positive and negative impacts on transportation systems, particularly in countries like India where they play a significant role in urban mobility. While they offer affordability, accessibility, and environmental benefits, their presence can also affect the efficiency and safety of roadways. Your suggestion of conducting further research to better understand the impact of non-motorized vehicles on traffic flow and safety is crucial. By conducting comprehensive studies, policymakers and urban planners can make informed decisions about transportation infrastructure and regulations to mitigate any negative effects while maximizing the benefits of non-motorized transportation. In the absence of dedicated tracks for non-motorized vehicles, it becomes even more important to study their interactions with other traffic elements and the overall impact on roadway capacity and safety. This research can help identify strategies to optimize traffic flow, improve safety measures, and integrate non-motorized transportation into urban planning more effectively. Overall, conducting thorough and rigorous research on non-motorized vehicles and their effects on traffic characteristics is essential for developing sustainable and efficient transportation systems in countries like India. By understanding the nuances of non-motorized vehicle movement and their interactions with other modes of transportation, policymakers can make informed decisions to address the challenges and harness the benefits of non-motorized transportation for urban mobility.

OBJECTIVES

The study aims at the following objectives:

1. To study the impact of percentage of non-motorized vehicles on the flow, speed and density in different sections.
2. To study the different primary diagrams i.e. the inter-relationships between the three primary variables.
3. To study the lateral occupancy of vehicles in varied traffic conditions.
4. To study the impact of density on the lateral occupancy of non-motorized vehicles and motorized vehicles individually.
5. To determine the importance of the values found using statistical methods.

ORGANISATION

The complete project aims at finding the impacts of non-motorized vehicles on the varied traffic conditions.

1. *Data Collection*: The first step involves gathering relevant data related to traffic conditions, including the presence and movement of both non-motorized and motorized vehicles. This data may include traffic volume, vehicle speed, density, queue length, and other relevant parameters. Various data collection methods such as manual counts, video surveillance, or automated traffic monitoring systems may be employed.
2. *Data Extraction*: Once the data is collected, it needs to be extracted and organized for analysis. This step involves processing raw data to extract relevant variables and parameters that will be used to evaluate the impact of non-motorized vehicles on traffic flow behavior. This may involve data cleaning, formatting, and filtering to ensure accuracy and consistency.
3. *Data Analysis*: With the extracted data, statistical and analytical techniques are applied to assess the impact of non-motorized vehicles on traffic flow behavior. This analysis may involve examining correlations between variables, conducting hypothesis testing, and identifying patterns or trends in the data. Statistical models may also be developed to predict traffic flow behavior under different scenarios.
4. *Field Observations*: In addition to data analysis, field observations are conducted to gather qualitative insights into the behavior of non-motorized vehicles and their interaction with motorized traffic. This may involve direct observation of traffic patterns, interviews with road users, and documentation of infrastructure features that influence traffic flow.
5. *Experimental Analysis*: Experimental studies may be conducted to investigate specific aspects of non-motorized vehicle impact on traffic flow behavior. This could include controlled experiments in simulated or real-world settings to measure the effects of non-motorized vehicles on parameters such as vehicle speed, flow, and density.

6. *Statistical Analysis using Hypothesis Testing*: Statistical techniques, including hypothesis testing, are employed to analyze the data and draw meaningful conclusions about the impact of non-motorized vehicles on traffic flow behavior. This helps in quantifying the significance of observed differences and relationships between variables.

By systematically following these steps, the project aims to provide a comprehensive understanding of how non-motorized vehicles influence traffic flow behavior under varied conditions. This knowledge can then be used to inform transportation planning and policy-making efforts aimed at improving road safety, efficiency, and sustainability.

The analysis of the above listed is done with a method which is divided into:

1. Learn from experiments and results.
2. Statistical conclusion.

EXPERIMENTAL ANALYSIS

This part is done to study the primary variables and the inter-relationships. The study is done to find the following:

1. To learn the impact of percentage of non-motorized vehicles on the flow, speed and density in different sections.
2. To learn the different primary diagrams i.e. the inter-relationships between the three primary variables.
3. To learn the impact of percentage of non-motorized vehicles queue and delay of the mixed. NMV % vs. queue/delay is plotted to study the same.
4. To learn the lateral occupancy of vehicles in varied traffic conditions.
5. To learn the impact of density on the lateral occupancy of non-motorized vehicles and motorized vehicles individually.
6. To find the capacity of the observed sections from the flow-density curve.

The experimental analysis involves the following three steps:

- Data collection
- Data extraction
- Study of results from extracted data

RESEARCH METHODOLOGY

The data gathering mainly involved the collection of video data with the help of digital video camera. The study aims around taking and analyzing video data in specified sections around Madhapur. The video data is collected from six different locations in Madhapur that are:

1. Road from Phulbani to Boudh.
2. Road from Boudh to Phulbani.
3. Road from Phulbani to Daspalla.
4. Road from Daspalla to Phulbani.
5. Road from Boudh to Daspalla.
6. Road from Daspalla to Boudh.

Setting up the video data recording process with these specifications requires careful planning and execution to ensure accurate and comprehensive data collection. Here's a step-by-step guide:

1. *Selection of Road Segment*: Identify a road segment that meets the criteria of having a high traffic volume, designated no parking zones, and minimal turning vehicle activity. This segment should represent typical traffic conditions for the study area.
2. *Measurement of Section Length*: Determine the minimum length of the road section to be analyzed, ensuring that it provides sufficient space for data extraction. A minimum length of 5 meters is specified to accommodate the required data collection activities.
3. *Camera Placement*: Position the digital camera in a location that provides optimal coverage of the selected road segment. The camera should be mounted at an appropriate height and angle to capture the maximum portion of the road section. Consider factors such as traffic flow direction, visibility of the road surface, and avoidance of obstructions.
4. *Camera Alignment*: Ensure that the camera is aligned properly to cover the entire width of the road section. Adjust the camera angle and orientation as needed to capture clear and comprehensive footage of the traffic flow. Pay attention to factors such as lens distortion and perspective to maintain accurate representation of vehicle movements.
5. *Video Recording*: Record video data using the digital camera set to the maximum available resolution. Ensure that the recording duration is sufficient to capture a representative sample of traffic conditions, including peak traffic periods if applicable.
6. *Data Extraction*: After recording the video footage, extract relevant data from the recordings using appropriate software tools. This may include vehicle counts, speed measurements, and analysis of traffic patterns. Ensure accuracy and consistency in data extraction procedures to facilitate meaningful analysis.
7. *Quality Assurance*: Conduct quality assurance checks to verify the accuracy and reliability of the extracted data. Review the recorded footage to confirm that all relevant information has been captured effectively.

By following these steps, you can establish a robust process for recording video data of the selected road segment, allowing for comprehensive analysis of traffic flow behavior and the impact of non-motorized vehicles. This data can then be used to inform research findings and transportation planning efforts aimed at optimizing road infrastructure and traffic management strategies.

Sl. No.	Location of Data Collection	Length of the Section	Width of the Section	Time of data collection
1	Phulbani to Boudh	6.0 m	6.90 m	9.30 am to 10.00 am
2	Boudh to Phulbani	7.0 m	10.0 m	10.30 am to 11.00 am
3	Phulbani to Daspalla	7.0 m	9.0 m	10.30 am to 11.00 am
4	Daspalla to Phulbani	6.0 m	6.75 m	9.30 am to 10.00 am
5	Boudh to Daspalla	7.0 m	7.50 m	5.00 pm to 5.30 pm
6	Daspalla to Boudh	7.0 m	7.0 m	10.30 am to 11.00 am

Table1: Dimensions of different Sections in Madhapur

STUDY OF LATERAL OCCUPANCY

By Lateral occupancyit is found out to study the behavior of the vehicles with respect to the adjacent vehicles. In order to find out the lateral occupancy of the vehicles the following locations were taken:

1. Road near Samrat Market, Phulbani.
2. Road near Sector-2, Madhapur.
3. Road at Apna Bazaar, Bundh.
4. Road at Madikunda Chowka, Phulbani.

The main purpose of the study of lateral occupancy is to find the impact of change in percentage on the nature of flowing of motorized and non-motorized vehicles.

RESULTS

The following are the graphs to compare the parameters with respect to different percentages of non-motorized vehicles. These graphs are drawn to clarify the impacts of non-motorized vehicles on Indian various traff.

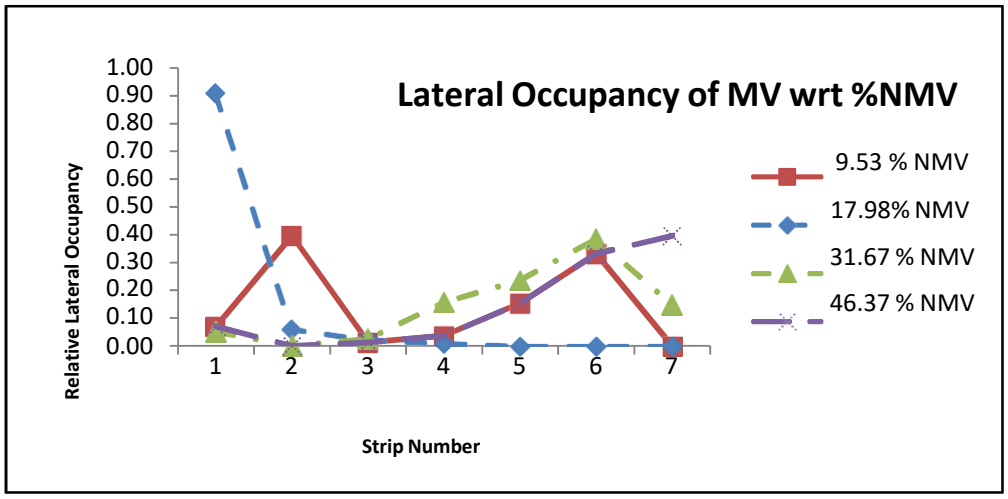


Fig.1: Lateral occupancy of Motorized vehicles wrt. Percentage of Non-motorized Vehicles

The above graph shown in Fig. 1 is a plot between relative lateral occupancy of motorized vehicles and strip number for different sections with different percentages of non- motorized vehicles. As we can see that for low percentage of non-motorized vehicles the motorized vehicles tend to possess the left most strip of the road but gradually when the %age of the non-motorized vehicles increases the motorized vehicles possesses the right and middle strips. The possible reason of which may be that when the non-motorized vehicles percentage increases they tend to possess the left most strip because Indian traffic is left moving.

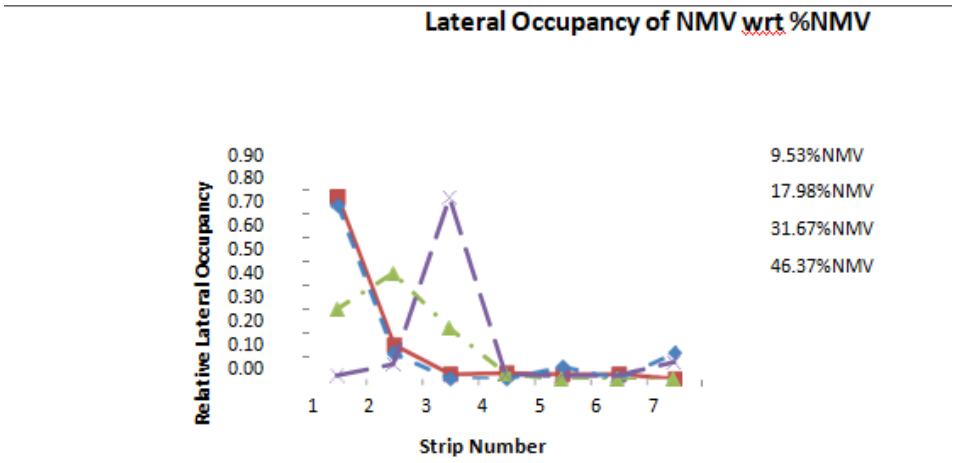


Fig. 2: Lateral occupancy of Non-Motorized vehicles wrt. Percentage of Non-motorized Vehicles

The above graph shown in fig. 4.32 is a plot between relative lateral occupancy of non- motorized vehicles and strip number for different sections with different percentages of non-motorized vehicles. As we can see that for low percentage of non-motorized vehicles the non-motorized vehicles tend to possess only the left most strip of the road but gradually when the %age of the non-motorized vehicles increases the non-motorized vehicles possess the right and middle strips also due to pre-occupancy of the left strip and the capacity of the section being the same.

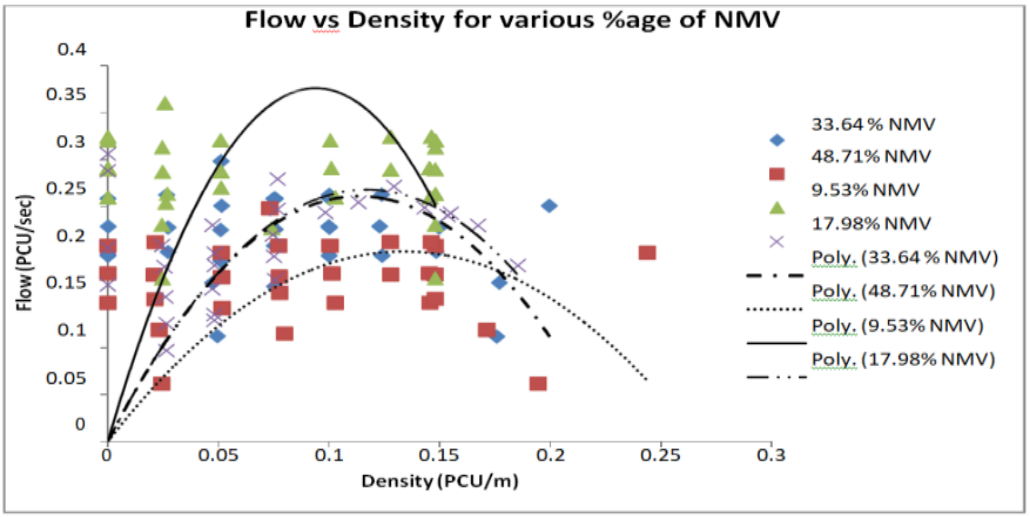
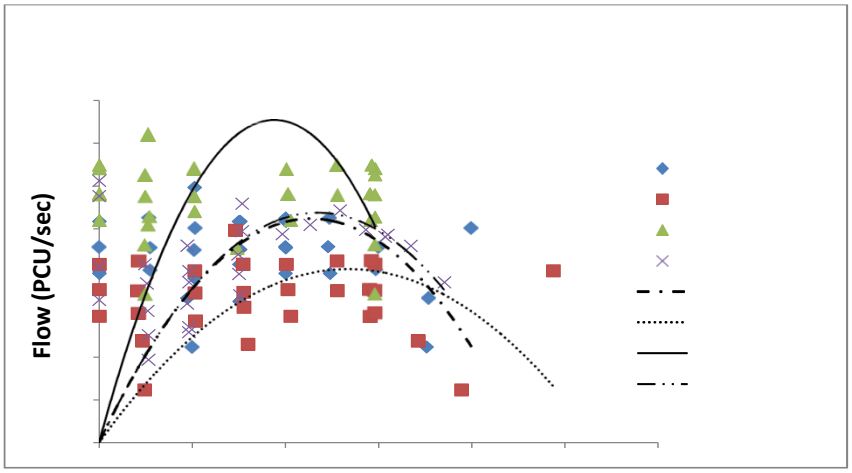
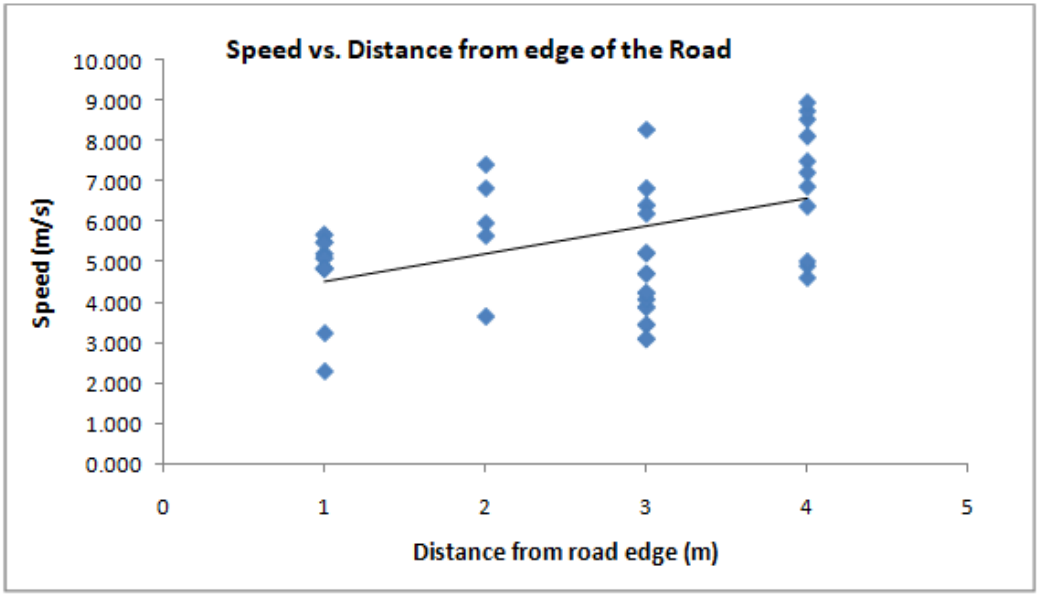


Fig 3: Flow vs. Density for different %age of Non-motorized Vehicles.



The graph shown in the fig above i.e. Fig. 3 the graph is plotted between flow and density for various percentages of non-motorized vehicles. It can clearly be seen that when the percentage of non-motorized vehicles increases the trend line of the flow vs. density curve becomes flatter and hence the capacity of the section decreases. The flow values obtained in the same are also less when the percentage of non-motorized vehicles increases. Even at a constant flow rate the density of the section decreases with increase in non-motorized vehicles.

Fig.4: Speed vs. Distance from road edge



The graph shown in Fig. 4 shows a plot between speed and distance from road edge. It can be seen that the speed of the vehicles are higher when we go farther than the road edge because the non-motorized vehicles occupy the left side of the road. Hence the average speed of the left most strips is less than that of the right most strips and hence the trend line comes out to be increasing. The overtaking vehicles are on the right side hence as we go far from the road edge of the speed increases.

ANALYSIS AND INTERPRETATION

It seems like you're referring to the capacity of different types of traffic (non-motorized vehicles, motorized vehicles, and mixed traffic) at various locations during morning peak hours. However, it appears that the table containing the capacities is missing. If you provide the data, I can help analyze and interpret it to understand the capacity of each type of traffic at different locations.

From the primary diagrams, the capacity is the peak point of flow in the flow density curve and the density corresponding to this flow is the maximum density of the section.

The following table shows the capacities of NMV, MV and mixed traffic at differentlocations from primary diagrams.
The below mentioned capacities are in PCU/Sec at the respective sections during themorning peak hours.

Sl. No.	Location	NMV Capacity	MV Capacity	Total Capacity
1	Samrat Market Phulbani	0.050	0.300	0.325
2	Sector-2, Madhapur	0.133	0.514	0.598
3	Apna Bazaar, Bundh	0.080	0.280	0.343
4	Madikunda Chowka, Phulbani	0.080	0.150	0.180

Table 1: Table showing capacity of different sections

HYPOTHESIS TESTING

Hypothesis testing is a statistical tool to find statistical inference and to show the difference between various sets of data. Hypothesis testing or statistical testing is used to compare the found values or results with the standard values and hence even decide whether the statement or the hypothesis made is correct or wrong. The following are the values of speeds at three different locations compared with the data collected in previous years from the samelocations.

Comparison of Speed for roads at Samrat Market and Sector 2, Madhapur Junction

Table 3. z-Test: Samples with known variances for speed for roads at Samrat Market and Sector 2, Madhapur Junction

Speed at road in Samrat Market Phulbani		Speed at road in Sector-2, Madhapur junction
Mean	3.572377157	8.120401984
Known Variance	5.150583	6.799164
Observations	30	30
Hypothesized Mean	0	
Z	-7.206163288	
P(Z<=z) one-tail	2.8777E-14	
z Critical one-tail	1.644853628	
P(Z<=z) two-tail	5.7554E-14	
z Critical two-tail	1.959963986	

In the test results above obtained by z-Test of comparison between the speeds; alpha value, α=0.05 and the p-value obtained from the test should be less than α so that the values are concluded to be significant. Here the p-value = 5.7554E-13 and that is much less than 0.05 (α). Hence the values cannot be considered to be significant. Even the p-value < 0.0001, soit may be considered as extremely important.

Comparison of Speed for roads at Apna Bazaar, Bundh and Madikunda Chowka, Phulbani

Table 4. z-Test: Samples with known variances for speed for roads at Apna Bazaar, Bundh and Madikunda Chowka, Phulbani

Speed at road near Apna Bazaar, Bundh		Speed at road near Madikunda Chowka, Phulbani
Mean	2.878613857	8.120401984
Known Variance	1.208354	6.799162
Observations	30	30
Hypothesized Mean	0	
z	-10.14591415	
P(Z<=z) one-tail	0	
z Critical one-tail	1.644853628	
P(Z<=z) two-tail	0	
z Critical two-tail	1.959963984	

In the test results above obtained by z-Test of comparison between the speeds; alpha value, α=0.05 and the p-value obtained from the test should be less than α so that the values are concluded to be significant. Here the p-value = 0 and that is much less than 0.05 (α). Hence the values cannot be considered to be significant. Even the p-value < 0.0001, so it may be considered as extremely important.

Comparison of Speed for Samrat Market, Phulbani

The first comparison is performed between the speeds at road in Samrat Market, Phulbani found out from the data collected for this study and the speeds at road Samrat Market, Phulbani found out from the data in 2011 and the comparison is shown in table 6. Again in the next table i.e. table 7 the data collected for this study is compared with the data collected in 2015. The results of the comparison are as follows:

Table 6 z-Test: Samples with known variances for speed for road at Samrat Market, Phulbani in 2011 and 2016.

Speed at Samrat Market, Phulbani in 2011		Speed at Samrat Market, Phulbani in 2016
Mean	1.059574468	3.572377158
Known Variance	0.092318	5.150584
Observations	30	30
Hypothesized Mean	0	
Z	-6.010812013	
P(Z<=z) one-tail	9.22982E-10	
z Critical one-tail	1.644853627	
P(Z<=z) two-tail	1.84596E-09	
z Critical two-tail	1.959963985	

In the test results above obtained by z-Test of comparison between the speeds; alpha value, α=0.05 and the p-value obtained from the test should be less than α so that the values are concluded to be significant. Here the p-value = 1.84596E-09 and that is much less than 0.05 (α). Hence the values cannot be considered to be significant. Even the p-value < 0.0001, soit may be considered as extremely important.

Table 7 z-Test: Samples with known variances for speed for road at Samrat Market in 2015 and 2016.

Speed at Samrat Market, Phulbani in 2015		Speed at Samrat Market, Phulbani in 2016
Mean	2.867550578	3.572377157
Known Variance	3.136458	5.150585
Observations	30	30
Hypothesized Mean Difference	0	
z	1.341044399	
P(Z<=z) one-tail	0.008995302	
z Critical one-tail	1.644853628	
P(Z<=z) two-tail	0.00179907	
z Critical two-tail	1.959963985	

In the test results above obtained by z-Test of comparison between the speeds; alpha value, α=0.05 and the p-value obtained from the test should be less than α so that the values are concluded to be significant. Here the p-value = 0.00179906 and that is much less than 0.05 (α). Hence the values cannot be considered to be significant.

Comparison of Speed for Apna Bazaar, Bundh

The next comparison is performed between the speeds at road near Apna Bazaar, Bundh found out from the data collected for this study and the speeds at road near Apna Bazaar, Bundh found out from the data in 2011 and the comparison is shown in table 8. Again in the next table i.e. table 8. the data collected for this study is compared with the data collected in 2015. The results of the comparison are as follows:

Table 8. z-Test: Samples with known variances for speeds at road near Apna Bazaar Bundh in 2011 and2016.

Speed at Apna Bazaar Bundh in 2011		Speed at Apna Bazaar Bundh in 2016
Mean	2.816599427	2.878613856
Known Variance	0.550725	1.20835
Observations	30	30
Hypothesized Mean Difference	0	
z	2.6084889	
P(Z<=z) one-tail	0.003898538	
z Critical one-tail	1.644853627	
P(Z<=z) two-tail	0.007172756	
z Critical two-tail	1.959963985	

In the test results above obtained by z-Test of comparison between the speeds; alpha value, α=0.05 and the p-value obtained from the test should be less than α so that the values are concluded to be significant. Here the p-value = 0.007172756 and that is less than 0.05 (α). Hence the values cannot be considered to be significant.

Table 9. z-Test: Samples with known variances for speeds at road near Apna Bazaar in 2015 and 2016.

Speed at Apna Bazaar Bundh in 2015		Speed at Apna Bazaar Bundh in 2016
Mean	5.478194924	2.805329471
Known Variance	4.3792	1.0993
Observations	30	30
Hypothesized Mean Difference	0	
z	6.149577281	
P(Z<=z) one-tail	3.88449E-10	
z Critical one-tail	1.644853627	
P(Z<=z) two-tail	7.76897E-10	
z Critical two-tail	1.959963985	

In the test results above obtained by z-Test of comparison between the speeds; alpha value, α=0.05 and the p-value obtained from the test should be less than α so that the values are concluded to be significant. Here the p-value = 7.76897E-10 and that is much less than 0.05 (α). Hence the values cannot be considered to be significant. Even the p-value < 0.0001, so it may be considered as extremely important.

Comparison of Speed for Madikunda Chowka

The next comparison is performed between the speeds at road near Madikunda Chowka, Phulbani found out from the data collected for this study and the speeds at road near Madikunda Chowka, Phulbani found out from the data in 2011 and the comparison is shown in table 10. Again in the next table i.e. Table 11. the data collected for this study is compared with the data collected in 2015. The results of the comparison are as follows:

Table 10. z-Test: Samples with known variances for speeds at road near Madikunda Chowka, Phulbani in 2011 and 2016.

Speed at	Madikunda Chowka, in 2011	Speed at	Madikunda Chowka, in 2016
Mean	1.549253732		1.991771825
Known Variance	0.571657		1.510048
Observations	30		30
z	-1.679895127		
P(Z<=z) one-tail	0.046488862		
z Critical one-tail	1.644853627		
P(Z<=z) two-tail	0.092977722		
z Critical two-tail	1.959963985		

In the test results above obtained by z-Test of comparison between the speeds; alpha value, α=0.05 and the p-value obtained from the test should be less than α so that the values are concluded to be significant. Here the p-value = 0.092977722 and that is greater than 0.05 (α). Hence the values cannot be considered to be important.

Table 11. z-Test: Samples with known variances for speeds at road near Madikunda Chowka in 2015 and 2016.

Speed at	Madikunda Chowka in 2015	Speed at	Madikunda Chowka in 2016
Mean	2.084441204		1.991771824
Known Variance	3.267462		1.510048
Observations	30		30
Hypothesized Mean Difference	0		
z	2.232218108		
P(Z<=z) one-tail	0.004081843		
z Critical one-tail	1.644853627		
P(Z<=z) two-tail	0.008163686		
z Critical two-tail	1.959963985		

In the test results above obtained by z-Test of comparison between the speeds; alpha value, α=0.05 and the p-value obtained from the test should be less than α so that the values are concluded to be significant. Here the p-value = 0.008163686 and that is less than 0.05 (α). Hence the values are considered to be important.

CONCLUSIONS

It's evident from your description that the fundamental diagrams generated in previous chapters provide valuable insights into the interrelationships between flow, speed, and density of traffic, particularly in the context of non-motorized vehicles (NMVs). Here are some key observations and findings based on your description:

1. *Impact of NMVs on Traffic Parameters*: The diagrams illustrate that the presence of NMVs significantly affects traffic parameters such as density, speed, and flow. As the percentage of NMVs increases, there's a decrease in density, speed, and flow of the total section of the road. This effect is consistent across different road patterns, whether divided or undivided lanes, although it appears to be less pronounced in divided lanes.
2. *Lane Distribution*: Field observations confirm that NMVs tend to occupy the leftmost strip of the road due to the left-hand side driving convention in India. Motorized vehicles, with higher speeds, typically overtake slower vehicles from the right-hand side, leading to their concentration on the right side of the road. However, when the percentage of NMVs is low, motorized vehicles may also occupy the left side.
3. *Effect of Infrastructure*: The presence of raised kerbs or lack of shoulders influences traffic flow patterns, with fewer vehicles preferring the left strip for uncongested traffic. In contrast, roads with shoulders tend to have traffic flow concentrated in the left strip.
4. *Flow Density Curve*: With an increase in the percentage of NMVs, the flow density curve becomes flatter, indicating a decrease in flow for a given density in the road stream. This suggests that NMVs have a substantial impact on traffic flow characteristics, affecting the overall efficiency of the roadway.
5. *Statistical Inference and Hypothesis Testing*: The study employs statistical methods such as hypothesis testing to infer relationships between variables and validate findings. This provides a robust framework for analyzing the collected data and drawing meaningful conclusions about the impact of NMVs on traffic parameters.
6. *Queue Length Variation*: The study also investigates the variation of queue length with respect to the percentage of NMVs. It identifies a significant effect of NMVs on queue length, highlighting the importance of considering NMVs in traffic management strategies.

Overall, your study contributes valuable insights into the complex dynamics of traffic flow, particularly in the presence of non-motorized vehicles, and underscores the importance of considering NMVs in transportation planning and infrastructure design.

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