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Research Article

MITIGATING TRAFFIC CONGESTION: STRENGTHENING PUBLIC TRANSPORTATION SYSTEMS IN IMUS, AGUINALDO HIGHWAY, CAVITE

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ABSTRACT

Aims: The primary aim of this study is to assess the impact of public transportation system enhancements on reducing traffic congestion along Aguinaldo Highway in Cavite. The study aims to evaluate the level of improvement in public transportation services and determine if these improvements have contributed to alleviating traffic congestion. **Study design:** This study utilized a quantitative, descriptive-correlational research design to explore the relationship between public transportation system enhancements and the reduction of traffic congestion. The design was chosen to allow for the examination of perceptions, as well as the statistical analysis of correlations between the improvements in public transportation and traffic congestion. **Methodology:** A random sampling technique was used to select 117 participants from the commuter population. Data were gathered through a structured survey questionnaire, which collected information on respondents' demographic profiles, their use of public transportation, and their perceptions of the public transportation system's enhancements and their impact on traffic congestion. Descriptive statistics were used to summarize the data, while Pearson's correlation analysis was employed to examine the relationship between public transportation improvements and traffic congestion. **Results:** The study found that respondents generally perceived moderate improvements in the public transportation system, with the highest mean score for "Service Efficiency and Accessibility" (3.41). The overall mean score for the perceived impact on reducing traffic congestion was 2.96, categorized as "Agree." Pearson's correlation analysis showed a moderate positive correlation (r = 0.458) between public transportation system enhancements and traffic congestion reduction, with a highly significant p-value of 0.000. This indicates that public transportation improvements are significantly associated with reduced traffic congestion. **Conclusion:** The study concludes that public transportation system enhancements along Aguinaldo Highway have contributed to a moderate reduction in traffic congestion, as indicated by the perceptions of the respondents. The moderate correlation between public transportation improvements and reduced congestion supports the effectiveness of these enhancements. However, the study also suggests that further improvements are necessary, particularly in infrastructure development, sustainable transportation options, and regulatory enforcement, to achieve more significant reductions in congestion.

Keywords: Aguinaldo Highway, Cavite, Public Transportation, Traffic Congestion, Urban Mobility.

INTRODUCTION

At the international level, traffic congestion has become a critical and escalating issue in urban transportation systems. Cities around the world are grappling with its myriad consequences, including heightened air pollution, prolonged travel times, and diminished economic productivity. According to the World Bank (2020), the economic losses caused by traffic congestion, in terms of wasted time and reduced efficiency, amount to billions of dollars annually for cities globally. These effects have prompted a range of interventions, especially in developed countries, such as substantial investments in public transportation infrastructure, the promotion of eco-friendly transportation options, and the adoption of smart traffic management technologies. While such efforts have led to improvements, the rising urban population and increasing vehicle ownership continue to exacerbate congestion in urban centers. A study by Zuk *et al.,* (2022) highlighted that the persistent gap between infrastructure development and growing demand has led to a continuous cycle of congestion, affecting both the environment and public health.

On the national front, the Philippines faces similar challenges, particularly in Metro Manila, where traffic congestion has become synonymous with urban life. According to the Philippine Statistics Authority (2021), vehicle ownership continues to rise, while public transportation systems struggle to accommodate the growing

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commuter demand. Despite various government initiatives, such as the Public Utility Vehicle Modernization Program (PUVMP) and efforts to expand mass transit networks like the MRT and LRT, traffic woes persist, particularly in suburban and provincial areas. A study by Lim *et al.,* (2023) reported that while these efforts aim to improve public transport services, their limited scope and slow implementation have failed to significantly reduce congestion.

Locally, in Cavite, the situation along the Aguinaldo Highway serves as a microcosm of the broader transportation issues facing suburban regions. The rapid urbanization and population growth in Cavite have placed immense pressure on the area's transportation system. The expansion of residential and commercial developments has resulted in a steady increase in vehicle numbers, straining the already inadequate road infrastructure. Commuters often face long delays, overcrowded public transport options such as buses and jeepneys, and road networks that are unable to handle the increasing demand. Local government units (LGUs) in Cavite have recognized the urgency of addressing these challenges but continue to face obstacles in implementing sustainable, comprehensive solutions that effectively tackle the root causes of traffic congestion.

A critical gap exists in the literature regarding the comprehensive impact of public transportation improvements on traffic congestion in suburban areas like Cavite. While numerous studies have explored specific aspects of public transportation improvements, such as the development of infrastructure, the introduction of new policies, or the expansion of services (Santos & Gutierrez, 2022), few have

examined the integration of these components into a cohesive system and their cumulative effects on reducing traffic congestion. Furthermore, the unique challenges in Cavite, such as its rapidly evolving urban landscape and limited transport options, have not been adequately addressed in the existing body of research.

This study aims to bridge this gap by examining how strengthening the public transportation system in Cavite—through infrastructure development, service efficiency improvements, regulatory measures, and the promotion of sustainable transportation options—can alleviate traffic congestion along the Aguinaldo Highway. The objective is to provide policymakers and transportation planners with valuable insights on effective strategies for reducing congestion while improving public transport services in the region. Recent studies by Cheng *et al.,* (2023) have shown that integrating sustainable transport solutions can lead to significant reductions in traffic congestion, yet few studies have focused on how these strategies play out in suburban settings like Cavite.

In light of these challenges, the specific objectives of this study are to: (1) determine the demographic profile of the respondents, focusing on their age, sex, income, and use of public transportation; (2) assess the level of enhancement in the public transportation system along Aguinaldo Highway; (3) evaluate the extent to which these enhancements have contributed to the reduction of traffic congestion; and (4) examine whether there is a significant relationship between improvements in public transportation and reduced traffic congestion along Aguinaldo Highway. Through these objectives, the research seeks to provide a comprehensive analysis of how public transportation system improvements can contribute to alleviating traffic congestion and enhancing the overall commuting experience in Cavite.

Theoretical Framework

The study was anchored on the Theory of Planned Behavior (TPB) and the Congestion Pricing Theory, which provided a comprehensive framework for understanding the dynamics between public transportation system enhancements and traffic congestion reduction. The TPB, proposed by Ajzen (1991), asserted that an individual's behavioral intentions were influenced by their attitudes, subjective norms, and perceived behavioral control. In the context of this study, the enhancement of the public transportation system, such as improving infrastructure and service efficiency, positively shaped commuters' attitudes, making public transportation a more appealing choice over private vehicles. This shift in commuter behavior, in turn, contributed to reducing the dependency on private vehicles and mitigating congestion. Additionally, the Congestion Pricing Theory, introduced by Vickrey (1969), posited that traffic congestion resulted from the overuse of road infrastructure, and one of the most effective ways to alleviate this was by promoting the use of alternative modes of transport. By enhancing the public transportation system along Aguinaldo Highway in Cavite, the study explored how these improvements could reduce the number of private vehicles on the road, leading to smoother traffic flow and less congestion. Together, these theories informed the study's investigation into the impact of public transportation improvements on traffic congestion, providing a robust theoretical foundation for understanding the potential benefits of system-wide enhancements in reducing road traffic and improving the overall commuter experience.

The conceptual framework of this study was composed of the independent variable (IV), which was the enhancement of the public transportation system, and the dependent variable (DV), which was the reduction of traffic congestion. The IV encompassed various factors such as infrastructure development, service efficiency and accessibility, policy and regulatory measures, and sustainable transportation options that contributed to improving the overall effectiveness and reliability of the public transport system. These enhancements were expected to influence the DV by reducing the reliance on private vehicles, improving traffic flow, enhancing the commuter experience, and delivering environmental and socioeconomic benefits. Through this framework, the study explored the relationship between public transportation improvements and traffic congestion alleviation, particularly along Aguinaldo Highway in Cavite.

METHODOLOGY

This study used a quantitative, descriptive-correlational research design to examine the impact of public transportation system enhancements on traffic congestion along Aguinaldo Highway in Cavite. A random sampling technique was employed to select 117 participants from the commuter population, ensuring that each individual had an equal chance of being included. Data were gathered using a structured survey questionnaire that collected information on participants' demographic profiles, their use of public transportation, and their perceptions of the transportation system's enhancements and its impact on traffic congestion. Descriptive statistics summarized the data, while Pearson's correlation analysis assessed the relationship between public transportation enhancements and the reduction of traffic congestion. The findings provided insights into how public transportation improvements influenced commuter behavior and alleviated traffic congestion in the region.

RESULTS AND DISCUSSIONS

1. **What is the demographic profile of the respondents in terms of age, sex, monthly income, and their use of public transportation?**

The results of the study revealed key insights into the demographic profile and transportation habits of the respondents. The majority of participants were between the ages of 18 and 45, with 38.5% in the 26-35 age group and 28.2% in the 18-25 age group. A smaller portion of respondents fell into the 36-45 age group (13.7%), with even fewer in the older age categories (6.8% between 46-60 years old and 1.7% above 60 years old). Notably, 11.1% of respondents were under 18 years old. In terms of gender, 52.1% of respondents were female, 47.0% were male, and 0.9% identified as both male and female. The majority of participants were employed (59.8%), followed by students (24.8%), business owners (8.5%), and a small number of unemployed individuals or those combining business ownership with unemployment.

The age distribution of the respondents aligns with findings from Tung *et al.,* (2021), which reported that young adults and middle-aged individuals form the majority of public transportation users in urban areas, primarily due to their need to commute for work or education. This is particularly evident in the 18-45 age group, which reflects the importance of public transportation for individuals in these life stages. Additionally, Delacruz and Santos (2021) emphasized that these age groups tend to rely on public transportation more due to financial constraints and a lack of access to private vehicles. Similarly, the income distribution among the respondents—where 23.1% earned below ₱10,000 per month—demonstrates that public transportation is a critical mode of travel for lower-income individuals. Garcia *et al.,* (2022) found that lower-income groups are more likely to use public transport because private vehicle ownership is often financially unfeasible. These findings reinforce the study's conclusion that

affordable and reliable public transportation is crucial for these demographics.

The study also revealed that nearly half (47.0%) of the respondents used public transportation daily, followed by 29.1% who used it occasionally, 19.7% weekly, and 4.3% who never used it. This frequency of use highlights that public transportation is an essential part of the daily commute for many residents of Cavite. The high rate of daily public transportation use is consistent with the findings of Hernandez *et al.,* (2022), who observed that individuals in suburban areas tend to use public transport more frequently due to limited access to private vehicles. Their study suggested that suburban commuters rely heavily on public transportation for work and education, echoing the results of this study. Moreover, Santos *et al.,* (2023) emphasized that as the frequency of public transportation use increases, so does the demand for improved services. This study's findings suggest that enhancing service frequency, vehicle capacity, and reliability would benefit daily commuters, further supporting the need for infrastructure improvements to accommodate the growing demand for public transport.

In terms of addressing traffic congestion, the study found that enhancing the public transportation system could significantly benefit daily commuters by improving service reliability and accessibility. A substantial portion of the respondents reported daily use of public transportation, making it crucial for the system to meet their needs effectively. The study's findings support the conclusions of Chavez *et al.*, (2023), who argued that rapid urbanization in areas like Cavite demands integrated transport solutions to prevent worsening congestion. Their research indicated that better public transportation options, such as increased bus frequency and modernized vehicles, could help reduce the reliance on private vehicles and ease traffic congestion. Rodriguez and Li (2023) also found that expanding and improving public transportation infrastructure is essential to reducing congestion in urbanizing areas. In line with these studies, the respondents' frequent use of public transport suggests that investing in service improvements would likely decrease the number of private vehicles on the road, contributing to smoother traffic flow and reducing congestion along major thoroughfares like Aguinaldo Highway.

Overall, the findings of this study are consistent with recent literature, which emphasizes the critical role of public transportation in alleviating traffic congestion, especially in suburban areas. By improving service reliability, accessibility, and infrastructure, public transport systems can better meet the needs of daily commuters, particularly those from lower-income groups. As Martinez *et al.,* (2023) suggested, targeted improvements in public transport systems can have a significant impact on reducing traffic congestion while enhancing the commuter experience. Policymakers should prioritize these enhancements to ensure public transport meets the needs of the community, reduces traffic congestion, and contributes to sustainable urban mobility in Cavite.

2. What is the enhancement level in the public transportation system along Aguinaldo Highway in Cavite?

Table 1 reveals the perceived enhancement levels of the public transportation system along Aguinaldo Highway in Cavite, with respondents generally indicating a moderate improvement, as reflected in the overall mean score of 3.07, categorized as "Agree." This suggests that while respondents believe there have been significant advancements in the system, there is still substantial room for improvement. Notably, the highest mean score of 3.41 (SD = 0.56) was recorded for "Service Efficiency and Accessibility," signaling strong agreement among respondents that improvements in the

efficiency and accessibility of public transportation were the most noticeable. This finding aligns with recent studies, such as the one by Santiago *et al.,* (2022), which emphasized the crucial role of service reliability and frequency in enhancing commuter satisfaction. Respondents' perceptions suggest that changes aimed at increasing service frequency, improving schedule reliability, and making public transportation more accessible have been particularly effective in meeting commuter needs.

In contrast, "Policy and Regulatory Measures" scored a mean of 2.52 (SD = 0.50), indicating strong agreement with improvements in regulations like fare integration and bus lane enforcement. While these regulatory measures are recognized as effective, the slightly lower score compared to service efficiency hints at concerns over the full implementation and impact of these measures. This observation is supported by a 2023 study by Lim and Reyes, which noted that while regulatory measures are in place, their inconsistent enforcement often leads to mixed perceptions among commuters. Despite this, respondents still acknowledged the value of regulatory improvements, highlighting their importance in enhancing overall system efficiency.

"Infrastructure Development" and "Sustainable and Alternative Transportation" both received mean scores of 3.22 (SD = 0.62) and 3.13 (SD = 0.61), respectively, suggesting that respondents generally agree that improvements in these areas have been positive. These components include upgrades in infrastructure such as roads, terminals, and vehicle fleets, as well as the promotion of alternative transportation options like electric vehicles and bike lanes. However, both components scored lower than service efficiency, indicating that while progress has been made, more work is needed. Recent studies, such as one by Tan *et al.,* (2020), emphasize the need for continued investment in infrastructure to meet the demands of growing populations in rapidly urbanizing areas like Cavite. Furthermore, despite positive perceptions of alternative transportation options, research by Bautista *et al.,* (2022) highlights ongoing challenges such as infrastructure limitations and the high initial cost of electric vehicles, which may impede the widespread adoption of sustainable transportation.

While significant progress has been made in enhancing the public transportation system along Aguinaldo Highway, the results suggest that further improvements are needed, particularly in infrastructure development and the promotion of sustainable transportation options. The high ratings for service efficiency and regulatory measures indicate that commuters value timely, accessible services and effective policies. To further enhance the system, policymakers should focus on improving transportation infrastructure, investing in sustainable solutions like electric vehicles, and ensuring the consistent enforcement of regulatory measures. Addressing these areas will help the public transportation system better meet the needs of commuters and promote long-term sustainability.

Table 1. The summary on the enhancement level in the public transportation system

Items	Mean	SD	Description
Infrastructure Development	3.22	0.62	*Agree*
Service Efficiency and Accessibility	3.41	0.56	*Strongly Agree*
Policy and Regulatory Measures	2.52	0.50	*Strongly Agree*
Sustainable and Alternative Transportation	3.13	0.61	*Agree*
Overall Mean	**3.07**	**0.57**	**Agree**

Legend: 1.00 – 1.75 (Strongly Disagree), 1.76 – 2.50 (Disagree), 2.51 – 3.25 (Agree), 3.26 – 4.00 (Strongly Agree)

3. **What is the extent of reducing traffic congestion along Aguinaldo Highway in Cavite due to public transportation system enhancements?**

Table 2 illustrates the extent to which enhancements in the public transportation system have contributed to reducing traffic congestion along Aguinaldo Highway in Cavite. Respondents generally perceive a moderate reduction in congestion, with an overall mean score of 2.96, categorized as "Agree." This indicates that the improvements in the public transportation system have had a noticeable, though moderate, impact on alleviating traffic congestion.

Among the components, "Environmental and Socioeconomic Benefits" received the highest mean score of 3.18 (SD = 0.73), reflecting strong agreement from respondents that the enhancements have led to significant environmental and socioeconomic improvements. These benefits include reductions in vehicle emissions, better air quality, and cost savings for commuters. The positive impact on the environment and society is consistent with recent literature, which highlights that public transportation improvements can contribute to more sustainable urban mobility by decreasing air pollution and providing cost-effective travel alternatives (Santos *et al.,* 2021). This finding reinforces the notion that public transportation can play a pivotal role in enhancing the broader urban environment.

"Enhanced Commuter Experience" scored 3.10 (SD = 0.77), indicating that the improvements in public transportation services have contributed to a better overall experience for commuters, such as reduced overcrowding and shorter wait times. This, in turn, encourages more people to use public transport, which can reduce the number of private vehicles on the road. Recent studies have shown that a more positive commuter experience leads to greater satisfaction and increased public transport ridership, which helps alleviate congestion (Garcia & Lim, 2020). Respondents' perceptions suggest that such improvements have contributed to more efficient and enjoyable commuting, indirectly reducing traffic congestion by encouraging greater use of public transportation.

"Decrease in Private Vehicle Dependency" received a mean score of 3.02 (SD = 0.61), indicating that although there has been a reduction in the reliance on private cars, this effect is less significant compared to other factors. This result suggests that while public transportation enhancements have somewhat contributed to fewer private vehicles on the road, the continued use of private cars may still limit the overall reduction in traffic congestion. A 2022 study by Aquino and Dizon pointed out that while public transportation improvements can reduce private car use, strong cultural preferences for personal vehicle ownership and limited alternatives can slow this shift (Aquino & Dizon, 2022).

"Improvement in Traffic Flow" received the lowest mean score of 2.55 (SD = 0.55), categorized as "Agree." While some respondents agreed that traffic flow has improved due to public transportation enhancements, the score indicates that the perceived impact on traffic flow is moderate and not as pronounced as the other improvements. This result suggests that while public transportation has alleviated some congestion, it may not have fully addressed issues related to traffic flow, such as bottlenecks or insufficient road capacity. This aligns with findings from a 2023 study by Rodriguez et al., which noted that improvements in public transportation are often accompanied by other infrastructure challenges, such as road congestion and traffic signal inefficiencies, which can reduce the overall effectiveness of public transport in improving traffic flow (Rodriguez *et al.,* 2023).

The results imply that while public transportation system enhancements have significantly contributed to reducing traffic congestion along Aguinaldo Highway, there is still substantial room for further progress. The reduction in private vehicle dependency and the enhanced commuter experience indicate that public transport improvements are influencing commuter behavior, leading to less reliance on private cars. However, the overall impact on traffic flow remains moderate, suggesting that additional measures are needed. Policymakers may need to implement more aggressive strategies to further decrease private vehicle use, such as congestion pricing, expanded carpooling programs, or further investments in sustainable transportation options. Additionally, focusing on improving traffic flow efficiency, including better road management and traffic signal coordination, should remain a priority to maximize the benefits of public transportation improvements and achieve more substantial reductions in congestion.

Table 2. The summary on the extent of reducing traffic congestion

Items	Mean	SD	Description
Decrease in Private Vehicle Dependency	3.02	0.61	*Agree*
Improvement in Traffic Flow	2.55	0.55	*Agree*
Enhanced Commuter Experience	3.10	0.77	*Agree*
Environmental and Socioeconomic Benefits	3.18	0.73	*Agree*
Overall Mean	2.96	0.66	*Agree*

Legend: 1.00 – 1.75 (Strongly Disagree), 1.76 – 2.50 (Disagree), 2.51 – 3.25 (Agree), 3.26 – 4.00 (Strongly Agree)

4. **Is there a significant relationship between public transportation system enhancements and the reduction of traffic congestion along Aguinaldo Highway in Cavite?**

The results from Table 3 reveal the relationship between public transportation system enhancements and the reduction of traffic congestion along Aguinaldo Highway in Cavite. The r-value of 0.458 indicates a moderate positive correlation between the two variables, suggesting that as the public transportation system improves, traffic congestion tends to decrease. The p-value of 0.000 is highly significant, well below the commonly used threshold of 0.05, leading to the rejection of the null hypothesis (Ho) that asserts there is no relationship between public transportation system enhancements and the reduction of traffic congestion.

The statistical analysis demonstrates a significant and positive relationship between public transportation system improvements and reduced traffic congestion. A moderate correlation (r = 0.458) suggests that various enhancements in the public transportation system, such as better service efficiency, infrastructure upgrades, and more effective regulatory measures, are likely contributing to alleviating traffic congestion. The rejection of the null hypothesis supports the alternative hypothesis that these enhancements have a meaningful impact on reducing congestion along Aguinaldo Highway.

These findings imply that public transportation system improvements are an effective strategy for reducing traffic congestion. The moderate correlation indicates that continued efforts to enhance the public transportation system could further improve traffic flow, especially if accompanied by stronger policies to increase public transport usage. The statistical significance of these results suggests that local policymakers and transportation authorities should prioritize investments in expanding and modernizing the public transportation system. This includes improving service reliability, enhancing infrastructure, and promoting greater use of public transport through

targeted incentives. Further research could investigate additional factors that might influence this relationship or identify specific interventions that are particularly effective in reducing congestion.

Table 3. The Test of the relationship between public transportation system enhancements and the reduction of traffic congestion

	Reduction of Traffic Congestion		
	r-value	p-value	Decision on Ho
Public Transportation System Enhancements	.458**	.000	Rejected

Significant if P-value <0.05
Legend: Ho is rejected if Significant
Ho is accepted if Not Significant

CONCLUSION

This study examined the impact of public transportation system enhancements on reducing traffic congestion along Aguinaldo Highway in Cavite. The findings reveal that respondents generally perceive significant improvements in the public transportation system, particularly in service efficiency and accessibility, infrastructure development, and policy measures. The enhancements have contributed to a moderate reduction in traffic congestion, as indicated by decreased private vehicle dependency, improved traffic flow, and enhanced commuter experience. Furthermore, a statistically significant positive relationship was found between public transportation system enhancements and the reduction of traffic congestion, suggesting that improvements in the public transport system play a key role in easing traffic congestion. However, while the results are promising, the impact on traffic flow remains moderate, indicating room for further improvements.

Recommendations

Based on the findings, the following recommendations are proposed:

1. **Infrastructure Investment:** Continued investment in public transportation infrastructure, such as expanding MRT, LRT, and BRT systems, modernizing vehicle fleets, and improving terminals, is essential to enhance the capacity and efficiency of the public transport system.
2. **Promotion of Sustainable Transportation:** Efforts to promote sustainable transportation, including the development of bike lanes, pedestrian-friendly infrastructure, and the use of electric vehicles, should be expanded to reduce private vehicle dependency and improve air quality.
3. **Strengthening Traffic Management:** Stricter enforcement of traffic regulations, such as dedicated bus lanes and stricter management of road usage, can further enhance the flow of traffic and reduce congestion.
4. **Public Awareness and Incentives:** Public awareness campaigns should be conducted to encourage the use of public transportation. Additionally, incentives for using public transport, such as subsidies or discounts for commuters, can help shift more people away from private car use.
5. *Continued Research:* Further studies should be conducted to explore additional factors influencing traffic congestion and the effectiveness of different public transportation enhancements, allowing for more targeted interventions.

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