Vehicle preventive maintenance: a comprehensive analysis of its impact on society, economic, and environmental factors in General Villamil Playas City

ABSTRACT
This study investigates the pivotal role of preventive maintenance for vehicles in General Villamil Playas City, Ecuador, exploring its multifaceted impact on economic, social, and environmental aspects. With a focus on tricycle passengers and taxis, the research employs a comprehensive methodology involving literature review, strategic collaboration with local authorities, and targeted educational strategies for tricycle drivers. Implementation includes campaigns, talks, and practical workshops, strategically located to ensure maximum outreach. Results from beneficiary surveys underscore positive perceptions regarding knowledge enhancement, activity duration, and overall methodology. The paper emphasizes the economic savings, extended vehicle lifespan, optimized performance, and environmental benefits associated with preventive maintenance. The study concludes by advocating for sustainable, collaborative efforts, stressing the enduring impact of promoting preventive maintenance practices within the community.

Keywords: road safety, preventive maintenance, social projects, environment.
INTRODUCTION

General Villamil, also known as Playas, is a coastal city located in the province of Guayas, Ecuador. It is the seat of Playas Canton. The city takes its official name from the independence hero, General José de Villamil.

The city is situated to the southwest of the Guayas Province. It is 96 kilometers away from the provincial capital, Guayaquil. It borders the cantons of Guayaquil and Santa Elena to the north and east, and the Pacific Ocean to the south and west.

The main activities of the city are fishing, commerce, and tourism. The city is known for its vast coasts that offer various resorts that are visited all year round. The city also has a very active commerce sector thanks to the initiatives of the population and the presence of companies dedicated to commerce, in addition to shrimp and tuna industries (Prefectura del Guayas, 2023).

Playas de Villamil is one of the main tourist destinations on the central coast. It includes 14 kilometers of beautiful white sand beaches that extend from the city of General Villamil, known as Playas, to the town of Data de Posorja, at the southern end of the Santa Elena peninsula. The terrestrial area and the two-kilometer-wide marine strip off the coast were established to take care of the beaches, protect the natural remnants of marine and coastal ecosystems, and promote proper environmental management for the treatment and elimination of solid waste from the neighboring population (Ministerio del Ambiente, 2023).

Preventive maintenance for vehicles is crucial to ensure optimal performance and extend their lifespan. This article analyzes how efficiency in this regard not only benefits vehicle owners but also has substantial repercussions on the broader societal landscape, particularly in the context of General Villamil Playas City.

The intricate relationship between transportation and the economic vitality of Playas underscores the indispensable role that various modes of transport play in shaping the urban dynamics of this coastal city. Beyond the mere facilitation of movement, the transportation network in Playas acts as a linchpin for economic activities, influencing both local commerce and the flourishing tourism industry.

The multifaceted nature of transportation in Playas is characterized by a diverse array of vehicles, each serving a distinct purpose within the urban framework. The primary modes of transport include motorcycles, tricycle passengers, taxis, and private vehicles, collectively forming a dynamic tapestry that threads through the city's socioeconomic tapestry. Understanding the nuanced interactions and dependencies within this transportation ecosystem is paramount for comprehending the city's economic landscape comprehensively.

The Dynamics of Playas' Transportation Network:
1. Motorcycles, agile and well-suited for navigating through the city's diverse topography, emerge as a popular choice for both commuters and local businesses. Their role extends beyond mere personal transport, influencing the efficiency of local delivery services and contributing to the agility of the overall transportation system.

2. Tricycle Passenger, with their distinctive three-wheel design, represents a unique facet of Playas’ transportation landscape. Widely employed for short-distance commuting, these vehicles cater to the specific needs of residents and visitors, offering an alternative and accessible means of travel within the city's bustling streets.

3. Taxis, recognized for their reliability and convenience, play a pivotal role in fostering local commerce and tourism. As a preferred mode of transport for both residents and visitors, taxis contribute significantly to the mobility infrastructure, ensuring efficient and timely transit throughout Playas.

4. Private Vehicles, the prevalence of private vehicles signifies a growing urbanization trend and individual mobility preferences. Understanding the patterns and dynamics of private vehicle ownership is essential for gauging the city's economic development and the evolving lifestyles of its residents.

2 METHODOLOGY

The research methodology begins with a comprehensive literature review to establish a theoretical foundation for the significance of preventive maintenance for tricycle passengers. This review will provide the necessary theoretical framework and guide the identification of effective strategies to promote these practices among drivers.

Subsequently, strategic allies will be identified for the implementation of proposed activities. Discussions will be initiated with the local government, emphasizing the relevance of preventive maintenance to enhance road safety and reduce costs associated with vehicular breakdowns. Additionally, potential collaborations with educational institutions and community organizations will be explored to strengthen support for the initiatives.

Based on the identified allies, tailored educational strategies will be designed to meet the specific needs of tricimotos drivers. These strategies will encompass the planning and execution of interactive educational lectures and practical workshops, effectively addressing the correct practices of preventive maintenance. Cultural and socioeconomic adaptation will be a crucial criterion in the design of these activities.

The execution phase will take place in strategically located areas accessible to tricimotos drivers. During these activities, participatory methods will be employed to ensure the effective transmission of
knowledge and skills. Pre- and post-assessments will be conducted to measure the intervention's effectiveness, collecting data on participation, drivers' understanding, and changes in preventive maintenance practices.

Result evaluation will be a critical component of the methodology, utilizing quantitative and qualitative indicators to analyze the effectiveness of the implemented activities. The obtained information will allow for adjustments and improvements in future initiatives, ensuring a continuous and adaptive approach.

Continuous collaboration with the local government will be an integral aspect of the methodology. Results will be shared, demonstrating the effectiveness of implemented strategies and emphasizing how the promotion of preventive maintenance benefits drivers, road safety, and the local economy. This feedback and collaboration process aims to establish a long-term relationship, ensuring the sustainability and lasting impact of preventive maintenance promotion initiatives within the tricimotos driver community.

The execution of preventive maintenance on vehicles involves following the manufacturer's recommendations or the user manual, taking into account the type and model of the vehicle in question. Among the essential measures are the regular change of oil and filters, periodic inspection of levels and quality of liquids such as coolant, antifreeze, brakes, and transmission. It is also necessary to assess the condition and pressure of the tires on a monthly basis or before long trips, and at least once a year or every 20,000 kilometers, it is necessary to check the condition and alignment of the steering and suspension.

Additionally, it is essential to examine the situation and adjustment of the lights every six months or when any anomaly is detected, and to monitor the condition and tension of the engine belt every 40,000 kilometers or when wear is noticed. Likewise, it is advisable to check the level and quality of the transmission fluid every 60,000 kilometers or according to the manufacturer's instructions. Finally, the state of the battery and cables should be evaluated annually or when a loss of power is perceived. (Sánchez, 2016).

Not carrying out preventive vehicle maintenance has multiple disadvantages that negatively impact both its performance and safety. Some of these drawbacks include: (grupoors.com.mx, 2021):

- Reduction of the engine's lifespan and other components.
- Increase in repair costs.
- Higher risk of breakdown

Preventive vehicle maintenance provides numerous benefits, both in terms of the driver's experience and environmental impact, such as the following:

- Preserves the safety of the driver and passengers.
- Protects the environment.
• Reduces fuel consumption and saves money. (Chevrolet, 2022).

• Ensures compliance with legal regulations for vehicular traffic.

The practice of preventive vehicle maintenance becomes essential to ensure proper performance and safety of automobiles. In addition to this category of maintenance, two other approaches can be identified: corrective and predictive. (Lumiformapp.com, 2022).

However, the implementation of preventive maintenance may lead to the generation of potentially hazardous waste, which requires proper management (EPAA, 2018). Therefore, it is crucial that preventive maintenance be carried out with consideration for environmental concerns and adequate knowledge. This way, it contributes to preserving a healthier and safer environment, which, in turn, can positively impact the health and quality of life of the population.

The emissions of gases generated by vehicles in circulation in the province of Guayas have a detrimental impact on both the natural environment and the health of its inhabitants, including those residing primarily in urban areas. Vehicles emit a series of highly polluting gases, such as carbon monoxide (CO), nitrogen oxides (NOx), and hydrocarbons (HC). These compounds contribute to the phenomenon of global warming, the greenhouse effect, and the ozone formation process in the troposphere. Tropospheric ozone arises as a result of the chemical reaction between NOx and HC in the presence of sunlight. Tropospheric ozone poses a danger to both human health and vegetation, causing irritation of the respiratory tract, a decrease in lung capacity, damage to the immune system, and a reduction in the growth and performance of plants (Llanes Cedeño, Rocha-Hoyos, Peralta Zurita, & Leguísamo Milla, 2018).

The Ecuadorian government plays a central role in the supervision and control of the use and care of vehicles through various entities and programs, such as the Transit Commission of Ecuador (CTE), the Ministry of Transportation, and automobile manufacturing companies (Secretaria de la Amazonia, 2013).

The practice of preventive maintenance in vehicles generates a variety of waste, including some that pose risks to the environment and human health. These include batteries, oils, refrigerants, recyclable materials, tires, and gas emissions (EPA, 2015) These waste materials must be handled properly to prevent their dispersal or discharge into the soil or water (Incinerox, 2018).

Once the target group, consisting of taxis and tricycles, has been identified, the process begins to establish a strong connection with local authorities, as illustrated in Figure 1. This step is crucial to forge an effective and coordinated collaboration aimed at raising awareness among the drivers of these vehicles about the importance of proper preventive maintenance.

Figure 1 visually represents the interconnection between the project and local authorities, highlighting the necessary synergy to comprehensively address awareness of preventive maintenance in the taxi and tricycle sector. This strategic link aims to leverage the support and influence of the authorities
to effectively reach the driver community, establishing a close collaboration that ensures the success of the initiative.

Collaborating with local authorities not only involves sharing information about the importance of preventive maintenance but also engaging them in the implementation of educational and awareness programs. This may include conducting workshops, informational campaigns, and distributing educational materials in coordination with the relevant local institutions.

Ultimately, the goal is not only to raise awareness among drivers about the need for preventive maintenance but also to foster a sustainable culture of vehicle care in the taxi and tricycle sector. This collaborative approach, supported by a strategic connection with local authorities, not only strengthens the effectiveness of the initiative but also contributes to improving the safety, efficiency, and sustainability of these vehicles for the benefit of the community at large.

Within the framework of preventive maintenance implementation, with the goal of generating a significant impact on social, economic, and environmental levels, various actions will be carried out, including talks, field campaigns, and practical workshops. These methodological strategies are designed to comprehensively address key aspects related to awareness and the practice of preventive maintenance, thus contributing to the achievement of the set objectives. The summary of activities to be executed can be observed in Figure 2.
Campaigns will be implemented, bringing the message directly to drivers and vehicle owners. These campaigns may include free inspections, live demonstrations of basic maintenance procedures, and the distribution of informational material. Direct interaction will allow for a more effective connection with the target audience, addressing their specific concerns and encouraging active participation.

Educational Talks aimed at the driver community will be conducted, emphasizing the importance of preventive maintenance in extending the lifespan of vehicles, improving road safety, and reducing long-term costs. These talks will focus on explaining recommended practices, tangible benefits, and positive impacts that preventive maintenance can have both individually and collectively.

Practical workshops will be an integral part of the strategy, providing participants with the opportunity to directly apply the concepts learned. These workshops will focus on practical skills, such as oil changes, fluid checks, and basic tire inspections. Necessary resources and tools will be provided to empower drivers with confidence and competence in performing simple but fundamental maintenance tasks.

These methodologies will complement each other to achieve a holistic approach that not only informs the driver community about the importance of preventive maintenance but also empowers and motivates them to implement these practices in their daily routine. Additionally, a follow-up mechanism will be established to assess the effectiveness of interventions and make adjustments as necessary, ensuring a positive and sustainable impact in the long term on social, economic, and environmental aspects.
3 DISCUSSION

Vehicle preventive maintenance analysis has a significant impact on society, economic, and environmental factors. By adopting predictive maintenance strategies, fleets can reduce costs, improve safety, enhance environmental compliance, and contribute to infrastructure development. This approach to maintenance can also lead to increased customer satisfaction and better warranty and insurance outcomes.

Extended Lifespan: By conducting regular maintenance, issues can be identified and addressed before they become major breakdowns. This helps extend the lifespan of vehicle components, preventing costly repairs or even premature replacement.

Reduced Repair Costs: Detecting and addressing problems in their early stages prevents them from developing into more expensive breakdowns. Preventive maintenance allows for minor adjustments and repairs, typically at a much lower cost than major repairs that might be necessary if maintenance is neglected.

Optimized Performance: A properly maintained vehicle tends to operate more efficiently. This can translate into lower fuel consumption and overall improved performance, contributing to economic savings over time.

Accident Prevention: A well-maintained vehicle is less prone to mechanical failures that could cause accidents. Preventive maintenance contributes to ensuring the safety of the vehicle, its occupants, and other road users, avoiding costs associated with repairs and potential legal consequences.

Warranty Compliance: For vehicles still under warranty, adhering to the manufacturer's preventive maintenance guidelines is crucial. Failure to comply with these guidelines could void the warranty, resulting in additional costs if issues arise. Lower risks associated with predictive vehicle condition management can lead to a 20% reduction in accidents and up to a 75% reduction in unnecessary downtime (Questar, 2022).

Environmental benefits: Proactive maintenance practices, such as monitoring tire pressure and other aspects of vehicle health, can lead to improved fuel economy and reduced emissions. For example, the US Department of Energy (DOE) reports that properly inflated tires can improve gas mileage by 3.3% (RTInsights, 2022). By identifying and addressing maintenance needs before they become critical, predictive maintenance can contribute to a cleaner environment.

User satisfaction is directly correlated with the overall experience of the tourism service. Well-maintained vehicles provide a seamless travel experience, contributing positively to tourists' overall perception of the service quality.

A survey was conducted among the beneficiaries of the talks and workshops to assess their perception and satisfaction with the activities. The results are as follows:
Knowledge and Awareness: Seventy-four percent (74%) of participants believe that the talks and workshops allowed them to improve their knowledge and become aware of the importance of preventive maintenance. This indicates that the activities had a positive impact in terms of learning for the majority of attendees.

Duration of Activities: Regarding the duration, 81% of participants consider that the topics covered had an adequate length. On the other hand, 19% express that they would have liked to receive more training time, suggesting that the content or duration of the talks could be expanded.

The methodology employed in the activities was assessed by the beneficiaries through a survey conducted at the end of the sessions. A Likert scale ranging from 1 to 5 was used, where 1 corresponded to strongly disagree and 5 to strongly agree, to assess different methodological aspects.

The results of the methodology assessment are shown in Figure 1. As observed, the average score obtained was 4.5, indicating a positive perception of the methodology by the participants. Specifically, aspects such as the organization of the content, the applied dynamics, and the resolution of doubts received average scores above 4. In contrast, the extent of some topics received the lowest rating with an average of 3.8, suggesting that it could be improved by slightly extending the duration of the activities.

**Figure 3 Results of the methodology assessment.**

![Average Training Evaluation - Beneficiaries](image)

Source: Alex Llerena

**4 CONCLUSIONS**

The talks, campaigns, and training workshops have proven effective in raising awareness among tricycle and taxi drivers about the importance of preventive maintenance. As a result, many drivers have decided to implement these practices, leading to a reduction in breakdowns.
The social impact is evident through the number of beneficiaries who have received free advice and training. The transmission of fundamental knowledge related to traffic education, preventive maintenance of motorcycles, and environmental preservation has a positive effect on the community. Since motorcycles and tricycles are the most commonly used means of transportation in the area, the application of this knowledge translates into better behavior by drivers and pedestrians on the roads, contributing to the reduction of accidents in the region.

An integrated approach is adopted that addresses both social and environmental issues. Beneficiaries can adopt good practices in managing toxic waste generated in motorcycle maintenance, actively contributing to environmental preservation.

The economic impact is evident through the number of beneficiaries participating in talks related to preventive motorcycle maintenance. Thanks to this knowledge, beneficiaries have the ability to perform preventive maintenance themselves, resulting in significant cost savings.
REFERENCES


