

## **CARIG: A Proposed Parking Building with Extended Terminal at Four Lanes, Santiago City, Isabela**

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### **ABSTRACT**

This thesis proposed the development of a four-story multi-level parking building at Four Lanes, Santiago City, Isabela. Surveys, site visits, and data gathering revealed a significant shortage of designated parking spaces, causing congestion and inconvenience for motorists. To address this, a strategic site was selected and thoroughly analyzed based on infrastructure, traffic flow, accessibility, zoning regulations, and environmental factors. The proposed building, with a footprint of 4,644 square meters, included complete architectural, structural, plumbing, electrical, and auxiliary plans designed in compliance with national codes and standards. The structure prioritized functionality, safety, and cost-efficiency and allowed for future expansion. The building will provide a total of 541 parking slots, distributed as follows: 24 for jeepneys, 16 for buses, 24 for public-use vans, 105 for motorcycles, 348 for private vehicles (cars, pickups, and vans), and 24 for persons with disabilities (PWDs). The estimated construction cost is ₱279,606,224.52, with an expected completion time of 324 calendar days. This proposed project aimed to support Santiago City's urban development efforts by offering a practical, research-based solution to its growing parking infrastructure needs.

*Keywords:* Parking building, extended terminal, Santiago City, parking sensors, lack of parking slots/spaces

### **INTRODUCTION**

#### **Background of the Study**

Parking congestion is a growing urban problem in many developing cities, and Santiago City, Isabela, is no exception. As one of the commercial centers in the Cagayan Valley, the city has experienced rapid growth in vehicle ownership in recent years. According to data from the Land Transportation Office, Santiago recorded over 33,000 registered vehicles in 2021, and national trends indicate this number is continuing to rise. The significant increase in vehicles has not been matched by sufficient parking infrastructure, resulting in widespread parking shortages, illegal roadside parking, and traffic congestion, especially in key commercial areas.

The situation is particularly difficult in the Four Lanes area, identified as one of Santiago City's Central Business Districts (CBDs). A 350-meter radius assessment around the proposed project site revealed that commercial and institutional establishments require 372 parking slots, per the National Building Code of the Philippines. However, only 159 slots are currently available, creating a deficit of over 200 parking spaces. This lack of infrastructure has forced drivers to park along highways and non-designated areas, leading to safety hazards and reduced road efficiency.

Additionally, the existing terminal facility in Santiago cannot accommodate the growing number of public utility vehicles (PUVs), such as jeepneys, buses, and vans. Overflow from the terminal has further congested the area, with PUVs using informal spaces as waiting and loading

zones. City authorities, including the Department of Public Order and Safety (DPOS), have noted frequent issues of double parking, traffic obstruction, and violations of local ordinances.

Given these challenges, there is a critical need for a structured, multi-level parking facility that can accommodate both private and public vehicles. Addressing this infrastructure gap is essential to improving traffic flow, enhancing safety, and supporting Santiago City's ongoing urban development.

### Objectives

This study was proposed to address the current parking space issue in Santiago City, specifically in Four Lanes, Malvar. Below are the specific objectives to help achieve the study's primary goal.

1. Assess if establishments within the 350m radius meet the parking requirements stipulated by the National Building Code of the Philippines (NBCP) and collect data on the average number of public utility vehicles parked within the terminal and in the proposed site.
2. To prepare the project's architectural, structural, plumbing, sanitary, electrical, and electronics/auxiliary plan.
3. To prepare the construction methodology, overall cost, detailed project estimate, and duration of the proposed parking building.
4. Provide the traffic analysis for the planning of the proposed building.
5. To present the ROI (Return on Investment) of the proposed building.

### Significance of the Study

The proposed parking building will be significant to the following:

1. **The Public.** This proposal can help reduce on-street parking, especially at Malvar, Santiago City, thereby improving traffic flow, as the road has a wider pathway. Also, it can create employment opportunities if the building begins operating.
2. **Private Car Owners.** This will provide a safer and better place for private cars to park. As Four Lanes in Malvar is becoming a commercial hub in Santiago, it is more convenient for customers to know there is a reliable place to park.
3. **The Government.** The proposed parking building will benefit the government, especially once it begins operating. The income will be collected and used as additional funds for other projects in Santiago City, Isabela.
4. **The Researchers.** This study will help the researchers apply their engineering knowledge and skills, especially in structural analysis, computations, and structural design.
5. **Future Researchers.** This study will help them learn and serve as the basis for future research on parking buildings.

### Scope And Delimitations

1. The study proposed a parking building with a roof deck at Four Lanes, Santiago, Isabela. This research included architectural design, structural analysis, plumbing and sanitary design, electrical plans, cost estimates, and program of works. The project's cost was determined by regulations and constraints of the National Structural Code of the Philippines (NSCP), National Building Code of the Philippines (NBCP), National Plumbing Code of the

Philippines, Association of Structural Engineers of the Philippines (ASEP), Fire Code of the Philippines, and Accessibility Law (BP 344).

2. In this proposal, soil investigation and detailed plans for automated parking sensors were not included in the study's technical designs.
3. For the return on investment of the proposed parking building, the revenue from public vehicles was not counted in the calculation of the gross annual income of the building.

## METHODOLOGY

### Research Design

The proposal involved the project's design and the gathering and interpretation of the data. The data-gathering results were used to inform the technical design, draw conclusions, and explain how the suggestions could be applied. Significant data and deductions were shown with plans, tables, and photos. The National Structural Code of the Philippines (NSCP), National Building Code of the Philippines (NBCP), National Plumbing Code of the Philippines, Association of Structural Engineers of the Philippines (ASEP), Fire Code of the Philippines, and Accessibility Law (BP 344) were used as the bases of the study.

### Conceptual Framework

Concerns about traffic on roadways and parking spots have been raised in most cities, including Santiago City. It is one of Isabela's industrial hubs, drawing more traffic and automobiles. Previous research estimated that around 150,000 people live in Santiago City and that parking takes up more than half of the available road space. These days, drivers are more likely to park their cars on the side of the road and less in enclosed spaces.

### Research Paradigm

The study for the proposed parking building in Malvar, Santiago, Isabela, involved a systematic process of problem identification, site selection, data collection, planning, and construction preparation. This approach ensured that the final design and construction plan was based on objective data, addressing the area's growing need for parking and efficient traffic management. Following this procedure, the study provided a sound outline for implementing the proposed parking facility and improving urban mobility in Santiago City.

### Research Locale

The project location is in Malvar, Santiago, Isabela. The nearest landmarks of the proposed project are SaveMore, Four Lanes Plaza, and Xentro Mall Santiago. The total area is around 10276 sq. meters, currently being used as a parking space for various vehicles such as PUVs, PUJs, buses, motorcycles, and tricycles.

### Research Participants

Local Government Unit (LGU)

- Mayor's Office
- City Engineering Office
- City Planning and Development Office
- Department of Public Order and Safety

Integrated Terminal Complex Office

### Instruments And Tools

1. *Microsoft Excel*  
This software helped the researchers estimate costs, manage projects, and analyze structural analysis.
2. *AutoCAD 2024*  
This software helped researchers create detailed 2D and 3D drawings for planning and the proposed parking building.
3. *Sketch-up 2020*  
This software allowed the researchers to provide 3D modeling, including architectural interior design enabling them to provide more realistic and visualized designs.
4. *Lumion*  
A rendering software helped the researchers create 3D animation for the proposed parking building.
5. *Design Software (ETABS, STAAD, etc.)*  
This is a software for modeling, analyzing, and designing buildings and structural systems. It was used to design building frames, analyze the effects of loads (such as wind, seismic, and gravity), and optimize material usage.

### Data Gathering Procedure

The researchers investigated and gathered data, e.g., studies and past proposals similar to the proposed project. Moreover, the researchers integrated a self-structured concept to collect, analyze, and formulate findings and ideas for the project proposal. The information and data gathered were then used to formulate a design concept for the project proposal.

The researchers addressed the city hall, particularly the engineering and mayor's offices, to obtain a copy of the lot plan and clarify zoning requirements and restrictions on the proposed location. However, the researchers could not obtain a copy of the lot plan as the Mayor's Office stated that the lot was not under their jurisdiction and was a private property. With that said, the researchers proceeded to the Registry of Deeds, Santiago City, to obtain the name and contact of the owner; despite that, the Registry of Deeds, Santiago City, did not disclose the name or any information about the owner. So, the researchers assumed the land was government-owned, and this is due to the reason that the proposed location is being used as a parking space for numerous vehicles. Moreover, the plot of land is also used as a venue to hold fiestas/festivals and even concerts, as stated by an employee in the city's Engineering Office when the researchers went to obtain a copy of the lot plan. Additional information regarding the number of vehicles registered in Santiago City was obtained from the Land Transportation Office of Santiago City to understand the growth in vehicle population and parking demand.

### *Site Visitation*

Site visits were conducted near the proposed location to evaluate the area's current state and to measure current parking occupancy rates, traffic flow, and on-street parking usage. The researchers surveyed how many nearby establishments, businesses, public spaces, and high-traffic areas are within a 350-meter radius. Moreover, it also provided additional data on the location's physical and natural characteristics which guided the researchers during the design and planning phase of the proposed parking building.

#### *Online Research and Previous Project Proposals*

Related studies and literature from journals, dissertations, books on the internet, and previous proposals from the Jubilee Library in Saint Mary's University, Bayombong, Nueva Vizcaya, were used for the project's design. The data and information gathered provided a concrete basis for the project's design process.

#### **Treatment Of Data**

To support the need for parking facilities in Malvar, Santiago, Isabela, a comprehensive data collection about the growth of the vehicle population was conducted. The researchers determined the number of slots needed with the data obtained from the LTO and by considering the number of vehicles currently parked in the proposed location and the number of vehicles parked illegally in the proposed site.

A 1/4-mile (400 meters) rule of thumb is a widely recognized benchmark applied across several disciplines, each utilizing it to assess accessibility and proximity to critical services. In urban planning, this distance is foundational for creating walkable neighborhoods where essential services are within easy reach, enhancing the overall quality of life (Speck, 2018). In transportation and public health, the 400-meter measure is similarly applied as a practical distance for active transportation and commuter access to transit points, helping planners design environments that encourage physical activity and reduce reliance on cars (Krizek & King, 2021). Furthermore, this standard is relevant to real estate and zoning practices, as developers use it to gauge a property's proximity to amenities such as schools, parks, and commercial centers, influencing both property value and the perceived desirability of neighborhoods (Luque et al., 2019). In public transport planning, it serves as an essential radius for determining accessible routes to transit stations, ensuring that most residents live within a manageable walking distance, thereby supporting more significant equity in access (Nikolaou et al., 2022). Kim (2015) further underscored the applicability of this measure in assessing walkable distances, noting that a 400-meter radius is a familiar rule for evaluating site accessibility to transit and other urban amenities. Additionally, the 400-meter rule is familiar in athletics, where it defines typical training distances and pacing for runners, acting as a spatial standard that is easy to understand and apply across multiple types of spatial assessments (Anderson, 2018). For this study, a radius of 350 meters was applied to capture a more localized impact area around the site, building on the widely used 1/4-mile (400 meters) rule of thumb applied across urban planning, transportation, public health, and real estate.

**Figure 27**  
350m Radius from the Proposed Location



Source: (<https://www.calcmaps.com/map-radius/>)

**LEGEND:**

- |  |                             |
|--|-----------------------------|
| 1. DTI Santiago                                | 8. Santiago City Dermcentre |
| 2. Santiago City Integrated Transport Terminal | 9. Xentro Mall              |
| 3. 4 Lanes Plaza                               | 10. KFC Fast Food           |
| 4. Santiago City Fire Station                  | 11. Xenia Building          |
| 5. Northern College (BEC) Department           | 12. Zen Hotel               |
| 6. Oryza Hotel                                 | 13. Northern College        |
| 7. Max's Restaurant                            | 14. 3K Hotel                |

**RESULTS AND DISCUSSION**

**Project Description**

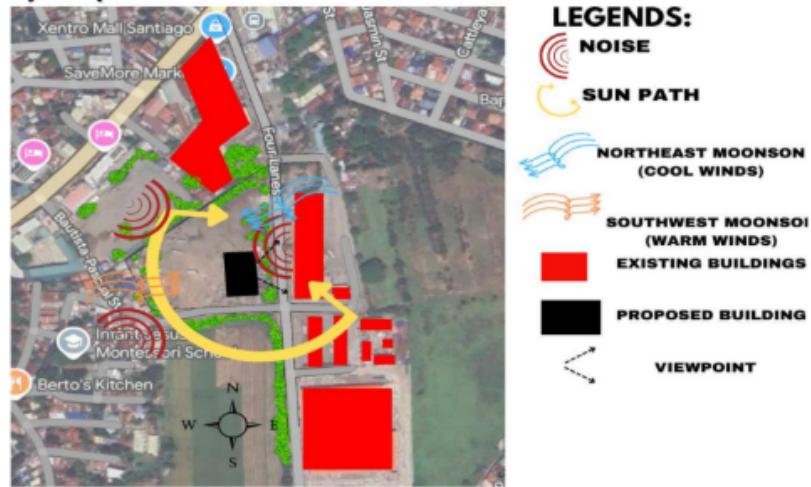
The four-story parking building and terminal serve as a parking building in the city of Santiago to aid the limited parking slots at commercial establishments as well as to provide additional parking slots for public utility vehicles that the existing terminal is not able to cater. This proposed building will function as a parking area for the drivers', customers', and employees' private vehicles. The proposed parking building encompasses 24 parking slots for jeepneys, 16 slots for buses, 24 slots for public-use vans, 105 slots for motorcycles, 438 slots for private vehicles like cars, pickups, and vans, and 24 slots for PWD parking. Therefore, the total number of parking slots in the proposed parking building is 541.

**Traffic And Site Analysis**

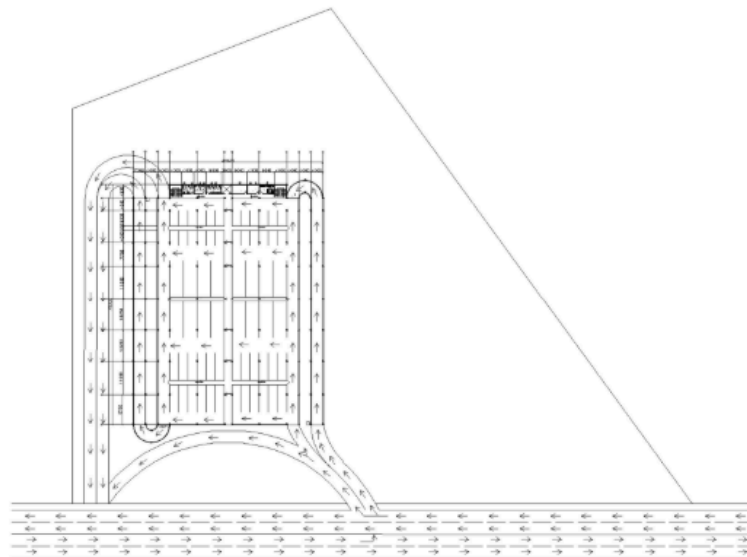


The site analysis was conducted to understand the location's context, accessibility, and surrounding environment for the parking building proposal. It was used to assess important factors such as traffic patterns, nearby infrastructure, climate, and local building codes, ensuring the design meets the area's needs. The analysis also evaluates pedestrian and vehicular flow, allowing for the optimal placement of entrances, exits, and circulation features to maximize functionality and reduce congestion.

**Figure 29**  
*Site Analysis of Proposed Location*



**Figure 30**  
*Traffic Analysis*



**Technical Components**

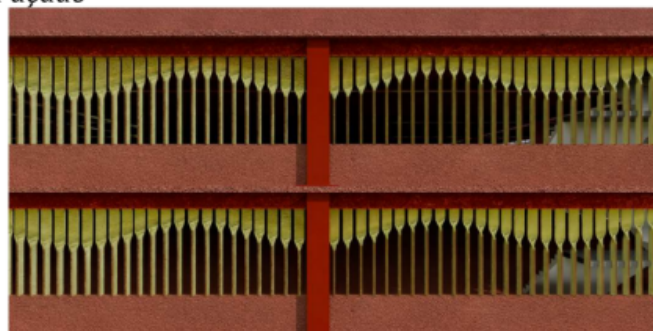
The CARIG Parking Building is a modern infrastructure project designed to integrate historical and cultural elements with contemporary architectural principles. The name CARIG, the wave-inspired facade, and the brown and yellow color scheme were deliberately chosen to reflect the deep historical roots, geographical significance, and cultural identity of Santiago City. This document provides a technical rationale for these design choices, drawing from historical references and architectural principles.

The name CARIG was selected as a tribute to the original name of Santiago City before Spanish colonization. Historically, Carig was an indigenous settlement primarily inhabited by the *Gaddang*, *Ibanag*, and *Ilongot* peoples, who lived along the riverbanks and plains of the region (Provincial Government of Isabela, n.d.).

By naming the building after Carig, the project honors the indigenous roots of Santiago City, reinforcing a sense of historical identity in modern infrastructure. As Carig was a vital area for trade and movement along river systems, the name symbolizes the parking building's role as a central hub for transportation and accessibility within the city. Using "Carig" in a contemporary structure bridges the past with the present, fostering an architectural dialogue between history and modernization (History of Santiago City, 2015).

The wave-inspired facade of the CARIG Parking Building was intentionally designed to represent the geographical and historical significance of Santiago City's River systems. These rivers were essential to early indigenous settlements and colonial economic development. The Cagayan Valley, where Santiago City is located, is known for its vast river networks, including the Cagayan River, which influenced the livelihoods of indigenous communities (Santiago City - The Queen City of the North, 2020). The waves symbolize these waterways, highlighting their role in the city's historical development. Beyond aesthetics, the wave design incorporates openings that allow natural ventilation, reducing the need for mechanical cooling inside the structure. The curved surfaces help diffuse sunlight, minimize glare, and create a more energy-efficient design (Yeang, 2008).

**Figure 31**  
*Wave-inspired Façade*



Brown represents the earth and land, reflecting the agricultural heritage of Santiago City (Provincial Government of Isabela, n.d.). The brown façade complements the surrounding urban and natural environments, reducing visual disruption in the cityscape (Porter, 2003). The bright yellow sun in the seal symbolizes hope, prosperity, and progress for Santiago City. In addition, yellow can be a striking color that contrasts with the surrounding colors, making the building stand out, while brown blends in.

**Figure 32**  
*Color Palette Used*



## Architectural Components

The architectural design of the proposed parking building complied with the provisions of the National Building Code of the Philippines and its implementing regulations. Since space is not limited by the lot's size, parallel parking was adopted. The first story of the parking building serves as an extension of the existing terminal; hence, the dimensions of the parking slots are adjusted to the minimum dimensions required by the National Building Code of the Philippines. The dimensions of the parking slot for buses will be 4.5 x 12m, 3m x 9m for jeepneys, 1.15m x 2.5m for motorcycles, and 3m x 5m for both public utility vans, 4.5m x 5m for PWD, and 3m x 5.5m for private vehicles.

A car stopper is integrated into each parking slot to guide drivers during parking, with dimensions of 0.15m x 2m x 0.15m.

## Structural Design and Specifications

### 1. Design Strength of Materials

The structural design for the building will utilize concrete with a compressive strength of 28 MPa (for slabs, footings, tie beams, and pedestals) and a standard class of AA concrete mix 1:1.5:3, ensuring high durability and strength. Reinforced steel bars to be used in the project are standard ASTM Grade 60 reinforcing bars with a diameter of 12 mm or greater, commercially available in the area.

Structural steel will be specified as ASTM A36 with a yield strength ( $F_y$ ) of 250 MPa and ultimate tensile strength ( $F_u$ ) ranging from 400 to 550 MPa. Structural steel was used for the structure's main members. According to Emile Troup and John Cross, structural steel is a superior choice for parking structures due to its lower construction and life-cycle costs, faster build times, and earlier occupancy. It enables greater parking efficiency with smaller columns and longer spans, while offering enhanced durability through advanced coatings and galvanizing. Steel structures require less maintenance, provide improved safety, visibility, and security, and are easier to expand or adapt to changing needs. Additionally, structural steel offers greater design flexibility, lighter weight that reduces foundation and seismic costs, and greater quality control through shop fabrication. It is highly sustainable, with over 95% of its components recyclable.

### 2. Design Loads

The design loads for the structure were based on the guidelines of the National Building Code of the Philippines (NBCP). This code provides comprehensive standards and

specifications for determining the appropriate loads, including dead, live, wind, and seismic loads, to ensure the safety and stability of buildings. By adhering to the NBCP, the design ensures compliance with national regulations. It addresses the specific environmental and seismic conditions present in the Philippines. The design loads are as follows:

#### *Dead Loads*

The dead load calculations were based on Section 204 of the National Structural Code of the Philippines 2015, which is composed of the minimum design dead loads of the following structural components:

Unit weight of structural steel: 77 kN/m<sup>3</sup>

Unit weight of concrete: 24 kN/m<sup>3</sup>

Floor Finishes: 0.24 kPa

CHB 6": 3.45 kPa

#### *Live Load*

The live load calculations were based on Section 204 of the National Structural Code of the Philippines 2015, which is composed of the minimum design live loads of the following structural components:

Parking garages and ramps: 4.8 kPa

Toilets: 2.4 kPa

#### *Wind Loads*

The wind loads were calculated using Section 107 of the National Structural Code of the Philippines 2015, composed of the following data:

Wind speed: 270 kph

Building Classification: Category IV

Exposure Category: Category B

#### *Earthquake Loads*

The National Structural Code of the Philippines, Section 208, was used to calculate the earthquake loads:

Occupancy Category: Category IV/Standard Occupancy

Importance Factor: 1

Seismic Zone: Zone 4, 0.4

Approximate Distance of site from the nearest fault: 0.15 km

Near Source Factor, N<sub>v</sub>: 1

Near Source Factor, N<sub>a</sub>: 1

Seismic Resistance Factor: R= 8

Seismic Source Factor: Category B

Ct Value: 0.0853

Torsion Factor: 1.0

Factor for Accidental Torsion: 5 %

Natural Torsional Moment: 1.0

### 3. Load Combinations

For LRFD (203.3.1, NSCP 2015)

1.4D

1.2D + 1.6L + 0.5 (Lr or R)

1.2D + 1.6 (Lr or R) + (f1L or 0.5W)

1.2D + 1.0W + f1L + 0.5 (Lr or R)

1.2D + 1.0E + f1L

0.9D + 1.0W

0.9D + 1.0E

For ASD (203.4.1, NSCP 2015)

D

D + L

D + (L or S or R)

D + 0.75L + 0.75 (Lr or S or R)

D + (0.6W)

### 4. Codes and References

The design of the structure was based on a range of well-established codes and standards, including the National Structural Code of the Philippines (NSCP), American Institute of Steel Construction (AISC) guidelines, the Uniform Building Code (UBC), and the American Concrete Institute (ACI) regulations. These codes were used to ensure the safety, strength, and long-term performance of the structure. The NSCP was used to meet local building requirements and address regional environmental factors and load calculations in the Philippines. In contrast, AISC standards were used for the steel design. The UBC was used primarily for seismic and wind forces, which are important in the area. ACI codes were followed for concrete design to ensure the proper strength, mix, and construction techniques. The basis for the soil bearing capacity that was used in the design conformed with the allowable foundation and lateral pressure provided by the NSCP found in Table 304-1.

## CONCLUSION AND RECOMMENDATIONS

### Conclusion

In conclusion, the researchers successfully gathered the necessary data to produce complete architectural and structural plans, as well as cost estimates, for the proposed parking building. The design complied with relevant Philippine standards and regulations, including the National Structural Code, the National Building Code, the Accessibility Law, and the Fire Code of the Philippines. Moreover, the researchers were able to meet the specific objectives of the study.

1. The researchers were able to identify whether establishments within the projected 350m radius meet the required number of parking slots as stipulated by the National Building Code of the Philippines. Additionally, they collected data on the average number of public utility vehicles parked at the terminal and the proposed site.

2. The researchers were able to design a four-story parking building, the first floor solely intended as a parking space for public utility vehicles, and the other floors for private vehicles. The building has a total building footprint of 4644 square meters, which can accommodate 24 slots for public utility vans, 24 for public utility jeeps, 16 for public utility buses, and 24 for public utility vans, and 477 for other types of four-wheel cars and motorcycles for the second, third, and fourth floors respectively. Therefore, the total number of parking slots in the proposed parking building is 541.
3. The researchers were able to present the overall cost of the proposed project, which costs ₱279,606,224.52. Additionally, the researchers presented the construction methodology and the duration of the proposed parking building. The proposed parking building is estimated to be completed within 324 calendar days.
4. The researchers were able to present the traffic analysis of the proposed parking building, which demonstrated the smooth flow of vehicles within and outside the structure, ensuring efficiency and safety in circulation. The traffic analysis highlighted the strategic placement of entrance and exit points to minimize congestion, enhance accessibility, and optimize traffic movement.
5. The researchers were able to present the return on investment of the proposed project, in which the parking building will be able to generate a gross income of ₱10,089,360.00 for the first year, ₱14,293,260.00 for the second to fifth year and ₱16,815,600.00 for the sixth year onwards. As a result, the expected return on investment of the building is 25 years.

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