

Sustainable Parking Facility with Green Building Standards

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Abstract: *This research focuses on designing a three-storey parking facility that adheres to the standards outlined in the Green Building Code. The aim of this project is to address the escalating issue of inadequate parking space within the City Hall Compound. Positioned behind the City Health Building, the parking facility is strategically located within the confines of the City Hall Compound. Numerous considerations come into play when devising the research design. These factors encompass the assessment of the construction site's condition, as well as elements such as the project's scope of work and cost analysis. These components collectively formulate a budgetary framework and construction timeline. In the process of developing this project, data pertaining to the land area and the volume of vehicles were amassed. These statistics played a pivotal role in the strategic planning and architectural design of the parking facility. The project's viability and accomplishment were subsequently evaluated. Upon analyzing the outcomes, the researchers determined that the parking facility effectively aligns with the principles of the Green Building Code, highlighting its commitment to sustainable materials and indoor environmental quality. Furthermore, owing to its capacity, the three-storey parking facility aptly addresses the parking space scarcity issue at the City Hall Compound.*

Keywords: green building, parking, facility, sustainable

I. INTRODUCTION

Parking structures play a vital role within the urban landscape [1]. Originally pragmatic and unremarkable, these structures have undergone a transformation into versatile, aesthetically appealing edifices that harmonize with their surroundings [2]. Increasingly, proprietors recognize that parking provisions often shape visitors' initial and final impressions [3]. Inarguably, given the dominance of automobiles, parking is an imperative facet of modern living [4]. The significance of parking goes beyond mere utility, extending to sustainable urban development [5]. By curtailing land consumption, promoting efficient land usage, enhancing transportation modes, and augmenting open spaces, parking facilities contribute to the broader sustainable objectives of a project site [6]. This harmonization of parking infrastructure with ecological and urban planning goals underscores their multifaceted importance [7].

In 2018, the Land Transportation Office (LTO) in Manila recorded a substantial rise in motor vehicle registrations, reaching 11.6 million, up from 10.5 million in the previous year [8]. This surge in vehicle ownership has accentuated the challenge of parking due to the escalating number of private vehicles and their integration into the broader transportation network [9]. Locating suitable parking spaces has evolved into a daily struggle for many, particularly during specific events, leading to extended search times and inconvenience [10]. To enhance the convenience of drivers, the establishment of public parking lots with well-marked spaces has been advocated [11]. Addressing these concerns, the Proof-of-Parking Space Act aims to regulate vehicle acquisition within Metro Manila by necessitating the purchase of a parking space concurrently with the vehicle [13]. The Act further assigns responsibilities to the Land Transportation Office, the Metro Manila Development Authority, and local government units for consistent monitoring of major and minor thoroughfares within the National Capital Region, with the goal of eliminating unauthorized parking and enforcing penalties for non-compliance [14].

In 2019, Delgado conducted a study titled "Urban Mobility Challenges in Megacities: The Case of Metro Manila, Philippines," which delved into the intricate issues surrounding urban mobility in megacities like Metro Manila [15]. Dizon, in 2017, contributed research titled "Improving Parking Management Strategies in Metro Manila," which

focused on enhancing parking management approaches within the context of Metro Manila [16]. Additionally, Garcia's work titled "Assessing the Traffic Congestion in Metro Manila, Philippines," published in 2020, assessed the prevalent traffic congestion in Metro Manila [17].

The Land Transportation Office (LTO) provided pertinent data through their "Motor Vehicle Registration Statistics" report of 2018, showcasing the numerical trends in motor vehicle registrations in Manila [18]. The legislative sphere addressed the parking issue with the "Proof-Of-Parking Space Act," Republic Act No. 11229, promulgated in 2020 by the Philippine Congress [19]. Prior to its enactment, the Senate of the Philippines introduced the pertinent legislation as "Senate Bill No. 201" [20].

The Green Building concept endeavors to enhance building performance efficiency by employing a comprehensive framework of established standards. These standards are designed to foster a harmonious environment and resource management strategy, countering the emission of detrimental gases responsible for climate change's adverse impacts. This comprehensive approach covers every phase of a building's existence, encompassing resource optimization, site selection, planning, design, construction, utilization, occupancy, operational procedures, and maintenance. All these aspects are incorporated while minimizing undue cost escalation [21].

The Green Building Code, herein referred to as the GB Code, prescribes a set of regulations that stipulate baseline standards for adherence. However, it's important to note that the code does not function as a building rating system but instead as a mechanism to ensure compliance [22]. By following the principles of sustainability and environmental responsibility, the GB Code safeguards the environment, public health, property, and the overall welfare of the community[23].The escalating population growth, accompanied by a corresponding surge in vehicle numbers, poses significant challenges in effectively controlling traffic flow, especially on the narrow streets of Surigao City [24]. Notably, the congestion issue is compounded by the heavy presence of parked vehicles within the City Hall compound, leading to severe overcrowding [25]. The situation is further exacerbated by the fact that a substantial portion of the workforce relies on commuting, thereby adding to the vehicular influx [26].

Given these concerns, the research initiative seeks to devise an innovative solution. The primary objective is to formulate an aesthetically appealing, utilitarian, and long-lasting three-storey parking facility, meticulously crafted in accordance with green building standards [27]. The envisaged outcome of this study holds potential as a practical remedy for the congestion plaguing narrow roads. By creating a designated parking structure, the pressure on street parking will be alleviated, thereby restoring traffic flow and easing the burden on commuting workers.

II. METHODS

The progression of this study, outlined in Figure 1, delineates its chronological course from inception to culmination. The initiation phase entails the precise measurement of the designated lot area coupled with comprehensive data collection. This phase is pivotal, as it establishes the foundational information required to determine the viable construction area for the forthcoming parking facility.

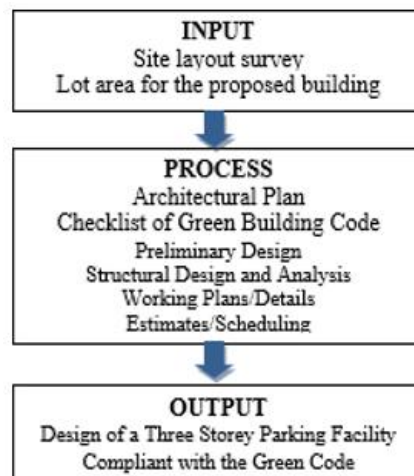


Figure 1.Flowchart of the Study

Sequentially, this is followed by the meticulous formulation of an all-encompassing blueprint. This blueprint is meticulously curated to align harmoniously with the National Building Code of the Philippines (NBCP), the overarching prerequisites of the Local Government Unit (LGU) of Surigao City, and the rigorous standards set forth by the Green Building Code. The subsequent step involves the development and examination of a Structural Design and Analysis, indispensable for ensuring the robust structural configuration that anticipates and counteracts imposed loads. As a continuum, the creation of Working Plans/Details transpires subsequent to the Design and Analysis phase. The scheduling of construction endeavors employs the PERT/CPM methodology to ensure optimal efficiency. In parallel, an essential cost estimate exercise is conducted to allocate the requisite budget for the project's execution. The culmination of this research effort materializes as the realization of a meticulously crafted Design for a Three-Storey Parking Facility, meticulously aligned with the tenets of the Green Code, strategically situated behind the City Health Building.

2.2 Project Design

As depicted in Figure 2, a pivotal determinant revolves around adherence to the Green Building Code, underscoring the imperative of aligning the structure's design with its stipulated requisites and benchmarks. Furthermore, meticulous consideration is extended to the optimal site selection and location of the proposed Parking Facility, necessitating the implementation of a comprehensive site survey to inform decision-making. The outcomes stemming from the computer program analysis assume a central role in shaping the subsequent plans and specifications, imbuing them with analytical precision. To facilitate prudent resource allocation, the comprehensive cost estimate process plays a crucial role in establishing a comprehensive budget allocation for the envisioned parking facility. By employing the PERT-CPM methodology, a reliable projection of the anticipated number of working days is ascertained, contributing to effective project scheduling. The Program of Works encompasses an insightful visual representation of cumulative costs, labor hours, or other pertinent quantities plotted against the temporal axis, aptly visualizing the progression of the project's resource allocation over time.

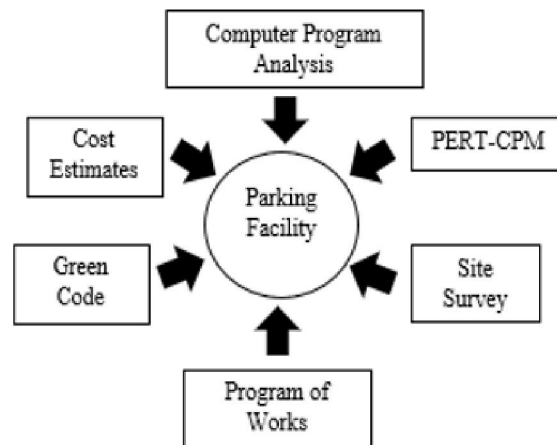


Figure 2.Project Design Chart

2.3 Project Setting

The forthcoming parking facility is set to emerge as a fresh addition within the premises of the Surigao City Hall Compound. This new structure is poised to serve a dual purpose, catering not only to the parking needs of the employees but also extending its convenience to the clients. Situated at the geographical coordinates of 9.7914° N and 125.4935° E, the Surigao City Hall's location will be enhanced by this essential addition.



Figure 3. Location of the Project

2.3 Instruments

The researcher harnessed a variety of software applications to bring this study to fruition. These included:

- **Microsoft Office Suite:** This encompassed Microsoft Word, Microsoft PowerPoint, and Microsoft Excel. These tools streamlined the process of generating reports, documents, PERT-CPM diagrams, and Construction Estimates, significantly enhancing efficiency and convenience.
- **Drafting Software:** Employed for creating both two-dimensional and three-dimensional models and drawings, this software is invaluable in the design phase. It empowers draftsmen to craft lines and figures with enhanced ease, particularly for time-sensitive elements. This tool is particularly instrumental in developing structural plans.
- **Graphic Software:** Functioning as visualization software, it transforms drawing models into images or videos that simulate real-life environments with a touch of artistic finesse. This software is particularly useful for generating video clips that comprehensively depict the scope of the entire project study.
- **Structural Design Software:** Engineered for the analysis, modeling, and design of structures, this software simplifies complex engineering tasks. Unlike manual computations that are time-consuming and susceptible to human error, this software expedites the process while ensuring precision in calculations.

By harnessing this array of software tools, the researchers not only accelerated their tasks but also improved the accuracy and quality of their outputs.

2.4 Ethical Considerations

During the execution of the project study, the researchers were diligent in avoiding any breach of legal and environmental regulations. Additionally, they placed a significant emphasis on the ethical dimension, with particular attention to the human aspect. This ethical consideration underscores an evaluation of how the project design influences human involvement and its impact.

III. RESULTS AND DISCUSSION

The researcher conducted an analysis of a structure, utilizing the measured lot area as the foundation for their assessment. An essential aspect of the parking facility's design was ensuring accessibility for Persons with Disabilities (PWD). In crafting the structure's design, strict adherence to both the National Structural Code of the Philippines (NSCP) and the Green Building Code was imperative. To aid in visualization, graphic software was employed,

resulting in the perspective view depicted below. This Three-Storey Parking Facility design has been conceptualized by the research team.



Figure 4.Perspective View of the Project

3.1 Compliance to Green Building Code

Embedded within the BERDE Program is a foundational framework delineating various essential credits pivotal to the development of a green building initiative. Among these frameworks lies Energy Efficiency and Conservation, encompassing strategies for the oversight, curtailment, or eradication of undue energy consumption within the project. The following dataset necessitates careful consideration:

TGFA (Total Gross Floor Area): 4,480m² Projected Occupancy Rates

Number of occupants per 8-hour shift: 30 Number of 8-hour shift in a project: 391

Energy consumption in (kWh)

As a minimum system requirement, projects registered under BERDE must submit data on the use of energy, water, materials and generated waste for the project.

TABLE 1: ENERGY EFFECIENCY AND CONSERVATION CHECK LIST

Credit	Complies the Green Building Code
Energy Consumption Reduction	✓
Energy Monitoring	✓
Natural Ventilation	✓
Use of Renewables	✓
Energy Efficient Lightning	✓
Energy Efficient Building Envelope	
Energy Efficient Air-Conditioning System	✓
Building Automation System	✓
Electrical Equipment Maintenance	✓

3.2 Parking Space Occupancy

As illustrated in Table 2, the City Hall Compound consistently accommodates an average of 86 vehicles within its confines. The envisaged three-storey parking facility has the capacity to house 20 motorcycles and 46 four-wheel vehicles, in addition to offering 8 dedicated parking spaces designed exclusively for persons with disabilities.

TABLE 2: OCCUPANCY OF THE FACILITY

Type of Transportation	Floor Area				Standard Area	Total No. of Occupancy
	Ground Floor	2 nd Floor	3 rd Floor	Total Area		
PWD (2.2 m x 6m)	80 m ²	-	-	80 m ²	13.2 m ²	6
Motor (1.25 x 2.75 m)	21 m ²	25 m ²	25 m ²	71 m ²	3.44 m ²	20
Car Vehicle (2.2 x 6 m)	185 m ²	185 m ²	238 m ²	608 m ²	13.2 m ²	46
Total	286 m ²	210 m ²	263 m ²	759 m ²		72

The parking facility's capacity to accommodate vehicles falls short of that available at the City Hall Compound. Additionally, according to data in Table 3, there is a notable increase of 46.83% in the number of vehicles using the parking facility compared to those at the City Hall Compound. Assessing the parking facility's performance, it has not yet met the required demand for parking space. However, it does contribute to mitigating the escalating issue of parking space inadequacy. In terms of its suitability, this facility represents a fitting solution by offering an environmentally conscious approach to the parking space challenge, aligning with the Green Building Code.

TABLE 3: OCCUPANCY OF THE NEW FACILITY

Type of Transportation	Number of Occupancy		Percentage
	City Hall	Three-Storey Parking Facility	
PWD	8	6	3.79%
Motor	30	20	12.66%
Car Vehicle (4 Wheels)	45	46	30.38%
Total	86	72	46.83%

Giving careful attention to all tasks is crucial, encompassing activities like clearing and layout planning, structural excavation, pouring of structural concrete, installation of reinforcing steel, execution of masonry tasks, application of cement plaster finish, completion of tile works, implementation of carpentry projects, fitting of doors and windows, execution of plumbing tasks, handling of electrical aspects, and carrying out painting jobs. These estimates encompass provisions for contingencies, overhead costs, and miscellaneous expenses, which facilitate various financial needs, including those associated with the processing of legal documentation prior to, during, and after the construction phase. Furthermore, the researcher is introducing additional dimensions and innovative approaches to ensure the parking facility aligns with the standards stipulated by the Green Building Code.

IV. CONCLUSIONS AND RECOMMENDATIONS

4.1 Conclusions

- The analysis confirms that the three-story parking facility adheres to the design specifications outlined in the National Structural Code of the Philippines (NSCP) and the Green Building Code for elements such as slabs, beams, columns, and footings.
- Additionally, it is established that the parking facility predominantly caters to the vehicles located at the City Hall Compound. This heightened occupancy capacity effectively mitigates the vehicular congestion within the area.

4.2 Recommendations

- It is advisable to expand the selection of materials considered for the decision, rather than confining the choices solely to those accessible within the country.
- It is also recommended to adapt new construction method for a higher efficiency of the project.

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