Urban Sheds: Enhancing Walkability through Green Sheltered Walkways in Del Pilar Street, Cabanatuan City

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Urban sheds are envision as green corridors that include vegetation and landscaping components to produce a more aesthetically pleasing and environmentally friendly urban environment. Adding more green spaces not only makes the city look nicer, but it also helps cool down the area and clean the air. This research focuses on the urban enhancement of Cabanatuan City's walkable streets, suggesting the installation of green covered walkways on city streets. The goal of this study is to develop a network that connects main roads, parks, and suburbs, making walking a leisure activity. Through an in-depth review of case studies, design principles, and the repercussions on community well-being, the study aims to provide substantial information to urban planners, builders, and policymakers. The creation of urban sheds, as a multifaceted approach to urban development, not only addresses the practical need for heat relief but also promotes the shift toward sustainable and active modes of transportation. This research contributes to the discourse on urban design by presenting a concept of tangible solution for Del Pilar Street, Cabanatuan City unique climate challenges, emphasizing the potential ripple effects on public health, environmental sustainability, and overall urban vibrancy.

Keywords: Green Corridors; Greenery; Urban Heat Island Effect (UHI); Urban Sheds; Walkability.

1. Introduction

As urbanization accelerates globally, the challenges of accommodating growing populations while maintaining the quality of urban life have become increasingly complex. One of the key facets of urban planning that significantly influences the overall urban experience is walkability. The concept of walkability encompasses various factors such as accessibility, safety, and the presence of amenities, all of which contribute to creating pedestrian-friendly environments. Recognizing the need for innovative solutions to enhance walkability, the

research explores the potential of "Urban Sheds" as a transformative approach to urban infrastructure.

The term "urban sheds" refers to sheltered walkways that go beyond mere utilitarian structures. These walkways are envisioned as green corridors, incorporating vegetation and landscaping elements To make the city more attractive and environmentally friendly, adding green spaces not only makes the area look better but also helps cool things down, clean the air, and support wildlife.

The focus of the research is to explore the way urban sheds in Cabanatuan City, Philippines, contribute to walkability. Through an in-depth review of case studies, design principles, and the effects on community well-being, the study aims to provide helpful insights to city planners, builders, and government leaders.

As cities around the world face the challenge of creating sustainable urban growth, the exploration of innovative concepts like Urban Sheds holds promise for reshaping the urban landscape to be more pedestrian-friendly, environmentally conscious, and socially inclusive. This research endeavors to contribute to the discourse on urban planning and design, offering a holistic understanding of the implications and benefits associated with the integration of green sheltered walkways in the pursuit of enhanced walkability in urban environments.

Input Process Output (IPO) was used in the conceptual framework of this study. It was produced mainly from the objectives of this research. This project main objective is to enhance walkability through green sheltered walkways in Del Pilar St., Cabanatuan City. This suggests that through this objective and proper consideration of local needs, a viable output will be achieved as shown in the figure 1.
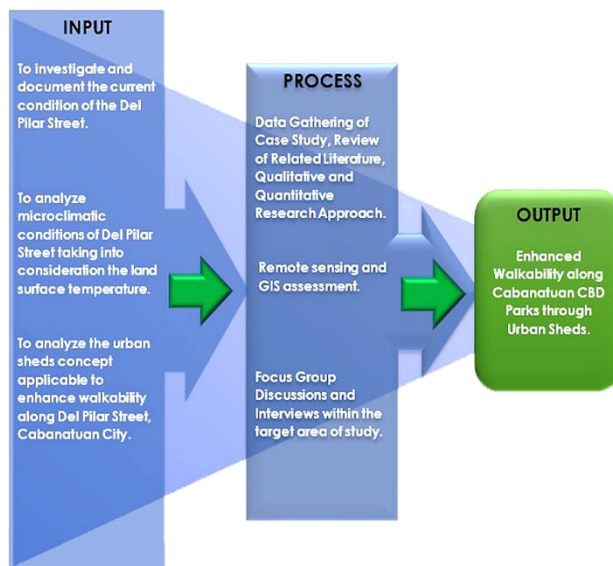

Fig. 1 The Research Followed A Specific Conceptual Framework.

2. Literature Review:

The researcher collects all the related papers and publications that were considered in establishing the importance of the current investigation. It also gives the synthesis of the idea so that to appreciate the research and get a better understanding of the investigation.

Urban Green Spaces Affect City Temperatures. Urban green spaces help cool down the city and make nearby areas more comfortable. Not only do they cool the green areas themselves, but they also have a cooling effect on their surroundings, known as the urban green space cooling effect. For city designers and planners, it is important to consider how intense and widespread this cooling effect is when dealing with the urban heat island problem [9]. Therefore, the urban green patch is an important part of some ecological systems in the adjustment of urban thermal environment, an improvement in urban climate, and the conservation of the urban ecological environment through alteration of the atmospheric water thermal cycles. One suggested adaptation measure for these projected health impacts of ongoing climatic changes has been to increase vegetation abundance and cover in cities, and public access to these 'green' areas. Finally, city green space is linked to citizen happiness because it fosters citizens' physical and mental health [2].

Walkability and Street Mobility. Walkability and mobility is a concept in urban planning. The term is built on the concept of offering healthy communities with reduced reliance on automobiles and increasing health consciousness to people. (Eltanal, 2019) Furthermore, the reliance on automobiles contributes to carbon dioxide emissions. This should be reduced to lessen greenhouse gases. A better alternative would be encouraging the use of bikes and safe pedestrian walkways as an initiative to a cleaner and greener city. (Sanchez, 2021) Walkability can also be improved by adopting Designing artificial shade in cities to be more sensitive to weather and climate changes is becoming more important as we face climate change [8]. A five-minute walk from residential areas to Pocket Green parks can also increase mobility and walkability by reducing the friction of distance. Pocket green parks act as nodes wherein people could interact and do activities.

Mitigating Urban Heat Island Effect. Adding walkways to city roads helps people get around and gives them more places to enjoy, but it can also make the area hotter and potentially unsafe for pedestrians. Plants that can provide appreciable shade beside walkways should be considered by researchers in order to increase comfort during hot weather. (Peralta, 2021) It is also suggested that natural shaded walkways should be provided to protect the pedestrians from the intense summer heat. This will also help in bringing down the temperature, CO2, create a buffer and filter for the air, noise pollution, danger from cars, etc. (Baidango, 2021) All these just go to prove the necessity of designing a pedestrian-friendly city.

Sustainable Urban Heat Island Mitigation Strategies. Adding green features and using eco-friendly materials in busy city areas can help cool things down and reduce the heat island effect. This includes using reflective pavement, light-colored paint, special materials that change with temperature, and energy-efficient appliances like coolers and air conditioners. Green infrastructure also covers things like green roofs, walls, parking lots, pavements, and shaded streets [1].

Walkable, Bikeable, and Livable Cities. Many benefits accompany more walkable and

bikeable urban environments: safer, friendlier streets; reduced air pollution and greenhouse gases; fewer traffic jams; and generally, an excellent source of physical activities. Some of the key objectives include increased pedestrian infrastructure, better signage and maps, more crossings for pedestrians, promotion of walking routes, timed road closure to automobiles and car-free days, and thousands to be allowed to walk to school. (Felino Palafox Jr., 2022)

Green Cities are Walkable Cities. This explains how tactical urbanism interventions, such as replacing carriageways with vegetation surrounding footway buildouts and crossings, can improve walking routes while also reducing the width of pedestrian crossings and streets, which calms traffic. Research in Australia shows that people who live in areas with lots of green space are more likely to walk and stay active [7].

Health Impact Assessments of Walkability and Urban Built Environments. This study elaborated on the detailed conduction of a health impact assessment of a project, initiative, or program that undertakes the objective of improving walkability within urban built environments. Walkability refers to the characteristic of urban built environments that enhance pedestrian mobility and physical activity. Most of the HIAs assess the impact of active or public transportation enhancement. Other details about walkability are often overlooked. However, most Health Impact Assessments (HIAs) that have been done show that better walkability generally leads to improved health, like reducing the risk of early death and chronic diseases [3].

Perceived heat stress in the Philippines. Rising temperatures can cause heat stress, even indoors, especially in places without air conditioning. This kind of stress is a major health concern, affecting people's well-being and productivity, which can lead to significant economic losses. This study looks at how heat affects people in cities across the Philippines, using responses from an online survey with 1,161 participants. Turning to the results, it turned out that almost the entire population, 91% of the respondents, were already experiencing heat stress rather badly, and heat stress gets worse as more people live in a smaller area. In a study that took various factors into account, people living in areas with fewer than about 7,000 people per square kilometer experienced less heat stress. Air conditioning at home helped people in less crowded areas, but not so much for those in more crowded areas. There was no difference in heat stress based on air conditioning use at work. The findings highlight how rising temperatures in cities affect people socially, in addition to the well-known physical impacts like the urban heat island effect [10].

Enhancing Pedestrian Walkability in Summer Sunny Conditions. Outdoor spaces are becoming increasingly important for quality of life as cities grow rapidly, but studies on walkability in hot and humid countries often overlook how weather affects people. This study looked at how different weather factors influence people's walking habits and tested how a shaded walkway could improve comfort. The walkway had aluminum fins and a tinted glass cover, creating sunny and shady areas. By measuring factors like the Physiologically Equivalent Temperature (PET) and the Universal Thermal Climate Index (UTCI), the study simulated how people feel temperature-wise. It found that the shaded area received 90% less solar radiation than the sunny area and had significantly cooler temperatures. The shaded zone also had a more comfortable heat experience compared to the sunlit zone, where people felt much hotter. Overall, shaded areas were shown to be preferred. Pedestrian preference for

shaded zones was highly correlated with both gender and age, specifically female and elderly. A biometeorological approach to comprehending walking behavior and pedestrian-friendly infrastructure may be sparked by the findings. Artificial shade that is designed with biometeorological sensitivity may make cities more walkable, as the need to prepare for climate change grows [8].

3. Research Methods:

Mixed-methods research refers to combining qualitative and quantitative approaches in one study. Using mixed-methods research methods involves gathering and analyzing qualitative and quantitative data concurrently or sequentially with an emphasis on integration for added comprehensiveness. Such decisions to adopt mixed methods, however, are many times realized by the assertion that what will come out is a stronger picture with better insight into the research topic. (Tegan George, 2021)

Data Gathering Methodology. The study took place on Del Pilar Street, which is surrounded by two city parks. Researchers used different methods to collect data, including surveys and questionnaires for numerical data, and focus groups and interviews for more detailed feedback. They focused on people living near Del Pilar Street in Cabanatuan City. For sampling, they randomly chose 250 people from a total of 5,218 residents across six nearby barangays. The study involved counting responses, calculating percentages, and finding averages. The main goal was to draw conclusions about the current conditions on Del Pilar Street based on this data.

The data will be pre-analyzed with frequency counts, percentages, and weighted means. The weighted mean will be described orally, along with a formula, and the following tables:

$$\bar{x} = \frac{\sum_{i=1}^{n}(x_i * w_i)}{\sum_{i=1}^{n} w_i}$$

Equation 1. Weighted Mean Formula. Image from https://www.statisticshowto.com/wp-content/uploads/2014/01/weighted-mean-formula.jpg

VD	WM	Range	Notes
SA - Strongly Agree	4.20-5.00	5	
A - Agree	3.40-4.19	4	
MA - Moderately Agree	2.60-3.39	3	
D - Disagree	1.80-2.59	2	
SD - Strongly Disagree	1.00-1.79	1	

Table 1. Verbal Description, Weighted Mean, and Range were used for Physical Characteristics as Causes of Unused Walkways.

VD	WM	Range	Notes
Warm	4.20-5.00	5	
Slightly Warm	3.40-4.19	4	
Neutral	2.60-3.39	3	
Slightly Cool	1.80-2.59	2	
Cool	1.00-1.79	1	

Table 2. Verbal Description, Weighted Mean, and Range were used for Thermal Comfort Level

Remote sensing and GIS assessment. Using remote sensing and GIS technology helped map out how urban surface temperatures change over time and space. The findings from this study can be used to better plan and manage cities by considering both environmental and health factors to control the urban heat island effect. (Gemes, Tobak, and Leeuwen, 2016) The researcher then remotely extracted LST and temperature values for the data sets from the satellite photos dated from launch dates and commissioning dates up to the present. These data can be used in ascertaining urban heat island trends over time rather than taking on-ground measurements within the study area.

Observation. Site visitation and observation are another appropriate method in this study used for data collection regarding the possible locations of the Urban Sheds.

Focus Group Discussion. The FGD is a group interviewing process, although it is moderated or guided by one moderator or interviewer who leads the discussions among the members of a small group of 10-12 people on different points raised about the topics of interest. According to Lokanath Mishra, 2016, the FGD technique will let the researcher elicit a large amount of data within a very short period.

Interview. An unstructured interview was conducted by the proponent with some selected organizations, facilitators, and individuals concerned in the fields of planning and ordinances. This is a qualitative study whereby questions are framed to ask about perspectives, opinions, belief, or ideals. (Herd, 2016)

Photographic documentation. This involves, among others, the display of images of sites and maps. The act of recording the images in photography to preserve some events is called photographic documentation. This type of documentation is important for works that will later be covered out of sight.

4. Result:

Investigation and Documentation of the Current Condition of the Del Pilar Street: The data is shown in tables and explained in detail. Table three shows the ages of the respondents. Most of them are between 15 and 25 years old, making up 66% (165 people) of the total. The next largest group is those aged 26 to 40, which is 28% (70 people). The smallest group is those 41 and older, representing 6% (15 people). This means that most respondents are in the 15 to 25 age range.

The Age Distribution of the Respondents			
Age	Frequency	Percentage	Rank
15-25 yrs. old	165	66 %	1
26-40 yrs. old	70	28 %	2
41 yrs. old and above	15	6 %	3
Total	250	100 %	

Table 3. The Age Distribution of the Respondents.

Table 4 shows the breakdown of gender among the 250 respondents. According to the data, 140 people, or 56%, are male, and 110 people, or 44%, are female. This means there are more male respondents, but the difference between males and females isn't very large.

The Gender Distribution of the Respondents			
Gender	Frequency	Percentage	Rank
Male	140	56 %	1
Female	110	44 %	2
Total	250	100 %	

Table 4. The Gender Distribution of the Respondents.

Table 5 shows the education levels of the respondents. According to the table, 120 people, or 48%, are college graduates. The next largest group is high school graduates, with 115 people or 46%. Fifteen people, making up 6% of the total, have a Master's Degree.

The Educational Level Distribution of the Respondents			
Education level	Frequency	Percentage	Rank
High School Graduate	115	46 %	2
College Graduate	120	48 %	1
Master Degree	15	6 %	3
Total	250	100 %	

Table 5. The Educational Level Distribution of the Respondents

Table 6 shows the results of a survey on the physical features of the study area. It reveals that the biggest issue reported by respondents is the lack of walking sheds. Other concerns include the absence of safety barriers and narrow walkways. While respondents also noted problems like missing road markings, lack of traffic equipment, missing warning signs, damaged pavements, and faded pedestrian lanes, these issues are considered less urgent. Overall, the average score of 3.80 indicates that respondents generally agree that the physical characteristics of the street contribute to underused walkways on Del Pilar Street.

Physical Characteristics as Causes of Unused Walkways			
No.	Statement	WM	VD
1	Absence of impediments to safety	3.94	A
2	Absence of signage on roads	3.80	A
3	Insufficient walking sheds	4.02	SA
4	Narrow walkways/pathwalks	3.92	A
5	Shop close to the walkways where there are no parking spots.	3.86	A
6	Absence of traffic signals and other equipment	3.54	A
7	Lack of warning signs	3.84	A
8	Unrepaired diggings /canals	3.74	A
9	Cracked and Uneven walkways pavement	3.76	A
10	Wiped off pedestrians lanes	3.60	A

Total Average Weighted Mean	3.80	A

Table 6. Physical Characteristics as Causes of Unused Walkways along Del Pilar Street.

Table 7 shows how comfortable people felt walking along Del Pilar Street near Freedom Park and Plaza Lucero. They were asked to rate their comfort as warm, slightly warm, slightly cool, or cool. In the morning, people felt slightly warm. By noon and in the afternoon, they felt warm. Overall, the average rating was warm, which suggests that people felt quite warm throughout the day. This discomfort is one reason why the walkways on Del Pilar Street aren't used more.

Thermal Comfort Level			
Time of the day	Weighted Mean	VD	Rank
Morning	3.76	Slightly Warm	1
Noon	4.90	Warm	2
Afternoon	4.86	Warm	3
Total Average Weighted Mean	4.50	Warm	

Table 7. Thermal Comfort level along Del Pilar Street.

Microclimatic Condition of Del Pilar St. taking into Consideration the Land Surface Temperature (LST): The data is collected using remote sensing and GIS technology, which are useful tools for tracking how city temperatures change over time and in different areas. This information can help with city planning and management by considering environmental and health factors and controlling the urban heat island effect. (Gémes, Tobak, & Leeuwen, 2016)

Cabanatuan City is one of the hottest cities in the country, with temperatures going up a lot between 2010 and 2022. Figure 3 shows a graph of the city's lowest, highest, and average temperatures during this time. The average temperature increased from 25°C in 2010 to 35°C in 2022.
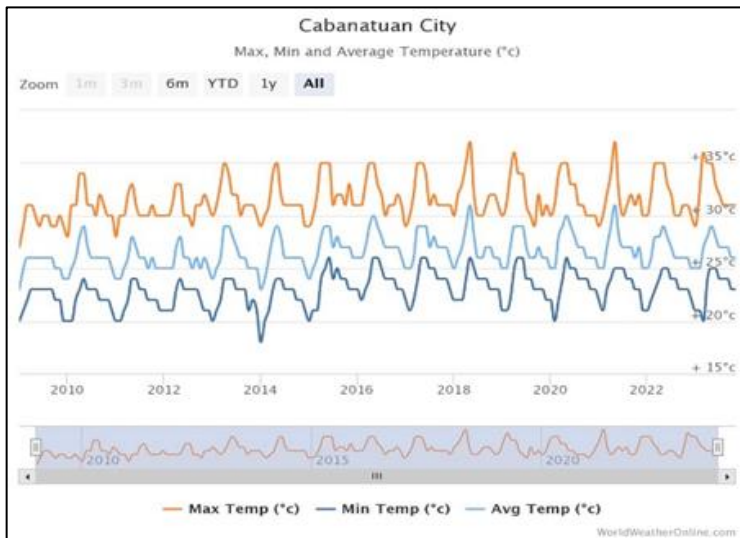

Figure 3. Minimum, Maximum, and Average temperatures of Cabanatuan City from 2010 to
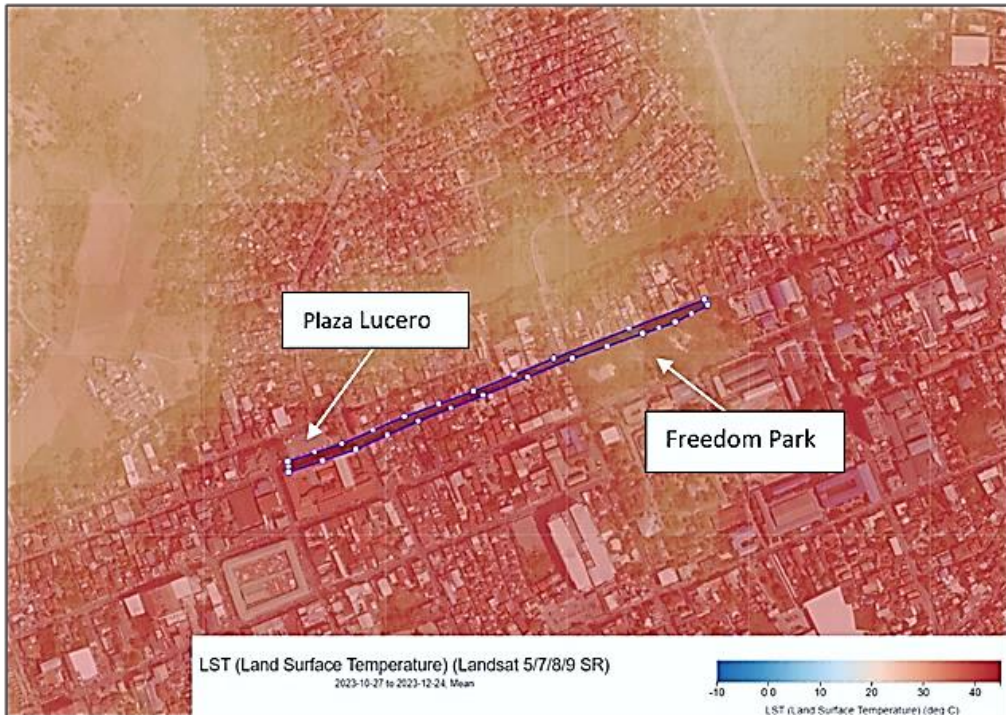
2022. Image from https://www.worldweatheronline.com.

Figure 4. LST data of Cabanatuan City with Del Pilar Street Custom Polygon Region. Image from https://app.climateengine.org/climateEngine

Land Surface Temperature (LST) data sets could be accessed from Landsat 5, 7, 8, and 9 satellites for the years 1984 to now. However, because these satellites only update their data every 16 days, daily readings aren't available. The image and the selected area can be used to create a summary of the data for January to December 2023, which is shown in the table below.

LST (MEAN)			
Month	Degree Celsius	Rank	Notes
January, 2023	43.10	8	
February, 2023	40.25	12	
March, 2023	46.80	5	
April, 2023	52.55	1	
May, 2023	48.73	3	
June, 2023	40.84	9	
July, 2023	40.74	10	
August, 2023	49.43	2	
September, 2023	45.12	6	
October, 2023	46.94	4	
November, 2023	40.49	11	
December, 2023	43.14	7	
Mean	44.84		

Table 8. Mean Land Surface Temperature for January-December 2023.

Table 8 shows the average LST from January to December 2023. A mean of 44.84 °C from January to December 2023 was measured, as seen in the graphical representation of the mean LST in figure 5.

Figure 5 shows the average temperatures along Del Pilar Street from January to December 2023. It helps us see how temperatures change over the year. The highest temperature recorded was 52.55°C in April, which contributes significantly to the urban heat island effect in the area. This extreme heat affects pedestrian comfort and can make walking less appealing. As temperatures rise due to global warming and heat from the city, it makes walking and staying safe more difficult, which is why people might avoid walking along Del Pilar Street, even though it connects to Freedom Park and Plaza Lucero.
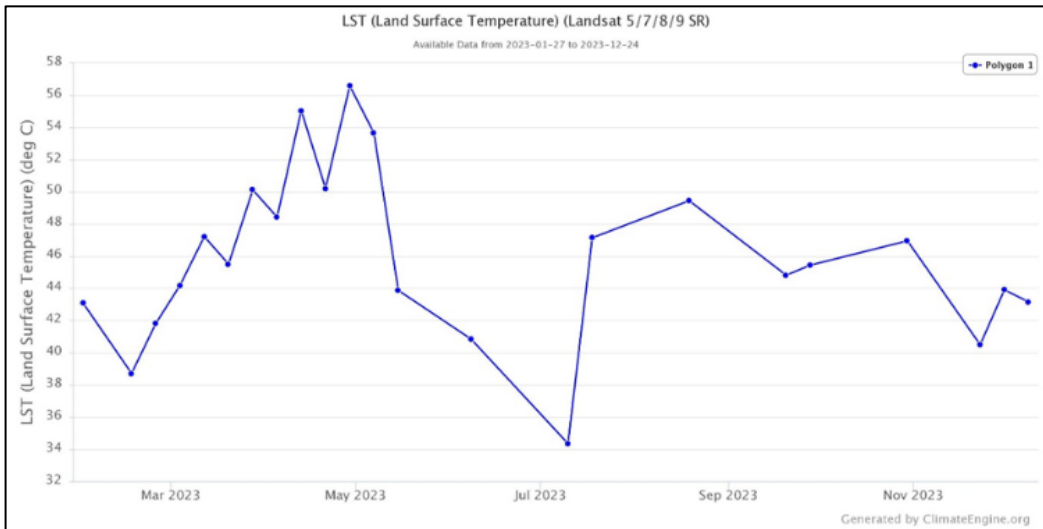

Figure 5. Line Plot of LST data along Del Pilar Street Custom Polygon Region. Image from
https://app.climateengine.org/climateEngine

4.3 Urban Sheds Concepts: Green areas are a significant feature influencing walking environments. (Park & Kwon, 2023) Green spaces help cool down the city and make it more comfortable. They also improve safety on narrow sidewalks and make the area look nicer, which encourages people to walk more. This greenery is integrated into the urban shed as green-sheltered walkways in order to enhance walkability along Del Pilar Street (Figure 7). Many of the respondents in that area of study agreed during the interview that they are all uncomfortable walking from Freedom Park to Plaza Lucero or vice versa. Respondents preferred to commute on public transportation and ride their own vehicles in order to escape the extreme heat outside.

The best way to lower temperatures is by reducing the amount of sunlight that hits people or the ground. This can be done with plants or shading structures, and it works well in all kinds of climates, from mild to very dry areas. (Rizzetto, 2016) According to Ar. Gregorio L. Villaviza Jr. (2023), adding green-covered walkways will create a green connection between Freedom Park and Plaza Lucero, benefiting more residents and visitors. It's important to expand the current parks to make this happen. The main advantage of these walkways will be
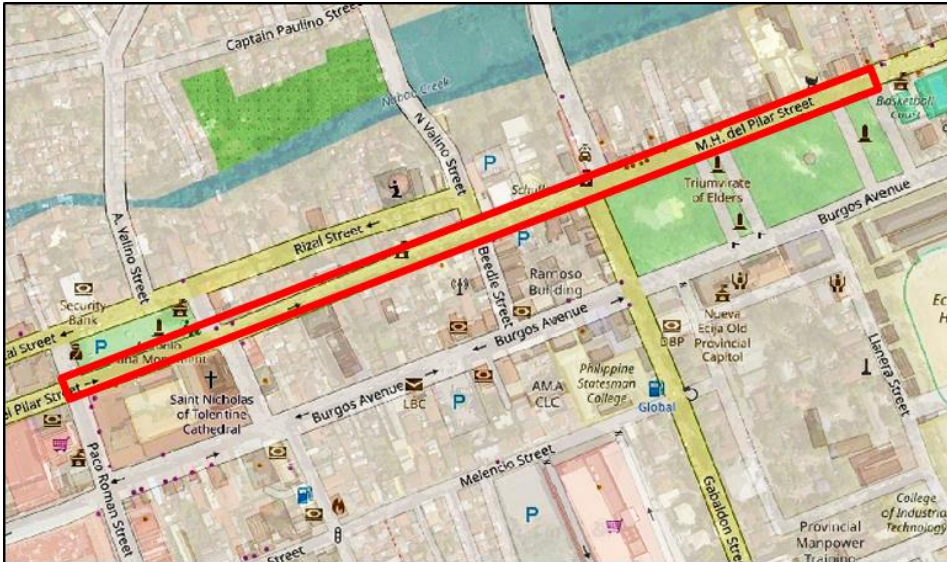
the health benefits they offer from walking.

Figure 6. Freedom Park (right) and Plaza Lucero (left) along Del Pilar Street. Image from https://www.openstreetmap.org/

The focus group discussion (FGD) method helps researchers gather a lot of information quickly. A moderator, who leads the group discussion to learn more about a specific topic, brings people with similar interests together. (Krueger, R. A. 1988) The moderator asked open-ended questions during the interview phase. In terms of the FGD results on the urban sheds that will be used along the sidewalks of Del Pilar Street, ten (10) participants provided positive feedback on the urban shed concept. The ability of the urban shed to enhance and encourage walkability for visitors and residents along Del Pilar Street, where the two (2) city parks and plazas are located, received the majority of positive answers from participants. In addition, as they agreed that making the street walkable will guarantee individuals to be healthy. Walking is a gentle exercise that helps people stay healthier by reducing the risk of obesity, diabetes, and heart disease. However, for green-covered walkways to work, the street may need to be widened. Adding more green spaces, like trees and green belts, is a common way to make sidewalks wider. (Jo & Ahn, 2012) As sidewalks get wider, adding more green areas can create a buffer between bike lanes and walking paths. This helps separate and protect each space, making the area safer and more pleasant for everyone. (Kaparias et al., 2016)

Figure 7. Plaza Lucero with Urban Sheds Concept along Del Pilar Street. Image from
https://www.google.com/maps

5. Conclusion:

Extreme heat is a major concern to the world's rapidly growing cities. (Evan Bush, 2021)
Cabanatuan City must deal with the escalating challenges posed by extreme heat, particularly
in its Central Business District (CBD). The pressing need for a sustainable solution is
underscored by the evident rise in microclimatic temperatures along Del Pilar Street, reflecting
a broader issue of urban warming. As the city undergoes rapid development, it becomes
imperative to address the adverse effects of urbanization on local climate conditions. In this
context, a strategic approach to enhance street walkability emerges as a promising avenue,
with a focus on incorporating greenery.

In conclusion, the data analysis and interpretation shed light on the current condition of Del
Pilar Street in Cabanatuan City. Physical characteristics and the resulting unutilized walkways,
coupled with reported discomfort by respondents, underscore the pressing need for
interventions. Remote sensing and GIS evaluations indicate an alarming maximum
temperature of 52.55°C in April, emphasizing the significant contribution of urban heat island
effects (UHI) to the thermal discomfort experienced along Del Pilar Street. According to Ar.
Irene G. Florendo., (2023) "The influence of thermal comfort on pedestrian decision-making
is a key consideration for future improvements".

The implementation of urban sheds along Del Pilar Street, as suggested by positive feedback
from the FGD. These urban sheds concept, functioning as green sheltered walkways, not only
provide shade but also contribute to the promotion of walkability and the alleviation of extreme
temperature impacts.

Another proposed measure is the integration of green infrastructure into the streetscape,
emphasizing the incorporation of vegetation and landscaping. There has been a lot of research
showing that greenery helps with adapting to climate changes. (e.g., Gill et al. 2007;
Kazmierczak and Carter 2010) This approach aims to enhance the overall aesthetics, air

quality, and environmental sustainability of Del Pilar Street. Furthermore, it is recommended to engage in public health promotion efforts that underscore the advantages of walkability. Public awareness campaigns should highlight the interconnection between green spaces, physical activity, and the reduction of lifestyle-related diseases, fostering a community culture that prioritizes an active and healthy lifestyle.

Future studies should delve into the long-term impact of urban sheds on pedestrian behavior and overall street dynamics. Investigate the effectiveness of green infrastructure in reducing temperatures and improving overall environmental quality. Additionally, explore innovative materials and technologies for urban shed construction that align with sustainability goals. It is necessary to use a collaborative and interdisciplinary strategy that integrates urban planning, environmental research, and community participation to create a more sustainable and pedestrian-friendly Del Pilar Street.

References

1. Abdul Munaf Mohamed Irfeey et al., (2023). Sustainable Mitigation Strategies for Urban Heat Island Effects in Urban Areas. Sustainability 2023, 15(14), 10767; https://doi.org/10.3390/su151410767
2. Saekyung Park and Youngsang Kwon (2023). A Study on Pedestrians' Satisfaction and Preferences for Green Patterns according to the Sidewalk Width Using VR: The Case of Seoul, South Korea. Land 2023, 12(3), 552; https://doi.org/10.3390/land12030552
3. Joachim Westenhöfer et al., (2023). Walkability and urban built environments a systematic review of health. https://bmcpublichealth.biomedcentral.com/articles/10.1186/s12889-023-15394-4.
4. Abdulla Baobeid et al., (2021). Walkability and Its Relationships with Health, Sustainability, and Livability: Elements of Physical Environment and Evaluation Frameworks. Sec. Urban Science Volume 7 - 2021 | https://doi.org/10.3389/fbuil.2021.721218
5. Zhenqi Zhou and Zhen Xu (2020). Detecting the Pedestrian Shed and Walking Route Environment of Urban Parks with Open-Source Data: A Case Study in Nanjing, China. Int. J. Environ. Res. Public Health 2020, 17(13), 4826; https://doi.org/10.3390/ijerph17134826
6. JJ. A. Jordan and I. G. Florendo (2020) Urban Greenery: Mitigating Urban Heat Island Effect in Lower Session Road, Baguio City. Engineering Sciences International Research Journal Volume 8 Issue 2. Retrieved from: https://drive.google.com/file/d/1dd-t4oPu28VDV67Q-E58JJfzWsQRZ5Yb/view
7. Richard Lambert (2019). Walkable Cities are Green Cities. https://naturalwalkingcities.com/walkable-cities-are-green-cities/.
8. Louis S. H. Lee et al., (2019). Improving street walkability: Biometeorological assessment of artificial-partial shade structures in summer sunny conditions. https://link.springer.com/article/10.1007/s00484-019-01840-9
9. Farshid Aram et al., (2019). Urban green space cooling effect in cities. doi: 10.1016/j.heliyon.2019.e01339
10. Kerstin K Zander et al., (2018). Perceived heat stress increases with population density in urban Philippines. Environ. Res. Lett. 13 084009. DOI 10.1088/1748-9326/aad2e