AN EXPLORATORY STUDY OF BUILDINGS WITH GREEN DESIGN TECHNOLOGY IN DHAKA AND ITS FEASIBILITY STUDY

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ABSTRACT

Bangladesh is situated in the northeastern region of South Asia, bordered by diverse and distinct geographical features. To the north, the majestic Himalayas stand at a distance, while the southern boundary is marked by the Bay of Bengal. The western border adjoins West Bengal, and to the east lie the hilly and forested regions of Tripura, Mizoram (India), and Myanmar.
These picturesque natural boundaries encompass a predominantly low-lying plain covering approximately 147,570 square kilometers, intricately interwoven with an extensive network of rivers and streams. The country is traversed by several major rivers, including the Padma (Ganges), Brahmaputra (Jamuna), Meghna, and Karnafuli, which play a significant role in shaping its topography and ecological systems.

Dhaka, the capital of Bangladesh for over a century, has experienced rapid and unplanned urbanization, characterized by the indiscriminate construction of infrastructure. This uncontrolled development has led to significant challenges in urban planning, environmental sustainability, and the overall livability of the city. Bangladesh, as a lower middle-income country, faces a critical need to assess the progress of Dhaka City in achieving sustainable urban building practices and to evaluate the feasibility of such efforts.

The history of Dhaka reflects its remarkable resilience and adaptability throughout centuries of transformation. From its early prominence as a capital during the Mughal era, through the disruptions of colonial rule, to its eventual emergence as the capital of an independent Bangladesh, Dhaka has consistently played a central role in shaping regional politics, economics, and culture. Today, as the city grapples with challenges such as rapid urbanization, environmental stress, and infrastructural demands, it continues to evolve, embodying the aspirations, dynamism, and cultural vibrancy of Bangladesh as a whole.
In recent years, there has been a growing emphasis on sustainable building practices in Dhaka to address environmental challenges such as energy consumption, pollution, and resource depletion. Green architectural initiatives, such as incorporating rooftop gardens, vertical greenery, energy-efficient designs, and water-saving technologies, are gradually gaining traction. Iconic projects like the SAARC Fountain, eco-friendly office spaces, and residential designs in Dhaka symbolize efforts to balance urbanization with sustainability.

However, currently, buildings are being constructed indiscriminately across Dhaka, often without consideration for long-term sustainability. For a developing country like Bangladesh, the preservation of resources such as energy, water, and raw materials is essential to support sustainable growth. The implementation of green architectural technologies in buildings can play a pivotal role in conserving these resources while minimizing environmental pollution, mitigating the effects of global warming, and reducing greenhouse gas emissions.

In this scenario, it has become essential to explore and understand the impacts of buildings designs considering the green architectural technologies. For instance, there are opportunities to enhance building surfaces by integrating green spaces, such as planting trees, which not only address specific environmental challenges but also add aesthetic value to the structures. However, further study is required to explore additional possibilities for integrating green architectural solutions to ensure broader sustainability outcomes in Dhaka's urban landscape.

All those discussed above, along with other related observations have prompted the undertaking of the current study.

This study investigates the current state of buildings in Dhaka City through the perspective of sustainable building design, with a primary focus on the application of green architectural technologies. It aims to assess the effectiveness of these technologies in achieving sustainability goals and to evaluate their broader feasibility in Dhaka's urban environment. By conducting a comparative analysis of two categories of buildings, the research offers insights into the potential of green architecture to contribute to a more sustainable urban infrastructure in Dhaka City.

The specific objective of this study is to perform a comparative analysis of two distinct categories of buildings in Dhaka, with the aim of evaluating their design approaches, sustainability performance, and the integration of green architectural technologies to help explore and assess the feasibility of Buildings with Green Design Technology in Dhaka in general.

ACKNOWLEDGEMENT

I would like to take this opportunity to express my deep respect and heartfelt gratitude to a number of individuals, without whose support and guidance, this thesis would have remained incomplete.

First and foremost, I am deeply indebted to Prof. Salvatore Fava, General Supervisor of the Selinus University of Science and Literature, for his invaluable advice, inspirational words and encouragement throughout my research journey. Despite his busy schedule, he took the time to review my thesis, offering thoughtful suggestions and guidance at every stage. Any remaining errors or shortcomings are solely my responsibility.

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ABBREVIATIONS

ASHRAE:	American Society of Heating, Refrigerating and Air-Conditioning Engineers".
BCCRF:	Bangladesh Climate Change Resilience Fund
BCCSAP:	Bangladesh Climate Change Strategy and Action Plan
BCCTF:	Bangladesh Climate Change Trust Fund
BGBC:	Bangladesh Green Building Council
BREEAM:	Building Research Establishment Environmental Assessment Method
BSEC:	Bangladesh Securities and Exchange Commission
CAGR:	Compound Annual Growth Rate CSR: Corporate social responsibility
CPTU:	Central Procurement Technical Unit
CRF:	Climate Risk Fund
EDGE:	Excellence in Design for Greater Efficiencies
EE&C:	Energy efficiency and conservation
EECMP:	Energy Efficiency & Conservation master Plan
EMF:	Electromagnetic field
EMK:	Edward M. Kennedy
EPA:	United States Environmental Protection Agency
ERD:	Economic Relations Division
ESG:	Environmental, social, and governance
ETP:	Effluent Treatment Plan
EV:	Electric Vehicle
GADT:	Green Building concepts or the Green Architectural Design Technology
GBIG:	Green Building Information Gateway
HERS:	Home Energy Rating System
HVAC:	Heating, Ventilation and Air Conditioning
IAQ:	Improved Indoor Air Quality
IDRA:	Insurance Development and Regulatory Authority
IgCC:	International Green Construction Code
IoT:	Internet of Things
LCA:	Life Cycle Assessment
LEED:	Leadership in Energy and Environmental Design
LED:	Light Emitting Diode
MIS:	Management Information System
MoEF:	Ministry of Environment and Forest
MoEFCC:	Ministry of Environment, Forest, and Climate Change
MoU:	Memorandum of Understanding
PMC:	Project Management Cell
SCM:	Supply Chain Management
SD:	Sustainable Development
SDGs:	Sustainable Development Goals
SMUD:	Sacramento Municipal Utility District
SS:	Self Sourced
STP:	Sewage Treatment Plant
SREDA:	Sustainable and Renewable Energy Authority
UNSD:	United Nations Statistics Division
USGBC:	U.S. Green Building Council
VOC:	Volatile Organic Compound
VRF:	Variable Refrigerant Flow

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CHAPTER 01

INTRODUCTION

Abbreviations
CAGR: Compound Annual Growth Rate

CHAPTER 01

INTRODUCTION
1.1 STATEMENT OF THE PROBLEM

Bangladesh is a densely populated country located in the south-eastern part of Asia. The capital of Bangladesh is Dhaka. Dhaka, formerly called Dacca, is the largest city in the country. As per Population and Housing Census 2022, National Report (Volume-I) the population of Dhaka Division is more than 44 million and 215 thousand. (*Ref. 1.1a*). Over 10.2 million people live in Dhaka city, according to the 'Population and Housing Census 2022' *(Ref; 1.1.b)*. There is a huge demand for housing and building other infrastructure to cater to the growing needs of population migrating to Dhaka City as well as the present city dwellers to meet their expectation of maintaining the basic standard of living*. According to World Bank approximately 3,00,000 to 4,00,000 people migrate to Dhaka each year The pressure of people is increasing day by day in urban areas, especially in Dhaka city. It was predicted that Dhaka would be more populous than Mexico City, Beijing or Shanghai by 2021. (*Ref. 1.2*). Other than this, there is currently an increasing rate of urbanization and commercialization in the city. The country's construction market size is valued at USD 28.55 Billion in 2022 and is projected to reach USD 49.98 Billion by 2031, expanding at a CAGR of 6.42% during the forecast period, 2023 – 2031. *(Ref. 1.3).*

Dhaka is a rapidly developing city. Rapid and haphazard construction growth in Dhaka City has led to a mass deterioration of its environment which has, in turn alarmingly impacted the health and livelihood of the city dwellers. In this scenario, the application of green architectural technologies in infrastructural designing, may lend a hand in alleviating further deterioration in the future.

The implementation of green architectural technologies presents an opportunity to create a cleaner and more sustainable environment in Dhaka City, benefiting both current residents and future generations to live a healthy life within a milieu of sustainable infrastructures. By integrating these technologies into building construction, structures can be designed to function with greater environmental responsibility and resource efficiency throughout their lifespans, thereby promoting sustainability. Embracing green architecture not only supports healthier urban living but also contributes to a resilient infrastructure that prioritizes environmental stewardship.

1.2 AIM AND SPECIFIC OBJECTIVE OF THE STUDY

1.2.i The Aim of the Study:

This study aims to investigate and critically analyze the current state of buildings in Dhaka City through the lens of sustainable building design, primarily focusing on the application of green architectural technologies. It seeks to assess the effectiveness of these technologies in meeting intended sustainability goals and to evaluate the future feasibility of their broader implementation in Dhaka's urban environment. Through this examination, the study intends to offer insights into the potential of green architecture to contribute to a more sustainable urban infrastructure in Dhaka City.

1.2.ii Specific Objectives of the Study:

The specific objective of this study is to conduct a comparative analysis of two categories of buildings in Dhaka.

** Article 15 of the Constitution of Bangladesh requires state to ensure people's access to basic necessities including food, clothing, shelter, and medical care as one of the fundamental principles of state policy (4).*

The first category includes, buildings where green architectural technology has been implemented, while the second consists of buildings without such applications. Two cases from each category shall be selected for an in-depth analysis. Through these case studies, this research will assess the performance, benefits, and limitations of both categories, aiming to derive insights into their relative sustainability. The study seeks to provide informed recommendations for future building projects, positioning these findings as exemplary models to enhance sustainability in Dhaka's urban development.

1.3 RATIONALE OF THE STUDY

"Over half of the world's population lives in urban areas and that number is expected to increase to 68 percent by 2050. The resulting demand for more and more space is expected to double the floor area of buildings by 2060, with most of the growth in residential construction, particularly in middle-income countries." *(Ref: 1.5)*

Bangladesh is a lower middle-income country *(Ref: 1.6)* and there is a necessity to understand where Dhaka City stands in the making of its urban buildings sustainable and the extent to which it is feasible. Presently, buildings are being indiscriminately built in Dhaka City. This is mainly due to the necessity to meet the rising demands of the incoming influx of people to the city. Simultaneously, the financial status of many of the city dwellers is also increasing day by day. This is giving them the capacity to rent houses or even to buy apartments which are often made by the building developers. In this scenario, the developers are also optimizing their capacity to undertake building projects as much as possible. They are also trying to complete the projects in a rush to meet the handover dates as well. This adverse trend is transforming the urban fabric into a dense, impermeable "concrete mesh." This is also pushing Dhaka infrastructural developments towards an indefinite future. It is evident that '*Now*' is the time to be responsible and address this issue without any further delay. This implies that the construction market of Dhaka, has to be sustainable before it is too late. Taking attempts like designing buildings using green technology would be a way of keeping the city environment desirable for now and for the future generations. This states, how there is a need to explore and understand the true impacts of constructing sustainable buildings, on their beneficiaries, at the recipient level, in Dhaka City. Green buildings are great examples of sustainable buildings. In Bangladesh the need for adopting policies responsive to the need of green buildings are now felt by the government as well as the planners and the professionals.

For a developing country like Bangladesh, it is vital to preserve its resources as much as possible. Application of green architectural technology in the buildings may ensure preservation of resources such as energy, water and other raw materials. Green architecture also helps to minimize environmental pollution against global warming and greenhouse gasses emission. An effort to explore and understand the impacts of buildings with green architectural technology is crucial in the current scenario.

For example, there are some scopes to explore the possibility of increasing the surfaces in buildings for planting green trees which may provide a problem-solving concept, apart from providing an interesting aesthetical quality to the buildings. But application of other scopes has to be explored as well.

All those discussed above, along with other related observations have prompted the undertaking of the current study.

1.4 LIMITATIONS OF THE STUDY

This research is primarily analytical and exploratory in nature. The present research is designed as an analytical and exploratory study. As with most research, certain limitations are inherent, and this study is no exception. Due to constraints related to time and resources, the scope has been restricted to an examination of only four case studies categorized under two primary classifications, as indicated in

Table 1.1. Apart from these, considering the limited time and resources available, focus has been given to fifteen number of Dhaka City households (with 30 respondents) only.

TABLE 1.1: DETAILS OF THE CASE STUDIES

Sl.	Category	Case Studies	
Type 1	**COMMERCIAL BUILDING WITH OFFICE SPACES**	**1. Buildings with green design Technology**	**Cityscape Tower** (Commercial cum Office Building) at 53, Gulshan Avenue, Gulshan Model Town, Dhaka-1212, Bangladesh.
		2. Buildings without any green design technology	**Grand Del Vista Tower** (Commercial cum Office Building) at Plot 1A, ROAD 113, Gulshan Aenue, Gulshan Model Town, Dhaka 1212, Bangladesh
Type 2	**FACTORY BUILDINGS (GARMENTS FACTORY)**	**3. Buildings with green design Technology**	**MNR Sweaters Ltd**. (Garments Factory) at Baraider Chala, Sreepur, Gazipur, Sreepur PS; Gazipur, Greater Dhaka, Bangladesh.
		4. Buildings without any green design technology	**EVE Dress Shirts Ltd.** (Garments Factory) at 219 Anwar Jung Road, Ashulia, Dhaka-1341, Bangladesh

Apart from the two categories above, fifteen residential homes/ households were under investigation.

-An extensive questionnaire had to be structured for a better understanding of the projects interventions and their results. Administering such questionnaires requires patience on both the interviewer and the respondents' part and therefore this had its own limitations.

-Due to different constraints the time available for conducting the survey had been limited. The survey team was unable to carry out an in-depth survey for all the buildings using the technology, due to financial and other constraints.

-Often the study had to depend directly on the interview, which may also have had the possibility of being biased or misinterpret.

-Lack of unavailability of key persons, reluctance for participating in the survey of the respondents who usually stayed busy with their own household activities were also a constraint.

Therefore, obtaining detail data for only four case studies and thirty households were made possible.

CHAPTER 02

THE ORGANIZATION OF THE STUDY

2. ORGANIZATION OF THE STUDY

The study is structured into seven primary chapters, followed by references and appendices. It begins with an abstract, providing a concise overview of the study. Following the abstract is the acknowledgments section, where gratitude is expressed to those individuals whose support was essential to the completion of the research. This section highlights contributors whose guidance, resources, or encouragement were instrumental in the study's development.

The layout arrangement of the research paper is provided in the table below:

TABLE 2.1: ORGANIZATION OF THE STUDY

Sl.	Name of Chapters of the Study	Subject Matter Discussed
1	**Chapter 1**	Introduction
2	**Chapter 2**	Organization of the Study
3	**Chapter 3**	Methodology
4	**Chapter 4**	Theoretical Perspective of the Study
5	**Chapter 5**	Description of the Case Studies
6	**Chapter 6**	Data Analysis
7	**Chapter 7**	Conclusion

Chapter 1 - Introduction provides foundational information about the study, encompassing the statement of the problem, aim and specific Objective of the Study, rationale and limitations of the study.

The **Statement of the Problem** outlines the current context and conditions of the research setting, identifying key issues for investigation. It establishes the basis of the research by describing existing scenarios that necessitate exploration.

The **Aim and Objectives of the Study** clarify the purpose and goals of the research. These objectives define the specific issues to be examined and indicate how addressing these may contribute to understanding broader, related challenges.

The **Limitations of the Study** expresses the constraints and obstacles encountered during the research process, providing context for interpreting the study's scope and findings.

The **Rationale of the Study** justifies the significance of the research by highlighting its relevance and potential impact. It also discusses the anticipated contribution of the findings to practical problem-solving within the field of study.

Chapter 2 - Organization of the Study: This part of the study, outlines the structure of the report, guiding readers through its arrangement and the flow of information.

Chapter 3 - Methodology of the Research: The chapter elaborates the approach to data collection, outlining the systematic processes of site selection, preliminary surveys, such as reconnaissance survey, questionnaire distribution and survey, methods of data processing, analysis, and representation. This chapter also describes each stage in the research process, offering a step-by-step guide to the methodology, which ensures transparency and reproducibility of the research findings.

Chapter 4 - Theoretical Perspectives and Literature Review: The Chapter establishes the theoretical framework for the study, guiding the research question through relevant theories and perspectives and providing updated insights from existing studies. This chapter compiles knowledge from an extensive review of scholarly sources, including journals, reports, and both published and unpublished articles in related fields. Through these insights, it reinforces the rationale for undertaking the research and contextualizes the study within the broader academic discourse.

Chapter 5 - Description of the Case Studies examines four distinct case studies selected for this research. These case studies are as follows:

1) **Cityscape Tower**: A Commercial cum Office Building, located in Gulshan Avenue within the residential area of Gulshan, Dhaka.

2) **Grand Del Vista Tower:** A Commercial cum Office Building located in Gulshan Avenue within the residential area of Gulshan, Dhaka.

3) **MNR Sweaters Ltd**. a Garments Factory at Gazipur, Dhaka, Bangladesh.

4) **EVE Dress Shirts Ltd.** a Garments Factory at Ashulia, Dhaka, Bangladesh.

Apart from that 15 households are examined.

Each case study is comprehensively examined, addressing aspects such as project profile, occupancy type, materials, technologies utilized, and other pertinent information. This detailed exploration provides a rich foundation for understanding the requirements of the research and evaluating the unique attributes of each case.

Chapter 6 - Data Analysis presents a detailed examination of the data collected to assess the extent to which the research objectives have been met. This chapter organizes and analyzes questionnaire responses structured around the aims and objectives of the study. It critically evaluates the success or limitations of each of the four case studies in achieving their specific objectives, offering insights into their relative effectiveness. The findings of this chapter contribute to developing the Summary Findings and Recommendations, which are synthesized in the final chapter of the research.

Chapter 7 - Conclusions and Recommendations consolidates the insights derived from the analysis and offers recommendations grounded in the study's findings. This chapter provides a comprehensive overview, encapsulating the study's contributions and suggesting directions for future research or practical application.

The report concludes with References and Appendices. The References section includes all sources that informed and supported the development of this research, while the Appendices contain supplementary materials, such as the List of Green Buildings in Dhaka, to provide further context and resources relevant to the study.

CHAPTER 03

THE METHODOLOGY OF STUDY

Abbreviations
ASHRAE: American Society of Heating, Refrigerating and Air-Conditioning Engineers".
BREEAM: Building Research Establishment Environmental Assessment Method
ESG: Environmental, social, and corporate governance
EDGE: Excellence in Design for Greater Efficiencies
HERS: Home Energy Rating System
IgCC: International Green Construction Code
LEED: Leadership in Energy and Environmental Design
USGBC: U.S. Green Building Council
IAQ: Improved Indoor Air Quality
VOC: Volatile organic compound
EMF: Electromagnetic field
ZEH: Zero Energy Homes
EC: Electrocromic Glass

CHAPTER 03

THE METHODOLOGY OF STUDY

A number of case studies relevant to the study had to be selected in order to conduct the research in details.

Selection of Cases

At the inception of the research, case studies from two types of buildings from commercial catewgory were chosen within Dhaka. They are, A) A Commercial Building with Office spaces and B) A Factory Building. Two case studies from each category were selected. In addition, 15 numbers of household were selected.
Both cases from the commercial category were selected in such a way that they would have a similar set of criteria as a prerequisite, regarding location and building functionality. This was required in order to achieve more or less accurate results from the conducted surveys. Furthermore, from each category, one case would be such where the green technology has been implemented and the other, not.

Methods adopted for data collection

A number of survey methods were adopted for the administration of the research. The reconnaissance survey and the questionnaire survey. For this, a total of one hundred and twenty numbers of questionnaires had been administered in four different sites within Dhaka, covering the four case studies under the commercial category. Again, a survey was conducted to fifteen households (two respondent from each house, total thirty questionnaires) or residential buildings in Dhaka. Ion both cases the concept was to assess the users'/residents' awareness and demand for the element indicative of green building design technologies. Additionally, the survey aimed to observe their interest in living within an environmental set up, shaped by sustainable building practices.

In the beginning of the study, the Case Studies were Selected and the sites were earmarked. The primary data were obtained from the different surveys, one such example is the reconnaissance survey. The reconnaissance survey was conducted to obtain physical data of the infrastructure. Next, the secondary data for the research was collected. The sources for the secondary data were drawn from relevant literature reviews and discussions with relevant people. Following that, a set of questionnaires were formulated. A major portion of the primary data were obtained from the formulated questionnaires' surveys and discussions with experts which were conducted specifically for the four case studies. The basic mode for collection of primary data were the application of a few selected indicators, relevant to green technologies, applied to building infrastructures.

Eventually, all the data collected from all cases were collated and analyzed in terms of rating systems or standards, associated with green buildings.

The results were combined and compared to draw conclusions as to whether the application of green technology in building infrastructure in Dhaka is better or not and make relevant recommendations for the future.

The following diagram graphically represents the process in chronological order.

Step 1: Selection of Case Study and its site

Step 2: Carrying out of reconnaissance survey to obtain physical data of the infrastructure

Step 3: Relevant Literature Review

Step 4: Formulation of a set of questionnaires and discussion with Experts

Step 5: Questionnaire Survey

Step 6: Collection of data and results from all four cases & 15 HHs from the questionnaires surveys

Step 7: Organization and analysis of collected data in terms of rating systems.
Comparison is drawn between the two types of data (with and without the intervention of the green technology) and representation

Step 8: Drawing relevant conclusion and recommendations

Diagram 3.1: Steps of Methods adopted for data collection

The Indicators Used for the Survey

The indicators used for evaluating the level of application of green technologies in building infrastructure are given below. The following indicators were used to conduct the questionnaire survey:

1. Location and Transportation:

This requires that the building is not built in an environmentally sensitive area, and public transportation is available to reduce the use of private cars.

2. Sustainable Sites

The sustainable sites may generally include the following aspects and considerations in building design:

Renovation/ restoration:

Renovating a building sustainably implies the use of sustainable materials, repurposing materials as much as possible and considering the change of climate (e.g. frequent hot summers).

Use of Open space:

Open spaces with strategic landscaping and vegetation can provide natural shading and wind protection, helping to moderate building temperatures and reduce energy consumption. This aligns with sustainable building goals and can reduce a building's overall carbon footprint. Incorporating open spaces in design is a prerequisite to having an environmentally friendly atmosphere for users. For example: The importance of high-quality outdoor spaces in improving physical and social well-being in the residential environment of the elderly.

Heat Island Reduction:

Heat island reduction is a core principle in green building design, focusing on minimizing the localized warming effect of urban environments, known as the "urban heat island" (UHI) effect. This effect occurs because dense urban areas with extensive concrete, asphalt, and dark surfaces absorb and retain heat, leading to higher temperatures compared to rural or suburban areas. Here's how green building practices address heat island reduction and its benefits:

Generally speaking, green building practices can help reduce the urban heat island (UHI) effect by replacing normal pavement with cool pavement.

Other means include reflective pavements and permeable pavements. The reflective pavements are designed to reflect more solar energy and absorb less heat than conventional asphalt, which can become extremely hot whereas permeable pavements allow water infiltration which helps cool surfaces naturally through evaporation, reducing surface and ambient air temperatures. Incorporating water features like fountains, pools, and ponds provides cooling as water evaporates, reducing ambient temperatures. Besides that, Cool roofs can decrease the energy needed for air conditioning by keeping building interiors cooler, reducing electricity consumption and greenhouse gas emissions. By this cool roof tend to reduce energy use. These are made with reflective materials that have high solar reflectance and thermal emittance, meaning they reflect more sunlight and absorb less heat. This can lower the surface temperature of a roof by up to 50°F (28°C).

Cool roofs may also be achieved by planting trees and increasing vegetation.

Benefits of Heat Island Reduction in Green Building:

- **Heat Islands Lower Energy Costs**: By reducing ambient and surface temperatures, green building practices lower air conditioning needs, which translates into energy savings and reduced operational costs.

- **Improved Air Quality**: Decreased heat in urban areas reduces ground-level ozone formation, which is beneficial for air quality and public health.

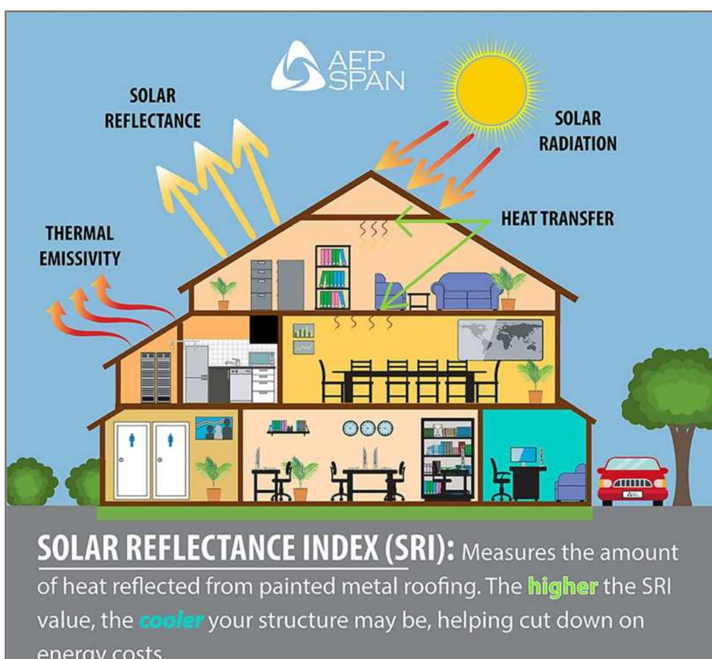
- **Enhanced Occupant Comfort**: Cooler buildings and shaded areas make outdoor spaces and indoor environments more comfortable for occupants.

- **Increased Longevity of Materials**: Reducing extreme heat exposure helps materials last longer, decreasing maintenance needs and replacement costs.

- **Climate Resilience**: As temperatures rise with climate change, heat island mitigation in green buildings helps urban areas adapt to extreme heat events, protecting vulnerable populations and ensuring urban livability.

- Having **Cool Roofs**: These are made with reflective materials that have high solar reflectance and thermal emittance, meaning they reflect more sunlight and absorb less heat. This can lower the surface temperature of a roof by up to 50°F (28°C).

  Cool roofs help save energy in building. Cool roofs are basically building roofs covered with light-reflecting materials or paints. Green roofs with vegetation are also a good example of cool roof. Cool roofs reflect more incoming sunlight than traditional darker roofs do and thus reduces the heat of the roof surface and surrounding air. This results in reduced cooling load of a building. They also mitigate the overall urban heat island effect in cities.



Pic. 3.1: *Building roofs covered with light-reflecting materials or paints and SRI Index (Ref 3.17)*

Pic.3.2: *Application of Green roof with vegetation at Bays-Chayaneer, Baridhara, Dhaka*

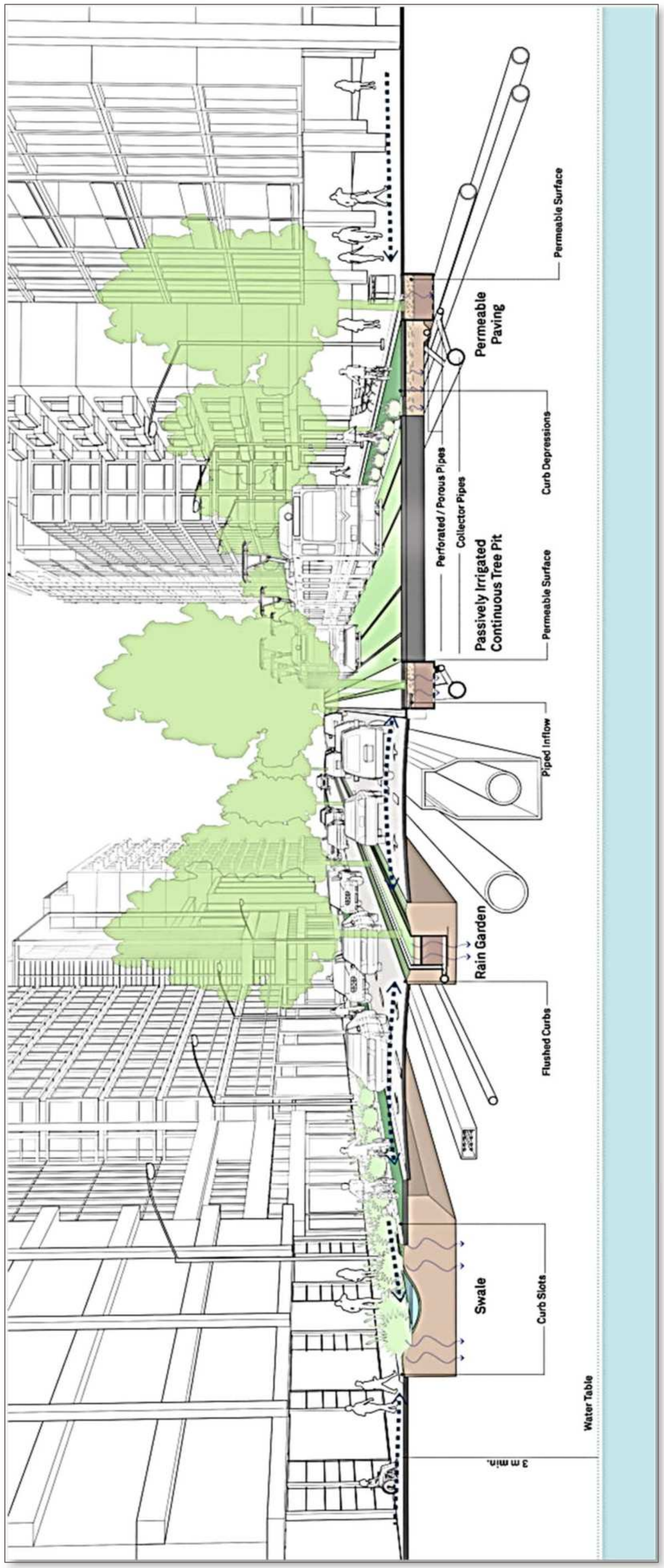
In summary, heat island reduction is an essential aspect of green building that enhances energy efficiency, reduces environmental impacts, and creates healthier, more comfortable living and working environments. Other sustainable sites may be achieved by means of: Building Orientation and Shading Design also plays an important role in heat reduction:

- **Strategic Building Placement**: Orienting buildings and using natural shading (e.g., overhangs, shading screens, and building geometry) minimizes direct sunlight exposure and decreases heat gain.
- **Passive Cooling**: Proper design can optimize natural ventilation and airflow, reducing the need for mechanical cooling systems and energy use.
- **Vegetation:** Maximizing green areas; Planting trees around buildings provides natural shade and lowers temperatures by blocking sunlight and cooling the air through evapotranspiration.

  Apart from having green gardens, vertical Walls with vegetation reduce the surrounding temperature by providing shade and releasing moisture into the air through evapotranspiration.

Hydrology & storm water management

Stormwater is the precipitation that does not soak into the ground or evaporate. Stormwater flows along the surface of the ground as runoff. As more and more earth's surface are covered by nonpermeable materials owing to increased land developments today, stormwater is becoming a bigger concern for the management required for sustainable design.
Green infrastructure must be carefully coordinated to avoid conflicts with utility placement, high water table levels, and subterranean conditions such as the location of bedrock. Considering the soil conditions is critical when planning green infrastructure strategies. While the components and processes involved in green infrastructure are vast (*Ref. 3.1*).



Pic.3.3. *The picture shows some of the major components of stormwater management* (*Ref: 3.13*)

Consideration of Human Health effect during and after construction

Green building practices, which focus on designing and constructing buildings with sustainability and energy efficiency in mind, can have significant positive impacts on human health. By integrating sustainable materials, energy-efficient systems, and healthy building environments, green buildings reduce environmental impact and foster healthier spaces for the users. help create sustainable sites. re are some ways in which green

1. Improved Indoor Air Quality (IAQ)

Reduction of Pollutants: Green buildings emphasize ventilation and the use of low-VOC (volatile organic compound) materials, reducing exposure to harmful chemicals found in traditional building materials, like formaldehyde and benzene.

Air Filtration: Many green buildings have advanced filtration systems that remove allergens, pollutants, and contaminants, which is especially beneficial for individuals with respiratory issues such as asthma.

2. Enhanced Natural Lighting and Access to Views

Daylighting Strategies: Maximizing natural light through strategic window placement, skylights, and reflective surfaces has been shown to improve mood, reduce stress, and increase productivity.

Connection to Nature: Access to green spaces or views of the outdoors contributes to mental well-being, reducing stress levels and enhancing cognitive performance.

3. Thermal Comfort and Temperature Control

Green buildings often have advanced insulation and temperature control systems, ensuring that the indoor environment stays within a comfortable range. Consistent and comfortable temperatures contribute to better sleep, reduced fatigue, and overall comfort for occupants.

4. Reduction of Noise Pollution

Acoustic Design: Noise pollution can lead to stress, sleep disturbances, and even cardiovascular issues. Green buildings often include sound insulation and layout strategies that minimize external noise and enhance privacy, creating a quieter environment that supports mental well-being.

5. Use of Nontoxic, Sustainable Materials

By using materials free from harmful chemicals, green buildings reduce the potential for exposure to toxins that can affect the endocrine, respiratory, and immune systems. Sustainable materials also reduce waste and pollution, indirectly benefiting public health.

6. Enhanced Water Quality

Many green buildings incorporate water filtration systems that ensure access to clean drinking water. This reduces exposure to contaminants such as lead, chlorine, and other chemicals commonly found in municipal water supplies.

7. Support for Active Lifestyles

Green building designs often encourage physical activity by integrating features like bike storage, accessible staircases, and outdoor spaces. This promotes physical health, encouraging exercise and movement that can help prevent chronic diseases.

8. Reduction of Electromagnetic Pollution and Toxins

Green buildings are increasingly addressing electromagnetic pollution, and some incorporate design elements to minimize electromagnetic field (EMF) exposure from building systems and appliances, potentially benefiting those sensitive to EMFs.

Mental Health Benefits

Beyond physical health, green buildings can reduce stress and improve mental health by fostering a relaxing environment through design elements like natural materials, plants, and access to natural light. For example, open spaces offer areas for relaxation, exercise, and social interaction, which promote physical health and community cohesion.

In essence, green buildings are designed not only to be environmentally friendly but also to provide healthier, more comfortable spaces for occupants. As such, green building practices offer an essential way to support and enhance both individual and public health.

3. Water Efficiency:

Water use efficiency is a core principle of green building design, aiming to reduce water consumption, enhance water conservation, and promote sustainable water management. Efficient water use in green buildings benefits the environment, reduces utility costs, and ensures water availability for future generations. Here's an overview of how water use efficiency is integrated into green buildings:

I. Key Strategies for Water Use Efficiency in Green Buildings

a) <u>Indoor Water Efficiency</u>

High-Efficiency Fixtures and Appliances:
Low-flow faucets, showerheads, and toilets significantly reduce water usage without compromising functionality.
Water-efficient dishwashers and washing machines consume less water and energy.

Leak Detection and Prevention: Advanced plumbing systems with leak detection technology prevent water waste and reduce damage risks.

Greywater Reuse: Systems for capturing and reusing greywater (from sinks, showers, and laundry) for non-potable purposes like flushing toilets or irrigation.

Smart Water Meters: Digital meters monitor and manage water consumption in real-time, identifying areas for improvement.

b) <u>Outdoor Water Efficiency</u>

Native and Drought-Tolerant Landscaping: Using plants adapted to the local climate minimizes the need for irrigation.

Efficient Irrigation Systems:
Drip irrigation, soil moisture sensors, and weather-responsive irrigation systems ensure water is delivered only when and where needed.

Rainwater Harvesting:
Capturing and storing rainwater for landscape irrigation, cooling systems, or even indoor non-potable uses reduces reliance on municipal water supplies.

c) <u>Building Design and Technology</u>

Green Roofs:
Vegetative roofs absorb rainwater, reducing runoff and providing additional water conservation benefits.

Permeable Pavements:
Allow water to infiltrate the ground, replenishing aquifers and reducing stormwater runoff.

Stormwater Management:
Bioswales, rain gardens, and detention basins are used to capture, filter, and reuse stormwater.

II. Benefits of Water Use Efficiency in Green Buildings

a) <u>Environmental Benefits</u>:

Reduced Water Stress:
Conserving water in buildings alleviates pressure on freshwater resources, especially in water-scarce regions.

Minimized Wastewater:
Efficient water use reduces the volume of wastewater requiring treatment, lowering energy and resource demands.

Stormwater Mitigation:
Capturing and reusing rainwater minimizes urban runoff, reducing the risk of flooding and water pollution.

b) **Economic Benefits:**

Lower water bills for occupants and building owners.
Decreased costs for water treatment and wastewater disposal.

c) **Social Benefits:**

Ensures water availability for future generations.
Promotes awareness and encourages sustainable water practices among occupants.

III. Technologies and Innovations for Water Efficiency

Dual-Flush Toilets: Allow users to choose the water volume required, saving significant amounts of water.
Greywater Treatment Systems: Treat greywater on-site for reuse in irrigation or flushing.
Rainwater Collection Systems: Advanced tanks and filters make rainwater harvesting more efficient and hygienic.
IoT-Enabled Water Management: Sensors and automation optimize water usage and detect inefficiencies.

IV. Water Efficiency in Green Building Certifications

Several green building standards and certifications emphasize water efficiency:

LEED (Leadership in Energy and Environmental Design): Awards points for efficient indoor and outdoor water use, rainwater management, and water metering.

WELL Building Standard: Focuses on water quality and accessibility alongside efficient use.

BREEAM (Building Research Establishment Environmental Assessment Method): Assesses water-efficient systems, reuse strategies, and innovative conservation solutions.

V. Sustainable Water Cycle in Green Buildings

Green buildings often adopt a **closed-loop water system**, integrating strategies for water conservation, treatment, and reuse to minimize the environmental impact. This holistic approach creates a sustainable balance between water supply and demand.

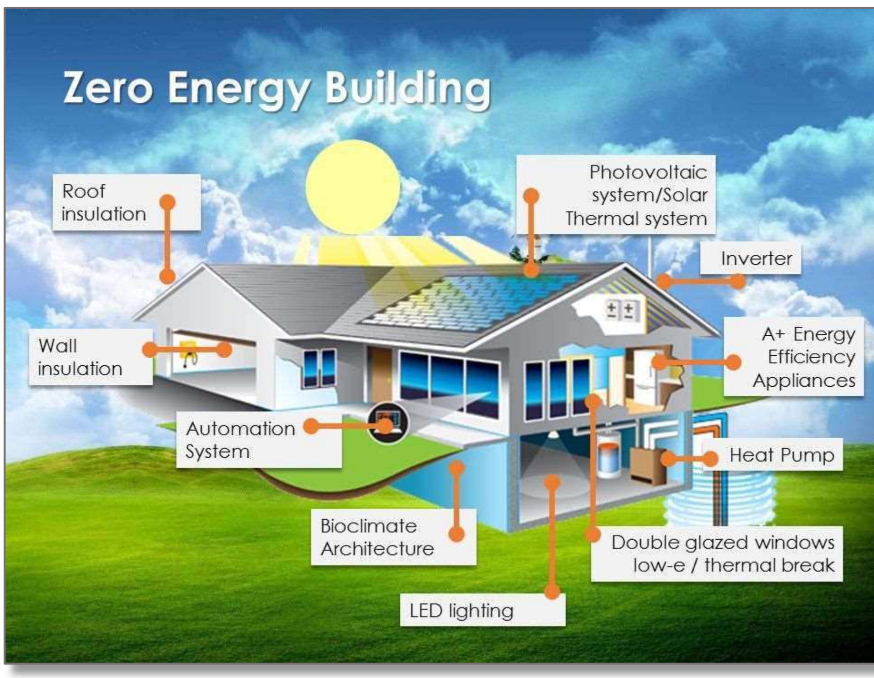
In summary, water use efficiency in green buildings is achieved through advanced technologies, sustainable design, and mindful resource management. These practices not only reduce water consumption and costs but also contribute to a resilient and sustainable built environment.

4. Energy and Atmosphere

Some interventions encompassing energy saving and atmosphere are cited below:

I. Zero Energy Homes

Zero Energy Homes (ZEH) are defined as residential buildings designed to achieve net-zero energy consumption over the course of a year. These homes are constructed to exceptionally high standards of performance, incorporating advanced airtightness, superior insulation, and high energy efficiency. By integrating renewable energy systems, such as solar panels, they generate as much energy as they consume annually. Consequently, ZEH provide homeowners with a net-zero energy bill while minimizing the home's carbon footprint, contributing to sustainability and environmental conservation *(Ref 3.1)*.



***Pic. 3.4**: A building model reflecting the elements of the conceptual Zero Energy building that makes it a green building. (Ref. 3.2)*

II. Smart Appliances

The major focus of constructing a building as a smart building of converting part of it into a smart building is to achieve energy efficiency and sustainability. As the world seeks sustainable alternatives to fossil fuels, renewable energy sources such as wind, solar, and hydro have been spotlighted as key players in the future energy landscape. They offer a pathway to not just reduce our carbon footprint but also to ensure a consistent and self-sustaining energy supply (RES4Africa Foundation, 2023) *(Ref 3.3).*

“The gravity of integrating smart systems into buildings is manifold. For one, there’s the cardinal focus on energy efficiency. As the world grapples with an impending energy crisis and the clarion call for sustainability grows louder, the capacity of smart buildings to fine-tune energy consumption becomes invaluable (Lawrence et al., 2016). By analyzing data and making real-time adjustments, these buildings can drastically reduce wastage, tailoring energy usage patterns to synchronize with both the occupants' needs and the availability of renewable energy (Alanne & Sierla, 2022; Yüksek & Karadayi, 2017)" *(Ref 3.3)*

In some instances, Smart buildings, equipped with advanced sensors, controls, and different energy management system which would be able to analyze the necessary data to optimize energy consumption and therefore reduce waste. It would also be designed such as to integrate renewable energy sources like solar panels or wind turbines. Foer example one would even have the chance to start preheating or even run the washing machines and save time. This has become a standard practice in some countries in the world already. electronics and information technology companies like LG and Samsung are leading the way in this smart home revolution.

Pic. 3.5: *Achieve zero carbon and a circular economy and promote an intelligent lifestyle. LG home appliances offering top-rated energy efficiency (from left, LG bottom freezer refrigerator, washing machine, tumble dryer, InstaView™ Oven and dishwasher.) Product images are simulated, color or model may differ from the actual product. (Ref. 3.4)*

III. Electrochromic Smart Glass

Electrochromic (EC) glazing is an innovative technology increasingly employed in modern building design. This advanced glazing system features "switchable" transmittance capabilities, allowing it to modulate incoming daylight effectively. By adjusting its optical properties, EC glazing can control the amount of light entering a building, offering flexibility in managing interior illumination and thermal comfort. Additionally, it can block views when privacy is required, while providing a clear, unobstructed view of the external environment when desired. This dual functionality enhances energy efficiency and occupant comfort in built environments.

Pic. 3.6*: The concept of switchable smart glass (Ref. 3.5)*

The property of Electrochromic smart glass is such that if it is stimulated by an electrical signal, it would be able to change its transmittance of light that passes through it. This can change the glass from opaque to transparent or somewhere in between.
This characteristic of the Electro-chromatic glass makes it a main component of green buildings. "By using EC smart windows in buildings, desirable energy savings in air conditioning and artificial lighting systems, as well as occupant comfort, are achieved simultaneously if the coloration of EC smart window is regulated by a suitable operation and control algorithm."
(Ref. 3.6)

IV. Solar Power

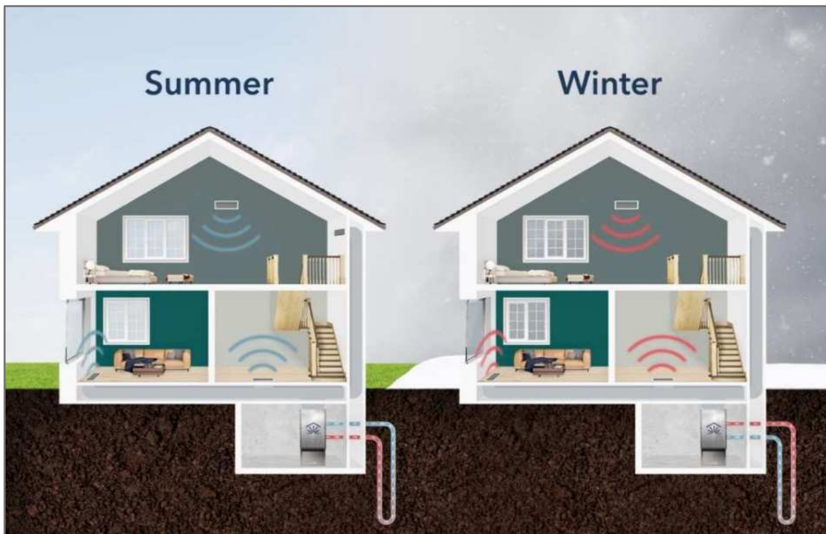
The use of solar power is a great way to save energy from a building no matter what type it is. This is what makes it to be a great candidate for element of a green building. We have the scope to use solar energy in different ways for a custom-made building. In many buildings around the world, the application of solar panels is already seen. When electrical power is produced using solar panels, no greenhouse gas is emitted into the atmosphere.

Pic. 3.7*: Solar system installed in remote rural areas of Bangladesh (Ref. 3.7)*

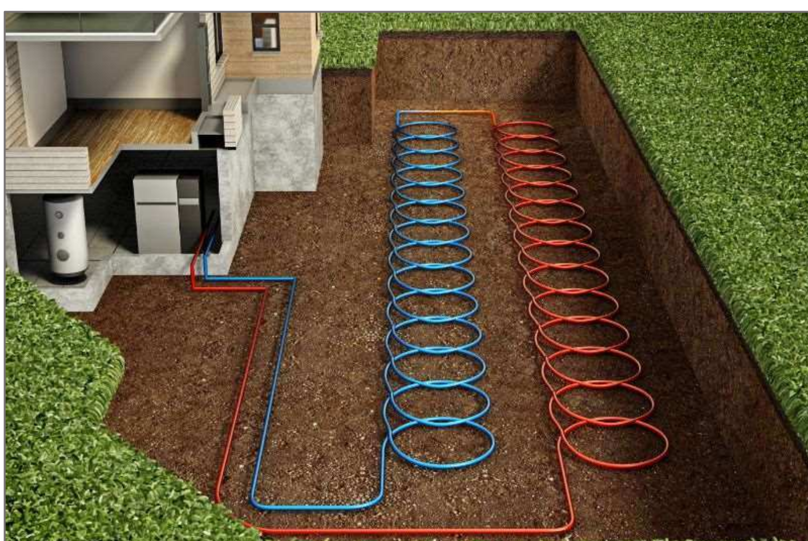
Sun is a ubiquitous resource for essential energy for electricity that may help us in developing the green buildings in a green environment.

V. Geothermal Heating

The world is getting warmer every day. A south eastern country like Bangladesh experiences extreme heat in summer and the middle and northern part experiences cold weather in winter. The people's earnings are also low on an average. Therefore, some form of cooling and heating technologies are required that would both emit low-carbon to the atmosphere at the same time be affordable to the mass population of the country.
Earth's crust is a source of heat. A series of interconnected pipes may be close to a building that can provide cooling or heating with the help of a pump and thus help create electricity, heating or cooling and save energy in turn.



***Pic. 3.8**: Picture showing the concept how geothermal heating can help keep a house interior cool in summer as well as warm in winter. (Ref. 3.8)*



Pic. 3.9 *(Ref 3.9)*

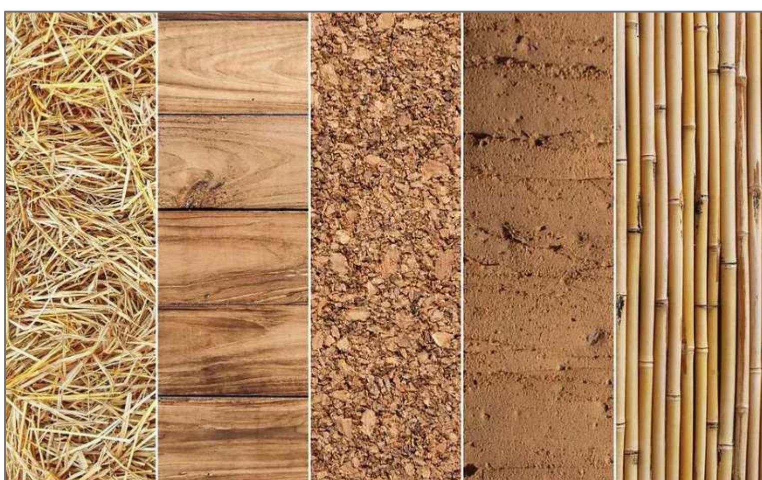
Geothermal heating is more applicable for countries facing severe winte

IV. Green Insulation

In construction, green insulation materials reduce thermal energy transmission through ceilings, floors, and walls and help in saving energy. In simple terms, it keeps air-conditioned space cooler during summer and helps keep heated interior spaces warmer during winter. Examples of green insulation materials are Fiberglass, mineral wool, cellulose, natural fibers etc.

For example, Rockwool insulation slabs can be installed inside walls, outside walls, under floors, above ceilings and in roof spaces – helping to protect buildings against excessive noise, heat loss and the spread of fire. However, factors like manufacturing, materials, process toxicity should be considered to create a more ecofriendly material.

***Pic. 3.9**: Rockwool insulation in walls and slab (Ref 3.10)*



***Pic. 3.10**: Biodegradable materials used in construction (Ref. 3.11)*

Use of Biodegradable Materials or
Rammed Earth Brick or Earth Made Structure also contribute to achieving sustainability

Rammed earth is a simple type of construction. The concept of using rammed earth for construction has been used for centuries with evidence of its use dating as far back as the Neolithic Period (*Ref. 3.11)*

Rammed earth walls are constructed by compacting a selected mixture of aggregates—typically gravel, sand, silt, and a small percentage of clay—between flat panels known as formwork. Once compacted, these walls serve as a durable building material for construction. This method is considered environmentally friendly due to its reliance on locally sourced materials and its straightforward construction process.

The rammed earth brick used for the project below was however made by the traditional local materials are bamboo for constructions and earth for walls and foundations, straw for the roofs and jute rope for lashing constructions.

***Pic. 3.11**: Earth made structural building Meti Handmade School*
in Rudrapur, by Anna Heringer (Ref: 3.12)

The definition of biodegradable material is a quoted below:
"Biodegradable" refers to the ability of things to get disintegrated (decomposed) by the action of micro-organisms such as bacteria or fungi biological (with or without oxygen) while getting assimilated into the natural environment. There's no ecological harm during the process. We can either speak of biodegradable solids (also called compostable) or liquids that biodegrade into water." *(Ref. 3.13)*

Construction materials like concrete and steel, have a heavy carbon footprint unlike biodegradable materials which have a minimal impact on the environment. This is why the use of biodegradable construction materials are useful towards achieving sustainability in construction.

5. Indoor Environmental Quality:

Green building practices, which focus on designing and constructing buildings with sustainability and energy efficiency in mind, can have significant positive impacts on human health. By integrating sustainable materials, energy-efficient systems, and healthy building environments, green buildings reduce environmental impact and foster healthier spaces for occupants. IEQ encompasses multiple factors that influence the indoor environment, including air quality, lighting, acoustics, and thermal comfort. Key Features includes the followings:

I) Improved Indoor Air Quality (IAQ)

Ventilation plays a crucial role in maintaining good air quality and removing pollutants, allergens, and moisture. Green building standards like LEED (Leadership in Energy and Environmental Design) and WELL Building Standard emphasize efficient and healthy ventilation.

Green Building Ventilation Strategies:

Natural Ventilation:

Designs that maximize cross-ventilation through operable windows, vents, and strategic building orientation reduce reliance on mechanical systems.

Natural airflow improves occupant comfort and reduces energy consumption.

Mechanical Ventilation:

High-efficiency ventilation systems (e.g., energy recovery ventilators, heat recovery ventilators) provide fresh air while conserving energy.

Demand-controlled ventilation (DCV) systems adjust airflow based on occupancy levels, ensuring air quality without wasting energy.

Air Exchange Rates:

Green buildings often exceed minimum standards for air exchange rates set by codes like ASHRAE 62.1, ensuring a constant supply of fresh air.

Filtration and Air Purification:

Advanced filters (e.g., HEPA or MERV-rated) are integrated to remove particulates, allergens, and pathogens, ensuring cleaner air for occupants.

II) Enhanced Natural Lighting and Access to Views

Daylighting Strategies: Maximizing natural light through strategic window placement, skylights, and reflective surfaces has been shown to improve mood, reduce stress, and increase productivity.

Connection to Nature: Access to green spaces or views of the outdoors contributes to mental well-being, reducing stress levels and enhancing cognitive performance.

III) Thermal Comfort and Temperature Control

Green buildings often have advanced insulation and temperature control systems, ensuring that the indoor environment stays within a comfortable range. Consistent and comfortable temperatures contribute to better sleep, reduced fatigue, and overall comfort for occupants.

1. **Reduction of Noise Pollution**
   Acoustic Design: Noise pollution can lead to stress, sleep disturbances, and even cardiovascular issues. Green buildings often include sound insulation and layout strategies that minimize external noise and enhance privacy, creating a quieter environment that supports mental well-being.

2. **Use of Nontoxic, Sustainable Materials**
   By using materials free from harmful chemicals, green buildings reduce the potential for exposure to toxins that can affect the endocrine, respiratory, and immune systems. Sustainable materials also reduce waste and pollution, indirectly benefiting public health.
3. **Enhanced Water Quality**
   Many green buildings incorporate water filtration systems that ensure access to clean drinking water. This reduces exposure to contaminants such as lead, chlorine, and other chemicals commonly found in municipal water supplies.

4. **Support for Active Lifestyles**
   Green building designs often encourage physical activity by integrating features like bike storage, accessible staircases, and outdoor spaces. This promotes physical health, encouraging exercise and movement that can help prevent chronic diseases.

8. **Reduction of Electromagnetic Pollution and Toxins**
   Green buildings are increasingly addressing electromagnetic pollution, and some incorporate design elements to minimize electromagnetic field (EMF) exposure from building systems and appliances, potentially benefiting those sensitive to EMFs.

9. **Mental Health Benefits**
   Beyond physical health, green buildings can reduce stress and improve mental health by fostering a relaxing environment through design elements like natural materials, plants, and access to natural light.

In essence, green buildings are designed not only to be environmentally friendly but also to provide healthier, more comfortable spaces for occupants. As such, green building practices offer an essential way to support and enhance both individual and public health.

In conclusion, prioritizing IEQ and ventilation in green building design ensures healthier, more comfortable, and sustainable spaces for occupants. This dual focus not only improves the quality of life but also aligns with broader goals of environmental stewardship and energy efficiency.

6. Innovation

Innovation in green building encompasses the development and implementation of novel concepts, technologies, and methodologies aimed at enhancing sustainability and minimizing environmental impact.

A table was formulated using the indicators (Table 3.1) to conduct the questionnaire survey.

TABLE 3.1: GREEN TECHNOLOGIES INDICATORS USED FOR FORMING THE QUESTIONNAIRE FOR THE CASE STUDIES FOR THE DATA ANALYSIS (REF: 3.18)
(Questionnaire Format Based on the Indicators)

Sl.	(Indicators) Adopted concept & green design technology	COMMERCIAL BUILDING WITH OFFICE SPACES CATAGORY 1		FACTORY BUILDINGS (GARMENTS FACTORY) CATEGORY 2		IMPACTS AND NUMBRING BASED ON PERFORMANCE (YES=2, NO=0, NOT SURE=0)
		GREEN TECHNOLOGY **APPLIED**	GREEN TECHNOLOGY **NOT APPLIED**	GREEN TECHNOLOGY **APPLIED**	GREEN TECHNOLOGY **NOT APPLIED**	
		CITYSCAPE TOWER (COMMERCIAL CUM OFFICE BUILDING) AT 53, GULSHAN AVENUE, GULSHAN MODEL TOWN, DHAKA-1212, BANGLADESH	**GRAND DEL VISTA TOWER** (COMMERCIAL CUM OFFICE BUILDING) AT PLOT 1A, ROAD 113, GULSHAN AVENUE, GULSHAN MODEL TOWN, DHAKA 1212, BANGLADESH	**MNR SWEATERS LTD.** (GARMENTS FACTORY) AT BARAIDER CHALA, SREEPUR, GAZIPUR, SREEPUR PS; GAZIPUR, DHAKA, BANGLADESH.	**EVE DRESS SHIRTS LTD.** (GARMENTS FACTORY) AT 219 ANWAR JUNG ROAD, ASHULIA, DHAKA-1341, BANGLADESH	
01.	Location and Transportation					
02.	Sustainable Sites -Renovation/ restoration -Open space -Heat Island Reduction -Open green space vs Paved area -Hydrology & storm water management					

	-Vegetation -Human Health effect					
03.	Water Efficiency					
04.	Energy & Atmosphere -Solar panels -Cool Roofs -Smart Glass -Green Insulation -Smart Appliances/ fixtures (energy bulbs) -Biodegradable Materials					
05.	Indoor Environmental quality					
06.	Innovations (e.g. Use of Hydroponics)					

The result obtained are analyzed collated and conclusion drawn.

The followings are some stablished standards rating systems worldwide to evaluate the results of applying green technology in building design:

i) ASHRAE Standards

The abbreviation ASHRAE stands for the "American Society of Heating, Refrigerating and Air-Conditioning Engineers".

ASHRAE/IES/USGBC/ICC Standard 189.1, Standard for the Design of High-Performance Green Buildings, contains minimum requirements for the siting, design and construction of high-performance green buildings in support of reducing building energy use, resource consumption and other environmental impacts while maintaining acceptable indoor environments. *(Ref 3.14)*

ii) LEED

The standard LEED stands for "Leadership in Energy and Environmental Design". It is the world's most widely used green building rating system. was created by the non-governmental organization U.S. Green Building Council (USGBC) in 1998. The USGBC is a not-for-profit organization founded in 1993 to promote sustainability in the building, constructing, and operating of buildings and communities. LEED certification provides a framework for healthy, highly efficient, and cost-saving green buildings, which offer environmental, social and governance benefits. The LEED rating system is based on a point system, with buildings earning points for meeting certain criteria in categories such as energy efficiency, water conservation, and indoor environmental quality. The more points a building earns, the higher its LEED rating will be.*(Ref: 3.17)*

iii) BREEAM

This standard is a voluntary rating system practiced in UK. The full form of BREEM is The Building Research Establishment Environmental Assessment Method (BREEAM). It is used for assessing the environmental performance of buildings. A BREEAM assessment uses recognized measures of performance, which are set against established benchmarks, to evaluate a building's specification, design, construction and use. The measures used represent a broad range of categories and criteria from energy to ecology. *(Ref: 3.15)*

iv) WELL Building Standard

The WELL Building Standard® is a performance-based system for measuring, certifying, and monitoring features of the built environment that impact human health and wellbeing, through air, water, nourishment, light, fitness, comfort, and mind. To put it another way, LEED aims to determine the overall sustainability of a project based on factors like design, construction, maintenance and operation while WELL instead, focuses on factors affecting occupant health and includes areas such as nourishment, fitness and mind. *(Ref: 3.16)*

v) Green Mark Certification Scheme

The Green Mark certification scheme was launched in January 2005. It is a green building rating system designed to evaluate a building's environmental impact and performance. It provides a comprehensive framework for assessing the overall environmental performance of new and existing buildings to promote sustainable design,and best practices inconstruction and operations in buildings. *(Ref: 3.18)*

vi) Green Globes

Green Globes is a science-based, three-in-one building rating system that evaluates the environmental sustainability, health & wellness, and resilience of commercial buildings and portfolios. Supporting a wide range of new construction and existing building project types, Green Globes certification demonstrates an owner and occupant commitment to sustainability & ESG goals. *(Ref: 3.19)* As a nationally recognized green building rating program, Green Globes works with building owners to help with sustainability goals for new constructions, existing buildings, and interiors. The rating system could help buildings reduce operating costs, receive incentives through rebates, retain and attract talent, and increase marketability. They provide in-depth support to help manage these goals.

vii) EDGE

EDGE is a green building certification system that focuses on making buildings more resource efficient. An innovation of IFC, a member of the World Bank Group, EDGE empowers emerging markets to scale up resource-efficient buildings in a fast, easy, and affordable way.

"IFC helps to create a virtuous cycle of supply and demand in emerging markets for resource-efficient building design, construction and ownership through its Green Buildings Market Transformation Program (GBMTP). The aim is to set a metrics-driven definition of what constitutes a green building, reward property developers for building green, increase regulatory pull and promote direct investment. The GBMTP is part of IFC's holistic strategy to steer construction in rapidly urbanizing economies onto a more low-carbon path. The program outlines the benefits to developers, owners, governments, banks and building professionals to work together to unblock the potential for an era of green construction and development. It's an example of IFC's commitment to creating markets that are competitive, sustainable, inclusive and resilient." *(Ref: 3.20)*

viii) HERS Index

"HERS, which stands for Home Energy Rating Score, was developed by the Residential Energy Services Network (RESNET) and introduced in 2006. Since then, it's become the gold standard used by the building industry to score and measure the energy efficiency of a home—nearly 3.5 million homes have been HERS rated. The HERS rating of a home is calculated by looking at two factors: how much energy the home uses and how much clean energy the home generates (through renewable energy sources like solar panels). The lower the number, the greener the home. The HERS index score, or Home Energy Rating System score, is a measure of a home's energy efficiency. It is calculated on a scale of 0 to 100, with 100 being the least energy efficient and 0 being the most energy efficient." *(Ref: 3.21)*

In the current study, the LEED standards are used as the parameter since this certification has become the gold standard in sustainable green buildings all around the world. Furthermore, many new projects are undertaken in Bangladesh during the recent past in which a few have used the LEED Certification. Based on the LEED rating point system, the buildings under the study was evaluated the more points a building shall earned, the higher its LEED rating was. The conclusions and recommendations of the study was drawn after drawing comparison and analysis acquired from the results.

CHAPTER 04

THEORETICAL PERSPECTIVES AND LITERATURE REVIEW

Abbreviations

BCCRF: Bangladesh Climate Change Resilience Fund
BCCSAP: Bangladesh Climate Change Strategy and Action Plan
BCCTF: Bangladesh Climate Change Trust Fund
BEEER: Building Energy Efficiency & Environment Rating
BGBC: Bangladesh Green Building Council
BREEAM: Building Research Establishment Environmental Assessment Method
BSEC: Bangladesh Securities and Exchange Commission
CPTU: Central Procurement Technical Unit
CRF: Climate Risk Fund
CSR: Corporate social responsibility
EE&C: energy efficiency and conservation
EECMP: Energy Efficiency & Conservation master Plan
EPA: United States Environmental Protection Agency
ERD: Economic Relations Division
ESG: Environmental, social, and governance
EV: Electric Vehicle
GADT: Green Building concepts or the Green Architectural Design Technology
GBIG: Green Building Information Gateway
HVAC: Heating, Ventilation and Air Conditioning
IoT: Internet of Things
IDRA: Insurance Development and Regulatory Authority
LCA: Life Cycle Assessment
LEED: Leadership in Energy and Environmental Design
MoEF: Ministry of Environment and Forest
MoEFCC: Ministry of Environment, Forest, and Climate Change
MoU: Memorandum of Understanding
SD: Sustainable Development
SDGs: Sustainable Development Goals
SMUD: Sacramento Municipal Utility District
SREDA: Sustainable and Renewable Energy Authority
UNSD: United Nations Statistics Division
USGBC: U.S. Green Building Council
VOC: Volatile Organic Compound

CHAPTER 04

THEORETICAL PERSPECTIVES AND LITERATURE REVIEW

4.1 Sustainability

Various definitions of sustainability exist. Basiago (Citation 1999) characterizes sustainability as the ability to uphold an entity, outcome, or process over time. ‘Sustainability’ is related to ‘futurity’ *(Ref 4.1)* However, within academic, research, and practitioner circles in development literature, sustainability is commonly construed as the enhancement and maintenance of a robust economic, ecological, and social framework conducive to human advancement.

In its broadest sense, sustainability pertains to the capacity to perpetuate or support a given process consistently over time. Within the spheres of business and policy realms, it entails the conscientious management of natural or physical resources to ensure their lasting availability. This paradigm emphasizes a forward-looking concept that considers a long-term ramification of human actions on both societal and ecological systems. This ethos is underpinned by the recognition that without significant alterations to current practices, irreversible damage to the planet is inevitable. In response to escalating concerns regarding anthropogenic climate change, biodiversity loss, and pollution, there has been a global pivot towards embracing sustainability. This transition is characterized by the increased implementation of sustainable business practices and escalated investments in green technology. (Daniel Thomas Mollenkamp, Updated December 13, 2023, Reviewed by Jefreda R. Brown, Fact-Checked by Timothy Li) *(Ref 4.2)*

The discourse on sustainability has been significantly enriched by scholars such as Mensah and Enu-Kwesi (Citation 2018), who underscore the imperative of incorporating the principle of cross-generational equity into its definition. This notion, while pivotal, introduces a complex challenge, as it necessitates the consideration of the needs and interests of future generations, which are inherently elusive and subject to uncertainty. "Although the literature is awash with a plethora of definitions and interpretations of SD, implicit in the pervasive viewpoints about the concept is intergenerational equity, which recognizes both the short and long-term implications of sustainability in order to address the needs of both the current and future generations." *(Ref 4.3)*

Contemporary perspectives on sustainability advocate for a comprehensive approach that integrates social, environmental, and economic dimensions to address human challenges in a manner that ensures enduring benefits for humanity (Hussain, Chaudhry, & Batool, Citation 2014; UNSD, Citation 2018b). In this regard, economic frameworks within this paradigm advocate for the sustainable accumulation and utilization of both natural and financial capital. Environmental models, on the other hand, prioritize the preservation of biodiversity and ecological integrity. Meanwhile, Social sustainability, though less tangible, emphasizes the human ramifications of economic systems, striving to foster a cohesive social fabric conducive to eradicating poverty, hunger, and promoting peace and equality among the human race. Social models aim to enhance various facets of human society, including political, cultural, religious, health, and educational systems, among others, thereby safeguarding human dignity and well-being (Acemoglu & Robinson, Citation 2012; Evers, Citation 2018) and thereby sustainable development. *(Ref 4.3)*

Hák, Janoušková, and Moldan (Citation 2016) assert that the transformation of global society, environment, and economy toward sustainability constitutes one of humanity's most formidable challenges, particularly given the imperative to operate within the planet's carrying capacity. The World Bank (Citation 2017) underscores the necessity for innovative approaches to address these realities. (Ref 4.4) Moreover, Gossling-Goldsmiths (Citation 2018) underscores the dynamic alignment and equilibrium required, emphasizing the imperative of a meaningful definition of sustainability centered around this principle. *(Ref 4.3)*

Central to the pursuit of sustainable development is the recognition that the interplay between these dimensions is intricate and dynamic. Thus, efforts to achieve sustainability must strive for a harmonious balance that acknowledges the interdependence of social, environmental, and economic factors while upholding the principles of equity and justice across generations.

4.2 Sustainable development

It is crucial to distinguish between the concepts of sustainability and sustainable development. Diesendorf (2000) postulates that sustainability represents the ultimate objective or endpoint of a process known as sustainable development. This distinction is further elucidated by Gray (2010), who argues that while "sustainability" refers to a state, SD refers to the process for achieving this state. (Ref 4.4). This differentiation underscores the dynamic and reiterative nature of sustainable development, emphasizing the continuous pursuit of balance and harmony among economic, environmental, and social dimensions. In the historical trajectory of sustainable development (SD), Pigou (1920) underscores its conceptual origins within the realm of economics. Central to early deliberations was the probing inquiry into whether the Earth's finite natural resources possessed the capacity to sustain an ever-expanding human populace, a discourse notably propelled by the Malthusian population theory of the early 19th century (Dixon and Fallon, 1989; Coomer, 1979). (Ref 4.3)

The notion of 'sustainability' emerged in The Ecologist's A Blueprint for Survival, in 1972. The quest to make modern civilization 'sustainable' inspired the UN's Stockholm Conference in 1972 and the 'global trusteeship' of subsequent international environmental treaties (Ref 4.1).

A pivotal moment in the institutionalization of sustainable development occurred in 1983 when the United Nations established the World Commission on Environment and Development. Tasked with exploring the intricate nexus between ecological integrity, economic progress, and social equity, the commission, led by former Norwegian Prime Minister Gro Harlem Brundtland, released its seminal report in 1987(Brundtland Report) *(Ref 4.5)* "Sustainability' is related to 'futurity', hence the Brundtland Commission in 1987 defined sustainable development as 'development which meets the needs of the present, without compromising the ability of future generations to meet their own needs"

Brundtland's formulation of sustainable development serves as a fundamental blueprint, encapsulating the imperative of balancing present imperatives with future exigencies. It embodies a paradigm shift in human development strategies, advocating for a harmonious convergence of economic prosperity, social equity, and environmental stewardship which recognizes the intrinsic value of natural resources and ecosystems.

In essence, it articulates a vision wherein human progress is intricately interwoven with the preservation of ecological vitality and the promotion of intergenerational equity (World Commission on Environment and Development. "Report of the World Commission on Environment and Development: Our Common Future," Page 16.) *(Ref 4.5)*

According to Dernbach, Lele and Stoddart sustainable development implies to "development that can be continued either indefinitely or for the given time period" (Dernbach, Citation1998, Citation2003; Lele, Citation1991; Stoddart, Citation2011).

Sustainable development is also seen as a core concept within global development policy and agenda by Cerin (Citation2006) and Abubakar (Citation2017).

Furthermore, sustainable development emerges as a central tenet within the discourse of global development policy and agenda, as underscored by Cerin (2006) and Abubakar (2017). This acknowledgment underscores the universal relevance and significance of sustainable development as a guiding principle in shaping socioeconomic policies and strategies at both national and international levels. It reflects a growing consensus among policymakers and stakeholders regarding the imperative of integrating environmental sustainability, social equity, and economic prosperity in development frameworks to foster resilient and inclusive societies.

It is a mechanism, in which society interacts with the environment without damaging the resources which are supposed to be required by the future generations. "Thus, it is a development paradigm as well as concept that calls for improving living standards without jeopardizing the earth's ecosystems or causing environmental challenges such as deforestation and water and air pollution that can result in problems such as climate change and extinction of species (Benaim & Raftis, Citation2008; Browning & Rigolon, Citation2019)."

A walk into the history of sustainable development also helps predict the future trends and flaws and, therefore, provide useful guide now and for the future (Elkington, Citation1999).

The imperative to transition away from detrimental socio-economic activities towards those yielding positive environmental, economic, and social outcomes has been underscored by Ukaga et al. (2011).

This call advocates for a holistic approach that integrates economic, environmental, and social considerations into decision-making processes, thereby fostering sustainable development.

A retrospective examination of the historical evolution of sustainable development provides valuable insights for anticipating future trends and addressing existing shortcomings. Elkington (1999) suggests that an exploration of past endeavors in sustainable development can serve as a guide for present and future endeavors, facilitating informed decision-making and strategic planning.

4.2.1 Pillars of sustainable development

As emphasized by Porter and van der Linde (1995), optimal choices are those that concurrently address the needs of society while maintaining environmental and social viability. This principle delineates three interrelated spheres or domains of sustainability: economic viability, social equity, and environmental integrity. These domains encapsulate the intricate relationships among the environmental, economic, and social dimensions of sustainable development, as illustrated in Diagram 4.1 below.

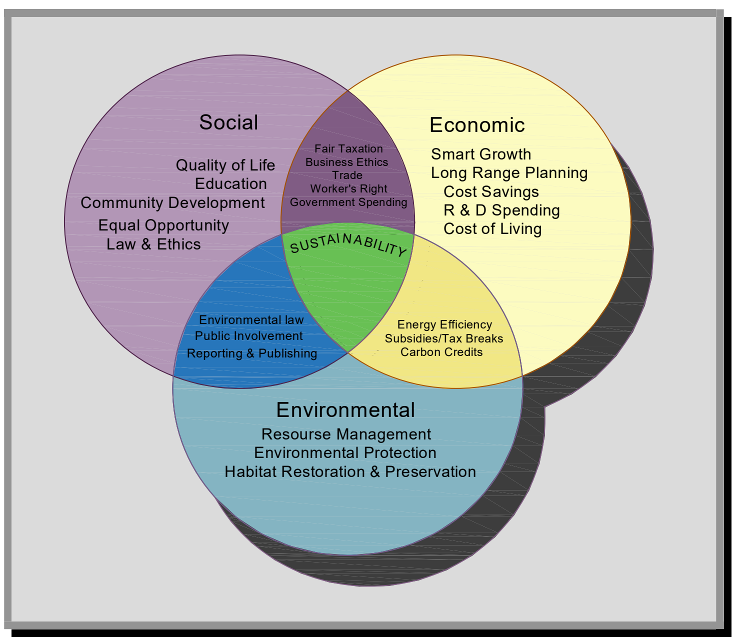


***Diagram 4.1 Relationships among social, environmental and economic sustainability*.**

The figure shows 3 interlocking spheres namely, Social, Economic and Environmental. Each sphere represents a concept and together they constitute a set of interrelated concepts which forms the basis of human decisions and actions in the quest for SD. *(Ref 4.3)*

Yang (2019) corroborates this assertion by suggesting that the diagram serves as a visual representation illustrating that judicious decisions pertaining to sustainable resource management engender sustainable growth conducive to the development of a sustainable society. Such decisions span various domains, including but not limited to land use, surface water management, agricultural practices, building design and construction, energy management, education, equal opportunities, as well as legislative enactment and enforcement (Montaldo, 2013; Porter & van der Linde, 1995).

Kahn (1995) and Basiago (1999) offer compelling illustrations elucidating the intricate interplay among economic, social, and environmental sustainability, underscoring the imperative of integrating these three domains for the sake of sustainability. Their arguments reinforce the notion that sustainability necessitates a holistic approach that acknowledges and addresses the interdependencies among economic, social, and environmental dimensions, thereby fostering resilience and enduring prosperity.

These may be further elaborated as below: -

"As a visionary and forward-looking development paradigm, SD emphasizes a positive transformation trajectory anchored essentially on social, economic and environmental factors. According to Taylor (Citation2016), the three main issues of sustainable development are economic growth, environmental protection and social equality. Based on this, it can be argued that the concept of SD rests, fundamentally, on three conceptual pillars. These pillars are "economic sustainability", "social sustainability", and 'environmental sustainability*" (Ref 4.3)*

The underlying premise is that when the principles encapsulated within the three spheres of sustainability are effectively applied to real-world scenarios, it engenders multifaceted benefits wherein natural resources are preserved, environmental integrity is safeguarded, economic prosperity is fostered, and social well-being is enhanced, characterized by harmony and respect for human rights (DESA-UN, 2018; Kaivo-oja et al., 2013).

Economic sustainability

In general terms sustainability in economics can be understood as the conditions, under which a certain level of production and consumption can be sustained forever. *(Ref 4.6)*

"Economic sustainability implies a system of production that satisfies present consumption levels without compromising future needs (Lobo, Pietriga, & Appert, Citation2015). Traditionally, economists assuming that the supply of natural resources was unlimited, However, it has been realised that natural resources are not infinite; besides not all of them can be replenished or are renewable. The growing scale of the economic system has overstretched the natural resource base, prompting a rethink of the traditional economic postulations" (Ref 4.3). Economies are intricate systems comprising markets wherein transactions transpire, serving as the nexus for economic activities and decision-making processes. However, amidst the dynamics of market interactions, certain guiding principles and evaluative criteria underpin the appraisal of transactions and the formulation of economic decisions.

Dernbach, (Citation1993), *(Ref 4.3)* He had earlier argued that due to population growth, human needs like food, clothing, housing increase; But essentials such as food, clothing, and shelter are juxtaposed against finite global resources and are incapable of indefinitely meeting burgeoning demands (Dernbach, 2003). This perspective underscores the inherent tension between human consumption patterns and the finite carrying capacity of the planet, necessitating a paradigm shift towards sustainable resource management and consumption practices. Moreover, Retchless and Brewer (2016) raise concerns regarding the prevailing emphasis on economic growth, noting the conspicuous absence of critical considerations such as the adverse impacts of resource depletion and environmental pollution. This myopic focus on economic expansion, they argue, perpetuates unsustainable consumption patterns that exact a toll on the environment, jeopardizing long-term ecological integrity (UNSD, 2018c). This perspective underscores the inherent tension between human consumption patterns and the finite carrying capacity of the planet, necessitating a paradigm shift towards sustainable resource management and consumption practices.

This necessitates a departure from conventional growth-oriented paradigms towards more inclusive and environmentally conscious economic frameworks. Thus, economic sustainability mandates a holistic approach that integrates environmental and social considerations into decision-making processes, ensuring equitable and fiscally prudent outcomes (Zhai & Chang, 2019).

Social sustainability

Social sustainability embodies a multifaceted construct encapsulating principles of equity, empowerment, accessibility, participation, cultural identity, and institutional stability (Daly, 1992). At its core, this concept emphasizes the intrinsic value of human well-being and underscores the pivotal role of people in the process of development (Benaim & Raftis, 2008). Fundamentally, social sustainability denotes a societal framework characterized by the alleviation of poverty and the promotion of inclusive socio-economic structures (Littig & Grießler, 2005).

However, the essence of "social sustainability" extends beyond mere poverty alleviation to encompass the intricate interplay between social conditions, such as poverty, and environmental degradation (Farazmand, 2016). The theory of social sustainability posits that efforts to address poverty must be pursued in a manner that mitigates environmental harm and safeguards economic stability (Kumar, Raizada, & Biswas, 2014; Scopelliti et al., 2018). In essence, social sustainability necessitates the pursuit of poverty alleviation within the confines of the society's existing environmental and economic resources, thereby promoting resilience and long-term well-being.

Understanding the nature of social dynamics and how these structures emerge from a systems perspective is of great importance to social sustainability (Lv, Citation2018). Gray (Citation2010) and Guo's (Citation2017) views, social sustainability to encompasses other issues such as human rights, gender equity and equality, public participation and rule of law as well, all of which promote peace and social stability for sustainable development. *(Ref 4.3)*

Environmental sustainability

Environmental sustainability refers to the responsible management of natural resources to fulfill current needs without compromising the ability of future generations to meet theirs. It aims to balance ecological, economic and social goals, such as reducing carbon emissions, promoting renewable energy and ensuring equitable resource access. *(Ref 4.7)*

Human wellbeing is closely linked to the health of the environment. Around the world, 24% of deaths can be traced back to avoidable environmental factors, according to the World Health Organization. People need clean air to breathe, fresh water to drink, and places to live that are free of toxic substances and hazards. *(Ref 4.8)*

Environmental sustainability encompasses the fundamental notion of preserving the natural environment's functionality and resilience to sustain human existence. It pertains to maintaining the integrity of ecosystems and the carrying capacity of natural environment (Brodhag & Taliere, 2006). Central to this concept is the prudent management of natural capital, ensuring its sustainable utilization as both a source of economic inputs and a receptacle for waste (Goodland & Daly, 1996). This necessitates a balance wherein natural resources are extracted no faster than they can be replenished, and waste is discharged no faster than it can be absorbed by the environment (Diesendorf, 2000; Evers, 2018). Such practices are imperative due to the inherent limits or boundaries within Earth's systems, which sustain equilibrium.

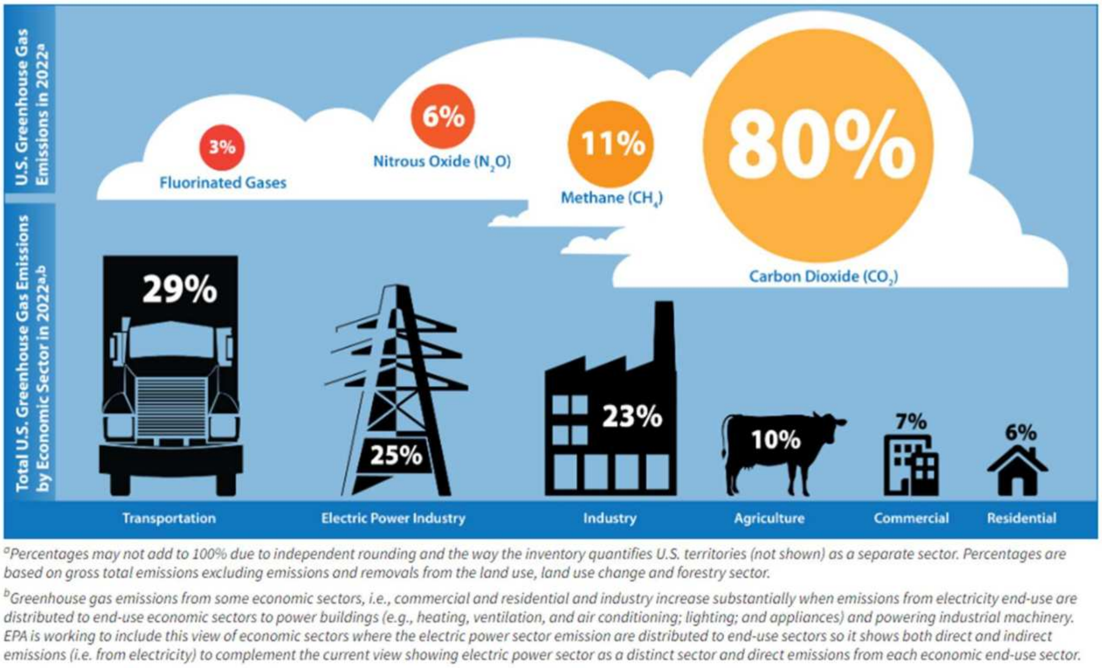


Diagram 4.2
***Total US Gas Emission* (Ref 4.10)**

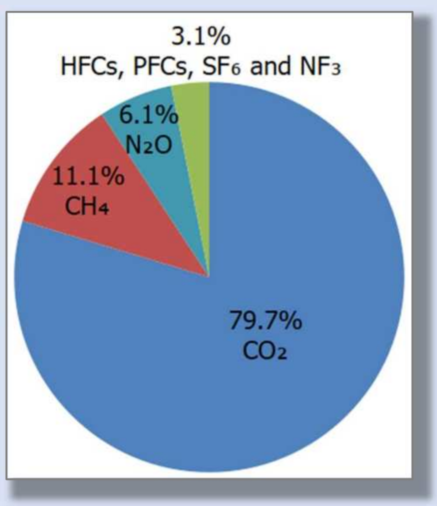


Diagram 4.3 Green House Gas Pie Diagram in US in 2022

Total U.S. Emissions in 2022 = 6,343 Million Metric Tons of CO_2 equivalent (excludes land sector). Percentages may not add up to 100% due to independent rounding. Land Use, Land-Use Change, and Forestry in the United States is a net sink and offsets 13% of these greenhouse gas emissions. This net sink is not shown in the above diagram. All emission estimates are sourced from the Ref: Inventory of U.S. Greenhouse Gas Emissions and Sinks: 1990–2022. [Ref 4.9]

This indicates that, adopting renewable energy technologies reduces greenhouse gas emissions, lessens our reliance on fossil fuels, and fosters energy independence. It also creates job opportunities in the renewable energy sector, contributing to economic growth. "GENEVA (ILO News) – Worldwide employment in renewable energy reached 12.7 million last year, a jump of 700,000 new jobs in one year, despite the lingering effects of COVID-19 and the growing energy crisis, according to a new report." *(Ref 4.11)* According to the Energy Information Administration, solar and wind power together accounted for 70% of the new energy capacity added in 2021 and worldwide, global investment in all renewable energy sources exceeded $300 billion in 2020 *(Ref 4.11)*

Climate change, an ongoing phenomenon, signifies substantial and enduring alterations in the climate system induced by either natural variability or human activities (Coomer, 1979). These changes manifest in various forms, including atmospheric and oceanic warming, dwindling ice masses, rising sea levels, escalating ocean acidification, and heightened concentrations of greenhouse gases (Du & Kang, 2016). The repercussions of climate change are already evident in biodiversity dynamics. Kumar et al. (2014) notes observable shifts in the reproductive timing of flora and fauna, alterations in animal migration patterns, and changes in species distributions and population sizes attributable to rising temperatures. While the precise extent of global warming's impact remains uncertain, Ukaga et al. (2011) suggest that predictions tend toward pessimism. Regardless, Campagnolo et al. (2018) assert that societies must adapt to the evolving environmental realities, emphasizing the imperative of managing ecosystems and respecting natural growth constraints for sustainability. *(Ref 4.3)*.

"SD has attracted much attention in the academic, governance, planning and development intervention space. A wide range of governmental and non-governmental entities appear to have embraced it as an appropriate development paradigm. This is because most, if not all proponents and advocates of the paradigm, virtually seem to concur that the challenges confronting humankind today such as climate change, depletion of ozone layer, water scarcity, loss of vegetation, inequality, insecurity, hunger, deprivation and poverty can be addressed by adhering to the tenets and principles of SD and promote meaningful progress". *(Ref 4.3)*

A key characteristic of the Sustainable Development Goals (SDGs) is their inherent interdependence and interconnectedness, as highlighted by Tosun and Leininger (2017). Contrary to being isolated objectives, the SDGs are intrinsically linked, suggesting that progress in one goal leads to achieving another and, therefore, they should be seen as indispensable pieces in a big and complex puzzle (Fasoli, 2018; Kumar et al., 2014).

As noted by Ritchie and Roser (2018), the global trend toward urbanization is accelerating, with more than half of the world's population already residing in urban areas, a figure projected to rise to two-thirds by 2050. This demographic shift underscores the significance of urban planning and development in the context of sustainable development.

Moreover, the development of environmentally-friendly infrastructure is imperative to support increased economic output and productivity, as emphasized by Waage et al. (2015). This underscores the importance of integrating environmental considerations into infrastructure planning and development processes.

In summary, the overarching principle of Sustainable Development lies in the systematic incorporation of environmental, social, and economic considerations into all aspects of decision-making processes across generations. This entails recognizing and addressing the interconnectedness of various development goals and ensuring that actions taken today do not compromise the ability of future generations to meet their needs.

"The ultimate aim of SD is to achieve a balance among environmental, economic and social sustainability, thus, making these the pillars on which SD rests. While not assuming a definitive posture, sustainability of society can be said to depend on the availability of proper health systems, peace and respect for human rights, decent work, gender equality, quality education and rule of law. Sustainability of economy, on the other hand, depends on adoption of appropriate production, distribution and consumption while sustainability of the environment is driven by proper physical planning and land use as well as conservation of ecology or biodiversity. Regarding SD, the concept is intergenerational equity, which recognizes both the short and long-term implications of sustainability in order to address the needs of both the current and future generations.

SD thrives on the commitment of people and so in order to translate the concept into action, public participation should be increased. All people must be aware and acknowledge that their survival and the survival of the future generation depend on responsible behavior regarding consumption and production, environment and progressive's social values. It is only by integrating the pillars can negative synergies be arrested, positive synergies fostered, and meaningful SD made to happen."
(Ref 4.3)

4.2.2 Activities That Promote Sustainability

The proliferation of technological advancements has facilitated consumers' access to information from across the globe, fostering an incremental increase in environmental awareness among them. Consequently, this heightened consciousness has propelled companies and businesses to undertake concerted efforts aimed at mitigating the adverse impacts that reverberate through both local communities and the broader environment over the long term.

Among the strategies adopted by enterprises committed to sustainability is the concerted reduction of their environmental footprint. This entails embracing initiatives such as the utilization of renewable energy sources and the implementation of waste reduction measures. For instance, in the realm of infrastructure development, companies may opt to minimize energy consumption by integrating solar energy solutions into their projects.

Moreover, in their pursuit of sustainability, organizations endeavor to foster diversity and equity within their workforce while also enacting policies that actively contribute to the betterment of the local community. By prioritizing inclusivity and fairness in employment practices, businesses not only uphold ethical imperatives but also cultivate environments conducive to innovation and productivity.

In essence, the convergence of technological progress and heightened environmental consciousness among consumers has catalyzed a paradigm shift within the corporate landscape, compelling businesses to prioritize sustainability as an integral facet of their operational ethos. Through the adoption of environmentally-conscious practices and the promotion of social equity, companies aspire to contribute meaningfully to the preservation of both local communities and the planet at large.

4.2.3. Five Methods to Practically Achieve Effective Sustainable Development

Prior to going into elaboration, certain details of green buildings need to be deliberated. Therefore, the definition of Green Building, its types as well as their advantages and disadvantages are discussed below.

Green building is an emerging concept in the rapid growing Infrastructure Industry. It is a solution to the climate change and Global warming which is mainly caused by worldwide carbon emission. *(Ref 4.12)* Green infrastructure or green building design is a concept, process and philosophy of constructing the structures in a way so as to achieve high performances and greater values over the lifetime of the structures.

Yet another reference delineates that "Buildings and their users impact the environment during their entire life cycle from construction through operation to demolition. They exploit natural resources, consume energy and water, and produce waste. A green building is a building that reduces or eliminates negative impacts that buildings may have on the environment and may also create positive impacts. Green buildings preserve precious natural resources and improve our quality of life." *(Ref 4.13)*

The Bangladesh National Building Code (BNBC) covers certain aspects regarding construction of green buildings. BNBC basically discusses aspects of building design such as the architectural design, construction materials, structural design and integrity, fire safety, electrical and plumbing installations, sanitation facilities, accessibility, and disaster resilience. However, apart from these discussions, the code highlights topics such as energy efficiency, water conservation, and waste management, encouraging the use of eco-friendly and resource-efficient building materials and technologies. It has been revealed that design and construction efficiency, and reduction of energy use are the highest ranked indicators of green building.

"Overall, the adoption of green building practices in Bangladesh is essential in addressing the challenges of climate change and ensuring sustainable development in the country. The construction sector has a crucial role to play in this, and the progress made so far in promoting sustainable construction practices is encouraging." *(Ref: 4.14)*

The future of green building in Bangladesh appears promising, buoyed by governmental initiatives and international partnerships aimed at fostering sustainable construction practices. Embracing sustainability in the construction sector holds the potential to yield manifold environmental and economic dividends. These include diminished energy consumption, decreased water usage, enhanced indoor air quality, and mitigated carbon emissions.

4.3 Green Buildings

"Simply put, a green building's structure is designed and constructed such that resource use is low in the construction and operation of a building". *(Ref 4.15)*

The green building concept was first introduced in the U.S. in 1976 by William A. Reilly as the design, construction and operation of a building employing methods and technologies which will protect and enhance the environment for the life of the building. After being introduced to a worldwide audience by Rachel Carson's book Silent Spring *(Ref 4.16)* in 1962, people started thinking about how they could create a healthier atmosphere for themselves and for their children. This gave rise to green technology in building construction that emphasizes sustainable architecture complemented with the promise of well-being.

Green buildings leverage various technologies and materials to minimize their environmental footprint and energy costs, thereby revolutionizing the construction industry. Some of these innovative elements include natural lighting facilitated by skylights or strategically placed windows, the integration of solar cells on the roof to harness renewable energy, rainwater harvesting systems to reduce water consumption, and the utilization of recycled products and materials to minimize waste.

Passive and active green buildings represent two distinct approaches to sustainable construction. Passive green buildings capitalize on natural elements such as wind, sunlight, and rain to optimize energy efficiency and minimize environmental impact. In contrast, active green buildings employ advanced technologies to enhance energy retention and reduce carbon emissions, thus further mitigating their ecological footprint.

Additionally, within the realm of green building, there are also notable subcategories such as Blue Buildings and Zero Energy Buildings. Blue Buildings integrate sustainable water management practices, emphasizing efficient water usage and conservation. On the other hand, Additionally, Zero Energy Buildings utilize renewable energy sources such as solar panels, wind turbines, and geothermal energy to achieve net-zero energy consumption, exemplifying a commitment to sustainability without compromising comfort or functionality.

The U.S. Green Building Council (USGBC) classifies green buildings into three primary categories: LEED Certified buildings, Energy Star Buildings, and Naturally Occurring (or "Zero") Net Buildings. These classifications signify adherence to rigorous sustainability standards and underscore a dedication to environmental responsibility and resource efficiency.

Beyond the conventional passive and active green building approaches, several other innovative green building technologies cater to both residential and commercial construction projects. Integrated Pest Management (IPM) strategies prioritize minimizing chemical reliance through the application of integrated tactics, encompassing mechanical, physical, and biological control methods. Solar energy emerges as a transformative solution, capable of reducing carbon dioxide emissions while providing clean energy and lowering utility bills. Moreover, the utilization of green building materials, including recycled, non-toxic, and low-embodied energy materials, contributes to sustainable construction practices, further advancing environmental stewardship and resource conservation.

4.3.1. Advantages and disadvantages of green buildings

Disadvantages of Green Building

- High Initial Investment; One of the main disadvantages of green building is the high initial investment.
- Getting the Right Materials since they may not be available at hand.
- Long Time to Build as it may take time in planning and designing
- Difficult to Control Indoor Air Temperature since they use solar energy to generate heat and do not use ventilation systems. Hence, they are not suitable for hot areas.
- Selecting Right Location. For example, all buildings may not be located such as to take maximum advantage from the sunlight in order to produce solar power.
- Finding Right Laborers or Experts since it is a relatively new industry.

However, these are outweighed by the advantages some of which are:

1. Lower Maintenance Cost as they have lower maintenance costs compared to traditional buildings. Although the construction cost may seem higher the long-term maintenance is substantially cheaper.
2. Improves Indoor Environment as the green building concept dramatically reduces the negative impact and helps in improving the quality of life.
3. Sustainable as this use of technology in the structures help keep the environment as well as the planet clean.
4. Prevent Water Wastage by enabling water recycling and in the process clean water is protected for future use.

5. Enhances Health of Occupants due to the utilization of eco-friendly materials during the construction.
6. Energy Efficient as structures are developed such as to use natural sources, like sun, water, and wind, to derive their energy.
   [Ref: 4.17]

TABLE 4.1: - BENEFITS OF GREEN BUILDINGS

	SECTOR	BENEFITS
01	**ECONOMIC**	• Green buildings require lower maintenance costs because sustainable components are used in their construction. • The operating costs are drastically reduced in a green building while enhancing occupant efficiency. • There are also large savings on tenant utility bills. • On average, green buildings are able to save between 10% – 40% of water consumption, and 25% – 50% of energy, and maintenance costs are reduced by about 12%.
02	**SOCIAL**	• The comfort and health of the occupants are improved. • Along with the great purpose that they serve, green buildings also heighten the aesthetic appeal. • The strain on the local infrastructure is minimized. • The overall quality of life is drastically improved.
03	**ENVIRONMENTAL**	• The biodiversity and ecosystems are enhanced and protected by green buildings. • The air and water quality are also improved. • There is proper waste management, and waste generation is also reduced. • Natural resources are conserved and restored efficiently by green buildings.

The sustainable goals as per the UN Sustainable Development article "Transforming our World: The 2030 Agenda for Sustainable Development [Ref :4.18] includes 17 goals, a few of which takes Sustainable goals as a major objective. The goals demonstrate the scale and ambition of this new universal Agenda which seek to build on the Millennium Development Goals and complete what these did not achieve.

4.3.2. The methods to achieve effective sustainable development

Sustainable development serves as the cornerstone for ensuring a prosperous and harmonious future for all. Sustainable development is the key to securing a prosperous and harmonious future for our planet and its inhabitants. It's a vision that balances economic growth, social well-being, and environmental protection. To transform this vision into reality, we need practical strategies that guide us toward sustainability.
The methods to practically achieve effective sustainable development are as follows:

i. Promote Green Infrastructure and Sustainable Urban Planning

ii. Transition to Renewable Energy Sources
iii. Implement Sustainable Agriculture Practices
iv. Advocate for Inclusive Social Policies.
v. International Collaboration and Goal Setting *[Ref 4.19]*

4.3.2.i. Promote Green Infrastructure and Sustainable Urban Planning

A large proportion of the world's population resides in urban areas. This poses a challenge to the urban populace to continue to live a sustainable life. In this scenario sustainable urban development has become a crucial component of sustainability in general. Researchers had been looking for measures to address this issue. One way to address this is by promoting green infrastructure and sustainable city planning.

The burgeoning urbanization worldwide presents a formidable challenge to maintaining sustainable lifestyles for the urban populace. In response, sustainable urban development has emerged as a pivotal facet of broader sustainability efforts. Researchers have diligently sought measures to confront this pressing issue, identifying the promotion of green infrastructure and sustainable city planning as crucial strategies.

Green infrastructure encompasses a range of natural and semi-natural features integrated into urban landscapes, serving multiple purposes such as stormwater management, biodiversity conservation, and climate regulation. By incorporating green spaces, permeable surfaces, and vegetated roofs into urban environments, cities can mitigate the adverse effects of urbanization while enhancing residents' quality of life.

Sustainable city planning entails the deliberate consideration of environmental, social, and economic factors in urban development initiatives. This approach prioritizes compact, mixed-use development patterns, efficient public transportation systems, and the preservation of natural habitats within urban areas. By fostering walkable neighborhoods, promoting energy-efficient building designs, and incentivizing renewable energy adoption, cities can reduce greenhouse gas emissions and resource consumption while fostering community resilience.

In essence, the promotion of green infrastructure and sustainable city planning represents indispensable strategies for addressing the sustainability challenges posed by rapid urbanization. By embracing these approaches, cities can strive towards creating vibrant, resilient urban environments that ensure the well-being of present and future generations.

“This includes initiatives such as expanding green spaces, building public transportation systems, creating pedestrian and bike-friendly pathways, and designing energy-efficient buildings. These efforts improve urban living conditions, reduce pollution, and enhance the quality of life for city dwellers. Green spaces like parks and rooftop gardens not only make cities look beautiful but also bring a lot of benefits to the environment. It helps absorb rainwater, reducing the risk of flooding and enhancing water quality. Additionally, green spaces offer recreational opportunities, improve air quality, and support biodiversity, making cities more pleasant and sustainable.” *[Ref 4.19]*

4. 3.2 ii. Transition to Renewable Energy Sources

Energy transition denotes the global energy sector's fundamental shift away from reliance on fossil-based systems of energy production and consumption, which primarily encompass oil, natural gas, and coal, towards renewable energy sources such as wind and solar, alongside the utilization of advanced technologies such as lithium-ion batteries [Ref 4.20]. This transition has been catalyzed by growing concerns regarding the depletion of natural resources and the environmental impacts associated with traditional energy sources.

In response to these concerns, many businesses are actively exploring and developing alternative energy sources that mitigate atmospheric carbon emissions and reduce pollution. Notably, solar and wind power have emerged as leading contenders in the renewable energy landscape, owing to their cost-effectiveness and widespread availability. In fact, solar panels have become increasingly affordable for homeowners in the United States, facilitating the adoption of solar energy at a consumer scale.

While solar and wind power have gained significant traction, other renewable energy alternatives such as geothermal and tidal energy are still in the nascent stages of deployment and have yet to be implemented at scale [Ref 4.21]. Despite their potential, these technologies require further research and development efforts to overcome technical and economic barriers before they can be widely adopted as viable alternatives to fossil fuels.

In essence, the energy transition represents a pivotal shift towards a more sustainable and environmentally friendly energy paradigm. By embracing renewable energy sources and innovative technologies, businesses and industries can play a pivotal role in driving this transition towards a cleaner and more sustainable energy future.

Moreover, hydroelectric power installations play a pivotal role in this transition by converting the kinetic energy of flowing water into electricity, thereby producing renewable energy. While these installations may exert an environmental impact during their operation, careful management and strategic planning can mitigate or minimize potential damage to ecosystems. By incorporating considerations for environmental preservation and sustainability into the planning and implementation of hydroelectric projects, adverse effects on ecosystems can be effectively mitigated.

In essence, the transition towards renewable energy sources such as solar, wind, and hydroelectric power represents a crucial step towards achieving emissions reduction and promoting sustainability on a global scale. Through continued innovation, investment, and responsible management practices, this transition holds the promise of fostering a more environmentally sustainable energy landscape for future generations.

Rain water harvesting is collection and storage of rain water that runs off from roof tops, parks, roads, open grounds and the like. This water run off can be either stored or recharged into the ground water. [Ref 4. 22].

Rainwater harvesting is one of the feasible options of fresh water sources in the coastal areas of Bangladesh and recently a lot of initiatives and programs were undertaken to promote and install rainwater harvesting systems both in the coastal and arsenic affected areas in Bangladesh. Moreover, every year the country is also blessed with ample rain. The average annual rainfall is about 2,200 mm a year with relatively high humidity all year around. Maximum humidity, over 80%, is recorded between June to September (Ministry of Environment and Forests 2012). [Ref 4.23]

Electric Vehicles

"Nearly a third of U.S. greenhouse gas emissions are released by transportation activities, according to the Environmental Protection Agency. Many manufacturers are exploring ways to reduce automotive emissions, either by designing more fuel-efficient engines or shifting to electrical power." [Ref 4.21].However, it is believed that the benefits of electric vehicles are limited by the fact that many power grids still rely on fossil fuels. The environmental implications of electric vehicles must be examined within the broader context of fossil fuel-dependent power grids. While EVs offer promise for reducing emissions and enhancing energy security, their effectiveness hinges on the carbon intensity of electricity generation. Policy efforts aimed at accelerating the transition towards renewable energy sources are essential to maximize the environmental benefits of EV adoption. By adopting a holistic and integrated approach to transportation electrification, society can advance towards a more sustainable and resilient future.

Recycling

Recycling represents a vital component of sustainable development strategies, offering a pathway towards resource conservation, waste reduction, and environmental stewardship. As per the Oxford Dictionary, the definition of recycling shall be "The reprocessing of discarded waste materials for reuse, which involves collection, sorting, processing, and conversion into raw materials which can be used in the production of new products."

"Recycling seeks to conserve scarce resources by reusing materials or finding sustainable substitutes. While plastic, glass, paper, and metal waste are the most familiar forms of recycling, more sophisticated operations can be used to recover expensive raw materials from e-waste or automobile parts." [Ref 4.21].By embracing innovative technologies, policy interventions, and consumer awareness campaigns, society can harness the full potential of recycling to address pressing environmental challenges and build a more resilient and equitable future.

Carbon Capture

Carbon capture refers to a group of experimental technologies that seek to remove and seize greenhouse gases, either at the point of combustion or from the atmosphere. This technology has been promoted by the fossil fuel industry. The largest carbon capture facility can absorb 4,000 tons of carbon dioxide per year, a minuscule amount compared to annual emissions. [Ref 4.21].. Carbon capture technologies represent a critical component of climate change mitigation strategies, offering the potential to reduce emissions from fossil fuel combustion and industrial processes. However, the scalability, cost-effectiveness, and regulatory acceptance of these technologies remain significant hurdles to overcome. Addressing these challenges will require concerted efforts from policymakers, industry stakeholders, and research communities to accelerate innovation, improve efficiency, and create enabling environments for carbon capture deployment. By harnessing the collective expertise and resources, society can leverage carbon capture technologies to advance towards a more sustainable and resilient future.

4. 3.2 iii. Implement Sustainable Agriculture Practices

Agriculture plays a pivotal role in global sustainability, serving as both a vital source of food production and a significant driver of environmental change. Sustainable agriculture practices have emerged as essential strategies to mitigate the adverse impacts of farming on ecosystems, natural resources, and climate. There are multifaceted benefits of sustainable agriculture which is why transitioning towards more regenerative and resilient farming systems is of paramount importance. "Agriculture is a fundamental pillar of global sustainability. Sustainable agriculture practices prioritize soil health, water conservation, and responsible use of fertilizers and pesticides. They also promote biodiversity and reduce the environmental impact of farming. Implementing sustainable agricultural practices is vital for ensuring food security and protecting natural resources. Sustainable agriculture emphasizes soil conservation techniques, such as no-till farming, cover cropping, and crop rotation, to improve soil fertility and reduce erosion. Sustainable farming methods protect water quality and aquatic ecosystems by minimizing synthetic fertilizers and pesticides. In addition, sustainable agriculture practices often incorporate agroforestry, where trees and crops are intermixed, creating more diverse and resilient farming systems. This approach promotes biodiversity, supports natural pest control, and improves soil health." *[Ref 4.22]*

Sustainable agriculture practices represent a vital pathway towards achieving global sustainability goals, including food security, biodiversity conservation, and climate change mitigation. By prioritizing soil health, water conservation, and responsible input use, sustainable farming methods offer tangible benefits for both farmers and ecosystems. However, concerted efforts are needed to overcome barriers to adoption, including knowledge gaps, policy constraints, and economic incentives. By promoting collaboration, innovation, and capacity-building initiatives, policymakers, researchers, and agricultural stakeholders can accelerate the transition towards more resilient, productive, and sustainable farming systems, thereby safeguarding natural resources and ensuring a sustainable future for generations to come.

4.3.2. iv. Advocate for Inclusive Social Policies

Achieving sustainable development necessitates addressing social inequalities and fostering inclusivity. Inclusive social policies are vital components of this endeavor, as they ensure that all members of society have access to essential resources and opportunities regardless of their background.

Quality education plays a crucial role in breaking the cycle of poverty and promoting social mobility. By providing equal access to education, regardless of socioeconomic status, gender, or ethnicity, societies can empower individuals to reach their full potential and contribute meaningfully to economic growth and social progress.

Similarly, ensuring access to quality healthcare is essential for promoting inclusivity and reducing disparities in health outcomes. Everyone should have access to affordable and comprehensive healthcare services, regardless of their ability to pay or where they live. This not only improves individual well-being but also contributes to overall societal health and productivity.

Furthermore, creating economic opportunities for all is key to fostering inclusive development. This involves implementing policies that promote job creation, entrepreneurship, and equitable distribution of resources. By removing barriers to economic participation and ensuring fair wages and working conditions, societies can reduce poverty and inequality while promoting sustainable economic growth.

Inclusive social policies also involve addressing systemic discrimination and promoting social cohesion. This requires challenging stereotypes, promoting diversity and inclusion in all spheres of society, and ensuring that everyone has a voice in decision-making processes.

Overall, inclusive social policies are essential for achieving sustainable development by ensuring that no one is left behind and that all members of society can fully participate and benefit from economic and social progress.

"Achieving sustainable development requires addressing social inequalities and fostering inclusivity. Inclusive social policies encompass access to quality education, healthcare, and economic opportunities for all, regardless of socioeconomic background, gender, or ethnicity. Education is a cornerstone of inclusivity. Access to good education is essential for people to learn and develop the necessary skills to actively engage in the community and workforce. It empowers people to make informed decisions and improve their well-being. Healthcare is another critical aspect of social inclusion. Universal access to healthcare services ensures everyone can lead a healthy life and receive the medical care they need, regardless of financial circumstances. Economic opportunities must also be distributed equitably. Progressive tax policies can help reduce income inequality by requiring higher-income people to pay a larger share of their tax earnings. Unemployment benefits and food assistance provide a safety net for people facing tough economic times. These programs help ensure that nobody is left behind and everyone has access to basic needs. Inclusive societies are better equipped to handle environmental, economic, and health challenges with resilience. Addressing social inequalities not only enhances well-being but also contributes to long-term stability and sustainable development." *[Ref 4.22]*

4.3.v International Collaboration and Goal Setting

Sustainable development is indeed a global endeavor that requires cooperation and collaboration among nations, organizations, businesses, and individuals worldwide. The United Nations Sustainable Development Goals (SDGs) serve as a comprehensive framework for addressing pressing global challenges and achieving sustainable development in a holistic manner.

The SDGs cover a wide range of interconnected issues, including poverty alleviation, climate action, clean water and sanitation, reduced inequalities, and many others. These goals provide a roadmap for countries and stakeholders to work together towards common objectives, despite their diverse socio-economic and cultural contexts.

International cooperation is particularly crucial because many of the challenges we face today, such as climate change, biodiversity loss, and global health crises, transcend national borders. These issues require collective action and shared responsibility to address effectively. By collaborating on research, technology transfer, capacity-building, and resource mobilization, countries can enhance their ability to tackle these challenges more effectively.

Moreover, the SDGs offer a common language and framework that enable governments, businesses, civil society organizations, and other stakeholders to align their efforts and resources towards achieving sustainable development. By setting clear targets and indicators, the SDGs help track progress, identify gaps, and guide policy-making and investment decisions at both the national and international levels.

Overall, international cooperation and the implementation of the SDGs are essential for building a more inclusive, resilient, and sustainable future for all. It's through shared commitment and concerted action that we can overcome global challenges and create a better world for present and future generations.

“Sustainable development is a global endeavor that necessitates international cooperation and goal-setting. Initiatives like the UN SDGs provide a worldwide framework for collaboration. These goals focus on poverty alleviation, climate action, clean water and sanitation, and reduced inequalities. International cooperation is essential for addressing issues that affect all of humanity. Climate change, biodiversity loss, and global health challenges do not recognize national borders. Solving these global challenges requires countries to collaborate, share knowledge, and pool resources. The Sustainable Development Goals provide a common language and framework for countries, businesses, and civil society to align their efforts toward a more sustainable future. By setting concrete targets and monitoring progress, these goals drive worldwide progress toward sustainability.” *[Ref 4.22]*

Embracing strategies like promoting green infrastructure, sustainable urban planning, transitioning to renewable energy sources, implementing sustainable agriculture practices, advocating for inclusive social policies, and fostering international collaboration are crucial steps towards achieving a more sustainable future.

Green infrastructure and sustainable urban planning help create cities and communities that are more resilient to climate change, reduce pollution, and enhance overall quality of life for residents. Transitioning to renewable energy sources not only mitigates climate change but also reduces dependence on fossil fuels, improves air quality, and creates new economic opportunities.

Implementing sustainable agriculture practices ensures that food production is environmentally friendly, socially responsible, and economically viable in the long term. Advocating for inclusive social policies helps address social inequalities and ensures that everyone has access to essential services and opportunities, regardless of background.

Furthermore, fostering international collaboration is essential for tackling global challenges such as climate change, biodiversity loss, and public health crises. By working together, countries can share knowledge, resources, and best practices to address these challenges more effectively.

Ultimately, sustainable development is not just an abstract concept but a concrete path towards building a world that is more resilient, equitable, and in harmony with nature. By embracing these strategies and working collectively, we can create a sustainable and prosperous future for current and future generations. *[Ref 4.22]*

4.4 Green Building Technology

Green technology plays a pivotal role in addressing the global challenge of single-use plastics and advancing environmental sustainability objectives. By investing in innovative solutions, promoting policy frameworks, and fostering stakeholder collaboration, countries and regions can accelerate the transition away from single-use plastics towards more sustainable alternatives. Singapore's Zero Waste Masterplan, aims to increase the national overall recycling rate to 70 per cent and reduce waste-to-landfill per capita per day by 30 per cent by 2030. *[Ref 4.23].* Moving forward, continued innovation, investment, and collaboration will be essential in realizing the vision of a plastic-free future and ensuring the health and resilience of ecosystems for future generations.

"Green technology is sparking a revolution in the field of architectural design. This transformation is reshaping both the process and end result of innovative architecture as the industry moves into new and exciting directions." *(Ref 4.24).*

"Green building is an approach to construction that seeks to reduce the impact of buildings on the environment by considering all aspects of a project's life cycle from beginning to end and incorporating "green" design principles." *(Ref: 4.25)*

"The goal of green building design is to create modern eco-friendly house plans with healthy indoor environments for occupants while minimizing the use of non-renewable resources and harmful emissions throughout the entire lifetime of the structure. *(Ref: 4.25)*

Some research has documented the environmental and socio-economic benefits of green building design, including reduced resource consumption, lower operational costs, improved indoor air quality, and enhanced occupant comfort and productivity.

Strategies such as energy-efficient building envelope design, passive heating and cooling techniques, water-efficient fixtures, renewable energy integration, and sustainable materials selection have been shown to mitigate environmental impact and promote long-term sustainability. Moreover, green building certification programs such as LEED (Leadership in Energy and Environmental Design) and BREEAM (Building Research Establishment Environmental Assessment Method) have emerged as valuable tools for assessing and benchmarking the environmental performance of buildings.

When a green building is constructed, its design and operation aim to minimize negative impacts on the natural environment. This is achieved through the efficient use of resources, such as water, energy, and raw materials, which significantly reduces their consumption by the building's users. Additionally, green buildings are designed to lower carbon emissions by incorporating renewable energy sources and adopting energy-efficient technologies. The use of eco-friendly materials further enhances environmental sustainability by reducing waste, pollution, and the depletion of non-renewable resources. These practices collectively contribute to creating structures that support environmental preservation while meeting human needs.

Green building design represents a holistic approach to sustainable development, aiming to create modern, eco-friendly structures that prioritize occupant health and well-being while minimizing environmental impact. This paper explores the goals, principles, and practices of green building design, emphasizing the reduction of non-renewable resource consumption and harmful emissions throughout the entire lifecycle of the structure. By examining the strategies employed to minimize water and energy consumption, reduce carbon emissions, utilize renewable energy sources, and incorporate eco-friendly materials, the paper elucidates the environmental and socio-economic benefits of green buildings. Furthermore, it discusses the implications of green building design for promoting sustainable development and fostering resilient communities in the face of environmental challenges.

Green building design represents a paradigm shift in the construction industry, emphasizing sustainability, resource efficiency, and occupant health and well-being. By integrating principles of environmental stewardship, energy efficiency, and material innovation, green buildings seek to minimize negative impacts on the natural environment while enhancing the quality of life for occupants. This paper provides an in-depth exploration of green building design, highlighting its goals, principles, and practices. Through a comprehensive analysis of water and energy conservation strategies, carbon emissions reduction measures, renewable energy utilization, and eco-friendly materials selection, the paper elucidates the multifaceted benefits of green buildings for both the environment and society.

By prioritizing energy efficiency, water conservation, and material sustainability, green buildings minimize environmental impact while enhancing occupant health, comfort, and productivity. Strategies such as passive design, renewable energy integration, and green materials selection contribute to reduced resource consumption, lower operational costs, and improved indoor environmental quality. Moreover, green buildings play a crucial role in mitigating climate change by reducing carbon emissions and promoting a transition towards a low-carbon economy. However, challenges remain in terms of cost considerations, regulatory barriers, and industry inertia, hindering widespread adoption of green building practices.

Green building design represents a transformative approach to sustainable development, offering tangible benefits for both the environment and society. By embracing principles of resource efficiency, environmental stewardship, and occupant health, green buildings contribute to the advancement of global sustainability goals and the creation of resilient communities.

Moving forward, continued investment in green building research, education, and policy support will be essential in overcoming barriers to adoption and accelerating the transition towards a built environment that is environmentally responsible, socially equitable, and economically viable. Through collaborative efforts and innovative solutions, green building design can serve as a catalyst for positive change, driving towards a more sustainable and prosperous future for generations to come.

"The tangible benefits may not be easily recognizable to tenants or visitors, but through sustainable design, construction and operations green buildings are reducing carbon emissions, energy and waste; conserving water; prioritizing safer materials; and lowering our exposure to toxins." [Ref 4.26]

Therefore, the Green Building concepts or the Green Architectural Design Technology (GADT) can be applied at all levels, from a single building to neighborhoods or even to the extent of an entire city.

A building is considered green if it is designed, constructed and operated using an approach that:

- Minimizes negative environmental impact
- Improves occupant health
- Uses resources efficiently
- Provides positive indoor environmental quality
- Is durable, comfortable and secure. *Ref 4.27*

Within architecture, technology's impact spans from computational design to cutting-edge apps and programs. Architects are no longer confined to the role of designing and supervising the construction of buildings. They're now entering new horizons in designs, chasing algorithms, experimenting with adaptability, robotics, 3D printing, and augmented reality.

4.5 The role of Technology in Sustainable Design

The solutions of sustainable design change simultaneously with the advents of new technologies and understandings across disciplines. There should be incorporation of green building technology in each new project. Building design concept plays a significant role in shaping the future of sustainable buildings and infrastructure. Architects, researchers and specialists in this field are striving persistently to figure out the solutions to meet the goals in this direction. With relevant architectural design technologies and implementer's cooperation as well as users' awareness the goals can be encountered.

Technology plays a significant role in sustainable design by providing innovative solutions to environmental challenges, optimizing resource use, and reducing the environmental footprint of buildings, infrastructure, products, and processes. Here are some ways in which technology contributes to sustainable design:

Top green technologies revolutionizing architecture

1. Energy Efficiency: Renewable energy sources like solar, wind, and geothermal power have indeed revolutionized the way we think about powering our buildings. Solar panels, for example, can be seamlessly integrated into building design, either as rooftop installations or as part of building facades, harnessing the sun's energy to generate electricity. Wind turbines, whether large-scale installations or smaller units suitable for urban environments, tap into the power of wind to produce clean electricity. Geothermal systems utilize the Earth's heat to provide heating, cooling, and hot water for buildings, offering a sustainable alternative to traditional HVAC systems.

The integration of these renewable energy sources into architectural design not only reduces dependence on fossil fuels but also contributes to lower carbon emissions and a more sustainable built environment. As technology continues to advance and costs decrease, we can expect to see even greater adoption of these renewable energy solutions in buildings worldwide, helping to create a more environmentally friendly and resilient energy infrastructure

Advancements in building materials, insulation, lighting, heating, ventilation, and air conditioning (HVAC) systems enable buildings to achieve higher energy efficiency standards. Technologies such as smart thermostats, occupancy sensors, and energy management systems help optimize energy use and reduce electricity consumption.

2. Green Materials: Sustainable design emphasizes the use of environmentally friendly materials that minimize environmental impact throughout their lifecycle. Technology facilitates the development of eco-friendly materials such as recycled content, biodegradable materials, low-VOC paints, and sustainable wood products.

3. Water Conservation: Innovative technologies like low-flow fixtures, rainwater harvesting systems, greywater recycling, and efficient irrigation systems help conserve water in buildings, landscapes, and urban environments. These technologies reduce water consumption, alleviate pressure on freshwater resources, and promote water sustainability. Water conservation is indeed a pressing issue, and architects are at the forefront of addressing it through innovative design solutions. Greywater recycling systems, for instance, treat wastewater from sources like sinks, showers, and washing machines, making it suitable for non-potable uses such as irrigation or toilet flushing. Rainwater harvesting systems capture and store rainwater for various purposes, reducing the strain on municipal water supplies.

In addition to these systems, advanced plumbing designs, including low-flow fixtures and dual-flush toilets, help minimize water usage in buildings without sacrificing functionality or comfort. These measures not only reduce water consumption but also lower utility bills and alleviate pressure on water infrastructure.

By incorporating these cutting-edge technologies and design principles into their projects, architects are playing a crucial role in promoting water conservation and sustainability. As water scarcity continues to be a global concern, these efforts will become increasingly essential in creating a more resilient and water-efficient built environment.

4. Waste Reduction: Technology enables the adoption of strategies to minimize waste generation and promote recycling and reuse. Digital design tools, such as Building Information Modeling (BIM), facilitate the efficient use of materials during the design and construction phases, reducing construction waste. Additionally, advanced recycling technologies help divert construction and demolition waste from landfills.

5. Smart and Sustainable Cities: Smart technologies, including Internet of Things (IoT) sensors, data analytics, and interconnected systems, play a crucial role in the development of sustainable cities. These technologies optimize urban infrastructure, transportation systems, energy distribution, waste management, and public services, enhancing efficiency, resilience, and quality of life for residents.

6. Life Cycle Assessment (LCA): Technology enables the assessment of the environmental impacts of products, buildings, and infrastructure throughout their entire lifecycle. Life cycle assessment tools help designers and decision-makers identify opportunities for improvement and make informed choices to minimize environmental impacts.

7. Innovative Design Strategies: Advances in computational design, parametric modeling, and simulation software enable designers to explore and optimize complex design solutions that balance environmental, social, and economic considerations. These tools facilitate the creation of high-performance, sustainable designs that meet the needs of users while minimizing environmental impact.

8. Passive design: Passive design principles represent a cornerstone of sustainable architecture, aimed at maximizing the utilization of natural resources to mitigate energy consumption in built environments. The conceptual framework of passive design revolves around strategic utilization of natural elements such as sunlight, ventilation, and thermal mass materials to optimize indoor environmental quality while minimizing reliance on mechanical systems for heating, cooling, and lighting.

Central to passive design is the strategic orientation of buildings to harness solar energy efficiently. Through meticulous consideration of a structure's placement and orientation relative to the sun's path, architects seek to optimize solar gain during the colder months while minimizing solar heat gain during warmer periods. This approach entails the strategic placement of windows, overhangs, and shading devices to regulate solar exposure and mitigate overheating, thereby reducing the need for active cooling systems.

Furthermore, passive design emphasizes the promotion of natural ventilation to enhance indoor air quality and thermal comfort. Architects incorporate features such as operable windows, cross-ventilation pathways, and stack-effect ventilation to facilitate the flow of fresh air throughout the building, thereby reducing reliance on mechanical ventilation systems. By harnessing prevailing breezes and exploiting natural pressure differentials, passive ventilation strategies contribute to energy savings while promoting occupant well-being.

In addition to solar orientation and natural ventilation, passive design advocates for the integration of thermal mass materials to optimize thermal performance. Materials with high thermal mass, such as concrete, brick, or stone, possess the ability to absorb, store, and release heat over time. By incorporating these materials into building envelopes and interior spaces, architects can moderate temperature fluctuations, improve thermal comfort, and reduce the need for supplemental heating and cooling.

Complementary strategies within passive design include robust insulation, efficient glazing systems, and the strategic placement of thermal barriers to minimize heat transfer and optimize energy efficiency. By integrating these principles into architectural design, buildings can achieve significant reductions in energy consumption, operational costs, and carbon emissions, while simultaneously enhancing occupant comfort and well-being.

Overall, passive design represents a holistic approach to sustainable architecture that prioritizes the harmonious interaction between built structures and their natural surroundings. By capitalizing on the inherent benefits of solar energy, natural ventilation, and thermal mass, passive design offers a compelling pathway towards achieving energy-efficient, environmentally responsible, and occupant-centric built environments. In summary, green technology plays a crucial role in advancing sustainable design by enabling energy efficiency, renewable energy generation, green materials, water conservation, waste reduction, smart and sustainable cities, life cycle assessment, and innovative design strategies. By harnessing the power of technology, designers and decision-makers can create a built environment that is environmentally responsible, socially equitable, and economically viable.

The ongoing energy transition represents a significant endeavor aimed at reducing emissions and fostering sustainability, a process already underway in numerous countries worldwide. Notably, the increasing popularity of solar and wind energy stands as a testament to this transition, driven largely by declining costs and government incentives. The proliferation of installations such as wind turbines and solar panels underscores the growing reliance on these renewable energy sources, harnessing the power of nature to generate electricity efficiently and sustainably. Many states/ countries have passed laws mandating the incorporation of green building technology in each new project or having a certain percentage of recycled material.

For instance, the state of California requires that all new public buildings be certified as LEED-certified so that they are built in a way to have less impact on the environment to reduce resource use, greenhouse gas emissions, and pollution. Sacramento State's recreation and wellness center, The WELL, has been awarded LEED Gold certification for achieving environmental goals such as energy efficiency and recycling.

The Sacramento Municipal Utility District presented a $75,572 award to Sacramento State in recognition of the energy efficiency of the WELL, the University's new recreation and wellness center. The ceremony took place April 26 on the second floor of The WELL with University and SMUD officials attending. SMUD participates in Savings by Design, a statewide program that rewards projects that exceed the state's energy standards. The WELL exceeded those standards by 20 percent.

Pic:4.1 *LEED Certified Building: University of California, Merced*
(Ref 4.28)

Picture 4.2 *California State University, Sacramento*
(Ref 4.29)

The Bosco Verticale is a unique example of the use of greenery in height and proportion. The "living facade" of the building, incorporating numerous trees and over 90 species of plants, serves as an active interface with the surrounding environment.The Bosco Verticale (Vertical Forest) is a complex of two residential skyscrapers

Pic 4.3a *Bosco Verticale in the center of Milan, Italy (Aerial View of Site)*
(Ref 4.29)

designed by Boeri Studio (Stefano Boeri, Gianandrea Barreca, and Giovanni La Varra) and located in the Porta Nuova district of Milan, Italy. They have a height of 116 metres (381 ft) and 84 m (276 ft) and within the complex is an 11-storey office building.

Pic 4.3b *Bosco Verticale in the center of Milan, Italy (Elevational View)*
(Pic 4.3b Ref 4.31)

The distinctive feature of the skyscrapers, both inaugurated in 2014, is the presence of over ninety plant species, including tall shrubs and trees, distributed on the facades. It is an ambitious project of metropolitan reforestation that aims to increase the biodiversity of plant and animal species in the Lombard capital through vertical greening, reducing urban sprawl and contributing to the mitigation of the microclimate.

Pic 4.4: *TAIPEI 101 Tower*
At No.7, Sec. 5 XinYi Road, Taipei, Taiwan, China, 110; Rating system: LEED O+M: Existing Buildingsv3 - LEED 2009; Last certified on: July 07, 2011 *(Ref 4.32)*

Taipei 101's own roof and facade recycled water system meets 20 to 30% of the building's water needs. In July 2011, Taipei 101 was certified "the world's tallest green building" under LEED standards. From 2008 to 2010, TAIPEI 101 invested in significant energy efficiency retrofit projects to generate energy and water savings. A review of public lighting was undertaken and resulted in the conversion to more energy efficient luminaires and lighting controls.

Legal mandates and policy interventions serve as powerful tools for driving the adoption of green building technology and sustainable practices in the construction industry. By requiring the incorporation of green building principles in new construction projects, policymakers aim to reduce resource consumption, minimize environmental impact, and enhance public health and well-being.

Using the LEED certification requirement for new public buildings in California as a primary example, the paper explores the motivations, challenges, and implications of such mandates for promoting environmental sustainability and advancing sustainable development goals.

the effectiveness of legal mandates and policy interventions in driving the adoption of green building technology and sustainable practices in the construction industry. Laws requiring LEED certification or the use of recycled materials in new construction projects have been shown to reduce resource consumption, lower greenhouse gas emissions, and improve indoor air quality. However, challenges such as compliance costs, enforcement mechanisms, and stakeholder resistance may hinder the successful implementation of such mandates. Case studies from California and other jurisdictions provide valuable insights into the practical implications and outcomes of green building policy interventions.

Common examples of sustainable designs and innovations include:

i. Green roofs: Rooftop gardens and vegetation that help insulate buildings, reduce stormwater runoff, and provide green spaces in urban areas.

ii. Passive solar design: Architectural features that maximize natural sunlight and heat, reducing the need for artificial lighting and heating.

iii. Solar panels: Photovoltaic installations that generate electricity from sunlight, powering homes and buildings with renewable energy.

iv. Sustainable materials: Use of eco-friendly building materials such as reclaimed wood, recycled steel, and low-VOC paints to reduce environmental impact.

v. Efficient insulation: High-quality insulation to improve energy efficiency and reduce heating and cooling needs.

vi. Cross-ventilation: Architectural design that promotes natural airflow, enhancing indoor air quality and reducing the need for air conditioning.

vii. Greywater recycling: Treating and reusing greywater from sinks and showers for toilet flushing and irrigation.

viii. Smart home systems: Automated controls for lighting, heating, and cooling that adapt to user behavior and reduce energy consumption.

ix. Low-impact foundations: Building on piers or stilts to minimize disruption to the natural terrain and reduce the need for extensive excavation. *(Ref 4.24)*

4.6 The advantages of green technology in building design or the smart choices regarding architectural green technology

Integrating green technologies into architectural design yields multifaceted benefits that extend far beyond mere aesthetics. Sustainable design not only enhances the visual appeal of built environments but also catalyzes profound transformations in the functionality and operation of businesses and public systems.

4.6.i. Reduce risk and improve project outcomes

Incorporating sustainable technology into architectural projects offers a host of benefits, foremost among them being the ability to reduce risk and enhance project outcomes. One of the primary advantages lies in the risk mitigation inherent in the utilization of renewable and biodegradable materials. By opting for these eco-friendly alternatives, businesses not only contribute to environmental protection but also insulate themselves from the adverse impacts of climate change, such as resource scarcity, regulatory changes, and environmental liabilities.

The adoption of sustainable technology also fosters a culture of innovation and productivity within businesses. Research indicates a notable percentage of businesses leverage sustainability practices to drive improvements in productivity and foster innovation. By embracing sustainable design principles and technologies, companies can streamline processes, optimize resource utilization, and unlock new avenues for creativity and problem-solving. Moreover, the pursuit of sustainability often spurs collaboration and cross-disciplinary thinking, leading to novel solutions and competitive advantages in the marketplace

Furthermore, sustainable technology enhances the attractiveness of businesses to long-term investors, who increasingly prioritize environmental, social, and governance (ESG) factors in their investment decisions. Companies with robust sustainability initiatives and excellent ESG scores are perceived as more resilient, responsible, and forward-thinking, thereby appealing to conscientious investors seeking to align their investments with positive environmental and social outcomes. By incorporating sustainable technology into their operations and projects, businesses can enhance their reputation, access capital more easily, and generate long-term value for shareholders.

In short, the integration of sustainable technology into architectural design not only delivers environmental benefits but also yields tangible advantages for businesses in terms of risk reduction, productivity improvement, and investor appeal. By embracing sustainability as a strategic imperative, companies can position themselves for long-term success while contributing to positive environmental and social outcomes. As sustainability continues to emerge as a key driver of business competitiveness and resilience, the adoption of sustainable technology will remain essential for businesses seeking to thrive in a rapidly changing world.

4.6.ii. Enhanced profitability

The integration of sustainable technology in architectural projects not only contributes to environmental stewardship but also enhances profitability through improved resource utilization and cost savings. By leveraging sustainable practices and technologies, businesses can streamline operations, reduce waste, and optimize resource consumption, leading to enhanced profitability and competitiveness.

One of the primary ways in which sustainable technology boosts profitability is by enabling more efficient use of resources. Through innovations such as energy-efficient lighting systems, smart building controls, and renewable energy sources, businesses can significantly reduce their energy consumption and utility costs over the long term. Similarly, water-saving technologies, such as low-flow fixtures and rainwater harvesting systems, help minimize water usage and lower operational expenses. By minimizing resource waste and maximizing efficiency, businesses can achieve substantial cost savings, directly impacting their bottom line.

Moreover, the adoption of sustainable technology enhances operational resilience and risk management. By diversifying energy sources and reducing dependence on finite resources, businesses can mitigate the impact of volatile energy prices and supply chain disruptions.

Sustainable practices also contribute to regulatory compliance and mitigate the risk of fines or penalties associated with environmental non-compliance. By proactively addressing environmental risks and embracing sustainable solutions, businesses can safeguard their operations and enhance long-term profitability. Furthermore, sustainability initiatives often generate positive brand associations and customer loyalty, which can translate into increased market share and revenue opportunities.

As consumers become more environmentally conscious, they are increasingly inclined to support businesses that demonstrate a commitment to sustainability. By promoting eco-friendly practices and products, businesses can attract environmentally conscious consumers, differentiate themselves in the marketplace, and command premium prices for their offerings.

Therefore, the adoption of sustainable technology in architectural projects offers a pathway to enhanced profitability and competitiveness for businesses. By optimizing resource utilization, reducing operational costs, and mitigating risks, businesses can unlock new opportunities for growth and innovation while contributing to a more sustainable future. As sustainability continues to emerge as a key driver of business success, the integration of sustainable technology will remain essential for businesses seeking to thrive in a dynamic and competitive marketplace.

4.6.iii. Attracting and retaining top talent

In the competitive landscape of talent acquisition and retention, sustainable technology emerges as a critical factor in attracting and retaining top talent. A growing body of evidence suggests that the commitment to environmental and social responsibility significantly influences the preferences and decisions of the modern workforce, particularly among millennials.

Statistics indicate that approximately three out of every four millennials prioritize working for companies that uphold environmental and social standards. This demographic cohort, comprising a significant portion of the current workforce, values purpose-driven organizations that prioritize sustainability alongside profitability. Consequently, businesses that demonstrate a genuine commitment to sustainability stand to attract a larger pool of highly qualified and motivated candidates who align with their values and mission.

Moreover, a business's dedication to sustainability not only attracts top talent but also fosters employee loyalty and engagement. Employees are more likely to feel proud of and connected to organizations that prioritize sustainability and contribute positively to environmental and social causes. By creating a culture of purpose and responsibility, businesses can cultivate a sense of belonging and fulfillment among their employees, leading to higher levels of job satisfaction, productivity, and retention.

Often, sustainable workplaces often offer tangible benefits that appeal to employees, such as healthier indoor environments, flexible work arrangements, and opportunities for professional development and growth. These factors contribute to a positive employee experience and reinforce the organization's reputation as an employer of choice.

The integration of sustainable technology in architectural projects not only enhances environmental performance and profitability but also serves as a powerful tool for attracting and retaining top talent. By aligning with the values and preferences of the modern workforce, businesses can position themselves as leaders in sustainability and create workplaces that inspire and empower employees to contribute to positive change. As the demand for sustainability-conscious organizations continues to rise, businesses that prioritize sustainability will enjoy a competitive advantage in attracting and retaining top talent in the evolving labor market.

4.6. iv. Reduced energy bills

Green technologies in building design indeed prioritize energy efficiency, leading to a multitude of benefits, including reduced energy consumption and lower utility bills. By incorporating sustainable design features such as energy-efficient lighting, insulation, and HVAC (heating, ventilation, and air conditioning) systems, businesses and homeowners can realize substantial cost savings over the long term.

One of the primary advantages of energy-efficient building design is the significant reduction in energy consumption. Energy-efficient lighting solutions, such as LED (light-emitting diode) fixtures, consume significantly less energy than traditional incandescent or fluorescent bulbs while providing the same or better illumination levels.

Similarly, advanced insulation materials and techniques help minimize heat transfer through building envelopes, reducing the need for heating and cooling and optimizing indoor thermal comfort. Moreover, energy-efficient HVAC systems employ innovative technologies such as variable-speed compressors, zone-based controls, and heat recovery ventilation, allowing for precise temperature regulation and optimal energy utilization. By optimizing energy consumption and reducing waste, these systems contribute to lower operating costs and improved environmental performance.

The cumulative effect of these energy-efficient design features is reflected in reduced utility bills over the lifespan of the building. By lowering energy consumption for heating, cooling, lighting, and other building functions, businesses and homeowners can realize significant cost savings on their monthly energy bills. These savings can translate into tangible financial benefits, enhancing cash flow, profitability, and overall economic viability.

Furthermore, energy-efficient building design offers additional advantages beyond cost savings. By reducing energy demand, businesses and homeowners can minimize their environmental footprint and contribute to sustainability goals. Additionally, energy-efficient buildings often provide superior indoor environmental quality, with benefits such as improved thermal comfort, better air quality, and enhanced occupant health and well-being.

The integration of green technologies in building design prioritizes energy efficiency, leading to lower energy consumption and reduced utility bills. By leveraging energy-efficient lighting, insulation, and HVAC systems, businesses and homeowners can achieve significant cost savings over the long term while simultaneously enhancing environmental sustainability and indoor comfort. As energy costs continue to rise and environmental concerns escalate, energy-efficient building design remains a cornerstone of sustainable development and responsible stewardship of resources.

4.6.v. smaller carbon footprint

Absolutely, green buildings play a crucial role in mitigating climate change and promoting environmental sustainability. By adopting eco-conscious design principles and leveraging renewable energy sources, green buildings contribute to a smaller carbon footprint and help combat the adverse effects of climate change on the planet.

One of the primary ways green buildings reduce environmental impact is through the harnessing of renewable energy sources such as solar, wind, and geothermal power. By integrating solar panels, wind turbines, and geothermal heating and cooling systems into building design, green buildings generate clean, renewable energy onsite, reducing reliance on fossil fuels and decreasing greenhouse gas emissions associated with energy production. Moreover, green buildings prioritize energy efficiency through measures such as high-performance insulation, energy-efficient lighting and appliances, and passive design strategies.

By optimizing energy use and minimizing waste, green buildings reduce overall energy consumption and mitigate the environmental impact of building operations. This not only lowers operating costs for building owners but also helps alleviate strain on energy infrastructure and reduce air and water pollution associated with energy production.

In addition to energy efficiency, green buildings focus on reducing waste and promoting sustainable resource management. Through strategies such as efficient water use, recycling and composting programs, and sustainable materials sourcing and construction practices, green buildings minimize waste generation and promote resource conservation throughout their lifecycle. By prioritizing waste reduction and recycling, green buildings contribute to circular economy principles and reduce pressure on landfills and natural resources.

Again, green buildings often incorporate features that enhance biodiversity, improve air and water quality, and provide habitats for native flora and fauna. Green roofs, rain gardens, and permeable pavements are examples of green building features that help mitigate urban heat island effects, reduce stormwater runoff, and enhance ecosystem resilience in urban environments.

Overall, green buildings represent a holistic approach to sustainable development that prioritizes environmental responsibility and resource efficiency. By harnessing renewable energy sources, optimizing energy use, and reducing waste, green buildings contribute to a smaller carbon footprint, combat climate change, and promote a healthier, more sustainable planet for current and future generations. As the global community continues to grapple with the challenges of climate change and environmental degradation, green buildings stand as a beacon of hope and a tangible solution for a more sustainable future.

4.6.vi. Increased property values

Investing in green technologies and sustainable design not only contributes to environmental stewardship but also has the potential to significantly enhance the value of properties in the real estate market. As environmental awareness continues to grow, eco-friendly buildings are increasingly perceived as desirable assets by both buyers and renters, offering a competitive edge and commanding premium prices in the marketplace.

One of the key factors driving the increased value of green properties is the growing demand for environmentally sustainable and energy-efficient buildings among consumers. As individuals become more conscious of their environmental impact and seek ways to reduce their carbon footprint, they are increasingly drawn to properties that incorporate green technologies and sustainable design features. Such features not only contribute to lower utility bills and operational costs but also offer the promise of a healthier, more sustainable lifestyle for occupants.Moreover, green buildings often enjoy enhanced marketability and attractiveness to prospective buyers and renters. Studies have shown that properties with green certifications or energy-efficient features tend to sell faster and at higher prices compared to conventional buildings.

Green certifications such as LEED (Leadership in Energy and Environmental Design) or Energy Star ratings serve as indicators of a property's environmental performance and quality, providing assurance to buyers and renters of its sustainability credentials. Furthermore, investing in green technologies and sustainable design can lead to long-term cost savings and enhanced asset value for property owners. Energy-efficient features such as solar panels, high-performance insulation, and energy-efficient appliances not only reduce operating costs but also increase the overall value and marketability of the property. Additionally, green buildings are often associated with higher levels of occupant satisfaction, which can contribute to lower turnover rates and higher rental yields for property investors.

Investing in green technologies and sustainable design offers a multitude of benefits for property owners, including increased property value, enhanced marketability, and long-term cost savings. As environmental awareness grows and sustainability becomes an increasingly important consideration for consumers, eco-friendly buildings will continue to enjoy a competitive edge in the real estate market. By embracing green building practices, property owners can not only contribute to a more sustainable future but also reap financial rewards and enjoy a higher return on investment in the long run.

4.6.vii. Healthier indoor environments

Certainly, the utilization of green technology in building design contributes to creating healthier indoor environments, benefiting the well-being and comfort of occupants. Green technology encompasses a range of features and systems aimed at minimizing environmental impact and optimizing resource efficiency, all of which have positive implications for indoor air quality, thermal comfort, and overall occupant health. *(Ref 4.24)*

One key aspect of green technology that promotes healthier indoor environments is the use of non-toxic and eco-friendly materials. Traditional building materials often contain volatile organic compounds (VOCs) and other harmful substances that can off-gas over time, leading to indoor air pollution and potential health risks. In contrast, green building materials are selected for their low VOC emissions and environmentally friendly properties, thereby reducing exposure to harmful chemicals and improving indoor air quality.

Moreover, green buildings prioritize natural ventilation and daylighting strategies to enhance indoor environmental quality. By incorporating features such as operable windows, atria, and skylights, green buildings facilitate the flow of fresh air and natural light throughout interior spaces, reducing reliance on mechanical ventilation systems and artificial lighting.

Adequate ventilation and daylighting not only improve occupant comfort and productivity but also help prevent the buildup of indoor pollutants and allergens, promoting healthier indoor environments. Furthermore, green buildings often employ advanced HVAC systems and filtration technologies to enhance indoor air quality and thermal comfort. Energy-efficient HVAC systems equipped with high-performance filters remove airborne contaminants and allergens, such as dust, pollen, and mold spores, from indoor air, reducing the risk of respiratory issues and allergies. Additionally, precise temperature and humidity control help maintain optimal thermal conditions, further enhancing occupant comfort and well-being. Additionally, green buildings may incorporate biophilic design elements, such as indoor plants, green walls, and natural materials, to create connections with nature and promote psychological well-being. Research suggests that exposure to nature and natural elements indoors can reduce stress, improve cognitive function, and enhance overall mental health, contributing to a more holistic and supportive indoor environment for occupants.

The use of green technology in building design leads to healthier indoor environments by minimizing exposure to harmful chemicals, improving indoor air quality, enhancing thermal comfort, and promoting connections with nature. As concerns about indoor air pollution, thermal comfort, and occupant health continue to grow, green buildings offer a compelling solution for creating spaces that prioritize the well-being and comfort of occupants while minimizing environmental impact *(Ref 4.24)*

As discussed before, “the construction industry is the producer of major greenhouse gas emissions and this has raised the concern of environmentalists, option tree huggers, and governments to seek emission reduction measures. The economic interest, however, remains a strong counterforce in obstructing the way to an environmentally friendly construction sector.

Many technically and economically feasible concepts for green buildings are found but the main obstacle is that their realization comes at a cost premium. Still, green building technology offers an opportunity for improving the effectiveness of existing models and their potential in reducing adverse environmental impact is enormous. Green building technologies help transform structures into green buildings that are eco-friendly and sustainable. These innovative technologies are in compliance with LEED certification requirements. They involve an integrated approach to constructing, maintaining and operating sustainable buildings that aim to minimize impacts on the environment. In short, green building technology is a revolutionary method of creating livable, energy-efficient buildings for human settlement.” (*Ref 4.27)*

TABLE 4.2: -LIST OF SOME OF THE GREEN BUILDING OF THE TOP WORLD-FAMOUS GREEN BUILDINGS AROUND THE WORLD

SL.NO.	NAME	DETAILS	RATING SYSTEM
01	SHANGHAI TOWER, CHINA	**Year: 2015** **Building Type:** Mixed Use High Rise **Size:** 576000sqm **Rating System:** China Green Building **Architects:** Gensler	Three-Star Rating & LEED Platinum Certification
02	BANK OF AMERICA, NEW YORK	The first high rise commercial building to achieve LEED platinum **Year: 2010** **Building Type:** Commercial Skyscraper **Size:** 2.2million sq ft LEED Platinum **Architects:** Cook + Fox Architects	LEED Platinum
03	MORE LONDON BUILDING	**Year:2003** **Building Type: Mixed-Use** **Size: 60850sqm** Architects: Foster + Partners	BREEAM 'Outstanding' accreditation.
04	BULLITT CENTRE, SEATTLE, USA	**Year: 2013** **Building Type: Office** **Size: 50000sft** Architects: Miller Hull Partnership	Rating System: Living Building Certification
05	THE CRYSTAL, LONDON, UNITED KINGDOM	**Year: 2012** **Building Type: Mixed Use, Cultural, Educational Architecture** **Size: 75368sft** Architects: WilkinsonEyre	**Rating System**: BREEAM outstanding, LEED Platinum
06	CLOCK SHADOW BUILDING	**Year: 2012** **Building Type: Mixed-Use** **Size: 28000sft** Architects: Continuum Architects + Planners	**Rating System:** Top Ten Green Project, AIA Committee on the Environment, 2013;
07	COUNCIL HOUSE 2, MELBOURNE	**Year: 2006** **Building Type: Commercial** **Size: 12500sqm** Architects:DesignInc	**Rating System:** 6-star Green Star rating by the Green Building Council of Australia.
08	ONE ANGEL SQUARE, MANCHESTER, UK	**Year: 2012** **Building Type: Offices** **Size: 328000sft** Architects: 3DReid	**Rating System:** BREEAM Outstanding Rating
09	OLYMPIC HOUSE (IOC HEADQUARTERS), LAUSANNE, SWITZERLAND	**Year:2019** **Building Type: Office** **Size: 135000sft** Architects: 3XN Architects	**Rating System:** LEED V4 Platinum, SNBS Platinum, Minergie P
10	ONE CENTRAL PARK, SYDNEY, AUSTRALIA	**Year: 2014** **Building Type: Mixed Use (Residential + Retail)** **Size: 255500sft** Architects: Ateliers Jean Nouvel	**Rating System:**5-star Green star – 'Multi-Unit Residential Design v1' Certified Rating by the Green Building Council of Australia

11	**AMHERST COLLEGE SCIENCE CENTRE, AMHERST, MASSACHUSETTS**	**Year: 2018** **Building Type: Educational** **Size: 251000sft** Architects: Payette	**Rating System:** AIA COTE Top 10 Recipient
12	**SOHRABJI GODREJ GREEN BUSINESS CENTRE, HYDERABAD, INDIA**	**Year: 2004** **Building Type: Commercial, Institutional** **Size: 20000sft** Architects: Karan Grover and Associates. The building form responds to **its** surroundings and	**Rating System:** LEED Platinum
13.	**SUNSHINE COAST UNIVERSITY HOSPITAL, QUEENSLAND, AUSTRALIA**	**Year: 2016** **Building Type: Health** **Size: 160000sqm** Architects: Architectus Brisbane and HDR	**Rating System:** Six Star Green Star Healthcare v1 Design and As-Built rating.
14.	**FRICK ENVIRONMENTAL CENTRE, PITTSBURGH**	**Year: 2016** **Building Type: Educational** **Size: 15570sft** Architects: Bohlin Cywinski Jackson	**Rating System:** Living Building Certification, LEED Platinum
15.	**VANCOUVER CONVENTION CENTRE, VANCOUVER, CANADA**	**Year: 2009** **Building Type: Public** **Size: 12,00,000sft** LMN Architects of Seattle, in association with Vancouver firms MCM Architects and DA Architects + Planners.	**Rating System:** double LEED® Platinum certified
16	**BLOOMBERG LONDON**	**Year: 2017** **Building Type: Office** **Size: 102190sqm** Architects: Foster + Partners	**Rating System:** BREEAM Outstanding rating
17	**COFCO LANDMARK, BEIJING, CHINA**	**Year: 2018** **Building Type: Office** **Size: 81,725sqft**Architects: Skidmore, Owings & Merrill LLP The project features twin towers connected by a central glass atrium with one of its towers located next to Beijing's historic temple of earth. Visual harmony is created by the reduction of height near the temple side and is incorporated with terrace gardens which helps to control the surface water runoff.	**Rating System:** BREEAM Excellent
18	**BAHRAIN WORLD TRADE CENTRE, MANAMA**	**Year:2007** **Building type: office+ shopping mall** **Floor Area: 121200sqm** Architects: WS Atkins and Architect, Shaun Killa Ref: 4.31	LEAF Award for Best Use of Technology within a Large Scheme 2006. EDIE Award for Environmental Excel Ref: 4.31
19	**MANITOBA HYDRO PLACE, CANADA**	**Year: 2009** **Building Type: Office, Tower** **Area: 695250sft** Architects: KPMB Architects	**Rating System:** LEED Platinum Certified
20	**TAIPEI FINANCIAL CENTER (TAIPEI 101), TAIWAN**	**Year: 2004** **Building Type: Mixed Use, Office, Retail** **Area: 374336sqm** Architects: C.Y. Lee and Partners	**Rating System:** LEED-EBOM Platinum

(Ref 4.32)

4.7 Brief description of some of the famous Green Buildings around the world

4.7.1) La Maison Olympique ("The Olympic House"), the CIO Headquarters

Pic 4.5 *La Maison Olympique ("The Olympic House"), the CIO Headquarter*

Olympic House, the International Olympic Committee's (IOC) headquarters, has received the European 2020 US Green Building Council (USGBC) Leadership Award. The award has been given to five organizations that are "a model for how Leadership in Energy and Environmental Design (LEED) can be used to improve communities, support human health and well-being and contribute to a more sustainable future for all. [*Ref: 4.34]*

The Olympic House is powered by renewable energy, part of which is produced on site. Ninety-five per cent of Olympic House construction waste was recycled, while more than 95 per cent of the former IOC building was recycled or reused. One year on from its inauguration, Olympic House has cut energy consumption and non-recyclable office waste by half compared to the former IOC building, it is claimed. IOC staff have also been able to reduce food waste by 30 per cent and increase the use of sustainable commuting modes from 50 per cent to 60 per cent since moving into the new building.

The Olympic House," officially designated as La Maison Olympique, represents a pinnacle of architectural innovation and sustainability. Constructed by 3XN Architects in collaboration with IttenBrechbühl, this edifice, unveiled in June 2019, commemorated the 125th anniversary of the International Olympic Committee (IOC), founded in 1894.

Situated in Lausanne's Vidy district, the structure serves as the IOC's headquarters, embodying the organization's ethos and values while symbolizing a commitment to environmental stewardship.

Central to The Olympic House's acclaim are its sustainable design principles and renewable energy initiatives. Noteworthy among these is the installation of over 1000 square meters of photovoltaic panels atop the building, indicative of a deliberate effort to harness solar energy for operational needs.

This integration of renewable energy technologies underscores a broader commitment to mitigating environmental impact and advancing sustainability within the built environment.

Furthermore, The Olympic House has garnered recognition through various certifications and awards attesting to its adherence to stringent environmental standards. Such accolades underscore the structure's role as a beacon of sustainable architecture, setting a precedent for future developments to prioritize ecological responsibility alongside functional and aesthetic considerations.

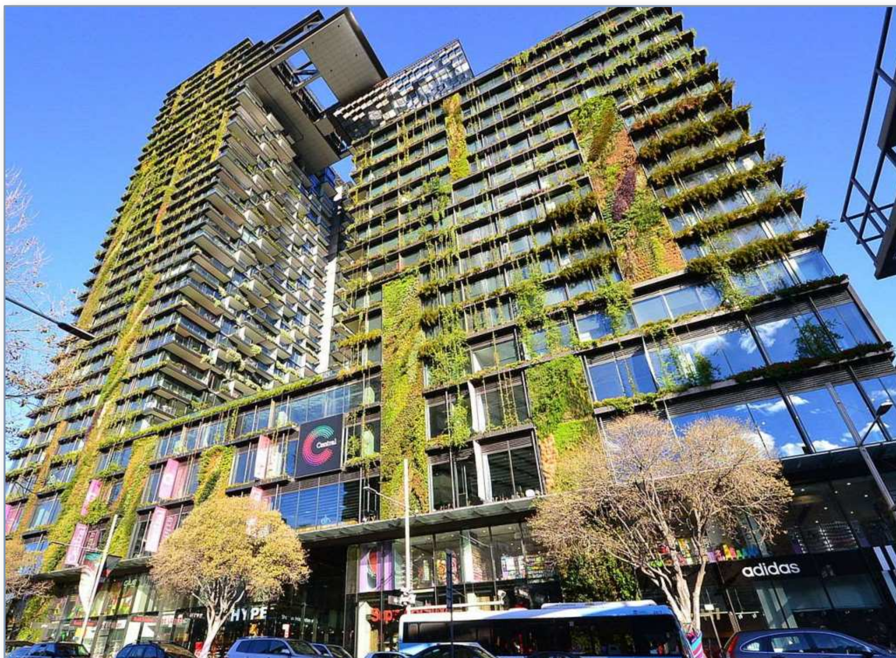
Beyond its architectural significance, The Olympic House assumes paramount importance as a locus for the global Olympic movement. Serving as the nerve center for IOC operations, it facilitates collaboration, dialogue, and strategic planning among stakeholders invested in advancing the Olympic ideals of excellence, friendship, and respect. In this capacity, the building transcends its physical dimensions, embodying the intangible spirit of international cooperation and athletic pursuit.

The Olympic House stands as a testament to the convergence of architectural ingenuity, environmental consciousness, and institutional significance. Its synthesis of form and function not only reflects the values of the Olympic movement but also exemplifies a paradigm shift towards sustainable design practices within the contemporary urban landscape.

As a beacon of innovation and inspiration, it reaffirms the transformative potential of architecture in fostering a more equitable and ecologically resilient future. A hydrogen production and filling station has been installed to refuel the organization’s pool of Toyota Mirai cars. *(Ref 4.35).*

4.7.2) One Central Park:

One Central Park, a prominent 34-story high-rise structure situated in the Sydney suburb of Chippendale, New South Wales, Australia, represents a significant milestone in urban development and sustainability initiatives. Opened in December 2013, this architectural marvel comprises two residential apartment towers, denoted as the east and west towers, alongside a six-level retail shopping center located at the towers' base.



Picture 4.6 : *One Central Park is a mixed-use dual high-rise building located in the Sydney suburb of Chippendale, New South Wales, Australia.* *(Ref 4.36)*

Developed as a collaborative effort between Frasers Property and Sekisui House, with construction executed by Besix Watpac, One Central Park serves as the inaugural phase of the broader Central Park urban renewal project. Embodying a mixed-use concept, this dual high-rise building seamlessly integrates residential and commercial functionalities, enriching the local urban fabric and fostering community engagement.

Central to One Central Park's ethos is a steadfast commitment to sustainability and self-sufficiency, epitomized by the incorporation of innovative measures aimed at reducing environmental impact and promoting resource efficiency. Of particular note are the establishment of a low-carbon tri-generation power plant and an internal water recycling facility within the precinct.

The tri-generation power plant, a pioneering endeavor within the realm of urban development, underscores the project's ambition to harness renewable energy sources and minimize reliance on traditional fossil fuels. Operationalized on natural gas, the two-megawatt tri-generation energy plant is slated to generate thermal energy for heating, cooling, and electricity consumption across the residential and commercial domains of One Central Park.

This initiative not only enhances energy efficiency but also contributes to a substantial reduction in greenhouse gas emissions, with projections estimating potential savings of up to 190,000 tonnes over the plant's 25-year design lifespan. Furthermore, the integration of an internal water recycling plant underscores One Central Park's holistic approach to sustainable resource management. By treating and reusing wastewater onsite, the development minimizes freshwater consumption while mitigating strain on municipal infrastructure, thereby exemplifying best practices in water conservation and environmental stewardship.

In summation, One Central Park stands as a testament to the transformative power of sustainable urban development, setting a precedent for future projects seeking to harmonize architectural excellence with ecological responsibility. Through its innovative design, conscientious resource utilization, and commitment to community well-being, this iconic landmark epitomizes the convergence of environmental sustainability and urban livability, embodying a vision of a more resilient and harmonious urban future.

Central park's recycled water network houses the world's biggest membrane bioreactor recycled water facility in the basement of the residential building. It is designed to service approximately 4,000 residents and more than 15,000 visitors and workers daily. The recycled water network has the capacity to harness multiple water sources with varying qualities and create a multitude of water supplies, which cover all the water requirements of the community. Water sources include:

- Rainwater from roofs
- Storm water from impermeable surfaces/planter box drainage
- Groundwater from basement drainage systems
- Sewage from an adjacent public sewer
- Sewage from all buildings within the Central Park community
- Irrigation water from all green walls
- Drinking water from the public water main.” (Ref 4.37)

In 2013, One Central Park was awarded a 5 star Green Star – ‘Multi-Unit Residential Design v1’ Certified Rating by the Green Building Council of Australia, making it the largest multi-residential building (by net lettable area) in Australia to receive such a designation.

4.7.3) Bahrain World Trade Center (BWTC)

The 50-story skyscraper situated in Manama, Bahrain, epitomizes the city's skyline with its imposing presence and architectural grandeur. This non-residential edifice boasts a net floor area approaching 90,000 square meters, showcasing a seamless blend of functionality and aesthetic appeal. Designed by the esteemed architectural firm WS Atkins, in collaboration with architect Shaun Killa, the building stands as a testament to visionary design and engineering prowess.

Seamlessly integrating wind turbines into its structure, the building harnesses renewable wind energy to augment its power supply, thereby reducing reliance on conventional energy sources and mitigating its environmental footprint. This innovative approach not only underscores the building's commitment to sustainability but also positions it as a beacon of innovation in the global architectural landscape.

Beyond its sustainability initiatives, the skyscraper's design captivates with its aesthetic allure, earning it accolades and recognition from architectural authorities worldwide. Its sleek lines, harmonious proportions, and thoughtful detailing contribute to its visual appeal, while its functionality remains paramount, catering to the diverse needs of its occupants.

The accolades garnered by this architectural marvel further attest to its significance and impact within the architectural realm. Its multiple awards, spanning both architecture and design categories, underscore its status as a paradigm of excellence and innovation. As the first commercial building in the world to fully integrate large-scale wind turbines into its design, it not only sets a precedent for sustainable construction practices but also serves as an inspiration for future endeavors seeking to marry architectural ingenuity with environmental responsibility.

Pic 4.7a: *Bahrain World Trade Center (BWTC)*
(Ref 4.38)

Pic 4.7b: *Bahrain World Trade Center (BWTC) (Ref 4.39)*

One of the most striking features of this architectural masterpiece is its incorporation of large-scale wind turbines, a pioneering endeavor that sets it apart as a trailblazer in sustainable design.

"The buildings design was inspired by traditional Arabian wind towers with sustainability being incorporated from its conception, reducing its overall power consumption by harnessing the sea breeze and self-generating power. BWTC's other renewable energy solutions include district cooling, water recycling, thermal insulation, reflection pools for evaporative cooling, low-leakage windows, and thermal glass with a low solar gain*." (Ref 4.31)*. The original year of construction was 2008. The net area is 88617 m2 to be precise and the land plot size is 16500 m2. The magnanimous skyscraper received a LEAF Award for Best Use of Technology within a Large Scheme 2006. EDIE Award for Environmental Excel.

The construction feature includes the followings:

The walls: Enough buffer spaces have been incorporated between the external environment and air-conditioned spaces to reduce solar gain on the building. Two car park decks above and on the southern side of the building minimize solar air temperature.

The Roof : The roof is a single pitch roof and there are deep gravel roofs that provide kinetic insulation, and energy efficient lighting, all of which demonstrate global leadership in the commitment to reduce demand of fossil fuel energy reserves.

Glazing: The skyscraper has adopted a double-glazing system. Double paned window consists of two facing glass panels in a frame separated by a small space filled with non-toxic gas to improve insulation

Basement Floor: Dense concrete core and floor slabs presented to the internal environment in a manner that will leave loads and reduce peak demand with associated reduction in air and chilled water transport system.

Space Cooling System:
The building is cooled by highly innovative air conditioning and cooling system using chilled water. It provides an environmentally sound alternative to conventional cooling system through recycling of water. **Water heater system:** Water consumption saving initiatives include: All the toilets have been installed with sensor wash basin mixers and urinals. The irrigation system is timer based which allows efficient usage of water.

Lighting system: Amenity lighting and high-frequency, energy-saving fluorescent lighting with zonal control are included in the building design.

Shading devices: Type of shading system installed. Static (fix) shading systems as part of the building architecture (e.g. Maschrabiyya, porch roofs, pergolas)

Energy reducing measures include innovative usage of shading across a significant proportion of projectile shading to external glass façade to minimize solar gains, deep gravel roofs that provide kinetic insulation, and energy efficient lighting, all of which demonstrate global leadership in the commitment to reduce demand of fossil fuels. (*Ref 4.38)*

In conclusion, the 50-story skyscraper in Manama, Bahrain, stands as a testament to the power of architecture to transcend mere functionality and elevate the human experience. With its innovative design, sustainable features, and aesthetic allure, it embodies the spirit of progress and possibility, leaving an indelible mark on the architectural landscape and reaffirming the transformative potential of design excellence.

4.7.4) GREEN BUILDING IN NEIHGHBORING COUNTRY, INDIA

SUZLON ONE EARTH

Pic 4.8: *Suzlon One Earth – LEED Rated Green Building in Pune*
Landmark Cyber Park: India's Cutting Edge IT Hub
(Ref: 40)

Suzlon One Earth stands as a beacon of sustainable innovation and corporate responsibility, exemplifying Suzlon's commitment to clean energy and environmental stewardship. Nestled in Maharashtra, India, this architectural gem serves as the corporate headquarters for Suzlon, India's largest and one of the world's foremost producers of clean wind energy. Designed by Christopher Charles Benninger Architects Pvt. Ltd., Suzlon One Earth embodies the ethos of sustainability and global leadership, reflecting the company's vision of a greener, more sustainable future.

Spanning across 10 acres of verdant land and boasting a built-up area of 820,000 square feet, Suzlon One Earth is more than just a headquarters—it is a living testament to Suzlon's dedication to sustainability. The campus not only accommodates all of Suzlon's functions and global verticals but also embodies the principles of functionality, aesthetics, and environmental consciousness. At the heart of Suzlon One Earth's design philosophy lies a deep commitment to green building practices and energy efficiency. By integrating sustainable design elements such as passive cooling techniques, natural lighting, and energy-efficient systems, the campus minimizes its environmental impact while maximizing occupant comfort and well-being. Furthermore, the incorporation of green spaces, water harvesting facilities, and renewable energy sources further reinforces Suzlon's dedication to creating a harmonious balance between nature and built environment.

Suzlon's ambitious renewable energy projects, including wind, solar, and hybrid installations, underscore the company's pivotal role in India's transition towards a cleaner, more sustainable energy future. With over 800+ MW of commissioned projects and an additional 2700+ MW under execution as of January 5, 2024, Suzlon continues to spearhead the renewable energy revolution, driving positive change and innovation on a global scale.

In essence, Suzlon One Earth transcends the conventional notion of a corporate headquarters, serving as a testament to Suzlon's unwavering commitment to sustainability, innovation, and global leadership. As a symbol of progress and environmental consciousness, Suzlon One Earth stands as a shining example of how businesses can thrive while simultaneously contributing to a more sustainable and equitable world.

Pic 4.9: *Suzlon One Earth Interior*
(Ref: 4.41)

The nomenclature "One Earth" embodies a profound acknowledgment of our planet as a singular, interconnected ecosystem, emphasizing the imperative for responsible stewardship of its resources. It symbolizes Suzlon's dedication to creating an environmentally conscious corporate headquarters, serving as a testament to their commitment to sustainability and global citizenship.

Reflecting this ethos, the corporate buildings at One Earth are aptly named after the fundamental elements of nature—Aqua, Tree, Sky, and Sun—underscoring the integration of natural elements within the built environment. This thematic approach not only imbues the campus with a sense of harmony and connection to nature but also underscores Suzlon's ethos of sustainability and reverence for the natural world.

At its core, One Earth embodies the concept of an "Office in the Garden," eschewing the conventional paradigm of concrete and metal structures in favor of a holistic and symbiotic relationship with the environment. By seamlessly blending architecture with nature, One Earth fosters a conducive and inspiring work environment while minimizing its ecological footprint.

The prestigious LEED (Leadership in Energy and Environmental Design) and GRIHA (Green Rating for Integrated Habitat Assessment) certifications further underscore One Earth's exemplary commitment to green building practices. As one of only five buildings in India to receive LEED certification and the first in the state of Maharashtra, One Earth stands as a pioneer in sustainable architecture, setting a benchmark for excellence in environmental performance.

Achieving the highest ratings from both LEED (Platinum rating with 57 points obtained in 2010) and GRIHA (Five Star rating with 96 points), One Earth distinguishes itself as a paragon of sustainable design and operational efficiency. Several factors contribute to its exceptional green rating, including:

1. Energy Efficiency: Implementation of state-of-the-art energy-saving technologies and systems to minimize energy consumption and carbon emissions.

2. Water Conservation: Adoption of water-efficient fixtures, rainwater harvesting, and wastewater treatment systems to reduce water usage and promote water sustainability.

3. Indoor Environmental Quality: Prioritization of occupant comfort and well-being through optimal daylighting, ventilation, and use of non-toxic materials.

4. Sustainable Site Development: Preservation of green spaces, utilization of permeable surfaces, and incorporation of native vegetation to mitigate environmental impact and promote biodiversity.

5. Innovation and Design Process: Embrace of innovative design strategies, construction practices, and operational protocols to enhance sustainability performance and minimize environmental footprint.

In conclusion, One Earth stands as a shining exemplar of sustainable architecture and corporate responsibility, embodying Suzlon's unwavering commitment to environmental stewardship and holistic well-being.

Through its thoughtful integration of nature-inspired design elements and cutting-edge green technologies, One Earth not only serves as a testament to Suzlon's leadership in the renewable energy sector but also inspires a paradigm shift towards a more sustainable and resilient built environment.

Planning & Design

Sustainability principles have been scrupulously adhered to, right from site selection and design to engineering, construction, materials and operations. This includes usage of native flora, minimizing both environmental impact and reducing the need for landscaping water, low-energy/green materials, appropriate orientation of the building facades that ensures adequate day lighting and minimizes glare etc.

Energy Efficiency

A hybrid wind (80%) – solar (20%; through photovoltaic panels) energy system located on-site and off-site generates 155 kW of power, making One Earth India’s first 100% renewable energy campus. Smart solutions like motion/occupancy sensors, Low-E glass for the buildings, low energy LED lighting, aluminum louvres that shade the interiors while providing ample natural illumination, HVAC systems that filter and cool air before resupplying them to ACs to reduce the load on ACs, optimize energy consumption.

Water Efficient

100% rainwater is harvested, 100% of grey water is recycled via an on-site sewage treatment plant into flushing, air-cooling and landscaping systems attesting to One Earth's water-efficiency. Water fixtures including low flow fixtures that reduce in-building water consumption by 65% and touchless urinals with hydronic sensors all help reduce water consumption and make One Earth water efficient.

Working Comfort

Ergonomics is also meticulously attended to; not only do the workstations provide an optimized balance between comfort and productivity, they are arranging to provide an unobstructive view of the surroundings that allows the wandering eye a chance to relax and refocus. Essential resources such as printers, fax machines, storage cabinets, the pantry etc., are located to minimize unproductive movement.

4.8. The Bangladesh scenario

Bangladesh is located in South Asia, sharing borders with India to the west, north, and east, Myanmar (Burma) to the southeast, and the Bay of Bengal to the south. Its geographical coordinates are approximately between 20°34′N and 26°38′N latitude and between 88°01′E and 92°41′E longitude.

The physical geography of Bangladesh is varied and has an area characterized by two distinctive features: a broad deltaic plain subject to frequent flooding, and a small hilly region crossed by swiftly flowing rivers. [Ref 4.40]

Bangladesh is Located in the north-eastern part of South Asia. The majestic Himalayas stand some distance to the north, while in the south lays the Bay of Bengal. West Bengal borders on the west and in the east lies the hilly and forested regions of Tripura, Mizoram (India) and Myanmar.

These picturesque geographical boundaries frame a low lying plain of about 1,47,570 square kilometer, crisscrossed by innumerable rivers and streams. Mighty rivers are Padma (Ganges), Brahmaputra (Jamuna), Meghna and Karnafuli.

The Bangladesh Green Building Council (BGBC) was established in 2009 in order to foster the development of green buildings in the country. The concept was to aim to transform the built environment of Bangladesh into a more sustainable and energy-efficient one. For example The Government of Bangladesh in 2009 stopped giving connections to newly constructed buildings which meant that new homes would not have access to energy, and even water due to shortages. Bangladesh Government has implemented various policies and initiatives to promote the green building and its adoption. It has recognized the importance of applying it as much as possible. The Bangladesh Green Building Council (BGBC) sets out certain guidelines and rating systems to evaluate and certify the environmental performance of buildings in Bangladesh.

The BGBC provides certifications and training programs, raising awareness about the benefits of green building and encouraging industry professionals to adopt sustainable practices.

Diagram 4.4 Geographic *Location of Bangladesh with Respect to South Asia (Ref 4.42)*

Pic. 4.10 *Beautiful Bangladeshi Village (Ref: 4.43)*

In recent years, several notable green building projects have emerged in Bangladesh.

In short,

- The history of green building in Bangladesh dates back to the early 2000s.
- Traditional rural buildings in Bangladesh have long been constructed with eco-friendly materials.
- The SURE House is an example of a sustainable urban building in Dhaka with green features.
- The Bangladesh Green Building Council (BGBC) plays a significant role in promoting green building practices in the country.

Bangladesh is one of the most vulnerable nations in the world due to climate change. It is a densely populated country and limited land space as compared to the population especially in the urban areas

have put tremendous strains on the urban ecosystem. Dhaka, the Capital of Bangladesh is not beyond this and as such the capital of Dhaka itself underwent severe transformations in recent years to catch up the increased rate of urbanization. “This change was paralleled by a boom in the real estate, construction and housing industry. According to United Nations Population Fund (UNFPA), Dhaka is one of the most polluted cities in the world.”

A couple of sectors most likely to be affected by climate change in Bangladesh are water resources and coastal zones, infrastructure and human settlements, agriculture and food security, forestry and biodiversity, fisheries, and human health. In this scenario the attempt to use the green architectural technology to assure efficient usage of water and energy works towards finding a solution to the crisis as the nation is struggling in the production of electricity and suffering from water. The introduction of “In recent years, several notable green building projects have emerged in Bangladesh. For example, the Bashundhara City Complex in Dhaka is one of the largest green buildings in South Asia. The complex incorporates solar panels, rainwater harvesting systems, and energy-efficient lighting to reduce its environmental footprint.” *(Ref 4.44)*

Housing and Building Research Institute (HBRI) at Dhaka, Bangladesh, is an autonomous organization under Government of Bangladesh Ministry of Housing and Public Works. The First Government Green Building Initiative was taken by the Housing and Building Research Institute in 2007. The Eco-Housing Project designed by Ar. Md Nafizur Rahman. *(Dia 4.5)*

With the support of IFC-world bank the HBRI Drafted the Guideline for Green building Code in 2012, in the same year a new chapter on Energy Efficiency and Sustainability was included in BNBC. The Building Energy and Environment Rating System for Bangladesh has been Drafted by Ar. Md. Nafizur Rahman in 2018 for the Sustainable and Renewable Ener
Authority (SREDA) The Bangladesh Bank with the support of SREDA also created a point-based rating system for their Refinancing scheme in 2017.

In the private sector, the first green building in Bangladesh was by EPIC group in May 2011. Since 2008, Sustainable Built Environment Initiative – Bangladesh (later Bangladesh Green Building Council) founder, Sanwar Azam had worked to unify the stake holders towards a greener country, saying that with growing population in a diminishing land and rapid urbanization to major cities, 'Going green' had become a marketing ploy for various organizations as there were no quantifiable way to judge a structures sustainability. He offered a centralized board to offer Leadership in Energy and Environmental Design (LEED) certifications to interested projects and firms. In addition, he proposed a similar voluntary building rating tool that is much cheaper to attain and one that is much suited to the socio-economic conditions of the country and relevant to its building environment and construction culture.

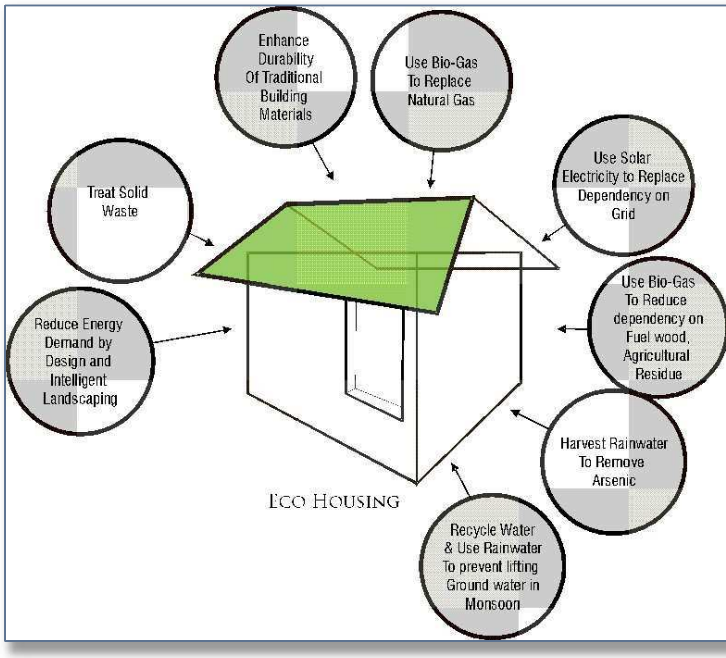


Diagram 4.5 Some of the major goals of the Eco-housing project
(Ref 4.44)

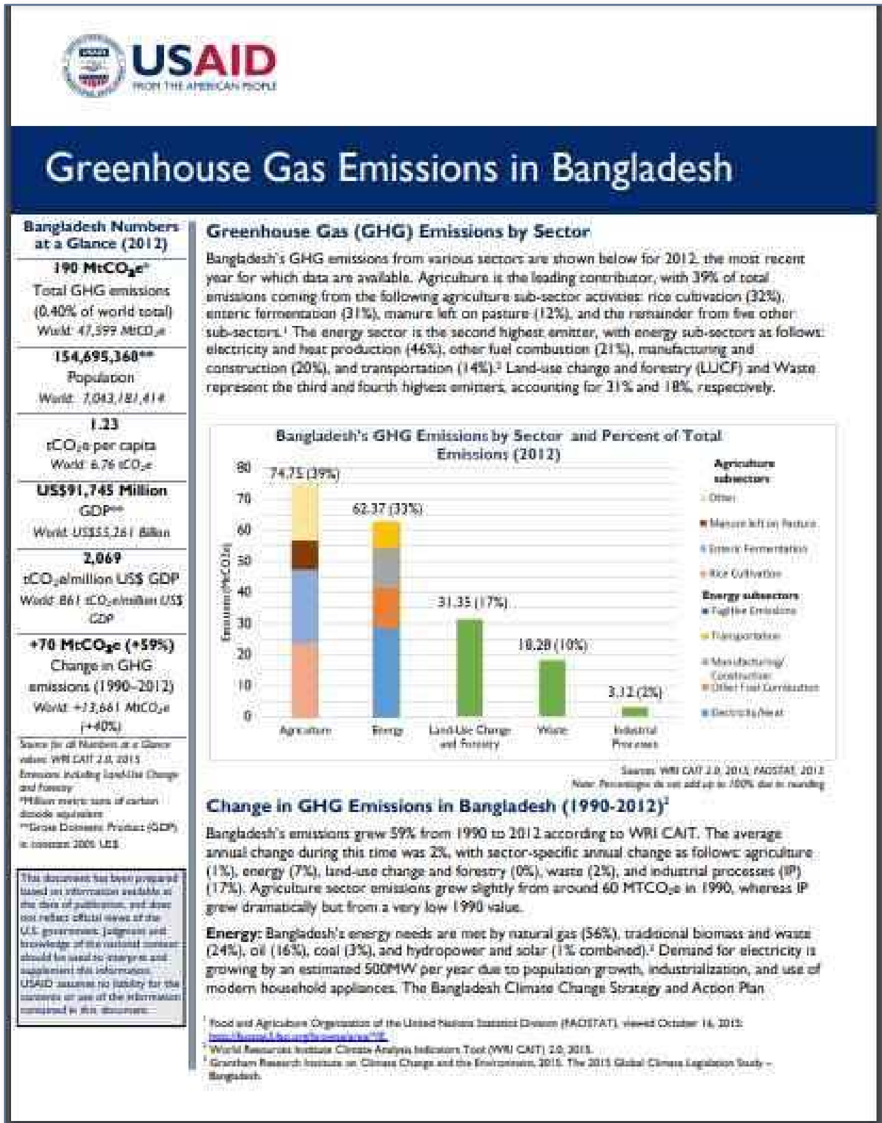
In an event with Architecture and construction experts, he urged for a national need for sustainable development in the nation's growing building industry and brought a forum together to act as the national GBC of Bangladesh. He stressed reductions of carbon emissions from buildings. National and international energy companies like Energpac and Siemens attended the event to assess the roles of the corporate stakeholders while United Nations Framework Convention on Climate Change (UNFCCC) and Intergovernmental Panel on Climate Change (IPCC) fellows commented on the global imperative of such an initiative. The first proposed rating tool aimed to fulfill the seventh target from the United Nations' Millennium Development Goals (MDGs), as for the first time the council provided support for green building certifications.

Sanwar said "there is a great misconception regarding the cost effectiveness of the green design and construction," and that increased productivity and energy savings of a green building outweighs initial costs. The Institute of Architects Bangladesh, which works with different government organization to offer education and government advocacy commented on the adaptability of sustainable principles in the national architecture community in the form of the BGBC rating tool.

By 2012, the Ministry of Public Works began working with the World Bank to study energy and water efficiency and emissions reductions through Green Building Codes.

The Bashundhara City Complex in Dhaka is one of the largest green buildings in South Asia. The complex incorporates solar panels, rainwater harvesting systems, and energy-efficient lighting to reduce its environmental footprint.

However, Sustainable urban planning goes beyond just green spaces. It includes zoning regulations encouraging mixed land use, minimizing the need for long commutes and reducing greenhouse gas emissions. (*Ref 4.45).*



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Greenhouse Gas Emissions in Bangladesh

Bangladesh Numbers at a Glance (2012)

190 MtCO$_2$e*
Total GHG emissions
(0.40% of world total)
World: 47,599 MtCO$_2$e

154,695,360**
Population
World: 7,043,181,414

1.23
tCO$_2$e per capita
World: 6.76 tCO$_2$e

US$91,745 Million
GDP**
World: US$55,261 Billion

2,069
tCO$_2$e/million US$ GDP
World: 861 tCO$_2$e/million US$ GDP

+70 MtCO$_2$e (+59%)
Change in GHG emissions (1990–2012)
World: +13,661 MtCO$_2$e (+40%)

Greenhouse Gas (GHG) Emissions by Sector

Bangladesh's GHG emissions from various sectors are shown below for 2012, the most recent year for which data are available. Agriculture is the leading contributor, with 39% of total emissions coming from the following agriculture sub-sector activities: rice cultivation (32%), enteric fermentation (31%), manure left on pasture (12%), and the remainder from five other sub-sectors.[1] The energy sector is the second highest emitter, with energy sub-sectors as follows: electricity and heat production (46%), other fuel combustion (21%), manufacturing and construction (20%), and transportation (14%).[2] Land-use change and forestry (LUCF) and Waste represent the third and fourth highest emitters, accounting for 31% and 18%, respectively.

Change in GHG Emissions in Bangladesh (1990-2012)[2]

Bangladesh's emissions grew 59% from 1990 to 2012 according to WRI CAIT. The average annual change during this time was 2%, with sector-specific annual change as follows: agriculture (1%), energy (7%), land-use change and forestry (0%), waste (2%), and industrial processes (IP) (17%). Agriculture sector emissions grew slightly from around 60 MTCO$_2$e in 1990, whereas IP grew dramatically but from a very low 1990 value.

Energy: Bangladesh's energy needs are met by natural gas (56%), traditional biomass and waste (24%), oil (16%), coal (3%), and hydropower and solar (1% combined).[3] Demand for electricity is growing by an estimated 500MW per year due to population growth, industrialization, and use of modern household appliances. The Bangladesh Climate Change Strategy and Action Plan

[1] Food and Agriculture Organization of the United Nations Statistics Division (FAOSTAT), viewed October 16, 2015.
[2] World Resources Institute Climate Analysis Indicators Tool (WRI CAIT) 2.0, 2015.
[3] Grantham Research Institute on Climate Change and the Environment, 2015. The 2015 Global Climate Legislation Study – Bangladesh.

Diagram 4.6 Change in GHG Emissions in Bangladesh (1990-2012)[2] *Ref 4.46*

Agriculture is the leading contributor, with 39% of total emissions coming from the following agriculture sub-sector activities: rice cultivation (32%), enteric fermentation (31%), manure left on pasture (12%), and the remainder from five other sub-sectors.

4.8.1) Initiatives:

Bangladesh, like many countries around the world, has recognized the urgent need to address environmental concerns and promote sustainable development within its built environment. In recent years, the country has made significant strides in adopting green building initiatives aimed at reducing carbon emissions, conserving resources, and improving overall environmental quality. Some of the key green building initiatives in Bangladesh include:

1. Green Building Policy and Guidelines: The government of Bangladesh has developed policies and guidelines to promote green building practices across the country. These policies provide incentives for developers and building owners to incorporate environmentally friendly design and construction methods.

2. Green Building Certification: Organizations such as the Bangladesh Green Building Council (BGBC) play a vital role in promoting green building practices and certifying buildings that meet specific environmental standards. Certification programs such as LEED (Leadership in Energy and Environmental Design) and EDGE (Excellence in Design for Greater Efficiencies) are gaining traction in Bangladesh, encouraging developers to adopt sustainable building practices.

3. Energy Efficiency Measures: With a focus on reducing energy consumption and carbon emissions, Bangladesh has implemented various energy efficiency measures in building design and operations. This includes the use of energy-efficient lighting, heating, ventilation, and air conditioning (HVAC) systems, as well as the integration of renewable energy sources such as solar panels and wind turbines.

4. Water Conservation and Management: Water scarcity is a pressing issue in Bangladesh, and green building initiatives prioritize water conservation and management. This includes the use of water-saving fixtures, rainwater harvesting systems, and greywater recycling technologies to reduce water consumption and promote sustainable water practices.

Rainwater harvesting is one of the feasible options of fresh water sources in the coastal areas of Bangladesh and recently a lot of initiatives and programs were undertaken to promote and install rainwater harvesting systems both in the coastal and arsenic affected areas in Bangladesh. Moreover, every year the country is also blessed with ample rain. The average annual rainfall in Bangladesh is about 2200 mm, seventy-five percent of it occurs between May and September. Ref 4.10

5. Waste Management and Recycling: Green building initiatives in Bangladesh also focus on minimizing construction waste and promoting recycling and reuse of materials. Strategies such as waste segregation, on-site composting, and the use of recycled materials help reduce the environmental impact of construction activities and promote a circular economy approach.

6. Green Roofs and Urban Greening: Incorporating green roofs and vertical gardens into building design helps mitigate the urban heat island effect, improve air quality, and provide habitat for wildlife. These initiatives contribute to enhancing the overall livability and sustainability of urban environments in Bangladesh.

7. Public Awareness and Education: Public awareness and education campaigns play a crucial role in promoting green building initiatives and encouraging sustainable practices among developers, building owners, and the general public. Workshops, seminars, and educational programs help disseminate information about the benefits of green buildings and the importance of environmental conservation.

Overall, green building initiatives in Bangladesh are essential for addressing environmental challenges, promoting sustainable development, and improving the quality of life for its citizens. By adopting green building practices, Bangladesh can reduce its ecological footprint, mitigate climate change impacts, and create healthier and more resilient communities for future generations.

These green building initiatives in Bangladesh highlight the country's commitment to sustainable development and environmental conservation. Through the use of sustainable construction practices, such as the use of renewable resources, waste management, and energy efficiency, Bangladesh is moving towards a greener future.

In response to the growing concerns over environmental sustainability and energy efficiency, developers and factory owners in Bangladesh are increasingly turning towards green building practices. The USGBC LEED certification has emerged as a popular rating system for ensuring high standards of sustainability in commercial and textile factory buildings. Moreover, Bangladesh Bank's initiatives to provide financial incentives, such as soft loans and reduced interest rates, for LEED-certified factories demonstrate the government's commitment to promoting energy efficiency in the construction sector. This paper evaluates the effectiveness of these measures in driving green building adoption and discusses potential avenues for further enhancing sustainability in Bangladesh's built environment.

4.8.2) Existing Policies:

The **BNBC** is mandatory and legal document for Buildings construction firms and owners, Architect, Engineers. The BNBC provides regulation and/or minimum requirement of building type (office, residence, commercial building, etc.), size (height, floor area), structure strength, indoor condition, construction material, etc.

“The updated version of BNBC is proposed with addition of energy efficiency requirement of buildings in near future BNBC will be the core program for promoting EE&C in Buildings and contain the following requirement on building energy efficiency:

a. Heat insulation and/or ventilation performance of building envelope

b. Energy efficiency of building equipment (HVAC, lighting, fans, hot water supply, lift, escalator, renewable energy options)

c. Water efficiency and management and Sanitation

d. Roof gardening and vegetation.

On the other hand, The Housing and Building Research Institute developed a Recommendation for Green Building Code at 2012 with the technical assistance of IFC. Its target is not only on energy/water use efficiency but also on reduction of environmental impact caused by building construction, use and decommissioning. The survey for the Recommendation of Green Building Code it is found that the baseline energy consumption of Dhaka is about 277 kw/h/m2 / year. According to this study the Green Building Rating for upcoming new buildings will save 300MW energy per year which is equal to save setup of one power plant in each year. *(Ref 4.47)*

Furthermore, “**The Dhaka Mahanagar Imarat Nirman Bidhimala -2008**” mainly enforcing the building set back, floor area ratio, maximum ground coverage, mandatory open space which are mostly passive approach to reduce the energy use in building. But the buildings are not regulated or inspected for any active energy or water saving measures to reduce the demand.

The following are some examples of how poor building design leads to higher energy and water consumption:

- Window selection is not based on the glass properties.
- The air conditioning units are not regulated
- Lighting systems are not designed with energy efficiency. Some buildings have excessive lights installed with no daylight control, which leads to lights remaining on in a day-lit room. Electric lighting generates heat which leads to more air conditioning load in buildings.
- Water fittings such as taps and toilet flushes are not water efficient and lead to high water consumption with no added value.
- In last decade the apartment units in Dhaka has increased almost 600%. The increase in the demand of new buildings mainly in the residential sector shows the potential impact of Energy and water use.”

(Ref 4.47)

Promoting Green Building Adoption in Bangladesh: The Role of USGBC LEED Certification and Financial Incentives.

USGBC LEED Certification: Driving Sustainability in Construction

The USGBC LEED certification has gained traction among developers and factory owners in Bangladesh due to its comprehensive framework for evaluating and recognizing green building practices. LEED-certified buildings demonstrate a commitment to environmental stewardship, energy efficiency, and occupant health and well-being. By incorporating sustainable design, construction, and operation principles, these buildings contribute to reducing carbon emissions, conserving resources, and enhancing overall building performance. The increasing number of buildings registered under the LEED certification reflects a growing awareness and appreciation for sustainable construction practices in Bangladesh's real estate sector.

Financial Incentives by Bangladesh Bank: Promoting Energy Efficiency

Bangladesh Bank's initiatives to promote energy efficiency in buildings through financial incentives play a crucial role in incentivizing green building adoption. The availability of soft loan facilities and single-digit interest rates for LEED-certified factories encourages developers and factory owners to invest in sustainable building practices. By reducing the financial barriers associated with green building construction, Bangladesh Bank aims to accelerate the transition towards a more sustainable built environment. These financial incentives not only benefit individual businesses but also contribute to the country's overall energy security and environmental sustainability goals.

Impact and Future Directions:

The combination of USGBC LEED certification and financial incentives from Bangladesh Bank has had a significant impact on the construction sector in Bangladesh. However, there remain opportunities for further enhancing green building adoption and sustainability outcomes. Continued collaboration between government agencies, financial institutions, industry stakeholders, and civil society is essential to streamline the certification process, increase awareness, and build capacity for sustainable construction practices. Moreover, the integration of emerging technologies and innovative financing mechanisms can further drive the uptake of green building initiatives and contribute to long-term environmental resilience and economic prosperity.

SREDA

The Sustainable and Renewable Energy Development Authority (SREDA) Act was passed in December 2012. The objectives of SREDA are to promote, develop and coordinate renewable energy and energy efficiency programs in the country. In May 2012 the government has established the Act as a national modal organization for promoting demand-side energy efficiency and conservation (EE&C) in the country. As per the mandate, SREDA addressing the area of energy efficiency and renewable energies for the building sector, and is hence natural partner for the project and the activities. It is able to ensure access to relevant governmental bodies, as well as to financing institutions. It also has excellent relationships with other government bodies and important stakeholders (e.g. Department of Environment, Housing and Building Research Institute, Department of Architecture, Public Works Department, Bangladesh Bank, City Corporations Municipalities) that are relevant to the green building sector in Bangladesh.

EE&C Master Plan up to 2030

In 2016, SREDA has developed the Energy Efficiency & Conservation Master plan up to 2030. The Energy Efficiency & Conservation master Plan (EECMP) is a supreme plan of Bangladesh’s initiative on energy efficiency and conservation, of which preparation requirement is stipulated in the Energy

Efficiency and Conservation Rules (2014). Under the EECMP, all the policies, programs, legal documents (Act, Rules, Regulations, Circulars or Standards etc.) and frameworks are to be established. The Master plan's aims to achieve this target through the adoption and implementation of EE&C regulatory measures: Energy Management Program (Energy Audit Program), EE Labeling Program and EE&C Buildings Program, and EE&C Financial Incentive Programs.

Energy Efficiency & Conservation Buildings Program

To ensure the energy efficiency in buildings, SREDA has developed the rating system for buildings and act as the implementation and execution body for the Building Energy Efficiency & Environment Rating (BEEER). The rating system will be voluntary at the initial stage. Moreover, it is based on certain baselines and calculation procedures in order to evaluate their impacts and to compare them. The rating systems that have been designed as a holistic approach to green buildings by taking the entire environmental footprint of buildings (e.g. water waste, resources) into account. In addition, social standards and working conditions will be assessed and aspects of, for instance, gender equality and rights of minorities and low-skilled workers will be rated.

At present, poor working and safety conditions are prevalent in the construction sector, which primarily employs low-skilled workers and forces women to carry out labor intense and physically demanding tasks on the construction side.

Through the consideration of social standards and working conditions, the BEEER will help to counteract these practices and transform the construction sector in a sustainable manner. In addition, training sessions and information for architects, developers, as well as for construction companies and suppliers will be provided to address the existing lack of awareness and know-how and build capacity. To ensure a comprehensive “greening” of Bangladesh’s building sector the program will support the integration and mainstreaming of green building considerations into national and municipal policies as well as public procurement.

Furthermore, dialogues and cooperation between policy makers and financial institutions will be facilitated and financial institutions will be advised on the provision of green loan products for buildings.

The objective to which the program aims to contribute is to:

- Promote green and sustainable building practices on the supply and demand side of Bangladesh’s construction sector;
- Contribute to climate change mitigation by saving resources in the building sector while enhancing economic prosperity and competitiveness, as well as alleviating poverty by considering both green and social standards;
- Establish a building energy efficiency and environmental rating systems serving as a standard/reference for green building construction practices;
- Enhance sustainable consumption in the building sector through a rating system, providing consumer information and a distinctive grade for sustainable buildings;
- Mobilize and capacitate key stakeholders to get involved in green building design and construction.
- Promote green equipment and construction materials, fixtures and make the market ready.
- Develop the capacity of architects and Engineers, Energy Managers & Energy Auditors in Green Construction.
- Provide access to soft and subsidize loan facilities for green building developer and consumers.

4.8.3) Rating Methodology

3. Rating and reference Points and Label Design

Certification level	Points
☆	40-50
☆ ☆	51-60
☆ ☆ ☆	61-70
☆ ☆ ☆ ☆	71-99
☆ ☆ ☆ ☆ ☆	100- 145
	145 points

Diagram 4.7 *REF: (Ref 4.47) (Pg. 9) Rating Methodology*

Apart from this there is another rating guideline which includes credit point for the followings (SREDA):

- Recognized professionals (Applicable for Building Type (Residential/Commercial/Factory/Industry) Building Stage (New/Existing)

- Assessment of the Site and Surroundings (Applicability Building Type (Residential/Commercial/Factory/Industry) Building Stage (New/Existing)

- Assessment of the Site and Surroundings
  Applicability : Building Type (Residential/Commercial/Factory/Industry) Building Stage (New/Existing)
- Site selection Applicability : Building Type (Residential/Commercial/Factory/Industry) Building Stage (New/Existing)
- Site Improvement & Protect/Restore Habitat Applicability : Building Type (Residential/Commercial/Factory/Industry) Building Stage (New/Existing)

- Open Space Management Applicability : Building Type (Residential/Commercial/Factory/Industry) Building Stage (New/Existing)

- Rainwater Management During Construction at Site Applicability : Building Type (Residential/Commercial/Factory/Industry) Building Stage (New)

- Outdoor Light Control at Site & Surrounding Applicability : Building Type (Residential/Commercial/Factory/Industry) Building Stage (New/Existing)

- Easy Access to the site Applicability : Building Type (Residential/Commercial/Factory/Industry) Building Stage (New/Existing)

- Bicycle Parking Applicability : Building Type (Residential/Commercial/Factory/Industry) Building Stage (New/Existing)

- Car Parking Applicability : Building Type (Residential/Commercial/Factory/Industry) Building Stage (New/Existing)

- Community services Applicability : Building Type (Residential/Commercial/Factory/Industry) Building Stage (New/Existing)

Indeed, Bangladesh's commitment to promoting green building initiatives is commendable and reflects a growing awareness of the importance of sustainability across various sectors. From educational institutions like the Aga Khan Academy Dhaka to garment factories, there's a clear recognition of the benefits that environmentally conscious practices can bring.

The certification from EDGE for the Aga Khan Academy Dhaka highlights the significance of resource efficiency and sustainability in building design. By prioritizing these factors, not only does the academy contribute to mitigating climate change, but it also sets a precedent for other institutions to follow suit.

In the garment sector, the emphasis on sustainability reflects a broader trend of businesses understanding the advantages of environmentally friendly practices. Green buildings not only help save costs and improve productivity but also prioritize the health and safety of workers. LEED-certified factory buildings, in particular, play a crucial role in creating safer working environments and enhancing the overall image of the industry.

The adoption of green building practices in Dhaka, Bangladesh's capital, showcases a proactive approach towards achieving sustainable development goals.

By integrating sustainability into construction and operations, institutions and businesses contribute to economic growth, social progress, and environmental conservation. Overall, these efforts demonstrate Bangladesh's commitment to a greener and more sustainable future.

From the findings, it has been revealed that design and construction efficiency, and reduction of energy use are the highest ranked indicators of green building, furthermore, environment-friendly design and construction, and long-term resource efficiency aspects should be included in the design and construction.

The future of green building in Bangladesh looks promising, with government initiatives and international collaborations aimed at promoting green building practices. Adopting sustainable practices in the construction sector can lead to numerous environmental and economic benefits, such as reduced energy consumption and lower water usage, as well as improved indoor air quality and reduced carbon emissions.

Overall, the adoption of green building practices in Bangladesh is essential in addressing the challenges of climate change and ensuring sustainable development in the country. The construction sector has a crucial role to play in this, and the progress made so far in promoting sustainable construction practices is encouraging.

With the United States Green Building Council’s and Leadership in Environmental and Energy in Design certification, Today Bangladesh has the most environmentally friendly garment manufacturers worldwide (USGBC).

The largest green factories in the world are in Bangladesh’s readymade garment (RMG) industry. Bangladesh has strengthened its position as the global leader in green environmentally-friendly apparel factories, with 204 factories in the sector now boasting the United States Green Building Council’s (USGBC) LEED certification (certificate for green factories).

Diagram 4.8 *Typical LEED Certification Logos*
A sample certificate for green buildings in Bangladesh is also provided (Diagram 4.12) at the end of the chapter (collected)

Bangladesh has made remarkable strides in sustainable fashion with 204 LEED Green Factories, including 74 Platinum-rated and 116 Gold-rated, solidifying its commitment to environmental stewardship.

So far, 54 of the world's top 100 LEED Green Factories are now located in Bangladesh, including 9 of the top 10 and 18 of the top 20, this achievement is poised to attract further investment and partnerships, solidifying Bangladesh's position as a global leader in sustainable manufacturing.

Bangladesh achieved 30 green building certifications in 2022, while 550 more factories are in the pipeline to get the USGBC's LEED certification.

USGBC honors factories based on several criteria – transformation performance, energy, water, and waste management. The best performers are rated with platinum, followed by gold and silver.

These criteria help green factories significantly to reduce operational costs over time even though they may initially cost more to set up, according to industry insiders. These factories also provide a safe working environment for employees.

BGMEA Director Mohiuddin Rubel said they are working on the green revolution.

"Even though there is a shortage of orders all over the world, we are still getting orders only because of our green factories," he added.

He also said that global buyers and brands are increasing their focus on the environment, which is why eco-friendly factories will no longer be an option, but will become mandatory.

Bo

x 1: Status of Green Factories in Bangladesh *(Ref: 4.48)*

The Government of Bangladesh (GOB) has prioritized green development as a means to mitigate the adverse effects of climate change and foster sustainable, pollution-free growth within the country.

In pursuit of this objective, the GOB took significant steps by establishing the Bangladesh Climate Change Resilience Fund (BCCRF) in May 2010, through the signing of a Memorandum of Understanding (MoU) with the World Bank and other development partners. Additionally, the GOB enacted legislation to create the Bangladesh Climate Change Trust Fund (BCCTF) in 2010, utilizing allocations from the national budget and operating under the legal mandate conferred by the Parliament (Hossain, 2019). Figure 2 illustrates the GOB's allocations to the Bangladesh Climate Change Trust Fund across various fiscal years, reflecting its ongoing commitment to addressing climate change challenges through dedicated financial mechanisms.

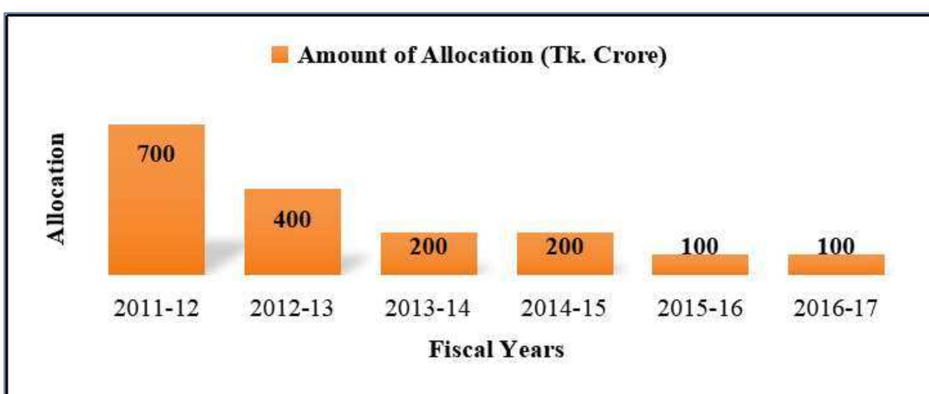


Diagram 4.9: *Government allocation to the Bangladesh Climate Change Trust Fund*
Source: BCCTF 2017(Ref 4.49)

As depicted in *Diagram 4.9*, the allocation to the Bangladesh Climate Change Trust Fund (BCCTF) peaked during the initial stages of its establishment, notably in the 2011-12 fiscal year, before gradually decreasing over time. This trend can be attributed to the implementation of separate policies by various ministries and regulatory agencies, each with its own budget allocation in alignment with government initiatives. Consequently, there is a necessity to rationalize government allocation to the BCCTF in response to these diversified policy undertakings.

Table 4.3 delineates the supportive initiatives undertaken by different government institutions in Bangladesh to promote green development. The Bangladesh Bank (BB) serves as the central regulatory authority for both commercial and specialized banks, overseeing their activities in accordance with green development objectives.

The Sustainable and Renewable Energy Development Authority (SREDA) is actively engaged in promoting sustainable energy usage across the country. Meanwhile, the Planning Commission assumes a pioneering role in the adoption and formulation of policies conducive to green development. Additionally, the Finance Division and the Economic Relations Division (ERD) function as pivotal authorities responsible for facilitating fiscal policies, incentives, and securing green finance to drive socioeconomic development initiatives within the nation.

Table 4.3: Role of Government Institutions for green development in Bangladesh

Sl. No.	**Institutions**	**Initiatives**
1	Bangladesh Bank	Policy formulation and governance, Introduction of green finance, supporting employee training, customer awareness and green events.
2	Sustainable and Renewable Energy Development Authority (SREDA)	Maintain coordination among the various organizations working on green technologies, capacity buildings in terms of manpower, logistics and funds.
3	Planning Commission	Inter-sectoral coordination among the planning ministries, allocation of resources towards implementation
4	Finance Division	Preparing, analyzing and implementing fiscal policies, budget functions, allocate fiscal incentives.
5	Economic Relations Division (ERD)	External support for the socio-economic development, securing green finance from international sources.

Sources: Shakil et al. 2014
(Ref 4.49)

Bangladesh Bank, as the central regulatory authority of the country's banking sector, has implemented comprehensive policy guidelines to promote green banking and green credit among banks and financial institutions. One notable initiative by the Bangladesh Bank is the establishment of the 'Climate Risk Fund' to incentivize and support green initiatives within the banking sector. Under this scheme, banks and financial institutions are mandated to allocate a minimum of 10% of their corporate social responsibility (CSR) budget to the Climate Risk Fund. In 2016 alone, these institutions collectively allocated Tk. 376,078.12 million to the Climate Risk Fund and disbursed Tk. 503.2 billion as green finance (Bangladesh Bank, 2016). Furthermore, Bangladesh Bank has set a 5% mandatory credit quota for green finance as a proportion of the total loan disbursement by banks and financial institutions in 2016 (Hossain, 2019).

Initially, the bank focused on formulating policies to enhance in-house environmental performance and promote green banking starting from 2011. Subsequently, it encouraged banks and financial institutions to disclose their environmental activities and performances on their websites and annual reports by 2012. By 2013, Bangladesh Bank mandated banks to publish sustainable annual reports adhering to international standards. Moreover, commercial banks have embraced various green initiatives under the guidance of Bangladesh Bank, including green governance, paperless banking, installation of solar energy systems in branches, promotion of green credit and financing, and reporting on green banking activities (Ullah, 2014). These concerted efforts underscore Bangladesh Bank's commitment to fostering sustainable development within the banking sector and the broader economy.

**Calculated from quarterly report of Bangladesh Bank during October-December in each year*

Diagram 4.10: *Amount of green finance in Bangladesh; Source: Rana and Siddique 2019 [Ref 4.49]*

Diagram 4.10 illustrates a notable upward trend in the amount of green finance in Bangladesh, with the exception of a slight decrease observed in the year 2018, which is partially attributed to incomplete data calculations. Despite efforts to promote green development, Bangladesh remains one of the lowest-performing countries worldwide in terms of environmental performance. According to the Environmental Performance Index (EPI) 2020 report by Yale and Columbia universities in the United States, Bangladesh ranks 162nd out of 180 countries evaluated for the condition of environmental health and the vitality of their ecosystems.

In response to these challenges, the Government of Bangladesh (GOB) has implemented various initiatives, such as environmental taxes and ecological compensation mechanisms, to advance green development within the country. Notably, the GOB has allocated 7% of public expenditure towards green growth activities (Macgregor et al., 2016). Additionally, during the 2014-2015 fiscal year budget, the GOB proposed a 1% 'green tax,' termed the 'Environmental Protection Surcharge,' targeting factories that produce pollution at hazardous levels. This tax incentivizes garment factories and brick factories to invest in waste treatment facilities and adopt environmentally friendly production methods (Keane, 2014). These measures reflect the GOB's commitment to fostering environmental sustainability and mitigating the adverse effects of pollution on public health and the ecosystem.

Table 4.4: Environmental taxes in Bangladesh

Sl. No.	Taxation System	Initiatives
1	Fossil Fuel Use	The tax rate for selling price on fossil fuel petrol (12.9%), diesel (10.2%), kerosene (10.2%) and fuel oil (15.7%).
2	Industrial air pollution	Takes initiatives to reduce air pollutions, focuses on the transport sector and brick manufacturing.
	Industrial water pollution	The GOB has restricted the production and use of polyethylene shopping bags and make mandetorry to set up Effluent Treatment Plants (ETPs) for industries to prevent waste discharge to water bodies.

Source: Ahmed 2018 [*Ref 4.49]*

The Government of Bangladesh (GOB) has initiated efforts to facilitate the introduction of green bond facilities within the country's capital market. In collaboration with the World Bank, Bangladesh Bank conducted a study on green bond development in 2019, identifying seven government bodies as key policy and regulatory actors in this endeavor. These actors include the Ministry of Finance, Bangladesh Bank (BB), Sustainable and Renewable Energy Development Authority (SREDA), Bangladesh Securities and Exchange Commission (BSEC), Insurance Development and Regulatory Authority (IDRA), National Board of Revenue, and the Dhaka and Chittagong Stock Exchange

s. Proposed issuers of green bonds encompass 59 scheduled banks, 34 non-banking financial institutions, and the Finance Division of the Ministry of Finance. Potential investors identified for green bonds comprise pension funds, insurance companies, scheduled banks, international investors, large corporates, asset managers, and non-banking financial institutions (WB & BB, 2019).

However, green insurance practices remain limited in Bangladesh compared to other South Asian countries. The GOB has prioritized the promotion of agricultural insurance as part of its green insurance initiatives.

Agricultural insurance serves as a mitigation strategy to transfer climate risks away from farmers. Various insurance products, including livestock, flood, and crop insurance, have been introduced to mitigate climate change-related negative impacts. Additionally, recent initiatives in Bangladesh have seen the launch of two weather index-based insurance schemes, led by both government-owned and private insurance companies. The World Bank has also identified four potential types of agricultural insurance in Bangladesh: dairy cattle insurance, aquaculture insurance, crop insurance, and insurance for climate-vulnerable populations (World Bank Group, 2018).

In Bangladesh, the readymade garments (RMG) and leather industries are two crucial sectors contributing significantly to the country's export earnings. The RMG sector alone contributes approximately 6% to the Gross Domestic Product (GDP) of Bangladesh, employing around 4.4 million workers. Similarly, the leather industry ranks as the second-largest export earning sector after RMG, with exports amounting to USD 1.13 billion in the 2015-2016 fiscal year. However, both industries face environmental challenges due to the disposal of solid and liquid waste into nearby water bodies, leading to environmental degradation (Paul et al., 2013; Reza et al., 2017). Addressing these environmental concerns is imperative for the sustainable growth and development of these vital industries in Bangladesh.

The Government of Bangladesh (GOB) has placed significant emphasis on promoting green production practices within the readymade garments (RMG) and leather industries, aiming to foster green trade within the country. To support this initiative, Bangladesh Bank (BB) has established the 'Green Transformation Fund,' totaling two hundred million dollars. This fund is specifically designated to provide low-cost loans to facilitate green production practices in RMG, leather, and other export-oriented industries. The allocated loans aim to bolster green initiatives within these industries, including waste management, water conservation, energy efficiency, renewable energy adoption, resource efficiency, and recycling activities (Reza et al., 2017).

Additionally, the GOB has actively engaged in formulating and implementing policies to ensure the availability of urban green spaces across the country. Special attention has been given to transforming Dhaka, the capital city, into an inclusive and livable urban center by prioritizing urban green spaces and green infrastructure initiatives (Byomkesh et al., 2012). Policy efforts are directed towards two primary objectives concerning urban green spaces: eco-aesthetic beautification and addressing the needs of urban informal settlements for migrants (Gopal and Nagendra, 2014; Matthews et al., 2015). The Rajdhani Unnayan Kartripakkha (RAJUK), the capital development authority of Bangladesh, has formulated Dhaka's overall development master plan for the year 2035, which includes provisions for green spaces, beautification projects, and green infrastructure development (Hasan, 2017).

These strategic interventions underscore the GOB's commitment to fostering sustainable urban development and enhancing the quality of life for its citizens through the promotion of green practices and infrastructure.

The Government of Bangladesh (GOB) has implemented various innovations and policy measures to combat environmental pollution and mitigate the adverse impacts of climate change. Notably, the Bangladesh Climate Change Strategy and Action Plan (BCCSAP) was developed in 2009 to steer the country towards low-carbon development. Recognizing the urgency of addressing climate change, the Ministry of Environment and Forest (MoEF) was expanded to the Ministry of Environment, Forest, and Climate Change (MoEFCC), reflecting an increased emphasis on climate change considerations in green development strategies.

In addition to that, the GOB has enacted a series of policies aimed at promoting green innovation and ensuring environmental well-being. Key policies include the Forest Policy (1994), Energy Policy (1995), Water Policy (1998), National Conservation Strategy (1995), National Environment Management Action Plan (1995), Environment Conservation Rules (1997), and Environment Court Act (2010). Additionally, the Renewable Energy Policy of Bangladesh (2008) was adopted to encourage the adoption of renewable energy technologies. To facilitate the implementation of these policies, the Sustainable and Renewable Energy Development Authority (SREDA) was established to raise awareness, build capacity, coordinate initiatives, demonstrate new technologies, provide subsidies for renewable energy projects, and offer capacity-building support.

The GOB has also prioritized green government procurement through the enactment of the Public Procurement Act 2006 and Public Procurement Rules 2008. These policies incorporate initiatives to promote green innovation, efficient use of resources, environmentally friendly processes, and energy-saving procedures in government procurement practices. Additionally, the Central Procurement Technical Unit (CPTU) oversees green practices in procurement, including adherence to health and safety standards, compliance with labor laws, minimal waste generation, and the exclusion of child labor (Ahammed, 2015). These measures reflect the GOB’s commitment to integrating sustainability principles into government operations and fostering a culture of environmental responsibility in procurement processes.

To conclude, green development is integral to achieving balanced growth in Bangladesh, addressing climate change, and ensuring the well-being of its citizens. Measures such as green banking, green bonds, and green insurance are essential for promoting sustainable business practices and mitigating environmental risks. The GOB should enhance environmental taxes and compensation mechanisms to reduce pollution and encourage sustainable production.

Promoting green trade initiatives in industries like ready-made garments and leather, along with investing in pollution-free production systems, will contribute to sustainable economic growth and increased export earnings. Ensuring green spaces in urban areas and promoting green procurement practices at all government levels are crucial steps toward sustainable development.

Encouraging green innovation and fostering collaboration among stakeholders will further advance green development goals in Bangladesh, promoting a harmonious balance between economic prosperity, social equity, and environmental sustainability.

TABLE 4.5: INDUSTRIAL PRODUCTION VALUES AND EMISSION FACTORS FOR BANGLADESH

Source Sector	Emission Factors				Source	COMMENT
	PM10	PM2.5	SO2	UNIT		
Brick Kiln	6.44	2.12	7.15	g/s	BAPMAN, CASE Project	
Metal Processing	1.84	1.61	0.052	Kg/MT	BAPS Task5 and EMEP/EEA emission inventory guidebook 2013	80%PM10, 70%PM2.5
Paper Processing	0.8	0.6	1	kg/Mg air dried pulp	EMEP/EEA emission inventory guidebook 2013	
Polyester	33.3			lbs/tons produced	EPA - Emission Inventory Improvement Program (EIIP) 2001	
PVC	0.1	0.05	0	Kg/MT	EMEP/EEA emission inventory guidebook 2013	
Glass factory	0.12	0.1	0	Kg/MT	EMEP/EEA emission inventory guidebook 2013	Assume average glass thickness 4mm and glass density 2500 Kg/M3
Cement	0.3	0.1	ND	Kg/MT	AP 42, Uncontrolled	In Bangladesh only 2 cement industry produce Clinker from raw materials. 85%PM10, 30%PM2.5 , Conversion of emission factor from 99% controlled emission factor
Clay Ceramics	702.9	206.74	1758.8	(g/ton ceramic ware)	BAPS Task5 and EMEP/EEA emission inventory guidebook 2013	50%PM10, 15%PM2.5
Battery Production	1300	650		g/Mg lead	EMEP/EEA emission inventory guidebook 2013	
Urea - CUFL	0.234	0.1677	0	Kg/MT	AP42, 60%PM10, 43%PM2.5	
Urea - KAFCO	0.069	0.05	0	Kg/MT	AP42	
Ammonia	ND	ND	0.0288	Kg/MT	AP42	
DAP	1.156	0.408	0.04	Kg/MT	AP42, 85% PM10, 30%PM2.5	Conversion of emission factor from 75% controlled emission factor
TSP	13.26	3.9	0	Kg/MT	AP42, Assuming uncontrolled. 51%PM10, 15%PM2.5	Conversion of emission factor from 99% controlled emission factor

Source sectors that are not mentioned are not included in this bottom-up emissions inventory study due to lack of data.

Source Sector	Average Annual Production/Plant	Units	Comments
Brick Kiln	1,290,500.00	Nos	
Metal Processing	9,087.58	MT	all steel pipes, rods, sheets, steel foundries
Paper Processing	56,968.00	(mt)	all paper processing
Polyester	1,328.86	'000' metre	all other plastic processing (except urea, pvc)
Polyvinyl Chloride	5,081.50	MT	
Glass factory	796,000.00	Sq. m	both glass sheet and glass products
Cement	433,293.13	MT	stone breaking and cement processing
Clay Ceramics	5,173.00	('000' doz)	
Battery Production	139,416.00	'000' No.	
Urea - CUFL	612,000.00	MT	
Urea - KAFCO	670,680.00	MT	
Ammonia	437,040.00	MT	
DAP	576,000.00	MT	
TSP	100,000.00	MT	

Source: Bangladesh Bureau of Statistics 2013
Assumptions:
All production are assumed to be equal to the average production for Bangladesh

(Ref: 4.12)

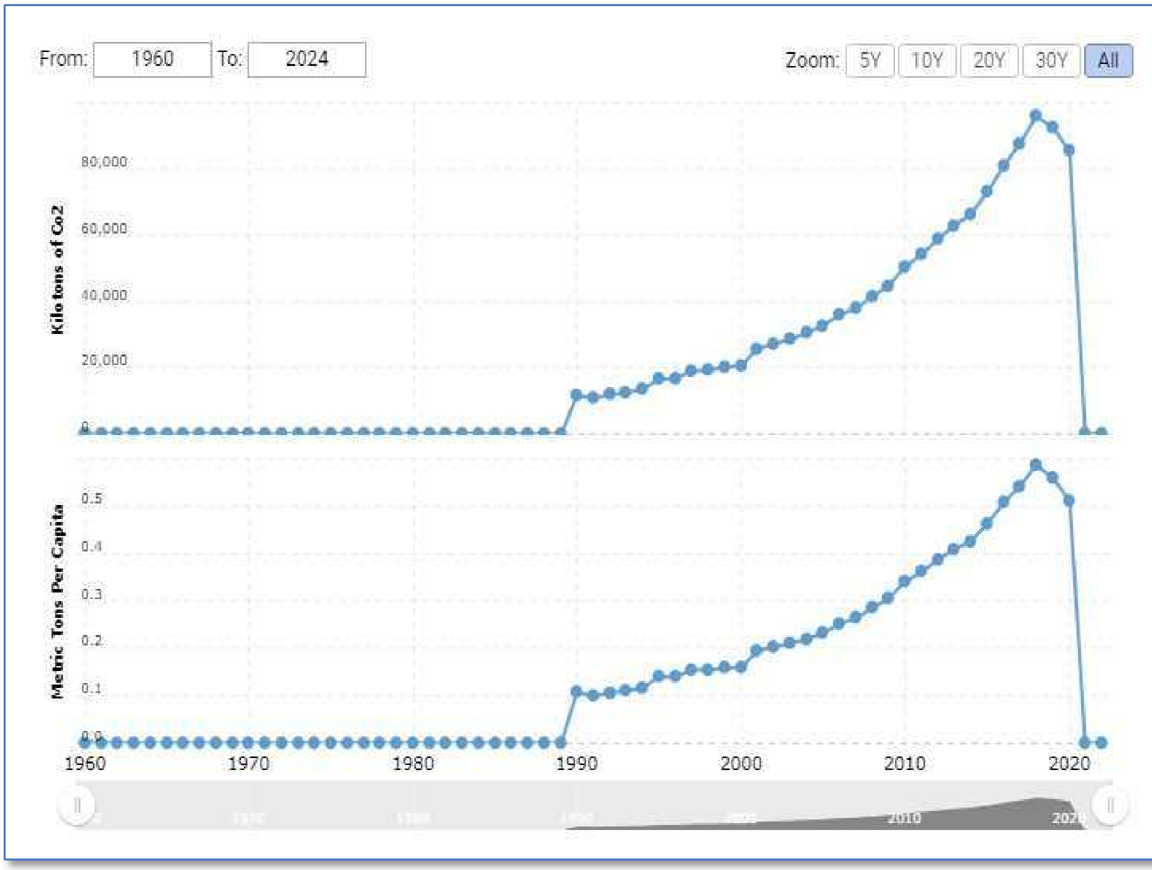


Diagram 4.11
Bangladesh Carbon (CO2) Emissions 1960-2024
(Ref 4.13)

Carbon dioxide emissions are those stemming from the burning of fossil fuels and the manufacture of cement. They include carbon dioxide produced during consumption of solid, liquid, and gas fuels and gas flaring. For example the graph shows that,

- Bangladesh carbon (co2) emissions for 2022 was 0.00, a NAN% decline from 2021.
- Bangladesh carbon (co2) emissions for 2021 was 0.00, a 100% decline from 2020.
- Bangladesh carbon (co2) emissions for 2020 was 85,493.10, a 7.72% decline from 2019.
- Bangladesh carbon (co2) emissions for 2019 was 92,645.00, a 3.44% decline from 2018.

4.9 DHAKA SCENARION

Dhaka, the capital city of Bangladesh, boasts a rich architectural heritage characterized by historical buildings.
The Indo-Saracenic (also known as Indo-Gothic, Mughal-Gothic, Neo- Mughal, Hindoo or Hindu-Gothic) was an architectural style movement by British architects in the late 19th century in British India. The fusion of building architectural styles in enriched cities often reflects a cultural dialogue between different periods and influences. So is the case of Dhaka. The Indo-Saracenic style is a prime example of this blending, where British architects in colonial India as well as in Bangladesh incorporated elements of native Indo-Islamic and Indian architecture into their designs, alongside Gothic revival and Neo-Classical motifs popular in Victorian Britain. This amalgamation created a distinctive aesthetic that symbolized the cultural exchange and historical context of the era.

Dhaka is an enriched city which is an ensemble of the old and the new. Dhaka, as one of the most densely populated cities in the world, grapples with the dual challenges of preserving its cultural heritage and addressing the pressing issues of urban heat islands and climate change. Amidst the sprawling urban landscape, historical buildings stand as tangible remnants of the city's rich architectural legacy, with traditional construction methods that prioritize comfort in a subtropical climate. However, rapid urbanization and modernization have led to the proliferation of new buildings characterized by high heat absorption and inadequate ventilation, exacerbating the urban heat island effect and compromising the livability of the city. In this context, there is a growing imperative to harness the inherent thermal advantages of historical buildings and integrate sustainable design principles to create a more resilient and ecologically conscious and user-friendly built environment.

The Evolution of Dhaka as the Capital of Bangladesh

Dhaka, the vibrant and historic city located in the south-central part of Bangladesh, has a long and complex history that reflects its importance as a cultural, economic, and political center. Positioned just north of the Buriganga River, Dhaka has not only become the most populated city in Bangladesh but also one of the largest metropolises in South Asia. The city's evolution into the capital of modern Bangladesh is the culmination of centuries of transformation, marked by significant political shifts and socio-economic changes.

Early History and Mughal Period

The historical significance of Dhaka can be traced back to the Mughal period. In 1610, the Mughal emperor Islam Khan Chisty made Dhaka the capital of the Bengal province, a decision that elevated the city's status as a political and administrative center. Under Mughal rule, Dhaka flourished as a hub for trade, commerce, and culture. The city became renowned for its thriving textile industry, particularly its production of muslin, a fine fabric that was highly sought after in global markets. However, in 1704, the Mughals shifted their capital to Murshidabad, a decision that significantly weakened Dhaka's economy. The relocation caused a decline in trade and commerce, leading to a period of stagnation for the once-prosperous city.

Colonial Period and British Rule

The next major transformation in Dhaka's history occurred in 1765, when the city came under the control of the British East India Company following the defeat of the Bengal Nawabs. During the British colonial period, Dhaka's economic and political importance diminished further, as British interests prioritized Calcutta (now Kolkata) as the center of colonial administration and trade. Despite this decline, Dhaka remained significant as a center for agriculture and small-scale industries. The colonial period, however, left a lasting architectural legacy, with buildings and infrastructure reflecting British influences that remain visible in parts of the city today.

Post-Partition and Dhaka as the Capital of East Pakistan

The Partition of British India in 1947 brought a new chapter for Dhaka. Following the creation of India and Pakistan, Dhaka became the administrative capital of East Pakistan, one of the two geographically separated wings of Pakistan. This change restored some of Dhaka's political prominence, as it now served as the center for governance in East Pakistan. In 1962, the city was declared the legislative capital of Pakistan, further solidifying its role as an administrative hub. However, during this period, significant economic and political disparities between East and West Pakistan led to growing dissatisfaction and movements for autonomy in East Pakistan.

The Liberation War and Dhaka as the Capital of Bangladesh

The culmination of these tensions was the Liberation War of 1971. The nine-month conflict resulted in Bangladesh gaining independence from Pakistan, and Dhaka was officially declared the capital of the newly formed country. This event marked a turning point in Dhaka's history, as the city became the center of a sovereign nation. The post-independence period saw rapid urbanization and economic development as Dhaka began to expand its infrastructure to accommodate its growing population and administrative needs.

Dhaka: History of the Present

Today, Dhaka stands as the most populous city in Bangladesh and one of the largest metropolises in South Asia. It serves as the economic, cultural, and political heart of the country, attracting millions of people in search of employment and opportunities. However, the city faces numerous challenges due to unplanned urbanization, including traffic congestion, environmental degradation, and inadequate infrastructure. Despite these issues, Dhaka continues to thrive as a dynamic and bustling metropolis, shaped by its rich history and its role as the capital of an independent Bangladesh.

The history of Dhaka is a reflection of its resilience and adaptability through centuries of change. From its early prominence as a Mughal capital to its colonial struggles and eventual role as the capital of an independent Bangladesh, Dhaka has remained at the heart of regional politics, economy, and culture. Today, as it continues to grow amidst challenges, Dhaka symbolizes the aspirations and vibrancy of Bangladesh as a whole.

Dhaka, the capital of Bangladesh, is characterized by a diverse architectural landscape that reflects its historical, cultural, and urban evolution. The city's buildings range from centuries-old Mughal structures to colonial-era architecture, modern high-rises, and contemporary green designs, illustrating its dynamic transformation over time.

In recent years, there has been a growing emphasis on sustainable building practices in Dhaka to address environmental challenges such as energy consumption, pollution, and resource depletion. Green architectural initiatives, such as incorporating rooftop gardens, vertical greenery, energy-efficient designs, and water-saving technologies, are gradually gaining traction. Iconic projects like the SAARC

Fountain, eco-friendly office spaces, and residential designs in Dhaka symbolize efforts to balance urbanization with sustainability.

Challenges in Contemporary Constructions

Challenges and Future Prospects

Despite its architectural diversity, Dhaka faces significant challenges, including unplanned construction, traffic congestion, and the loss of historical buildings to urbanization. Preserving architectural heritage while embracing sustainable development is essential for the city's future. With innovative planning, Dhaka has the potential to become a model for modern urban infrastructure that honors its rich history while addressing contemporary needs.

In essence, Dhaka's buildings serve as a testament to its past, present, and future—a blend of historical grandeur, rapid urban growth, and emerging sustainability efforts.

In contrast to historical buildings, contemporary constructions in Dhaka face several thermal challenges that compromise occupant comfort and energy efficiency. These include:

1. **High Thermal Inertia**: Modern buildings constructed with lightweight materials such as concrete and glass exhibit lower thermal mass properties, leading to rapid heat absorption and retention, particularly during peak hours of solar exposure.

2. **Insufficient Ventilation**: The prevalence of sealed, air-conditioned spaces in new buildings restricts natural ventilation and airflow, resulting in stagnant indoor environments with poor air quality and elevated temperatures.

3. **Urban Heat Island Effect**: The proliferation of heat-absorbing materials and the depletion of green spaces contribute to the exacerbation of the urban heat island effect, intensifying temperature differentials between urban and rural areas and exacerbating heat-related health risks.

To address these challenges and promote sustainable architecture in Dhaka, there is a need for concerted efforts to integrate traditional building techniques with innovative green technologies. For example, embracing adaptive reuse and retrofitting of historical buildings to enhance their thermal performance while preserving their cultural significance, thereby minimizing the environmental footprint associated with new construction. Or for that matter, incorporating passive design principles such as orientation optimization, natural ventilation strategies, and shading devices into new constructions to minimize energy consumption and optimize thermal comfort.

The Government of Bangladesh has taken some initiatives in the form of policies and other attempts as discussed earlier. These should be continued. Just for instance, the adoption of green building certification programs such as LEED (Leadership in Energy and Environmental Design) and BREEAM can be encouraged. Implementing urban greening initiatives such as rooftop gardens, vertical green walls, and tree planting campaigns to mitigate the urban heat island effect, improve air quality, and enhance the overall resilience of the urban ecosystem. However, the positive point is that some effective collaboration between stakeholders, including government agencies, architects, developers, and community members, are underway, as discussed in the earlier section of this chapter which is helping to realize this vision and foster a culture of sustainability in the city's-built environment.

Some Historical Buildings in Dhaka

Pic 4.11: *Ahsan Manzil, a city of historical edifices.* (*Ref: 4.51)*

Pic 4.12: *The Curzon Hall, a British Raj-era building and home of the Faculty of Sciences at the University of Dhaka, located in Shahbagh.*
Ref: 4.52

Pic 4.13 A residential building (Revati Mohan Das House)
Hidden Heritage - Homes in Dhaka,
Nasir Khan Saikat *Ref: 4.53*

Recent and Contemporary buildings

Pic 4.14 The *Parliament House remains one of the best landmarks in Dhaka*
Ref: 4.54

Pic 4.15 Bay's Edgewater at Gulshan 2 (*Ref: 4.55)*

Pic 4.16 : *City Center Dhaka at Motijheel Commercial Area*
Ref 4.56

Pic 4.17: *Commercial Building on Gulshan Avenue (Photo courtesy: Elhaam Parveen Hasan)*

Pic 4.18: *Arial view of building clusters at Dhaka City*
Ref: 4.57

Pic 4.19: *Some Residential Buildings in Adabor, Mohammadpur, Dhaka area (Ref 4.58)*

4.10. PICTURES OF SOME LEED CERTIFIED BUILDINGS IN DHAKA

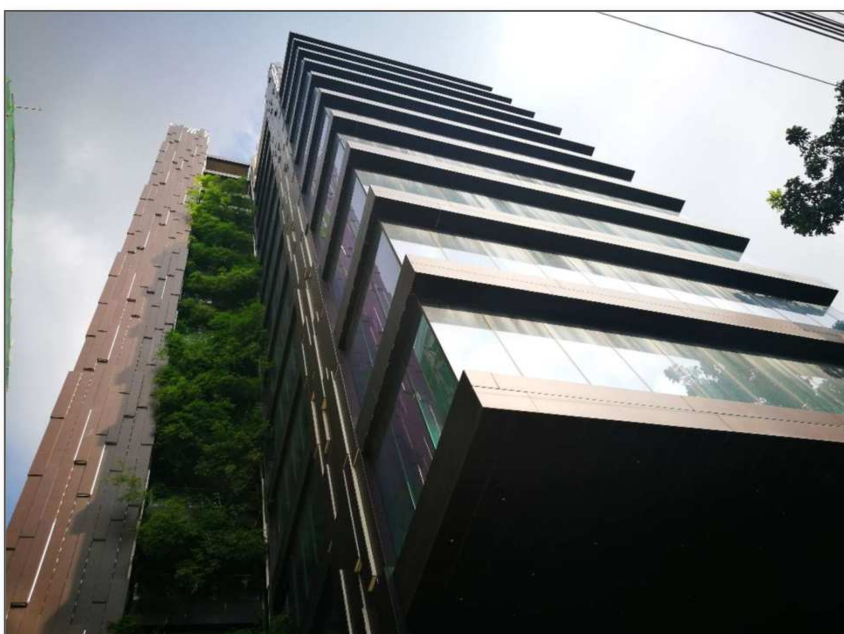
Pic 4.20a: Mega Mall Bashundhara-City-Shopping-Complex (a)
Ref 4.59

Pic 4.20b
Mega Mall Bashundhara-City-Shopping-Complex (b) *Ref 4.60*

The Bashundhara City Complex, which is the largest shopping mall in South Asia (Ref: 4.60), achieved the LEED certificate for its energy-saving measures. The mall features a range of sustainable design elements, including energy-efficient lighting and HVAC systems. The ACI Centre's LEED Platinum rating sets a high standard for office buildings in Dhaka, Bangladesh, showcasing the possibilities for energy efficiency and environmental responsibility in commercial construction.

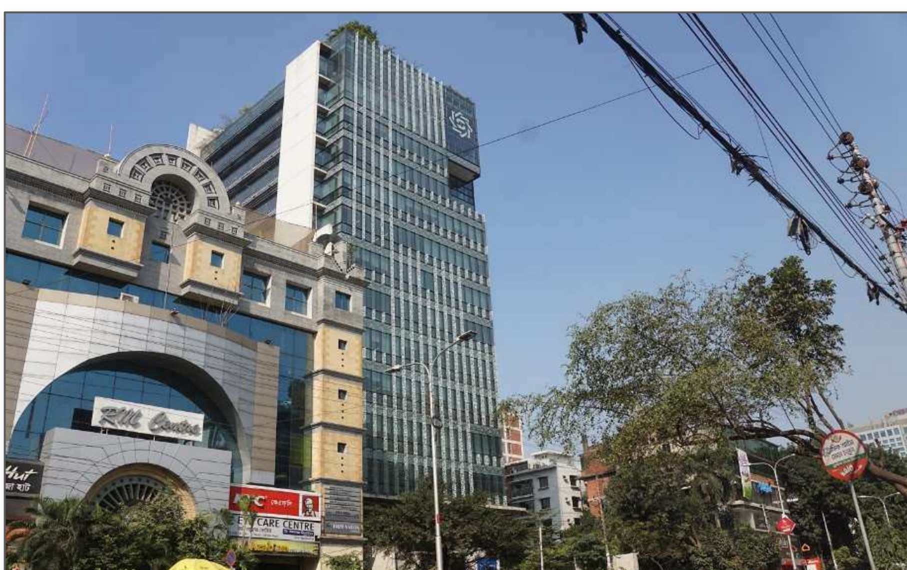
Similarly, the East West University Campus demonstrates how educational institutions can lead by example in adopting sustainable practices. With features like solar PV systems and rainwater harvesting, the campus not only reduces its environmental footprint but also serves as a learning environment for students about the importance of sustainability. These projects serve as excellent examples of how sustainable building practices can be integrated into various types of construction, from residential housing to commercial offices and educational institutions.

***Pic** 4.21**:** The East West University Campus (Ref 4.61)*



***Pic 4.22:** Cityscape Tower, a LEED Gold Certified Building in Dhaka City (Ref 4.62)*

***Pic 4.23**: Simple tree Anarkali a LEED Gold Certified Building in Dhaka City*



***Pic 4.24**: Shahjalal Islami Bank Corporate Headquarters at Foreground (with LEED Gold certification) on the right.*

Pic 4.25: *RM CENTER (A building without the interventions of Gren Technology)*
Photo Courtesy (25-28): Elhaam Parveen Hasan

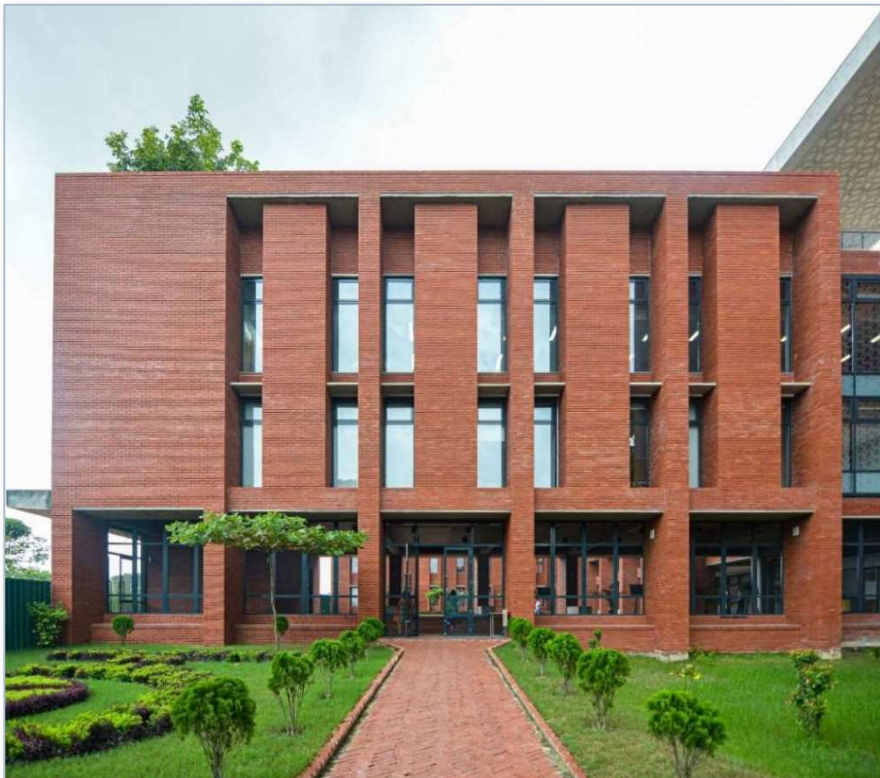
4.11) DESCRIPTION OF SOME LEED CERTIFIED BUILDINGS IN DHAKA

1) AGA KHAN ACADEMY DHAKA

The Aga Khan Academy in Dhaka is a remarkable addition to the educational landscape of the city. Drawing inspiration from the architectural heritage of the region's Buddhist universities for its masterplan layout and basic materials reflects a thoughtful approach to integrating the academy into its cultural context while also providing a modern educational facility.

The strategic location near major roads and adjacent to the American International University offers convenience and accessibility, which are important factors for a school's success. This integration into the urban fabric of Dhaka can also foster connections with the surrounding community and enhance the academy's role as a hub for learning and collaboration.

By incorporating elements of traditional design and materials, the academy not only pays homage to the rich cultural heritage of the region but also showcases the potential for blending tradition with modernity in contemporary architecture. It's exciting to see how such initiatives contribute not only to the educational sector but also to the architectural diversity and cultural identity of Dhaka. “The design aligns with the United Nations’ 2030 Sustainable Development Goals, and forms part of a planned network of eighteen Aga Khan Academies internationally. Strategically, the academies are implementing international educational standards, to develop future leaders; all pupils are selected solely on merit, and regardless of their background or ability to pay.” (*Ref 4.62)*



Pic 4.26: *Aga Khan Academy Dhaka Recognized for Commitment to Building Green (Above & Below) Ref 4.63*

Pic 4.27: *Application of Greenery in the Aga Khan Academy greens Ref 4.63*

Pic 4.28: *View of approach towards entrance*
Photo Courtesy: Elhaam Parveen Hasan

The Aga Khan Development Network's commitment to mitigating climate change and promoting environmental sustainability is truly commendable. By engaging with local communities on recycling projects, tree planting initiatives, marine conservation efforts, and implementing eco-friendly building practices, the AKDN is making a significant contribution to creating a more sustainable future.

The recognition of the Aga Khan Academy Dhaka with the Excellence in Design for Greater Efficiencies (EDGE) certification is a testament to the academy's dedication to sustainability. As the first project in Bangladesh to receive this certification, it sets a high standard for future developments in the country. This acknowledgment not only positions the academy as a leading sustainability benchmark in Bangladesh but also serves as inspiration for other projects to prioritize eco-friendly practices. The certification is more than just an accolade; it serves as a catalyst for change by encouraging other institutions and developers to follow suit in adopting environmentally responsible building strategies. By leading by example, the Aga Khan Academy Dhaka is paving the way for a greener, more sustainable built environment in Bangladesh and beyond.

"Our commitment to designing and building in response to the climate crisis has never been as important as it is today," said AKA Global Head of Design Moyez Alwani. "Our hope is that through excellence in environmental design, the projects of the Aga Khan Academies will offer future leaders of tomorrow clear signs that their future can and should be better connected to the realities of our environment and our collective responsibility to it." (*Ref 4.62)*.

2) VIYELLATEX LIMITED, TONGI, DHAKA

Pic 4.29 *Picture of the Buildings of VIYELLATEX group G89 (Ref: 4.64)*

Viyellatex group is a rapidly growing multi-dimensional organization in Bangladesh. Within a very short period of time.

3) PLUMMY FASHION LIMITED, NARAYANGANJ, DHAKA

Pic 4.30: *Exterior View of Plummy Fashion Limited (Ref 4.65)*

Plummy Fashions Ltd (PFL) is setting a commendable example in Bangladesh with its commitment to sustainable business practices through the establishment of the Green Knit Apparel manufacturing unit. By adhering to the principles of LEED and the U.S. Green Building Council (USGBC), PFL is demonstrating its dedication to environmental responsibility and accountability.

Located in Narayanganj, just south of Dhaka city center, the manufacturing unit occupies a spacious 5.5-acre site, thoughtfully landscaped with a combination of beautifully designed buildings and expansive gardens. This integration of green spaces not only enhances the aesthetic appeal of the facility but also contributes to biodiversity and creates a serene environment for workers.

One of the standout features of the project is its natural water management system, which sets a new standard for sustainability in the region. By recycling and reusing rainwater and surface water, PFL is reducing its water footprint and minimizing environmental impact. The inclusion of a natural lake within the factory premises not only supports a balanced ecosystem but also provides a space for relaxation and rejuvenation amidst the hustle and bustle of daily operations.

PFL's visionary approach to sustainable business serves as a model for other manufacturers in Bangladesh and beyond. By prioritizing the well-being of people, families, workers, and the planet, PFL is not only contributing to a greener future but also setting a definitive standard for responsible manufacturing practices.

4) NORTHERN TOSRIFA GROUP

Pic 4.31: External view of Northern Tosrifa *_(Ref 4.66)*
Corporate Office Address: Holding No 4/2 A, Gopalpur Munnu Nagar, Tongi, Gazipur Bangladesh

One of Bangladesh's largest textile industries is the Northern Tosrifa Group. They have been in the apparel industry for 32 years. Six units of production. Each year, 354 million clothes are made. They produce 35 tonnes of fabric each day. They received the BGMEA award for Best Environmentally Compliant Factory. *(Ref 4.67).*

The Northern Tosrifa Group's commitment to sustainability and excellence in the textile industry is highly commendable. With a diversified portfolio of companies specializing in knitting, dyeing, fabric finishing, and garment manufacturing, the group has established itself as a key player in Bangladesh's export-oriented apparel sector.

Being 100% export-oriented and catering to markets like Europe underscores the group's focus on meeting global standards of quality and reliability. Enlistment with prominent industry bodies such as BGMEA, BTMA, and EPB further reinforces the group's credibility and commitment to best practices in the industry.

Its emphasis on exceeding customer expectations by delivering high-quality products on time is a testament to its dedication to customer satisfaction. Moreover, its 26 years of experience in the industry speak volumes about its expertise and resilience in navigating the dynamic textile market.

The Northern Tosrifa Group's proactive approach to environmental sustainability, such as implementing the first green dyeing project in Bangladesh, demonstrates a forward-thinking mindset and a sense of responsibility towards the environment. 0By striving to become the preferred name among stakeholders and continuously exceeding customer expectations, the group sets a standard for excellence in the industry while also contributing positively to society and the environment.

5) SAIHAM TOWER

Pic 4.32: *Saiham Tower (Ref 4.68)*

Saiham Tower's achievement of the Pre-certified Platinum level of LEED rating under the Core & Shell Category of USGBC is a testament to its commitment to sustainability and environmental responsibility. Located in Gulshan, Dhaka, Bangladesh, this facility encompasses 105,134 square feet of space designed with optimization measures to reduce water usage, save energy, and utilize environmentally friendly materials and finishes.

The building's balanced combination of aesthetics and functionality makes it a genuine "green" building, conserving approximately 40% of the energy typically required for structures of similar size. This not only reduces power bills but also lowers water consumption. Additionally, the architectural design and materials used help minimize heat production, contributing to energy efficiency.

The inclusion of rainwater harvesting systems demonstrates Saiham Tower's commitment to water conservation. By collecting and purifying rainwater, the building can reuse water for various purposes, such as irrigation, reducing reliance on municipal water sources and minimizing environmental impact.

The design of Saiham Tower also prioritizes natural lighting, minimizing the need for artificial lighting throughout the day. This not only reduces energy consumption but also creates a more pleasant and productive indoor environment for occupants. Overall, Saiham Tower serves as a model of sustainable building design and operation, showcasing how thoughtful planning and implementation can result in significant environmental benefits while also providing a comfortable and efficient space for users.

6) THE NEW BRAC UNIVERSITY CAMPUS

Pic 4.33 BRAC University Campus, Badda, *Dhaka (Ref 4.68)*

Notable examples of green buildings in Dhaka include the BRAC University campus designed by WOHA, which employs a range of green strategies such as solar energy, vertical green walls, and adaptive cooling to create a comfortable and sustainable learning environment. WOHA's plans to transform the former flooded wasteland into a campus aims to reflect the intentions of BRAC University – a private university run by international development organization BRAC that aims "to instill in its students a commitment to working towards national development".

7) HOUSING PROJECT IN DHAKA, SINGAPORE'S RAFFLES INFRASTRUCTURE HOLDINGS LIMITED

Singapore's Raffles Infrastructure Holdings Limited has entered a joint venture in Bangladesh as part of a major real estate deal to build a $1 billion township, one of the largest housing projects in Dhaka. The Army Welfare Trust owns the 51.93-acre project land in Baunia designated for the development of an integrated residential town, "Trust Green City", adjacent to Mirpur DOHS and Uttara. More than 5,000 apartments will be built there, each covering 600-4,000 square feet area Pic 4.1

Picture 4.34 *Trust Green City, bd*
(Ref: 4.69)

Singapore's Raffles Infrastructure Holdings Limited has entered a joint venture in Bangladesh as part of a major real estate deal to build a $1 billion township, one of the largest housing projects in Dhaka. The Army Welfare Trust owns the 51.93-acre project land in Baunia designated for the development of an integrated residential town, "Trust Green City", adjacent to Mirpur DOHS and Uttara. More than 5,000 apartments will be built there, each covering 600-4,000 square feet area.

"In 2019, the Army Welfare Trust of the People's Republic of Bangladesh ("AWT") conducted procedures to select and appoint a developer for a new integrated residential township project, named Trust Green City (the "Project") in Baunia, Dhaka, Bangladesh. The Company, amongst several other participants, submitted proposals for this Project. In February 2020, the Company's proposal was selected and the Company was invited to formulate a memorandum of understanding with the AWT, which was executed on 7 May 2020, followed by the Final Agreement on 30 November 2020." (Ref: 4.69) "It will be a clean and smart city, just like what you see in Hong Kong and Singapore," said Brig Gen Mahmood Hasan who looks after the planning, development, and construction of the project. *Ref 4.48]*

There are hardly any green houses which has be identified as green houses at this moment.
However, in this year, the year 2024, Mansion 'de Salam, Dhaka, a Multi-Family Residential Building in Gulshan area has been awarded a silver certificate. "Energypac Power Generation Ltd, one of our dealer in Bangladesh, has just successfully installed and commissioned 2 P800P1 in the newly launched

apartment Mansion De Salam in Gulshan, Bangladesh, an affluent neighborhood and home to number of town facilities such as school, shopping centers and embassies." *[Ref 4.48 a]* However, some architects and enterpreneurs have began designing buildings consciously by incorporating green features in the recent days.

8) GARMENT FACTORIES

In the recent past a substantial number of garment factories are setting a commendable example in Bangladesh with its commitment to sustainable business practices. The followings are pictures of workers working at typical garments factories in Dhaka.

Picture 4.36: *Workers at typical garment factories in Bangladesh*
File photo, trainees work at Snowtex garment factory in Dhamrai, near Dhaka, Bangladesh.
Bangladesh's apparel industry enjoys rejuvenation (AP Photo/A.M. Ahad, File) (Ref: 4.70)

Picture 4.37 *(Ref 4.71) Bangladesh garment exports rebound from coronavirus crisis (1st sept, 2020)*

A Table showing the List of LEED Certified green garment factories as per accomplishment since 2022 till 2024, till the date of the research study is provided at the end of the chapter (Annex 1: Table 4.6).

4. 12) AN EXAMPLE OUTSIDE DHAKA

Karupannya Rangpur Ltd, located in Alamnagar, Rangpur, and designed by Ar Bayejid Mahbub Khondoker, represents a commendable example of sustainable industrial development. Specializing in the production of rural artifacts like Shataranji, a craftwork synonymous with the Rangpur area, Karupannya Ltd operates within an enormous green factory spanning around 3 lakh square feet.

The factory's commitment to sustainability is evident in its green design features. The green façade adorned with climbing plants not only enhances the aesthetic appeal of the building but also provides natural insulation, reduces heat absorption, and improves air quality. This integration of greenery contributes to environmental sustainability and creates a more pleasant working environment for employees.

Moreover, the factory's passively ventilated indoor spaces prioritize natural airflow, reducing the need for mechanical cooling systems and lowering energy consumption. This approach not only promotes energy efficiency but also reduces operating costs and carbon emissions.

Additionally, the factory implements an integrated closed-loop water cycle management system, highlighting its commitment to sustainable water usage. By recycling and reusing water within the facility, Karupannya Ltd minimizes water wastage and helps preserve local water resources.

Karupannya Rangpur Ltd's green building represents a significant milestone in sustainable industrial development. Designed to minimize environmental impact and promote resource efficiency, the green building incorporates a range of features aimed at reducing energy consumption, conserving water, and enhancing indoor environmental quality.

One notable aspect of Karupannya Rangpur Ltd's green building is its energy-efficient design. This may include features such as high-performance insulation, energy-efficient lighting systems, and passive solar design strategies to optimize natural light and heat. By minimizing energy use, the green building reduces its carbon footprint and operating costs while contributing to overall environmental sustainability.

Additionally, the green building likely incorporates water-saving measures to conserve this precious resource. These may include rainwater harvesting systems, water-efficient fixtures and appliances, and landscaping designs that minimize irrigation needs. By reducing water consumption and promoting water reuse, the green building helps alleviate pressure on local water supplies and supports sustainable water management practices.

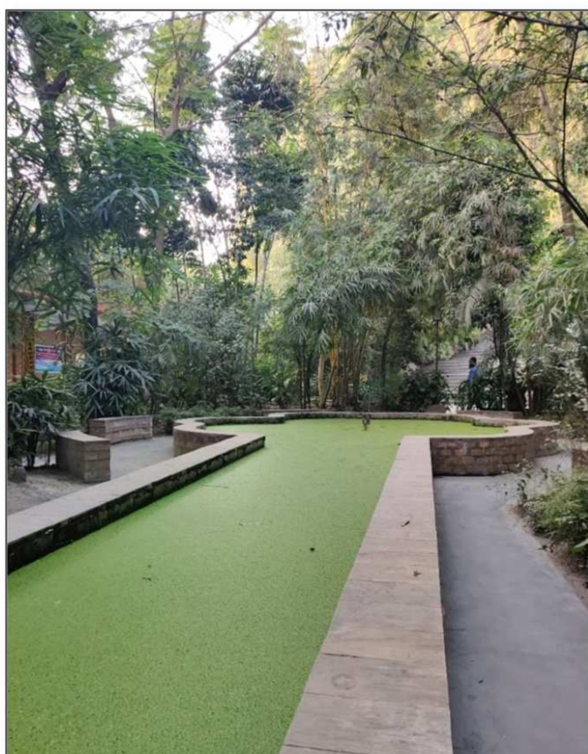
Furthermore, indoor environmental quality is prioritized in Karupannya Rangpur Ltd's green building to ensure a healthy and productive workplace for employees. This may involve using low-VOC (volatile organic compound) materials, providing ample natural ventilation, and implementing air filtration systems to improve indoor air quality. Creating a comfortable and healthy indoor environment not only enhances worker satisfaction and productivity but also contributes to overall well-being.

Overall, Karupannya Rangpur Ltd's green building serves as a shining example of sustainable industrial development, showcasing how businesses can thrive while minimizing their environmental footprint and promoting social responsibility. By prioritizing sustainability in its construction and operations, the green building sets a benchmark for others to follow in advancing towards a greener and more sustainable future.

Pic 4.38: *View of Karupannya Rangpur Ltd's green building (Ref 4.72)*

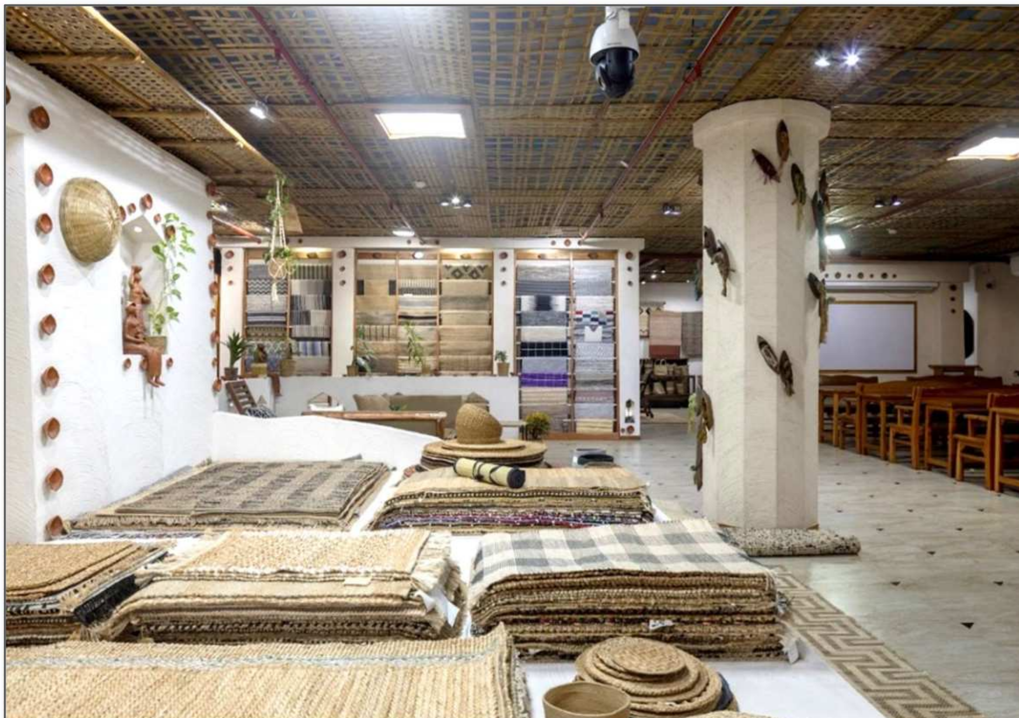
Pic 4.39: *The building is set amidst a natural setting*

Pic 4.40: *The Sculpture of a woman rejoicing women liberation*

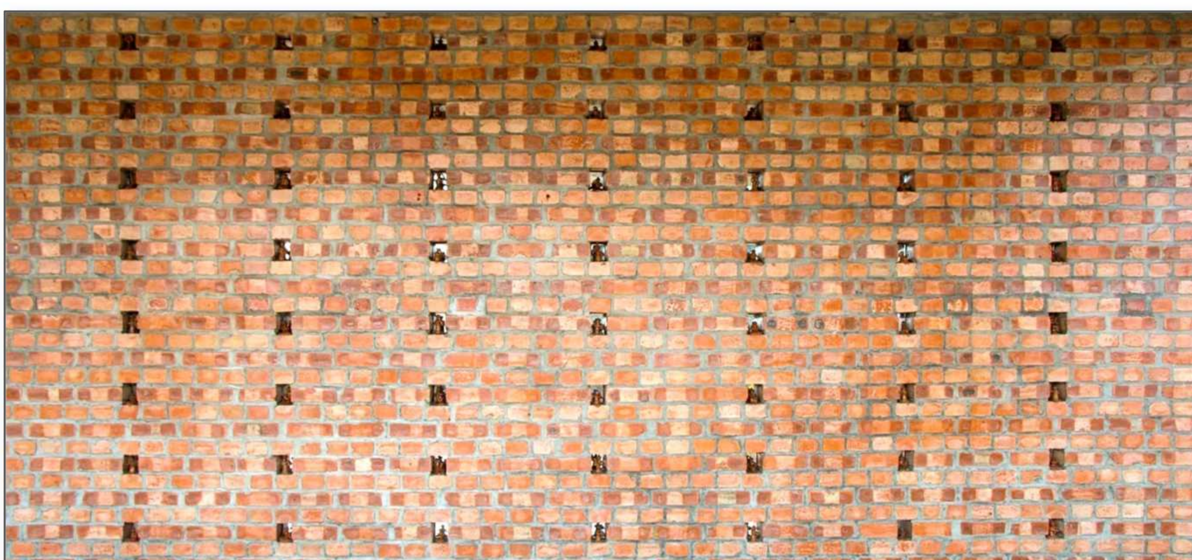


Pic 4.41: *A waterbody covered by in the compound*

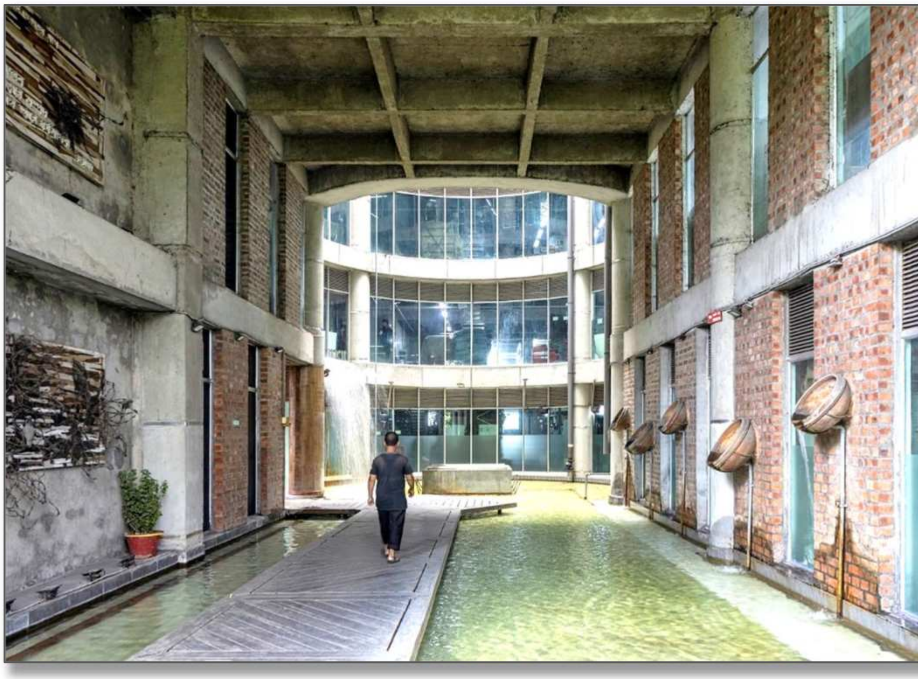
Photo Courtesy (36-39): Nazrana Khaled



Pic 4.42: *Karupannya-rangpur-factory-nakshabid-architects*



Pic 4.43: *Karupannya-rangpur-factory's wall made of clay brick woth perforation to allow wind*



Pic 4.44: *Designed layout of water inside the compound keeps the environment naturally cool (Ref 4.72)*

Pic 4.45: *Factory workers busy at work (Ref 4.72)*

The inclusion of four reservoirs totaling a radius of fifteen thousand square feet in the lobby at the ground floor of the factory is an impressive feature that enhances both safety and sustainability. With the capacity to preserve around five lakh liters of water simultaneously, these reservoirs serve multiple functional benefits, with fire hazard preparedness being one of the key advantages.

In the event of a fire hazard, having such a substantial volume of water readily available can significantly enhance the factory's firefighting capabilities. The reservoirs provide a reliable and immediate water source, allowing for quick response and effective suppression of fires, which is crucial for safeguarding both the premises and the occupants.

Furthermore, beyond firefighting purposes, these reservoirs also contribute to the factory's overall sustainability efforts. By collecting and storing rainwater or recycled water, the reservoirs help conserve precious freshwater resources. This aligns with the factory's closed-loop water cycle management system and reinforces its commitment to responsible water usage and environmental stewardship.

Overall, the presence of these reservoirs not only enhances safety measures within the factory but also underscores its dedication to sustainability and preparedness for various operational contingencies.

4. 13) CONCLUSION

The future of architecturally green and sustainable buildings in Dhaka apparently seems promising, driven by a growing commitment to environmental responsibility, technological advancements, and increasing awareness of the benefits of green architecture. However, there are many Challenges and Opportunities in this endeavor.

The key developments and trends include adoption of Green Building Standards. As a result, Dhaka is seeing an increase in buildings designed to meet international green standards such as LEED (Leadership in Energy and Environmental Design). Architects and developers in Dhaka are increasingly incorporating innovative sustainable design strategies. Other trends include Energy Efficiency, Water Efficiency and Waste Management, Biophilic Design, Economic and Social Benefits.

While the future looks bright, there are challenges to overcome, including the high initial costs of green technologies and the need for greater awareness and training among architects and builders and other stakeholders. However, the increasing involvement of multinational corporations and local developers in sustainable building projects is creating a positive momentum.

The push towards sustainable architecture in Dhaka is driven by both environmental necessity and economic incentives. As more buildings adopt green standards and innovative designs, Dhaka is poised to become a leader in sustainable urban development. This transformation not only benefits the environment but also enhances the quality of life for its residents, making it a crucial aspect of the city's future growth

APPENDIX 1

THE LIST OF LEED CERTIFIED GREEN GARMENT FACTORIES AS PER ACCOMPLISHMENT SINCE 2022 TILL 2024 (TILL DATE)

FROM 2022 TILL 2024 (TILL DATE)

	NAME OF COMPANY	DATE AND DETAIL	REGISTRATION/ CERTIFICATION
1	IT Hi Tech Park Bangladesh Dhaka (/activities/leed-1000197386) Keraniganj, Dhaka Division BD	2024-02-28 Bangladesh IT Park Authority Office / 135,576 sq ft	REGISTERED LEED v4 BD+C CS
2	IT Hi Tech Park Bangladesh Khulna (/activities/leed-1000197388) Khulna, Khulna Division BD	2024-02-28 Bangladesh IT Park Authority Office / 135,576 sq ft	REGISTERED LEED v4 BD+C CS
3	IT Hi Tech Park Bangladesh Gopalganj (/activities/leed-1000197417) Gopalganj, Dhaka Division BD	2024-02-28 Bangladesh IT Park Authority Office / 135,576 sq ft	REGISTERED LEED v4 BD+C CS
4	IT Hi Tech Park Bangladesh Barisal (/activities/leed-1000197430) Barisal, Barisal Division BD	2024-02-28 Bangladesh IT Park Authority Office / 135,576 sq ft	REGISTERED LEED v4 BD+C CS
5	IFL Factory Ltd. Salna (/activities/leed- 1000196168) Gazipur Sadar, BD	2024-02-26 IFL Factory Ltd. Industrial Manufacturing / 547,361 sq ft	REGISTERED LEED v4 BD+C CS
6	TM Jeans Limited (/activities/leed-1000196179) Gazipur, Dhaka Division BD	2024-02-26 TM Jeans Limited Industrial Manufacturing / 147,000 sq ft	REGISTERED LEED v4 BD+C NC
7	Fakir Eco Knitwears Ltd. RMG Building (/activities/leed-1000104872) Fatullah, Dhaka Division BD	2024-02-21 Industrial Manufacturing / 207,612 sq ft	PLATINUM CERTIFIED LEED v4 BD+C CS 85 pts
8	COMFIT, ECO VILLE (/activities/leed- 1000180232) Tangail District, Dhaka Division BD	2024-02-20 Industrial Manufacturing / 220,010 sq ft	PLATINUM CERTIFIED LEED v4 BD+C CS 85 pts
9	Jatra International DAC 01 (/activities/leed- 1000193968) Gazipur District, Dhaka Division BD	2024-02-15 The Osiris Group Datacenter / 202,447 sq ft	REGISTERED LEED v4 BD+C DC
10	HARNEST LABEL INDUSTRIES LTD (/activities/leed-1000193833)	2024-02-14 Harnest Label Industries	REGISTERED

	Estate, Dhaka Division BD	Industrial Manufacturing / 85,000 sq ft	LEED v4 BD+C NC
11	Columbia Garments Ltd. (/activities/leed- 1000192810) □ Gazipur, Dhaka Division B	2024-02-02 Columbia Garments Ltd. Industrial Manufacturing / 229,761 sq ft	REGISTERED LEED v4 BD+C NC
12	The STRAND by Navana (/activities/leed- 1000192644) □ Dhaka, Dhaka Division BD	2024-02-01 Navana Realestate Office / 75,600 sq ft	REGISTERED LEED v4 BD+C CS
13	Supti Sweaters Ltd (/activities/leed-1000192219) □ Seedstore, BD	2024-01-31 Supti Sweater Ltd. Industrial Manufacturing / 87,000 sq ft	REGISTERED LEED v4.1 ID+C: CI
14	Croydon Kowloon Designs Ltd (/activities/leed- 1000191974) BD	2024-01-29 Industrial Manufacturing / 460,000 sq ft	REGISTERED LEED v4 BD+C NC
15	Maheen Accessories Limited- Unit 02 (/activities/leed-1000192009) □ Bandar, Dhaka Division BD	2024-01-29 Industrial Manufacturing / 52,000 sq ft	REGISTERED LEED v4 BD+C NC
16	Ventura Milestone (/activities/leed-1000191777) □ Dhaka, Dhaka Division BD	2024-01-25 Ventura Properties Limited Office / 14,630 sq ft	REGISTERED LEED v4 BD+C CS
17	Shah Fatehullah Textile Mills Ltd. (/activities/leed-1000174864) □ Narayanganj, Dhaka Division BD	2024-01-24 Shah Fatehullah Textile Mills Ltd. Industrial Manufacturing / 281,000 sq ft	PLATINUM CERTIFIED LEED v4 BD+C NC 87 pts
18	Talisman Performanced Ltd (/activities/leed- 1000191474) □ Chittagong, Chittagong Division BD	2024-01-22 Industrial Manufacturing / 226,561 sq ft	REGISTERED LEED v4 BD+C NC
19	Evitex Dress Shirt Limited (/activities/arc-183756) □ Barishabo, Dhaka Division BD	2024-01-09 Evince Group Industrial Manufacturing / 84,685 sq ft	PLATINUM LEED v4.1 O+M: Existing Buildings Recertification 84 pts
20	GAVA Private Limited (/activities/leed- 1000190444) BD	2024-01-01 Guston Limited. Industrial Manufacturing / 222,949 sq ft	REGISTERED LEED v4 BD+C NC
21	Consist Apparels Limited (/activities/leed- 1000189842) □ Gazipur District, Dhaka Division BD	2023-12-21 Eurotex Group Industrial Manufacturing / 122,000 sq ft	REGISTERED LEED v4.1 O+M: EB
22	Karim Tex Ltd (/activities/leed-1000189425) Kalampur, Dhaka Division BD	2023-12-14 Karim Tex Ltd. Industrial Manufacturing / 320,226 sq ft	REGISTERED LEED v4 BD+C NC
23	PAXAR Green Site (/activities/leed-1000189292)	2023-12-12 Avery Dennison	

	Dhaka, Dhaka Division BD	Industrial Manufacturing / 245,000 sq ft	REGISTERED LEED v4 BD+C NC
24	Jeans 2000 Limited Recertification 2023 (/activities/leed-1000186299) Chattogram, Chittagong Division BD	2024-04-30 Pacific Jeans Group Industrial Manufacturing / 182,441 sq ft	GOLD CERTIFIED LEED v4 O+M EB 61 pts
25	KC Bottom & Shirt Wear Company (/activities/leed-1000168425) Dhaka, Dhaka Division BD	2024-04-18 Nipa Group Industrial Manufacturing / 178,488 sq ft	PLATINUM CERTIFIED LEED v4.1 O+M: EB 81 pts
26	J.M. Fabrics Limited (/activities/leed-1000203644) Gazipur District, Dhaka Division BD	2024-04-18 Industrial Manufacturing / 181,216 sq ft	REGISTERED LEED v4 BD+C NC
27	Fashion Makers Ltd (/activities/leed-1000175681) Mawna, Dhaka Division BD	2024-04-10 Md. Shahjahan Bhuiyan Industrial Manufacturing / 51,379 sq ft	PLATINUM CERTIFIED LEED v4.1 O+M: EB 87 pts
28	Topaz Dresses Limited (/activities/leed- 1000203237) Gazipur District, Dhaka Division BD	2024-04-02 Osman Group Industrial Manufacturing / 118,012 sq ft	REGISTERED LEED v4.1 O+M: EB
29	Aptech Caswier Ltd. (/activities/leed-1000203119) Gazipur District, Dhaka Division BD	2024-03-27 Aptech Caswier Ltd. Industrial Manufacturing / 229,000 sq ft	REGISTERED LEED v4.1 O+M: EB
30	Big Boss Corporation Limited (/activities/leed- 1000203121) Gazipur District, Dhaka Division BD	2024-03-27 Big Boss Corporation Limited Industrial Manufacturing / 249,050 sq ft	REGISTERED LEED v4.1 O+M: EB
31	FAISAL SPINNING MILLS LIMITED UNIT 1 (/activities/leed-1000203036) Habiganj District, Sylhet Division BD	2024-03-25 Industrial Manufacturing / 73,000 sq ft	REGISTERED LEED v4 BD+C NC
32	FAISAL SPINNING MILLS LIMITED UNIT 2 (/activities/leed-1000203037) Habiganj District, Sylhet Division BD	2024-03-25 Industrial Manufacturing / 146,000 sq ft	REGISTERED LEED v4 BD+C NC
33	FAISAL SPINNING MILLS LIMITED UNIT 3 (/activities/leed-1000203038) Habiganj District, Sylhet Division BD	2024-03-25 Industrial Manufacturing / 102,000 sq ft	REGISTERED LEED v4 BD+C NC
34	SAIHAM COTTON MILLS LIMITED UNIT 2 (/activities/leed-1000203040) Habiganj District, Sylhet Division BD	2024-03-25 Industrial Manufacturing / 144,000 sq ft	REGISTERED LEED v4 BD+C NC

35	ISPAHANI CENTRAL PARK (/activities/leed- 1000202720) □ Dhaka, Dhaka Division BD	2024-03-17 Retail / 225,500 sq ft	REGISTERED LEED v4 BD+C CS
36	COMFIT, BANANA LEAF (/activities/leed- 1000180233) □ Tangail District, Dhaka Division BD	2024-03-07 Industrial Manufacturing / 96,880 sq ft	GOLD CERTIFIED LEED v4 BD+C NC 73 pts
37	APS Knit Composite Limited-RMG Building (/activities/leed-1000170528) □ Gazipur, Dhaka Division BD	2024-03-07 APS Apparels Ltd. Industrial Manufacturing / 105,691 sq ft	GOLD CERTIFIED LEED v4.1 O+M: EB 71 pts
38	Windy Apparels Limited (/activities/leed- 1000151914) □ Tongi, Dhaka Division BD	2024-03-04 Industrial Manufacturing / 284,411 sq ft	GOLD CERTIFIED LEED v4 BD+C NC 69 pts
39	Pretty Composite Textiles Ltd (/activities/leed- 1000182943) □ Gazirchat, Dhaka Division BD	2024-03-03 Pretty Group Industrial Manufacturing / 610,715 sq ft	PLATINUM CERTIFIED LEED v4.1 O+M: E 81 pts
40	ANANTA JEANSWEAR LIMITED (/activities/leed- 1000199107) □ Dhaka, Dhaka Division BD	2024-02-29 Ananta Companies Industrial Manufacturing / 187,964 sq ft	REGISTERED LEED v4.1 O+M: EB
41	Building - 1 (/activities/leed-1000199130) □ Bhaluka, Mymensingh Division BD	2024-02-29 Industrial Manufacturing / 321,800 sq ft	REGISTERED LEED v4 BD+C NC
42	Building - 2 (/activities/leed-1000199132) □ Bhaluka, Mymensingh Division BD	2024-02-29 Industrial Manufacturing / 321,801 sq ft	REGISTERED LEED v4 BD+C NC
43	Building - 3 (/activities/leed-1000199134) □ Bhaluka, Mymensingh Division BD	2024-02-29 Industrial Manufacturing / 321,802 sq ft	REGISTERED LEED v4 BD+C NC
44	IT Hi Tech Park Bangladesh Rangpur (/activities/leed-1000197365) □ Rangpur, Rangpur Division BD	2024-02-28 Bangladesh IT Park Authority Office / 135,576 sq ft	REGISTERED LEED v4 BD+C CS
45	IT Hi Tech Park Bangladesh Natore (/activities/leed-1000197376) □ Natore, Rajshahi Division BD	2024-02-28 Bangladesh IT Park Authority Office / 135,576 sq ft	REGISTERED LEED v4 BD+C CS
46	IT Hi Tech Park Bangladesh Jamalpur (/activities/leed-1000197379) □ Jamalpur, Mymensingh Division BD	2024-02-28 Bangladesh IT Park Authority Office / 135,576 sq ft	REGISTERED LEED v4 BD+C CS

47	IT Hi Tech Park Bangladesh Mymensingh (/activities/leed-1000197383) Mymensingh, Mymensingh Division BD	2024-02-28 Bangladesh IT Park Authority Office / 135,576 sq ft	REGISTERED LEED v4 BD+C CS
48	S. M. Sourcing (/activities/leed-1000143530) Gazipur District, Dhaka Division BD	2023-12-12 S. M. Sourcing Industrial Manufacturing / 18,000 sq ft	PLATINUM CERTIFIED LEED v4 O+M EB 106 pts
49	Expo Accessories Limited (/activities/leed- 1000189076) Dhaka, Dhaka Division BD	2023-12-09 Expo Accessories Ltd Industrial Manufacturing / 45,000 sq ft	REGISTERED LEED v4 BD+C NC
50	Hamza Knit Dyeing Mills Limited (/activities/leed- 1000189078) Sherpur, Sylhet Division BD	2023-12-09 Palmal Group Industrial Manufacturing / 508,000 sq ft	REGISTERED LEED v4 BD+C NC
51	NAFA APPARELS LTD. - UNIT 1 (/activities/leed- 1000188876) Gazipur District, Dhaka Division BD	2023-12-07 Palmal Group Of Industries Industrial Manufacturing / 295,000 sq ft	REGISTERED LEED v4 BD+C NC
52	KM APPAREL KNIT PVT LTD. (/activities/leed- 1000188877) BD	2023-12-07 Palmal Group Of Industries Industrial Manufacturing / 300,000 sq ft	REGISTERED LEED v4 BD+C NC
53	CORTZ APPARELS LTD. - UNIT 1 (/activities/leed-1000188879) Gazipur District, Dhaka Division BD	2023-12-07 Palmal Group Of Industries Industrial Manufacturing / 150,000 sq ft	REGISTERED LEED v4 BD+C NC
54	AZMERI COMPOSITE KNIT LTD. (/activities/leed- 1000188925) Dhaka, Dhaka Division BD	2023-12-07 Palmal Group Of Industries Industrial Manufacturing / 46,000 sq ft	REGISTERED LEED v4 BD+C NC
55	ASWAD COMPOSITE MILLS LTD. - UNIT 2 (/activities/leed-1000188926) Savar, Dhaka Division BD	2023-12-07 Palmal Group Of Industries Industrial Manufacturing / 234,000 sq ft	REGISTERED LEED v4 BD+C NC
56	Nice Cotton Limited (/activities/leed-1000171620) Madhabpur, Dhaka Division BD	2023-12-07 LABIB GROUP Industrial Manufacturing / 59,778 sq ft	PLATINUM CERTIFIED LEED v4.1 O+M: EB
57	Cotton Club & Cotton Clout-Building 1 (/activities/leed-1000188862) Jarun, Dhaka Division BD	2023-12-06 Cotton Club (BD) & Cotton Clout (BD) Ltd Industrial Manufacturing / 221,174 sq ft	REGISTERED LEED v4.1 O+M: EB

58	Integra Dresses Limited (/activities/leed- 1000167383)	2023-11-22 Integra Dresses Limited	PLATINUM CERTIFIED LEED v4 BD+C NC
59	Snowtex Washing & Dyeing Ltd. (/activities/leed- 1000188033) BD	2023-11-22 Snowtex Washing & Dyeing Ltd. Industrial Manufacturing / 282,000 sq ft	REGISTERED LEED v4 BD+C NC
60	Ananta Huaxiang Limited (/activities/leed- 1000187842) BD	2023-11-21 Ananta Group Industrial Manufacturing / 250,000 sq ft	REGISTERED LEED v4 O+M EB
61	Knit Asia Limited. Yarn Store (/activities/leed- 1000187694) Shafipur, Dhaka Division BD	2023-11-16 Industrial Manufacturing / 174,202 sq ft	REGISTERED LEED v4 BD+C NC
62	Unitex Spinning Ltd ,Unit-2 (/activities/leed- 1000187646) Barabkunda, Chittagong Division BD	2023-11-15 UNITEX GROUP Industrial Manufacturing / 158,938 sq ft	REGISTERED LEED v4.1 O+M: EB
63	Dummy-Office Project-Chennai (/activities/leed- 1000187683) BD	2023-11-15 Conserve Consultants Private Limited Service / 7,000 sq ft	REGISTERED LEED v4.1 O+M: EB
64	Basic Shirts Limited (/activities/leed- 1000187582) Gazipur District, Dhaka Division BD	2023-11-14 Kaptex Group Industrial Manufacturing / 112,000 sq ft	REGISTERED LEED v4.1 O+M: EB
65	Palmal Tower (/activities/leed- 1000065439) Dhaka, Dhaka Division BD	2023-10-28 Palmal Garments Ltd. Office / 66,788 sqft	GOLD CERTIFIED LEED CS 2009
66	SAIHAM DENIMS LIMITED (/activities/leed- 1000186728) Habiganj District, Sylhet Division BD	2023-10-26 Industrial Manufacturing / 230,000 sq ft	REGISTERED LEED v4 BD+C NC
67	Sterling Styles Ltd. Unit-02 (/activities/leed- 1000186604) Ashulia, Dhaka Division BD	2023-10-24 STERLING STYLES LTD. Industrial Manufacturing / 368,642 sq ft	REGISTERED LEED v4 BD+C NC
68	Gazipur Tea Factory (/activities/leed- 1000186461) Gazipur, Dhaka Division BD	2023-10-20 Industrial Manufacturing / 71,617 sq ft	REGISTERED LEED v4 BD+C NC
69	Patriot Eco Apparel (/activities/leed- 1000186192) Dhaka, Dhaka Division BD	2023-10-10 Patriot Eco Apparel Industrial Manufacturing / 160,000 sq ft	REGISTERED LEED v4 BD+C NC
70	SM Accessories Ltd. (/activities/leed- 1000169011) Mawna, Dhaka Division BD	2023-10-05 SM Group Industrial Manufacturing / 124,861 sq ft	GOLD CERTIFIED

			LEED v4 BD+C NC
71	Comfit Rainbow Dyeing and Finishing (/activities/leed-1000185951) Tangail District, Dhaka Division BD	2023-10-04 Industrial Manufacturing / 40,000 sq ft	REGISTERED LEED v4 O+M EB
72	Comfit Green Centre (/activities/leed- 1000185952) Tangail District, Dhaka Division BD	2023-10-04 Industrial Manufacturing / 80,669 sq ft	REGISTERED LEED v4 O+M EB
73	Comfit Golden Leaf (/activities/leed-1000185953) Tangail District, Dhaka Division BD	2023-10-04 Industrial Manufacturing / 137,760 sq ft	REGISTERED LEED v4 O+M EB
74	Talisman Ltd. (/activities/leed-1000185296) Dhaka Division BD	2023-09-20 Talisman Ltd. Industrial Manufacturing / 250,000 sq ft	REGISTERED LEED v4 BD+C NC
75	Hopes & Dreams Pvt. Ltd (/activities/leed- 1000184501) Dhaka, Dhaka Division BD	2023-09-01 Hopes & Dreams Pvt. Ltd Industrial Manufacturing / 150,049 sq ft	REGISTERED LEED v4 BD+C NC
76	Unicorn Sweaters Ltd. (/activities/leed- 1000184310) Baipayl, Dhaka Division BD	2023-08-30 Unicorn Sweaters Ltd. Industrial Manufacturing / 86,000 sq ft	REGISTERED LEED v4.1 O+M: EB
77	Simpletree GSR (/activities/leed-1000184289) Dhaka, Dhaka Division BD	2023-08-29 Spacezero Ltd. Office / 248,360 sq ft	REGISTERED LEED v4 BD+C CS
78	Universal Menswear Ltd. (/activities/leed- 1000164949) Siddhirganj, Dhaka Division BD	2023-08-28 Ananta Group Industrial Manufacturing / 535,600 sq ft	GOLD CERTIFIED LEED v4 O+M EB 63 pts
79	AKIJ Wellness Ltd. (/activities/leed-1000184172) Gazipur District, Dhaka Division BD	2023-08-25 Industrial Manufacturing / 68,615 sq ft	REGISTERED LEED v4 BD+C NC
80	Sepal Garments Ltd (/activities/leed-1000183849) Gazipur, Dhaka Division BD	2023-08-17 Sepal Group Industrial Manufacturing / 256,730 sq ft	REGISTERED LEED v4.1 O+M: EB
81	Pacific Blue 'Jeans Wear' Ltd. (/activities/leed- 1000129815) Savar, Dhaka Division BD	2023-08-08 Al Muslim Group Industrial Manufacturing / 337,229 sq ft	GOLD CERTIFIED LEED v4 BD+C NC 60 pts
82	Lida Textile & Dyeing Limited (/activities/leed- 1000173987) Dhaka, Dhaka Division BD	2023-08-07 Industrial Manufacturing / 379,125 sq ft	PLATINUM CERTIFIED LEED v4 O+M EB 97 pts

83	Saadatia Sweaters Ltd. (/activities/leed- 1000182950) Ashulia, Dhaka Division BD	2023-08-07 Saadatia Sweaters Ltd Industrial Manufacturing / 161,333 sq ft	REGISTERED LEED v4.1 O+M: EB
84	J.M. Fabrics Limited (/activities/leed- 1000182043) Gazipur, Dhaka Division BD	2023-07-18 JM Fabric Ltd Industrial Manufacturing / 18,167 sq ft	REGISTERED LEED v4 BD+C NC
85	Pacific Knitex Limited (/activities/leed- 1000132738) Chittagong, Chittagong Division BD	2023-06-27 Pacific Jeans Group Industrial Manufacturing / 1,051,641 sq ft	PLATINUM CERTIFIED LEED v4 O+M EB 85 pts
86	Universal Jeans Limited Recertification (/activities/leed- 1000173079) Chittagong, Chittagong Division BD	2023-06-12 Universal Jeans Limited Industrial Manufacturing / 502,121 sq ft	GOLD CERTIFIED LEED v4 O+M EB 65 pts
87	Richcotton Apparels Limited (/activities/leed- 1000180445) Bagbari, Dhaka Division BD	2023-06-03 Richcotton Apparels Limited Industrial Manufacturing / 32,000 sq ft	REGISTERED LEED v4 BD+C NC
88	Unilever Bangladesh Ltd Corporate Office (/activities/leed-1000163679) Dhaka, Dhaka Division BD	2023-05-31 Unilever Bangladesh Ltd. Office / 41,636 sq ft	GOLD CERTIFIED LEED v4 ID+C CI 65 pts
89	Echotex Limited (/activities/leed- 1000180250) Tangail District, Dhaka Division BD	2023-05-29 Echotex Limited Industrial Manufacturing / 396,970 sq ft	REGISTERED LEED v4 BD+C NC
90	BIRDS A & Z LTD. (/activities/leed- 1000088094) Tangail District, Dhaka Division BD	2023-05-24 Industrial Manufacturing / 339,010 sq ft	GOLD CERTIFIED LEED NC 2009 68 pts
91	Fresh Knitwear Ltd (/activities/leed- 1000179869) Konabari, Dhaka Division BD	2023-05-18 Fresh Knitwear Ltd. Industrial Manufacturing / 105,002 sq ft	REGISTERED LEED v4 BD+C NC
92	Graphics Textiles Limited (/activities/leed- 1000179477) Dhaka, Dhaka Division BD	2023-05-08 Graphics Textiles Limited Industrial Manufacturing / 425,000 sq ft	REGISTERED LEED v4.1 O+M: EB
93	Knit Asia Limited (/activities/leed- 1000058651) Gazipur, Dhaka Division BD	2023-05-08 Industrial Manufacturing / 300,587 sq ft	PLATINUM CERTIFIED LEED NC 2009 99 pts
94	COMFIT GREEN LEAF (/activities/arc-98997) Dhaka, Dhaka Division BD	2023-05-01 Comfit Composite Knit Ltd Office / 174,993 sq ft	

			PLATINUM LEED v4.1 Recertification 80 pts
95	ZEST PACKAGING LTD. (/activities/leed- 1000176950) Kashimpur, Dhaka Division BD	2023-04-19 ZEST PACKAGING LTD. Industrial Manufacturing / 40,000 sq ft	REGISTERED LEED v4 BD+C NC
96	Epic Garments Manufacturing Co Ltd U-7 (/activities/leed-1000176554) Adamjee, Dhaka Division BD	2023-04-15 EPIC GROUP Industrial Manufacturing / 293,705 sq ft	REGISTERED LEED v4 BD+C NC
97	Epic Garments Manufacturing Co Ltd U-7 (/activities/leed-1000176543) Adamjee, Dhaka Division BD	2023-04-14 EPIC GROUP Industrial Manufacturing / 293,705 sq ft	REGISTERED LEED v4 BD+C NC
98	Trust Knitwear Industries Ltd. RMG Bldg. (/activities/leed-1000131226) Bara Rathura, Dhaka Division BD	2023-04-12 Industrial Manufacturing / 155,233 sq ft	GOLD CERTIFIED LEED NC 2009 61 pts
99	Trust Knitwear Dyeing & Washing Bldg. (/activities/leed-1000131227) Bara Rathura, Dhaka Division BD	2023-04-12 Industrial Manufacturing / 45,196 sq ft	GOLD CERTIFIED LEED NC 2009 64 pts
100	Universal Denim Ltd (/activities/leed- 1000175866) Dhaka, Dhaka Division BD	2023-04-11 Universal Group Industrial Manufacturing / 576,000 sq ft	REGISTERED LEED v4 BD+C NC
101	Universal Denims Limited (/activities/leed- 1000175954) Dhaka, Dhaka Division BD	2023-04-11 Universal Group Industrial Manufacturing / 576,000 sq ft	REGISTERED LEED v4 BD+C NC
102	WALTON MOLD AND DIE COMPLEX (/activities/leed-1000175690) Chandra, Dhaka Division BD	2023-04-10 Industrial Manufacturing / 394,035 sq ft	REGISTERED LEED v4 BD+C NC
103	Fin Bangla Apparels Ltd. (/activities/leed- 1000175704) Gazipur, Dhaka Division BD	2023-04-10 Pinaki Group Industrial Manufacturing / 124,305 sq ft	REGISTERED LEED v4 O+M EB
104	Continental Garments Production Bldg. (/activities/leed-1000175714) Dhaka, Dhaka Division BD	2023-04-10 Industrial Manufacturing / 131,782 sq ft	REGISTERED LEED v4 O+M EB
105	Continental Garments Admin Bldg. (/activities/leed-1000175715) Dhaka, Dhaka Division BD	2023-04-10 Industrial Manufacturing / 3,280 sq ft	REGISTERED LEED v4 O+M EB

106	TRZ Garments Industry Ltd (/activities/leed- 1000 Dhaka, Dhaka Division BD	2023-04-10 TRZ Group 1000175622) Shanta Holdings Ltd. Office / 1,501,845 sq ft	REGISTERED LEED v4.1 O+M: EB
107	G&F Printing Building (/activities/leed- 1000175467) Gazipur District, Dhaka Division BD	2023-04-06 Industrial Manufacturing / 84,703 sq ft	REGISTERED LEED v4 BD+C NC
108	G&F Narrow Fabrics (/activities/leed- 1000175468) Gazipur District, Dhaka Division BD	2023-04-06 Industrial Manufacturing / 89,384 sq ft	REGISTERED LEED v4 BD+C NC
109	G&F Yarn Dying (/activities/leed- 1000175469) Gazipur District, Dhaka Division BD	2023-04-06 Industrial Manufacturing / 100,712 sq ft	REGISTERED LEED v4 BD+C NC
110	G&F Warehouse A (/activities/leed- 1000175470) Gazipur District, Dhaka Division BD	2023-04-06 Industrial Manufacturing / 16,348 sq ft	REGISTERED LEED v4 BD+C NC
111	G&F Warehouse A (/activities/leed- 1000175470) Gazipur District, Dhaka Division BD	2023-04-06 Industrial Manufacturing / 16,348 sq ft	REGISTERED LEED v4 BD+C NC
112	G&F Warehouse B (/activities/leed- 1000175471) Gazipur District, Dhaka Division BD	2023-04-06 Industrial Manufacturing / 28,140 sq ft	REGISTERED LEED v4 BD+C NC
113	G&F Admin Building (/activities/leed- 1000175473) Gazipur, Dhaka Division BD	2023-04-06 Industrial Manufacturing / 12,000 sq ft	REGISTERED LEED v4 BD+C NC
114	AR-Tex Production Shed (/activities/leed- 1000175476) BD	2023-04-06 Industrial Manufacturing / 161,146 sq ft	REGISTERED LEED v4 BD+C NC
115	AR-Tex Ancillary Building (/activities/leed- 1000175477) Narayanganj, Dhaka Division BD	2023-04-06 Industrial Manufacturing / 43,457 sq ft	REGISTERED LEED v4 BD+C NC
116	AR-Tex Knitting Building (/activities/leed- 1000175478) Narayanganj, Dhaka Division BD	2023-04-06 Industrial Manufacturing / 243,390 sq ft	REGISTERED LEED v4 BD+C NC
117	AR-Tex Garments Building (/activities/leed- 1000175479) Narayanganj, Dhaka Division BD	2023-04-06 Industrial Manufacturing / 209,430 sq ft	REGISTERED LEED v4 BD+C NC
119	AR-Tex Dying Building (/activities/leed- 1000175480) Narayanganj, Dhaka Division BD	2023-04-06 Industrial Manufacturing / 507,822 sq ft	REGISTERED LEED v4 BD+C NC
120	AR-Tex Utility Building (/activities/leed- 1000175481)	2023-04-06	

	Narayanganj, Dhaka DivisionBD	Industrial Manufacturing / 36,818 sq ft	REGISTERED LEED v4 BD+C NC
121	Adzi Trims Ltd. (/activities/leed-1000175308) Dhaka, Dhaka Division BD	2023-04-04 Indet Group Industrial Manufacturing / 282,905 sq ft	REGISTERED LEED v4 BD+C NC
122	Quattro Fashion Ltd. (/activities/leed-1000161412) Gazipur, Dhaka Division BD	2023-04-04 Quattro Fashion Ltd. Industrial Manufacturing / 220,000 sq ft	PLATINUM CERTIFIED LEED v4.1 O+M: EB 86 pts
123	Univogue Garments Company Limited (/activities/leed-1000175040) Chittagong, Chittagong Division BD	2023-03-30 Univogue Garments Company Limited Industrial Manufacturing / 300,000 sq ft	REGISTERED LEED v4 BD+C NC
124	Renaissance Apparels Ltd (/activities/leed- 1000174774) Gazipur, Dhaka Division BD	2023-03-27 Industrial Manufacturing / 250,000 sq ft	REGISTERED LEED v4 BD+C NC
125	M.T. Sweaters Ltd (/activities/leed-1000174739) Gazipur District, Dhaka Division BD	2023-03-25 Shahana Group Industrial Manufacturing / 113,958 sq ft	REGISTERED LEED v4.1 O+M: EB
126	Banga Fashion Limited (/activities/leed- 1000174741) Gazipur District, Dhaka Division BD	2023-03-25 Shahana Group Industrial Manufacturing / 96,000 sq ft	REGISTERED LEED v4.1 O+M: EB
127	Parkview Dresses Limited (/activities/leed- 1000174565) Tongi, Dhaka Division BD	2023-03-22 Parkscene Group (BD) Industrial Manufacturing / 90,000 sq ft	REGISTERED LEED v4 O+M EB
128	TEAM DENIM STUDIO LTD. (/activities/leed- 1000174405) Dhaka District, Dhaka Division BD	2023-03-21 Team Group Industrial Manufacturing / 300,000 sq ft	REGISTERED LEED v4 BD+C NC
129	South End Sweater Co. Ltd. (/activities/leed- 1000174406) Dhaka, Dhaka Division BD	2023-03-21 Team Group Industrial Manufacturing / 200,000 sq ft	REGISTERED LEED v4 BD+C NC
130	BROTHERS FASHION LTD. (/activities/leed- 1000174407) Gazipur District, Dhaka Division BD	2023-03-21 Team Group Industrial Manufacturing / 150,000 sq ft	REGISTERED LEED v4 BD+C NC
131	Pahartali Textile & Hosiery Mills,Unit 2 (/activities/leed-1000174409) Chittagong, Chittagong Division BD	2023-03-21 M M Ispahani Limited Industrial Manufacturing / 200,000 sq ft	REGISTERED LEED v4 BD+C NC
132	Texeurop BD Ltd (/activities/leed-1000174410) Gazipur, Dhaka Division BD	2023-03-21 Texeurop (BD) Ltd. Industrial Manufacturing / 155,070 sq ft	REGISTERED

			LEED v4 BD+C NC
133	Pahartali Textile & Hosiery Mills,Unit 2 (/activities/leed-1000174416) Chittagong, Chittagong Division BD	2023-03-21 Industrial Manufacturing / 118,683 sq ft	REGISTERED LEED v4 BD+C NC
134	Tung Hing BD Manufactory Limited (/activities/leed-1000174367) Chandpur, Chittagong Division BD	2023-03-20 Tung Hing BD Manufactory Limited Industrial Manufacturing / 378,283 sq ft	REGISTERED LEED v4 BD+C NC
135	Soorty Textiles BD Ltd. (/activities/leed- 1000174157) Comilla, Chittagong Division BD	2023-03-16 Soorty Enterprises (Pvt) Ltd Industrial Manufacturing / 250,000 sq ft	REGISTERED LEED v4 BD+C NC
136	A. G. Dresses Ltd. (/activities/leed-1000173464) Dhaka, Dhaka Division BD	2023-03-07 Pinaki Group Industrial Manufacturing / 163,599 sq ft	REGISTERED LEED v4 O+M EB
137	NHT Fashions Ltd. Recertification (/activities/leed-1000164689) Chattogram, Chittagong Division BD	2023-03-01 Pacific Jeans Group Industrial Manufacturing / 367,219 sq ft	PLATINUM CERTIFIED LEED v4 O+M EB 84 pts
138	Adverto Footwear Ltd. (/activities/leed- 1000173040) Dhaka, Dhaka Division BD	2023-02-28 Industrial Manufacturing / 82,000 sq ft	REGISTERED LEED v4 BD+C NC
139	P.N Composite Limited (/activities/leed- 1000064582) BD	2023-02-26 P.N Composite Limited Industrial Manufacturing / 114,540 sq ft	PLATINUM CERTIFIED LEED NC 2009 82 pts
140	South East Private Textiles Ltd. (/activities/leed-1000172856)	2023-02-24	REGISTERED LEED v4 BD+C NC
141	Dhaka Garments & Washing Ltd. (/activities/leed-1000075310) Dhaka, Dhaka Division BD	2023-02-22 HAMS Washing and Dyeing Ltd Industrial Manufacturing / 294,415 sq ft	GOLD CERTIFIED LEED NC 2009 68 pts
142	Energypac Fashions extension Project (/activities/leed-1000168668) Gazipur District, Dhaka Division BD	2023-02-22 Energypac Fashions Ltd. Industrial Manufacturing / 181,017 sq ft	PLATINUM CERTIFIED LEED v4.1 O+M: EB 85 pts
143	Green Textile Limited Unit 4 (/activities/leed- 1000166158), BD	2023-02-21 EPIC GROUP Industrial Manufacturing / 54,000 sq ft	PLATINUM CERTIFIED LEED v4 BD+C NC 104 pts
144	Shanta Expression Ltd. (/activities/leed- 1000172535) Tongi, Dhaka Division BD	2023-02-20 MASCO Group Industrial Manufacturing /	REGISTERED

		149,384 sq ft	LEED v4 O+M EB
145	Tasniah Fabrics Ltd. RMG Building (/activities/leed-1000172538) Kashimpur, Dhaka Division BD	2023-02-20 Industrial Manufacturing / 199,148 sq ft	REGISTERED LEED v4 O+M EB
146	Tasniah Fabrics Ltd. Admin Building (/activities/leed-1000172539) Jarun, BD	2023-02-20 Industrial Manufacturing / 37,364 sq ft	REGISTERED LEED v4 O+M EB
147	Cotton Field BD Ltd. Admin Building (/activities/leed-1000172512) Tongi, Dhaka Division BD	2023-02-19 Industrial Manufacturing / 21,600 sq ft	REGISTERED LEED v4 BD+C NC
148	Cotton Field BD Ltd. Main Building (/activities/leed-1000172513) Tongi, Dhaka Division BD	2023-02-19 Industrial Manufacturing / 187,450 sq ft	REGISTERED LEED v4 BD+C NC
149	Masco Exports Ltd. Knit Dying (/activities/leed- 1000172517) Gazipur District, Dhaka Division BD	2023-02-19 Industrial Manufacturing / 62,000 sq ft	REGISTERED LEED v4 O+M EB
150	Masco Exports Ltd. Store & Guest House (/activities/leed-1000172518) Gazipur District, Dhaka Division BD	2023-02-19 Industrial Manufacturing / 160,000 sq ft	REGISTERED LEED v4 O+M EB
151	Masco Exports Ltd. Production (/activities/leed- 1000172519) Gazipur District, Dhaka Division BD	2023-02-19 Industrial Manufacturing / 17,800 sq ft	REGISTERED LEED v4 O+M EB
152	Masco Exports Ltd. Knit Dying 2 (/activities/leed- 1000172520) Gazipur District, Dhaka Division BD	2023-02-19 Industrial Manufacturing / 136,000 sq ft	REGISTERED LEED v4 BD+C NC
153	Concept Laundry House (/activities/leed- 1000172522) Tongi, Dhaka Division BD	2023-02-19 Industrial Manufacturing / 97,416 sq ft	REGISTERED LEED v4 BD+C NC
154	Concept Rongdhonu House (/activities/leed- 1000172523) Tongi, Dhaka Division BD	2023-02-19 Industrial Manufacturing / 218,919 sq ft	REGISTERED LEED v4 BD+C NC
155	Concept Stitches (/activities/leed-1000172524) Tongi, Dhaka Division BD	2023-02-19 Industrial Manufacturing / 467,935 sq ft	REGISTERED LEED v4 BD+C NC
156	Concept Store House (/activities/leed- 1000172525) Tongi, Dhaka Division BD	2023-02-19 Industrial Manufacturing / 97,559 sq ft	REGISTERED LEED v4 BD+C NC
157	Concept Smile House (/activities/leed	2023-02-19	REGISTERED LEED v4 BD+C NC
158	Concept Service House (/activities/leed- 1000172527) Tongi, Dhaka Division BD	2023-02-19 Industrial Manufacturing / 47,010 sq ft	REGISTERED LEED v4 BD+C NC

159	Concept Power House (/activities/leed- 1000172528) Tongi, Dhaka Division BD	2023-02-19 Industrial Manufacturing / 22,000 sq ft	REGISTERED LEED v4 BD+C NC
160	Masco Cottons Ltd. (/activities/leed-1000172529) Tongi, Dhaka Division BD	2023-02-19 MASCO Group Industrial Manufacturing / 222,800 sq ft	REGISTERED LEED v4 O+M EB
161	Masco Printing and Embroidery Ltd. (/activities/leed-1000172533) Tongi, Dhaka Division BD	2023-02-19 Industrial Manufacturing / 327,139 sq ft	REGISTERED LEED v4 O+M EB
162	Masco Picasso Ltd. (/activities/leed-1000172534) Tongi, Dhaka Division BD	2023-02-19 Industrial Manufacturing / 166,464 sq ft	REGISTERED LEED v4 O+M EB
163	Akij Jute Mills Ltd. Yarn Unit (/activities/leed- 1000172488) Muksudpur, Dhaka Division BD	2023-02-18 Industrial Manufacturing / 175,000 sq ft	REGISTERED LEED v4 BD+C NC
164	Crony Apparels Ltd. Building 1 (/activities/leed- 1000172157) Narayanganj District, Dhaka Division BD	2023-02-13 Industrial Manufacturing / 293,400 sq ft	REGISTERED LEED v4 BD+C NC
165	Crony Apparels Ltd. Building 2 (/activities/leed- 1000172158) Narayanganj District, Dhaka Division BD	2023-02-13 Industrial Manufacturing / 75,000 sq ft	REGISTERED LEED v4 BD+C NC
166	Crony Apparels Ltd. Utility & Office (/activities/leed-1000172159) Narayanganj District, Dhaka Division BD	2023-02-13 Industrial Manufacturing / 17,630 sq ft	REGISTERED LEED v4 BD+C NC
167	Aman Winter Wears Ltd (/activities/leed- 1000172167) Dhaka District, Dhaka Division BD	2023-02-13 Aman Winter Wears Ltd Industrial Manufacturing / 55,620 sq ft	REGISTERED LEED v4 O+M EB
168	Aman Sweaters Ltd (/activities/leed-1000172168) Savar, Dhaka Division BD	2023-02-13 Aman Sweaters Ltd Industrial Manufacturing / 34,000 sq ft	REGISTERED LEED v4 BD+C NC
169	Aman Fashions and Designs Ltd (/activities/leed- 1000172169) Dhaka, Dhaka Division BD	2023-02-13 Aman Fashions and Designs Ltd Industrial Manufacturing / 45,000 sq ft	REGISTERED LEED v4 O+M EB
170	Aman Knittings Ltd (/activities/leed-1000172170) Hemayetpur, Dhaka Division BD	2023-02-13 Aman Knittings Ltd Industrial Manufacturing / 64,000 sq ft	REGISTERED LEED v4 O+M EB
171	Aman Cement Mills Unit-2	2023-02-10	

	Limited (/activities/leed-1000171996) □ Narayanganj District, Dhaka Division BD	Industrial Manufacturing / 27,000 sq ft	REGISTERED LEED v4 BD+C NC
172	Aman Cement Mills Unit-2 Limited (/activities/leed-1000171996) □ Narayanganj District, Dhaka Division BD	2023-02-10 Industrial Manufacturing / 27,000 sq ft	REGISTERED LEED v4 BD+C NC
173	Fashion Pulse Limited (/activities/leed- 1000171868) □ Tongi, Dhaka Division BD	2023-02-09 Fashion Pulse Limited Industrial Manufacturing / 124,028 sq ft	REGISTERED LEED v4 BD+C NC
174	KDS IDR LTD. (/activities/leed-1000154915) □ Chittagong, Chittagong Division BD	2023-02-01 KDS Group of Industries Ltd. Industrial Manufacturing / 283,754 sq ft	PLATINUM CERTIFIED LEED v4.1 O+M: EB 84 pt
175	J.L. Fashions Ltd. (/activities/leed-1000165570) □ Gazipur District, Dhaka Division BD	2023-01-27 J.L Sweaters Ltd. Industrial Manufacturing / 334,365 sq ft	PLATINUM CERTIFIED LEED v4.1 O+M: EB 84 pts
176	JKL, Admin & Daycare Bldg. (/activities/leed- 1000136558) □ Mawna Union, Dhaka Division BD	2023-01-27 Industrial Manufacturing / 34,700 sq ft	PLATINUM CERTIFIED LEED NC 2009 80 pts
177	Green Factory for Ever Green Fashions (/activities/leed-1000171178) □ Gazipur, Dhaka Division BD	2023-01-26 Ever Green Fashions Ltd Industrial Manufacturing / 94,953 sq ft	GOLD CERTIFIED LEED v4.1 O+M: EB 62 pts
178	Amanat Shah Fabrics Ltd. (/activities/leed- 1000160621) □ Narsingdi District, Dhaka Division BD	2023-01-22 Amanat Shah Fabrics Ltd. Industrial Manufacturing / 124,866 sq ft	GOLD CERTIFIED LEED v4.1 O+M: EB 68 pts
179	SAL Bldg 1- Washing & Production (/activities/leed-1000170455) □ Chittagong Division BD	2023-01-09 Industrial Manufacturing / 143,978 sq ft	REGISTERED LEED v4 BD+C NC
180	SAL Bldg 2- Office, Cutting & Storage (/activities/leed-1000170456) □ Dhaka, Dhaka Division BD	Hamza Group Of Industries Ltd. Office / 75,000 sq ft	REGISTERED LEED v4.1 BD+C: NC
181	Swisstex Packaging Accessories Ltd. (/activities/leed-1000132809) □ Manikganj District, Dhaka Division BD	2022-12-21 Swiss Tex Group Industrial Manufacturing / 21,225 sq ft	GOLD CERTIFIED LEED NC 2009 65 pts
182	Esprit Apparels Ltd (/activities/leed-1000169796) □ Tongi, Dhaka Division BD	2022-12-20 Esprit Apparels Ltd Industrial Manufacturing / 305,000 sq ft	REGISTERED LEED v4 BD+C NC

183	NAFA Apparels Ltd. (/activities/leed- 1000169807) Chandra, Dhaka Division BD	2022-12-20 Industrial Manufacturing / 150,000 sq ft	REGISTERED LEED v4 BD+C NC
184	Jinnat Knitwears Ltd, RMG Building (/activities/leed- 1000136545) Mawna Union, Dhaka Division BD	2022-12-20 Industrial Manufacturing / 354,730 sq ft	PLATINUM CERTIFIED LEED NC 2009 84 pts
185	Jinnat Knitwears Ltd, Printing Building (/activities/leed- 1000136546) Mawna Union, Dhaka Division BD	2022-12-20 Industrial Manufacturing / 242,335 sq ft	PLATINUM CERTIFIED LEED NC 2009 81 pts
186	Dresden Textiles Ltd. (/activities/leed- 1000158683) Mymensingh, Mymensingh Division BD	2022-12-13 Dresden Knit Composite Ltd. Industrial Manufacturing / 138,732 sq ft	GOLD CERTIFIED LEED NC 2009 68 pts
187	Victoria Intimates Ltd. (/activities/leed- 1000119574) Dhaka, Dhaka Division BD	2022-12-12 Industrial Manufacturing / 164,541 sq ft	GOLD CERTIFIED LEED v4 BD+C NC 62 pts
188	NKM Fashion Limited (/activities/leed- 1000168615) Dhaka District, Dhaka Division BD	2022-11-21 NKM Fashion Limited Industrial Manufacturing / 74,550 sq ft	REGISTERED LEED v4 BD+C NC
189	HSBC GULSHAN BRANCH RELOCATION (/activities/leed-1000145268) Dhaka, Dhaka Division BD	2022-11-21 The Hongkong and Shanghai Banking Corp L Retail / 4,736 sq ft	PLATINUM CERTIFIED LEED v4 ID+C CI 82 pts
190	Bangladesh Export Import Co Ltd. (/activities/leed-1000144409) Dhaka, Dhaka Division BD	2022-11-17 Industrial Manufacturing / 660,000 sq ft	PLATINUM CERTIFIED LEED v4 BD+C NC 85 pts
191	KC Jacket Wear Company (/activities/leed- 1000168423) Dhaka, Dhaka Division BD	2022-11-16 Nipa Group Industrial Manufacturing / 178,280 sq ft	REGISTERED LEED v4.1 O+M: EB
192	Barnali Collections Limited (/activities/leed- 1000126190) Dhaka, Dhaka Division BD	2022-10-28 Barnali Group Industrial Manufacturing / 78,023 sq ft	GOLD CERTIFIED LEED v4 BD+C NC 64 pts
193	Purbani Fashion Limited (/activities/leed- 1000167507) Sirajganj District, Rajshahi Division BD	2022-10-28 Purbani Group Limited Industrial Manufacturing / 145,303 sq ft	REGISTERED LEED v4.1 O+M: EB
194	Snowtex Outerwear Ltd Building 10 (/activities/leed-1000167424) BD	2022-10-27 Industrial Manufacturing / 150,000 sq ft	REGISTERED LEED v4 BD+C NC
195	Maersk HQ Dhaka (/activities/leed- 1000167382)	2022-10-26	

	Dhaka, Dhaka Division BD	Maersk Bangladesh Ltd. Office / 30,708 sq ft	REGISTERED LEED v4 ID+C CI
196	Maxcrete Limited. (/activities/leed-1000166972) Manikganj District, Dhaka Division BD	2022-10-18 Maxcrete Limited Industrial Manufacturing / 100,000 sq ft	REGISTERED LEED v4 BD+C NC
197	Anwar Denim Limited (/activities/leed- 1000166880) Munshiganj District, Dhaka Division BD	2022-10-14 Anwar Denim Limited Industrial Manufacturing / 410,900 sq ft	REGISTERED LEED v4 BD+C NC
198	Sultana Sweaters Ltd. (/activities/leed- 1000115456) Dhamsur, Mymensingh Division BD	2022-10-12 Industrial Manufacturing / 80,183 sq ft	PLATINUM CERTIFIED LEED v4 BD+C NC 81 pts
199	Silken Sewing Ltd. - Building 1 (/activities/leed- 1000146160) Gazipur District, Dhaka Division BD	2022-10-11 Silken Sewing Ltd. Industrial Manufacturing / 116,170 sq ft	PLATINUM CERTIFIED LEED v4 O+M EB 92 pts
200	AMAN TEX LIMITED (/activities/leed- 1000156103) Mawna, Dhaka Division BD	2022-09-27 AMAN GROUP-AMAN TEX LIMITED Industrial Manufacturing / 281,656 sq ft	PLATINUM CERTIFIED LEED v4 O+M EB 89 pts

APPENDIX 2

A Sample of Green Building Certificate type called Edge Certificate for a Building in Dhaka (Aga Khan Academy Dhaka-collected)

CHAPTER 05

DESCRIPTION OF THE CASE STUDIES

Abbreviations

VRF: Variable Refrigerant Flow
ETPs: Effluent Treatment Plan
STPs: Sewage Treatment Plan
LED: Light Emitting Diode

CHAPTER 05

DESCRIPTION OF THE CASE STUDIES

INTRODUCTION: This chapter examines the current conditions of the selected case studies, focusing on their locations, physical and environmental contexts, and the infrastructure of the case study buildings. The analysis draws on multiple sources, including direct visual inspections, questionnaire surveys, and an extensive review of relevant literature. These combined approaches provide a robust foundation for understanding the features and challenges of the case studies, which are detailed in the sections below.

In this section, a survey was conducted involving thirty participants from various operational levels within the office-cum-commercial building. The objective was to assess users' awareness of green building design technologies and to gauge their interest in living and working in environments shaped by sustainable building practices.

5.1 CASE STUDY 01: GRAND DEL VISTA TOWER

***Pic. 5.1.1**: Picture showing Grand Del Vista Tower in Gulshan (Ref: Self-sourced, 2024)*

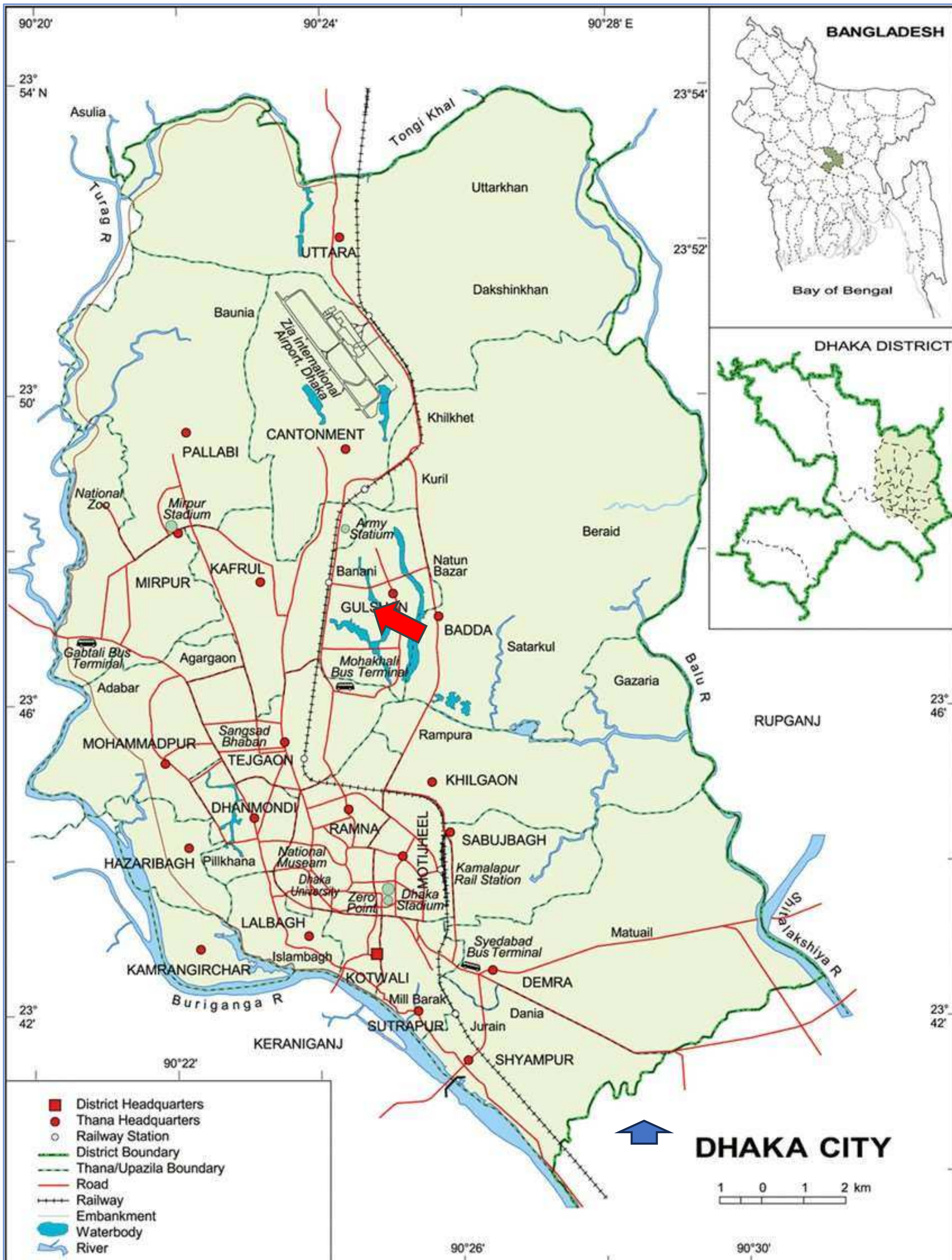


Diagram. 5.1.1*: Picture showing the location area of the Del Vista Tower, "Gulshan Residential Area" in the Map of Dhaka City (Ref: 5.1.1)*

BUILDING INFORMATION

NAME OF BUILDING: GRAND DEL VISTA TOWER

TYPE OF BUILDING: COMMERCIAL CUM OFFICE BUILDING

LOCATION OF SITE IN THE CONTEXT OF DHAKA CITY:
The location of the DEL VISTA TOWER is in the Gulshan Residential Area, one of the high-class areas in the Dhaka City which is located towards the northern part of Greater Dhaka. it is located in the segment east to the Gulshan Avenue towards the southern middle part of the avenue.

ADDRESS:
Grand Del Vista Tower
Plot 1A, ROAD 113, Gulshan Aenue,
Gulshan Model Town, Dhaka 1212, Bangladesh

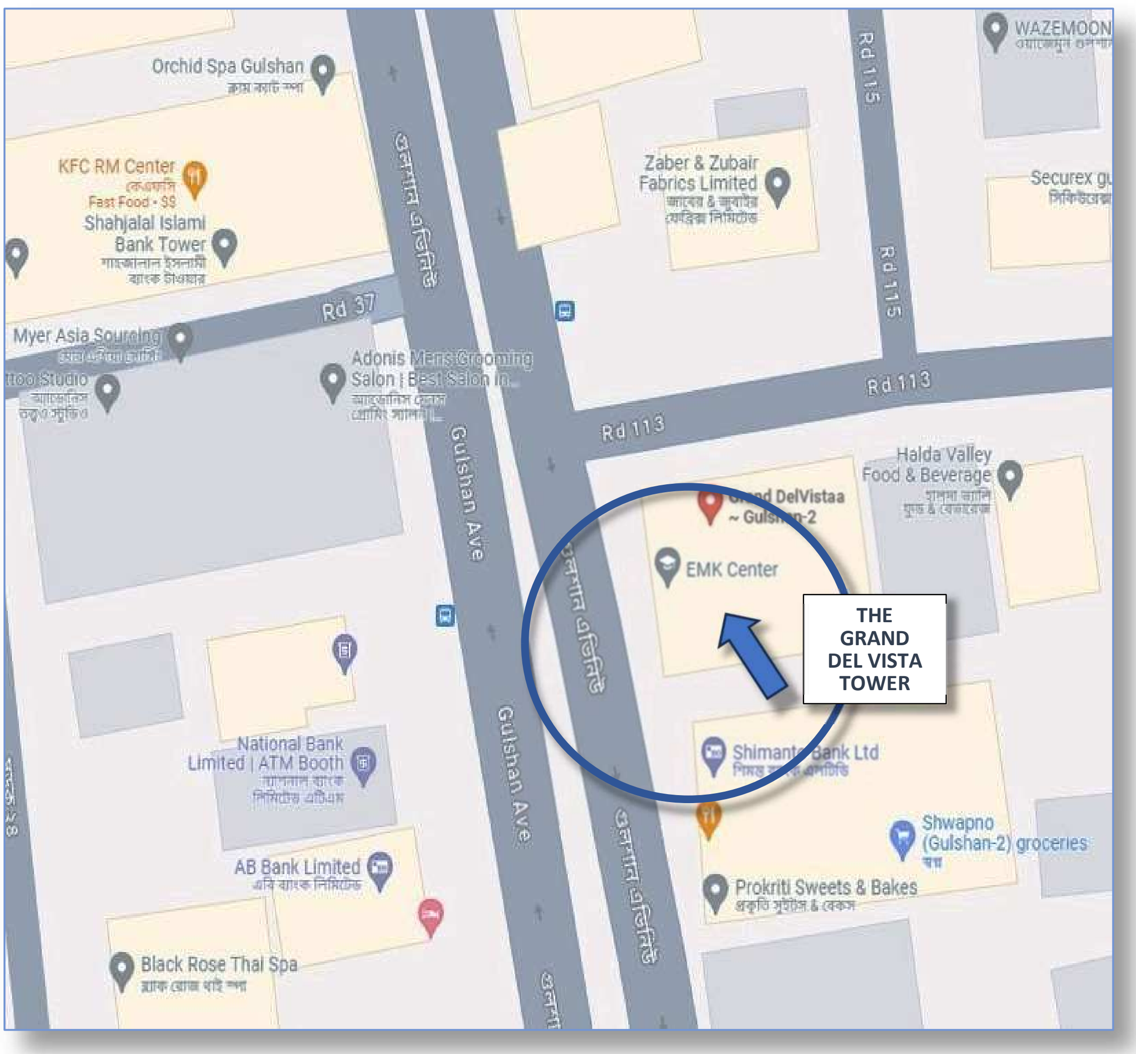


Diagram. 5.1.2: *Picture showing Graphical Map of the Grand Del Vista Tower on Gulshan Avenue (Ref. 5.1.2)*

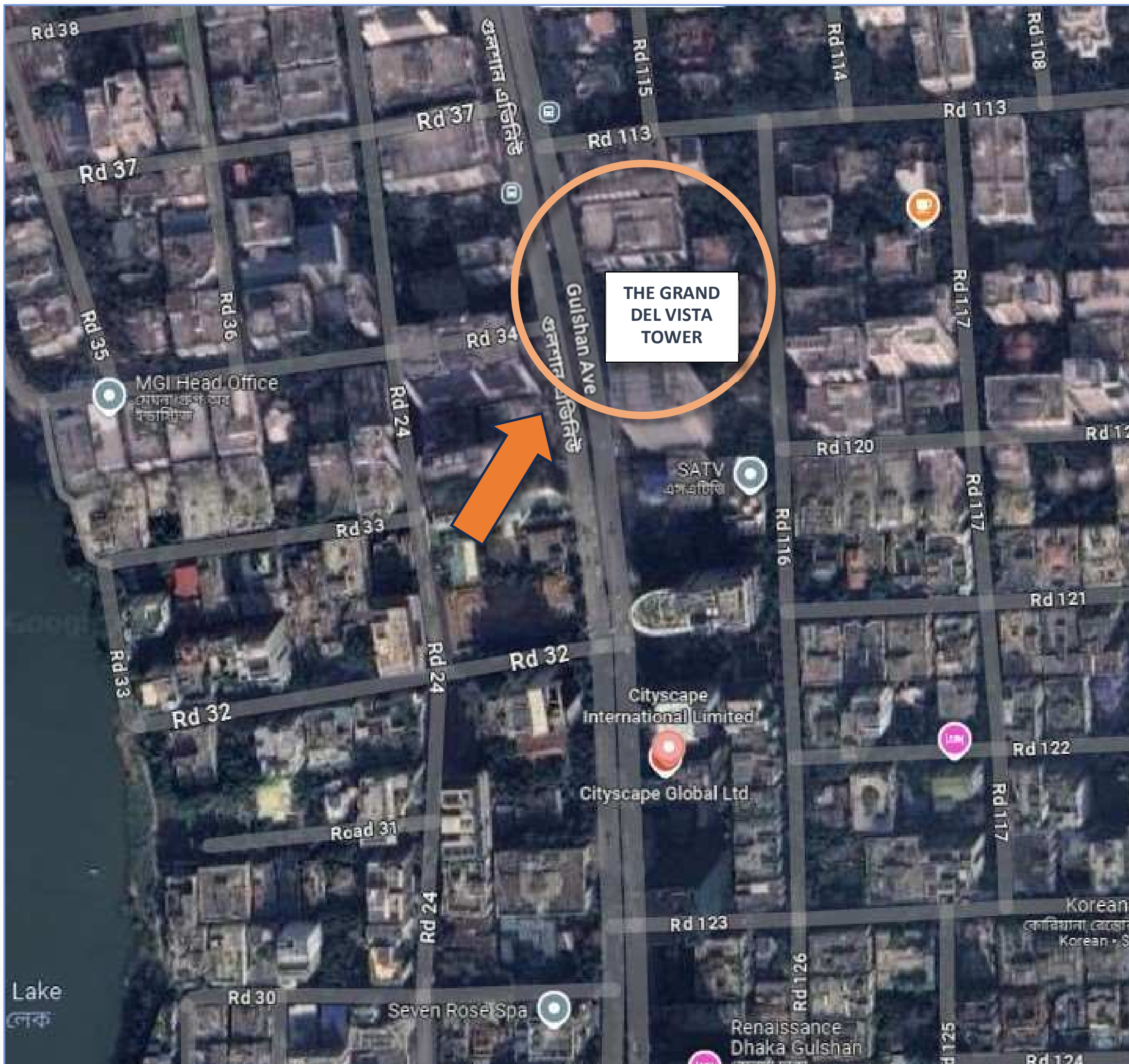


Diagram. 5.1.3: *Location Map of Grand Del Vista Tower on Gulshan Avenue (Aerial View) (Ref. 5.1.2)*

BACKGROUND:

Over the past decade, the growth of multistoried buildings along Gulshan Avenue has been remarkable. The government's approval for such developments has led to a surge in construction, while traffic movement has increased concurrently with the rise of new buildings.

The Grand Del Vista Tower in Gulshan, Dhaka, is one of the substantially prominent high-rise structures in this upscale neighborhood. Gulshan Residential Area serves as a hub for embassies, corporate offices, luxury apartments, and upscale retail spaces. The tower is expected to follow the trend of high-end real estate development in the area, catering to businesses, luxury residences, or possibly mixed-use purposes.
Located in one of Dhaka's premier urban development zones, the Grand Del Vista Tower likely emphasizes both luxury and convenience. Its proximity to major business centers, shopping districts, and entertainment venues makes it an attractive option for those seeking a modern lifestyle in the city.

The building is accessible from two major roundabouts—one to the north and the other to the south. The road connecting these roundabouts is known as Gulshan Avenue.

TYPE OF FACILITIES IN THE BUILDING:
Commercial outlets, Banks, Offices, Building Developers.

DISTRIBUTION OF FACILITIES IN THE BUILDING:

The building is a corner plot and its face is on the west side. This side is adjacent to the main road named Gulshan Avenue. There is a secondary road (Road No. 113) that is adjacent to the northside of the building as well. There are two commercial buildings adjacent to the building, one on the south side along the avenue called the Hosna Center and the other on the east side of the building.

A gift item shop called IHW is located at the ground floor of the building. Other than that, the Del Vista Tower houses a bank called Dutch Bangla Bank at the ground floor as well as the 1st and the 2nd floor. A Building Developers called the Bay Developments Ltd. is situated in the 3rd as well as in the 4th floor of the building.
A restaurant called Mamagocho & and an IT Company called Wipro Bangladesh is located at the fourth floor of the Del Vista Tower. A Wellness center called the Himalaya Wellness Bangladesh
And an imaging center called There are two restaurants on the top floor, one called the Spitfire and the other one, a Tea shop which is called Medionics Imaging is situated in the fifth floor of the building. The 6th and the 7th and the 8th floor consecutively accommodate the EMK (Edward M. Kennedy) Center, NDE Infrastructure Ltd. The top floor of the building features two dining establishments, a restaurant called Spitfire and a tea shop called Yumcha. The building has a two story high parking zone at the basement.

Table 5.1.1: Facilities Allocation as per Different Floors in the Building

Sl. No.	NAME OF FLOOR	ALLOCATION/ USE
i	Ground Floor	IHW (Giftshop) & Dutch Bangla Bank
ii	First Floor	Dutch Bangla Bank
iii	Second Floor	Dutch Bangla Bank
iv	Third Floor	Bay Developments Ltd. (Building Developers)
v	Fourth Floor	Mamagocho (restaurant) & Wipro Bangladesh IT Company)
vi	Fifth Floor	Medionics Imaging Ltd. & Himalaya Wellness Bangladesh
vii	Sixth Floor	EMK Centre
viii	Seventh Floor	NDE Infrastructure Ltd.

PHYSICAL ATTRIBUTES AND ENVIRONMENTAL CONDITIONS OF CASE STUDY BUILDING:
The building is an eight-story structure constructed with a steel column and beam framework. The walls are made of cement hollow bricks, while the front façade features a combination of red ceramic clay bricks and fair-faced concrete. A significant portion of the façade is also made of glass.
Situated on a corner plot, the building faces west (***Pic. 5.1.2***), with its front side adjacent to the main road, Gulshan Avenue. To the north of the building lies a secondary road. Two commercial buildings are located adjacent to the property—one on the south side (***Pic. 5.1.2***) and another on the east side.

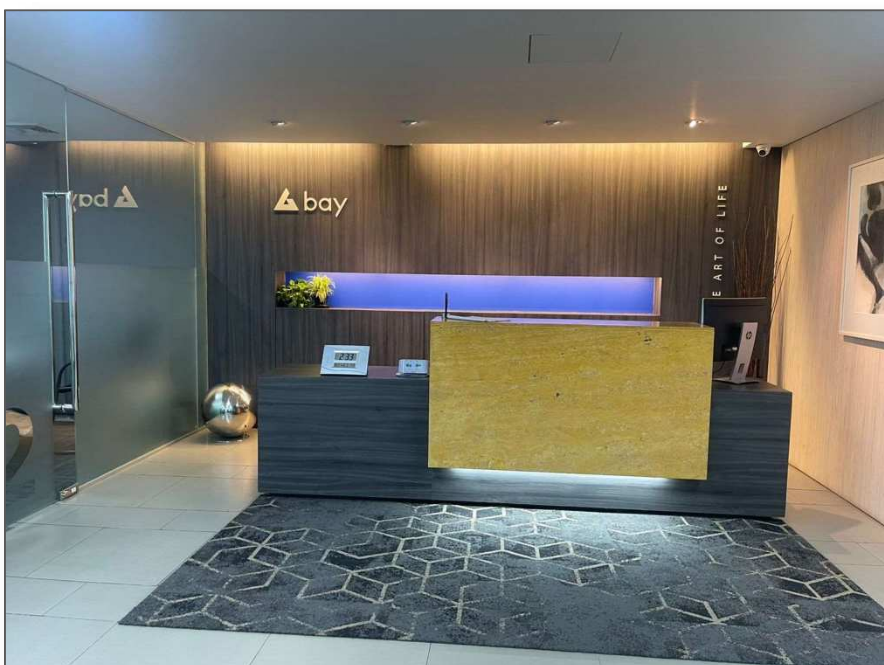
Pic. 5.1.2: *Picture showing the location of the building which is situated at a corner plot and its face is on the west side. The orange arrow shows the west direction and the yellow arrows shows the secondary road (Ref: Self-sourced, 2024)*

Pic. 5.1.3: *Picture showing the commercial buildings adjacent to the building one on the south (Ref: Self-sourced, 2024)*

Pic. 5.1.4*: A Board showing floor wise location of different facilities.*

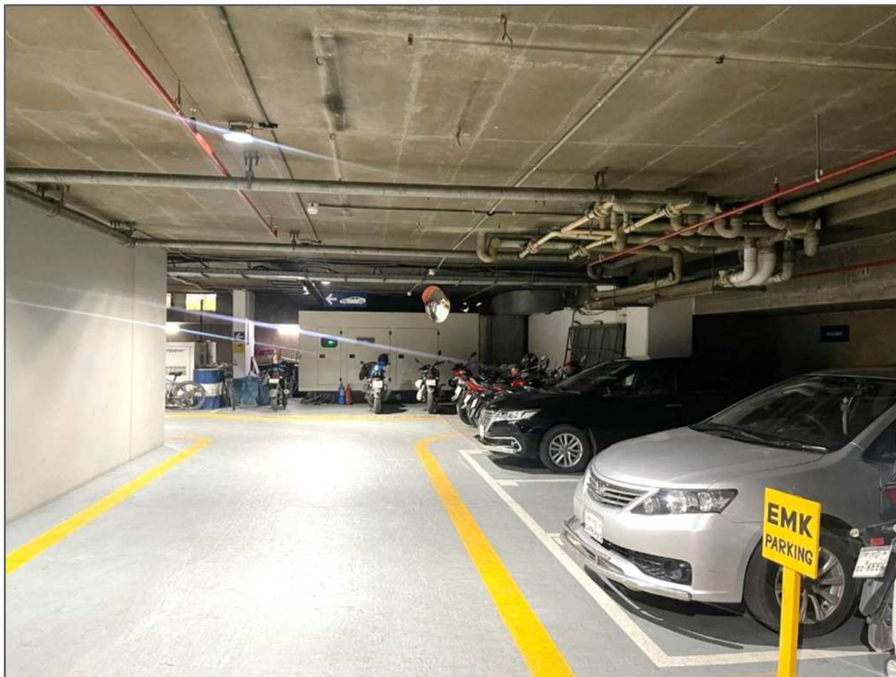
Pic. 5.1.5*: Picture showing the Footpath adjacent to the building on the North (Ref: Shakila & team, 2024)*

Pic. 5.1.6a*: The office interior inside the building on the North (Ref:. Shakila & team, 2024)*



Pic. 5.1.6b*: The office interior inside the building on the North (Ref: Shakila & team, 2024)*

The building's car parking areas are spread across two underground floors (*Pic. 5.1.7*).



Pic. 5.1.7*: The car parking lot at the basement of the building (Ref: Shakila & team, 2024)*

Pic. 5.1.8*: Parking lots used for motorcycle parking and electronic machineries (Ref: Self-sourced, 2024)*

ARCHITECTURAL GREEN TECHNOLOGY STATUS

The Grand Del Vista Tower in Gulshan, Dhaka, stands as a notable high-rise structure in one of the city's most prestigious areas. It is imperative in a building design that fire exits comply with local safety codes to facilitate secure evacuations during emergencies. If we take a look at the picture below, we can see an array of gas cylinders situated to serve the restaurants along this area which poses a great risk for the building.

Therefore, we can understand, from a safety technology perspective, concerns regarding narrow or hazardous fire exits should prompt the building management to implement corrective measures in accordance with advanced fire safety standards. It should potentially incorporate smart fire detection and evacuation systems.

Apart from that there are no sprinkler systems for firefighting in the building. Only some hose are available for firefighting but the hose length may not always be sufficient.

On the sustainability front, very insignificant means of energy saving is adopted. These days, in many countries which have heavy rainfall, rainwater harvesting is increasingly being integrated into urban developments to conserve water resources, alleviate pressure on municipal supplies, and reduce waterlogging risks during heavy rainfall. Unfortunately, the Del Vista Tower lacks a rainwater harvesting system, as well as integrated energy and water conservation technologies. The external glazing used on the building is not equipped with UV-filtering properties, which may negatively impact energy efficiency and occupant productivity. Furthermore, there are no systems in place for water reclamation or reuse, which could otherwise contribute to the building's sustainability profile.

There is not air exchange or fresh air supply system for the interior of the building while the air conditioners are in use. The same air is reused for the interior which is not such a healthy option for the users of the building. Although there are some green elements incorporated into the design, for example a medium portion of the roof has green plantations, they lack systematic organization. Heat is not reduced to any significant amount.

Therefore, while Del Vista Tower in Gulshan, Dhaka, features some sustainable design elements, it may still require significant enhancements to qualify as a green building under recognized standards like LEED or other certification systems. Current practices emphasize energy efficiency, water conservation, waste reduction, and integration of renewable energy. For buildings like Del Vista Tower to achieve formal green certification, improvements could include:

1. **Enhanced Energy Efficiency**: Adoption of renewable energy sources such as solar panels or wind turbines and optimizing building energy systems to reduce consumption.

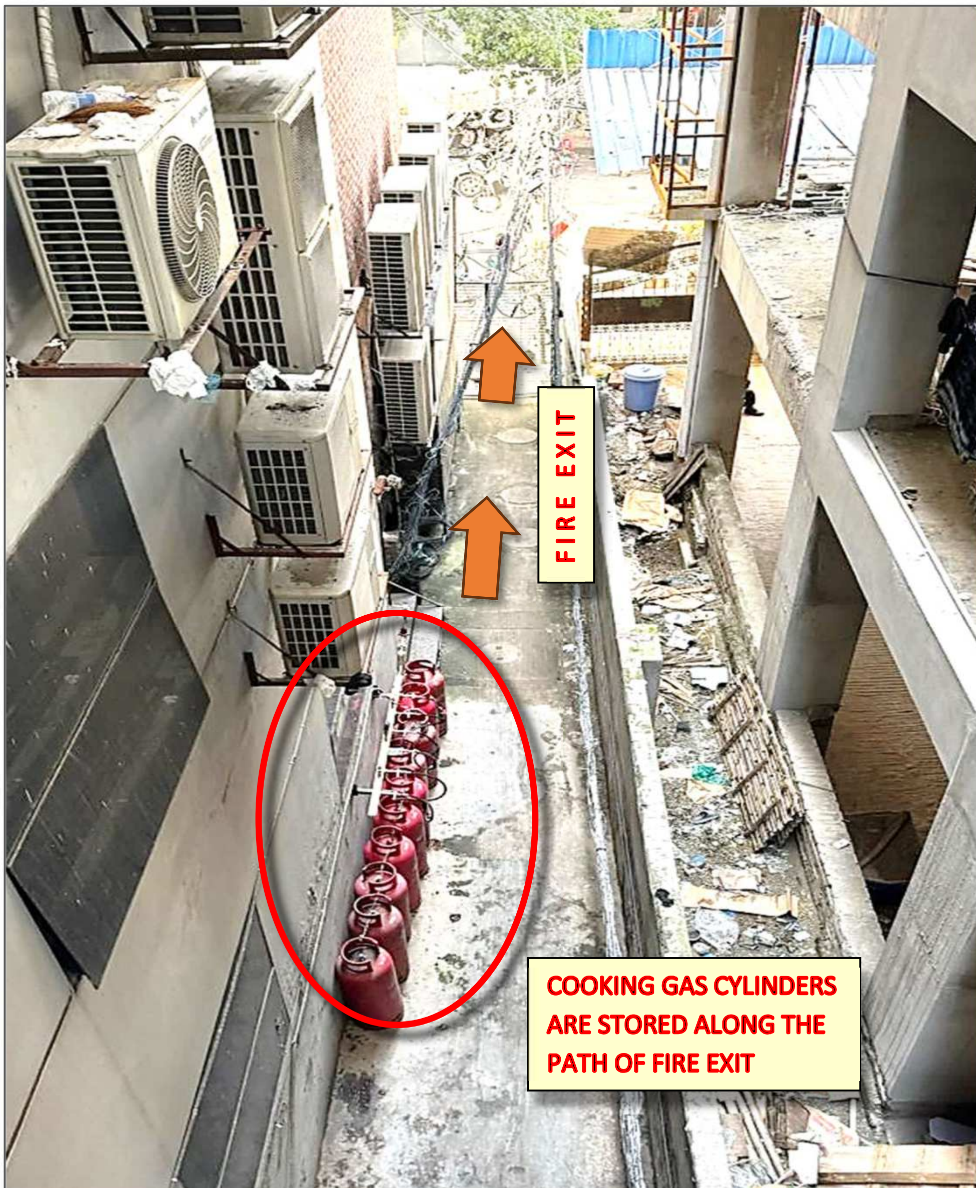
2. **Water Management Systems**: Installation of rainwater harvesting systems and greywater recycling for sustainable water use.

3. **Sustainable Materials**: Increased use of eco-friendly and recycled materials in construction and finishes.

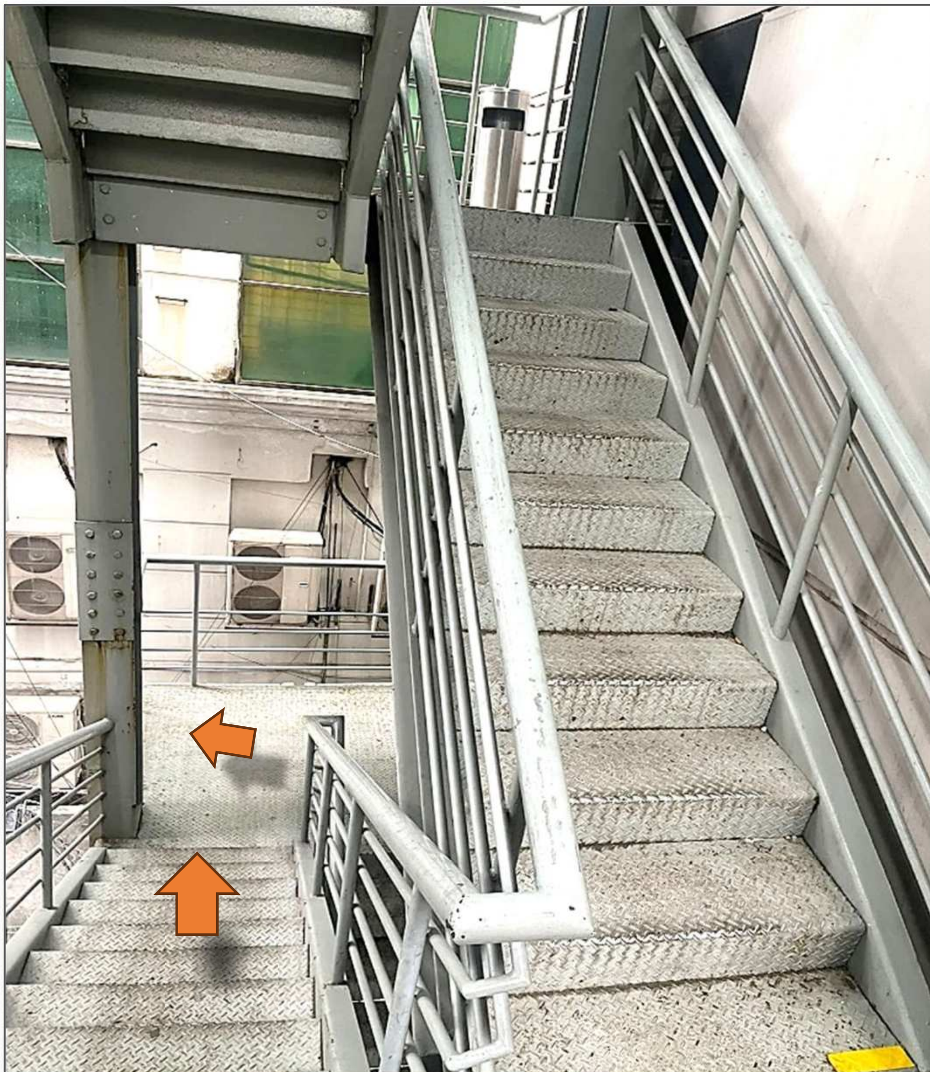
4. **Indoor Environmental Quality**: Incorporating better natural ventilation, air filtration systems, and access to natural light for occupant health and comfort.

5. **Green Landscaping**: Vertical gardens, green roofs, and biodiverse landscaping could further support urban ecological balance.

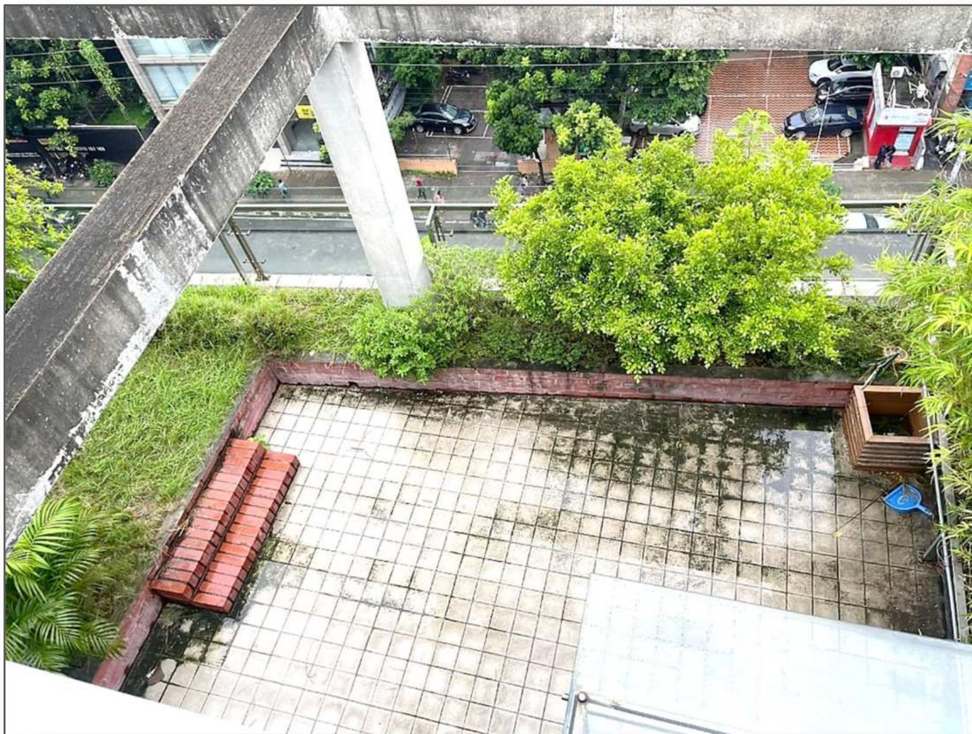
These modifications would align the tower more closely with the requirements of international green building certifications and help it contribute more effectively to sustainable urban development



***Pic. 5.1.9**: Fire safety is at stake in this scenario*
The orange arrow shows the escape way direction from the fire stair (Ref: Self-sourced, 2024)



***Pic. 5.1.10**: Although there is a fire stair, fire safety is at stake in this scenario (Ref: Self-sourced, 2024)*



Pic. 5.1.11*: Part green bed on roof (Ref: Self-sourced, 2024)*

Pic. 5.1.12*: Machineries on roof (Ref: Self-sourced, 2024)*

TABLE 5.1.2: LIST OF RESPONDENTS FROM DEL VISTA TOWER

	NAME	DESIGNATION	AGE
1.	MD. RIPON ISLAM	SECURITY MEMBER	26
2.	FOKRUL KOBIR	SECURITY MEMBER	42
3.	MD. KAMAL HOSSEN	DRIVER	40
4.	MD. FOYSAL AHMED	DRIVER	36
5.	ABDUR RAZZAK	DRIVER	53
6.	KAZI IMRAN HOSSAIN	DRIVER	44
7.	MD. ABDULLAH AL MAMUN	DEPUTY MANAGER, PROJECT MANAGEMENT CELL (PMC)	33
8.	AHMADUR RAHMAN	BRAND MANAGER	32
9.	MURAD HOSSAIN	ENGINEER	33
10.	HIA QURAISHY	CIVIL ENGINEER	27
11.	ASHURA TANJINA AHMED	SERVICE HOLDER	30
12.	SANJIDA CHOWDHURY	ACCOUNTS AND FINANCE	42
13.	SULTAN GIASUDDIN	LAND ADMINISTRATOR	66
14.	DELOAR HOSSAIN	LEGAL AND ADMINISTRATOR	32
15.	FAISAL ISLAM SHOSHI	PRIVATE JOB	35
16.	RAHAT ISLAM	EXECUTIVE, SUPPLY CHAIN MANAGEMENT (SCM)	28
17.	MD. MAINUL ISLAM	DEPUTY MANAGER	44
18.	FARHADUL ISLAM	ASSTT. MANAGER	31
19.	MD. AMDADUL HOQ	DEPUTY MANAGER	38
20.	KHANDAKAR SHAHADAT	ASSTT. MANAGER, ACCOUNTS	46
21.	A S M JAMILUZZAMAN	ASSTT. MANAGER	34
22.	ANM TOUHIDUZZAMAN	HOD, SCM, BAY	36
23.	MD. RABBE HASAN	EXECUTIVE, MANAGEMENT INFORMATION SYSTEM (MIS)	31
24.	SHAFAYET HOSSAIN	EXECUTIVE, ACCOUNTS & FINANCE	30
25.	MD ZABEL AL IMRAN	HEALTH AND SAFETY OFFICER	31
26.	ROKEYA AHMED	OFFICE ASSISTANT	24
27.	SABINA YASMIN	SECRETARY	29
28.	RAKIBUL ISLAM	CAD OPERATOR	26
29.	MOBARAK HOSSAIN	ACCOUNTANT	38
30.	SHELINA SHUBORNA	OFFICE ASSISTANT	27

5.2 CASE STUDY 02: THE CITYSCAPE TOWER

DESCRIPTION OF THE CASE STUDY

***Pic. 5.2.1**: Picture showing the Cityscape Tower at Gulshan, Dhaka (Ref 5.2.1)*

BUILDING INFORMATION

NAME OF BUILDING - THE CITYSCAPE TOWER

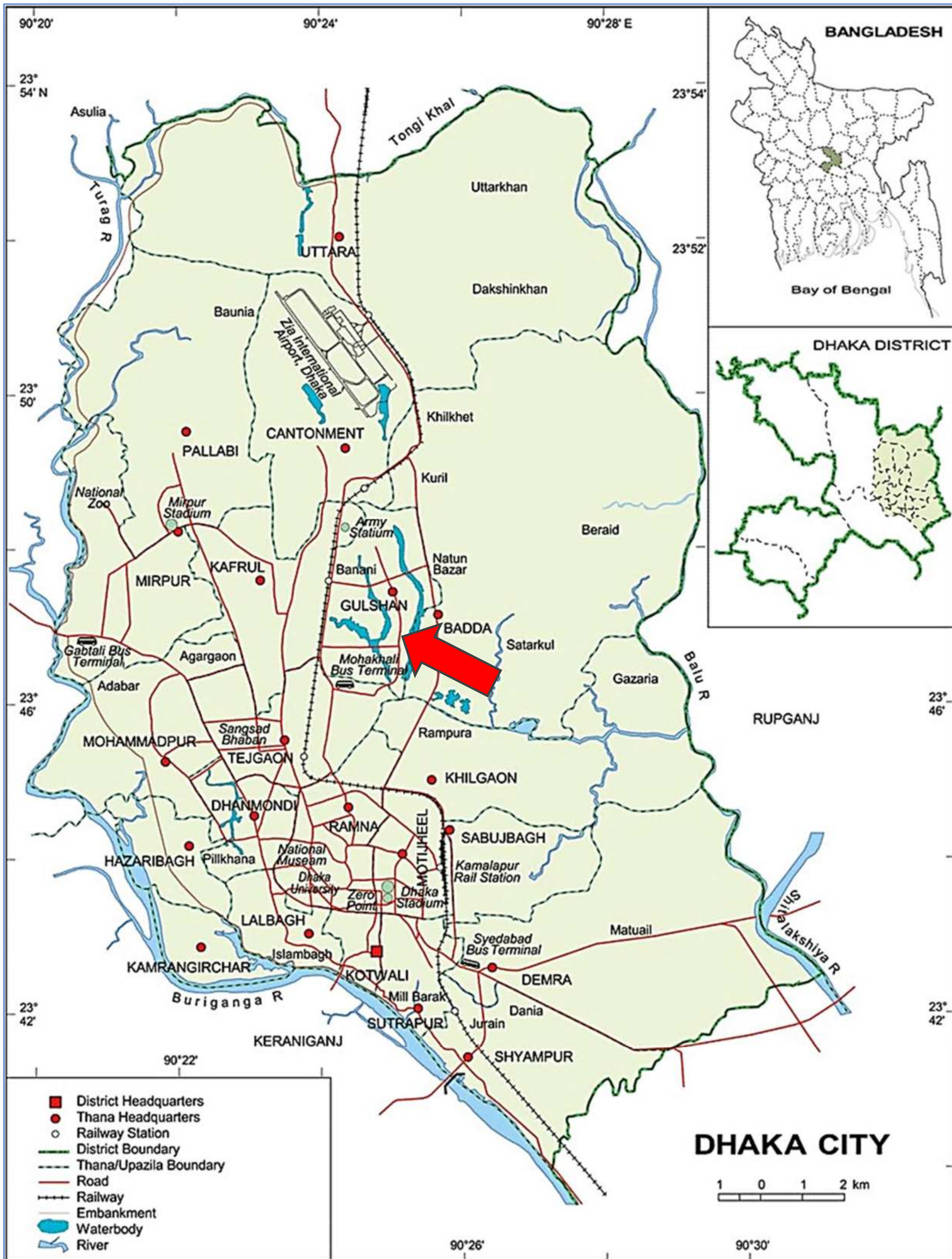
TYPE OF BUILDING - COMMERCIAL CUM OFFICE BUILDING

LOCATION OF SITE IN THE CONTEXT OF DHAKA CITY-
The location of the CITYSCAPE TOWER is in the Gulshan Residential Area, one of the high-class areas in the Dhaka City which is located towards the northern part of Greater Dhaka. it is located in the segment east to the Gulshan Avenue towards the southern middle part of the avenue.

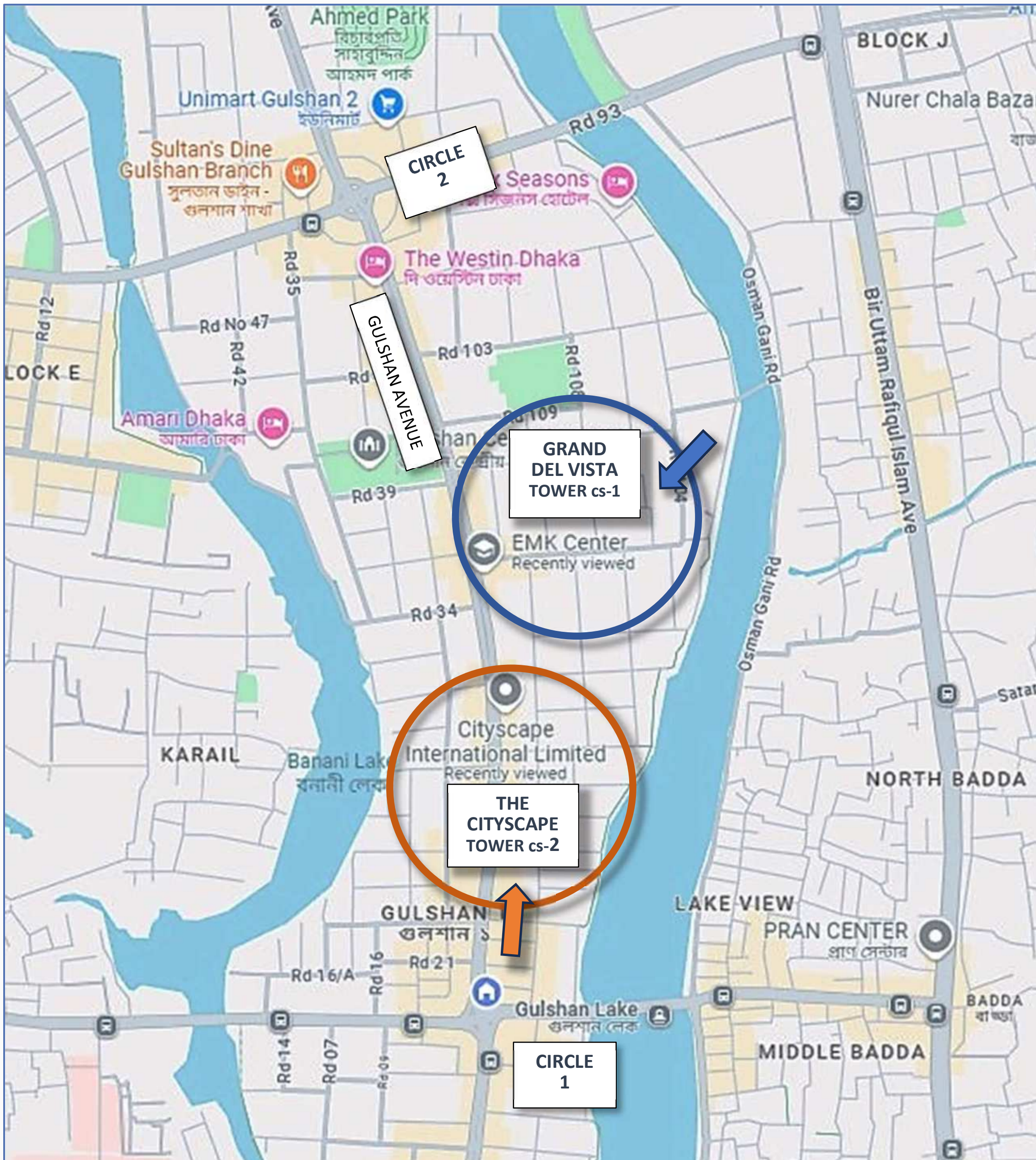
ADDRESS -

THE CITYSCAPE TOWER
53, Gulshan Avenue, Gulshan Model Town,
Dhaka-1212, Bangladesh.

TYPE OF FACILITIES IN THE BUILDING -
Commercial outlets, Banks, Offices.
SPACE: 19,000 sq-ft per floor



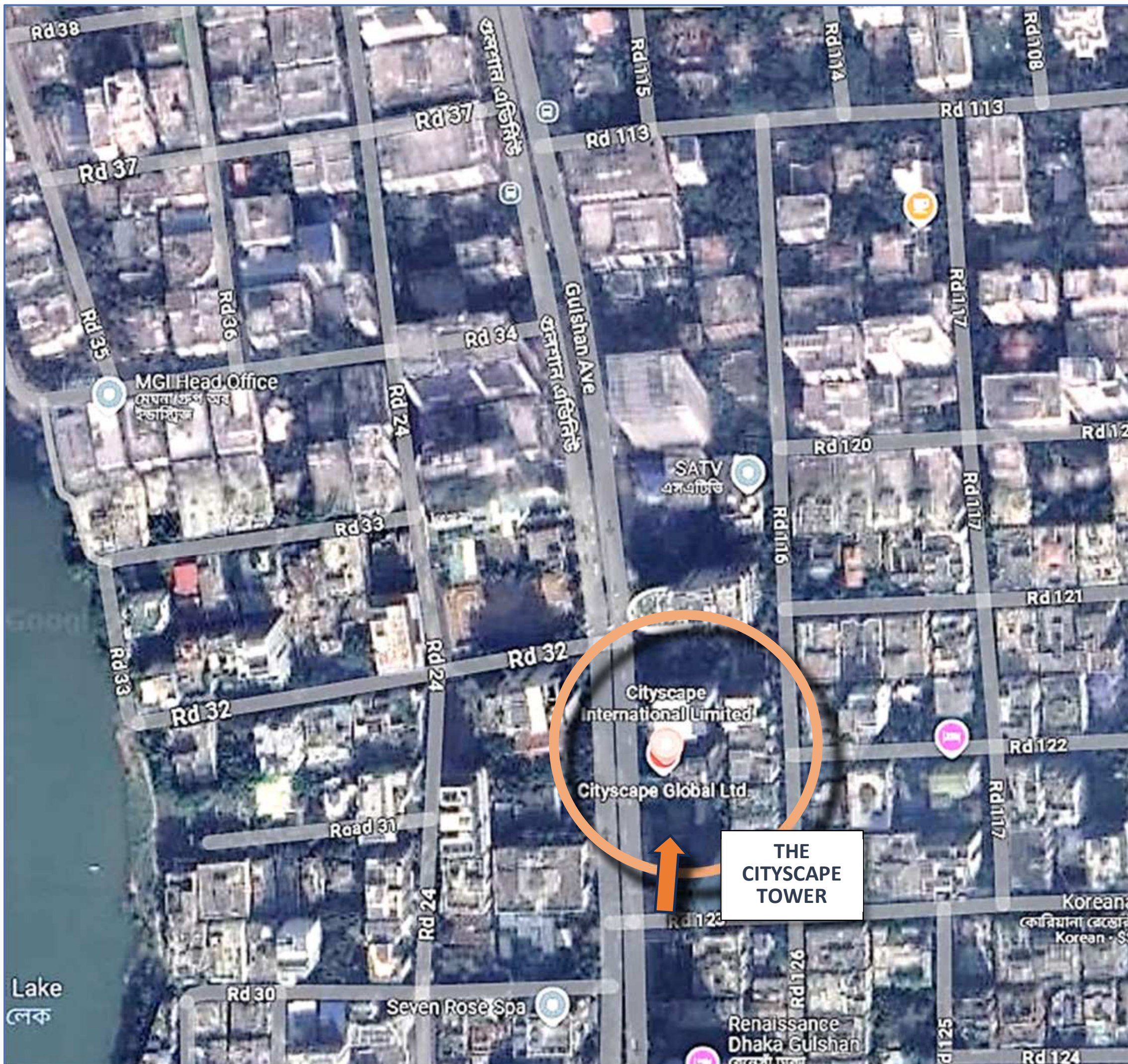
***Dia. 5.2.1**: Picture showing location area of the Cityscape Tower, "Gulshan Residential Area", in the Map of Dhaka City (Ref. 5.1.1)*



Dia 5.2.2: *Picture showing Graphical Map of the Cityscape Tower on Gulshan Avenue and its relative position to the case study 1, the Del Vista Tower. (Ref. 5.1.2)*

BACKGROUND:

Cityscape Tower, located in Dhaka, stands out as the first Platinum LEED-certified commercial building in the city. Developed by Cityscape International Ltd, the building achieved an impressive score of 81/110 on the LEED Certification scorecard. This certification reflects the developers' commitment to sustainability and environmentally conscious design.

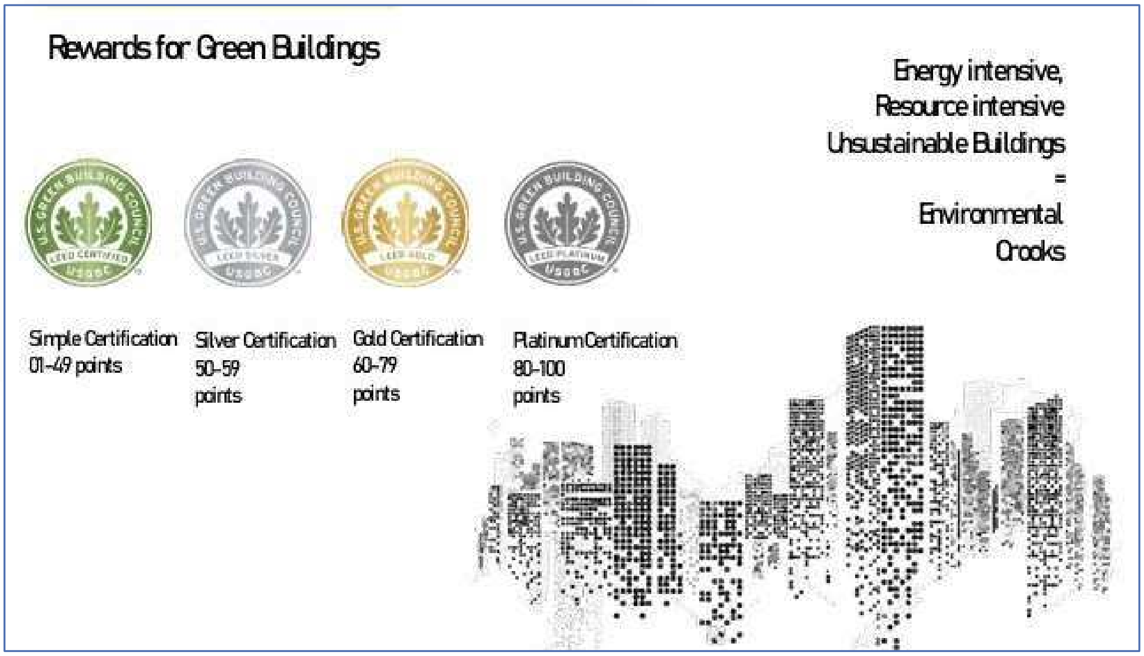


***Dia. 5.2.3**: Picture showing Location of The Cityscape Tower Building in Gulshan (Ref. 5.1.2)*

Building FACTS:

1st LEED Platinum Commercial Green Building in Bangladesh (*Pic. 5.2.2*)
It is built on a 11, 248 sq-ft land.
It has a 50 percent open space.
78196 sq-ft of floor area
54 car parking
18 bicycle parking
Size: 90564 sq-ft

The building excelled across all seven LEED factors, achieving a perfect score of 10/10 in water efficiency. Key features include energy-efficient air conditioning systems, CO_2 and CO sensors to monitor and maintain air quality, an on-site water treatment facility, and rainwater harvesting systems. Additionally, the roof is equipped with 18 KVA solar panels, contributing to the building's renewable energy use.



***Dia. 5.2.4**: Diagram showing different levels of LEED Certification awards (Ref. 5.2.3)*

One of the tower's distinctive features is its full wooden cladding, a rare sight in Dhaka, particularly on Gulshan Avenue, which is known for its glass towers. The building's renewable energy systems allow it to consume 44% less energy and achieve 60% water savings compared to nearby buildings, further emphasizing its role as a leader in sustainable architecture in Bangladesh.

Apart from all these, the Cityscape Tower is also considered to be the one of the very first “Green & Intelligent Infrastructure” with a panoramic view of Gulshan Avenue. It also features an earthquake-resistant sustainable design.

DISTRIBUTION OF FACILITIES IN THE BUILDING:

The Cityscape Tower in Gulshan, Dhaka, accommodates a mix of office spaces and restaurants and other commercial spaces. Trust Bank's corporate branch is located here, making it one of the prominent offices within the building. The tower is also home to North End Coffee Roasters, a popular café known for its quality coffee, and a restaurant called *Chaap Ghor*, which has a signature branch in the building. There are some floors allocated for future uses to accommodate life style facilities. The combination of these businesses aligns with Cityscape Tower's modern, eco-friendly design and LEED Platinum certification.

The Cityscape Tower building is a sixteen-story high building. Currently 14 stories out of the sixteen floors are already built and 5 stories serve as the basement parking areas which are situated in the underground. The 15th and the 16th floors are under construction. The building aims to provide a lifestyle service for the users as well as to the customers, in the long run. The services such as a wellness center, a gym, corporate lounges and similar services are items they are contemplating to accommodate in the future.

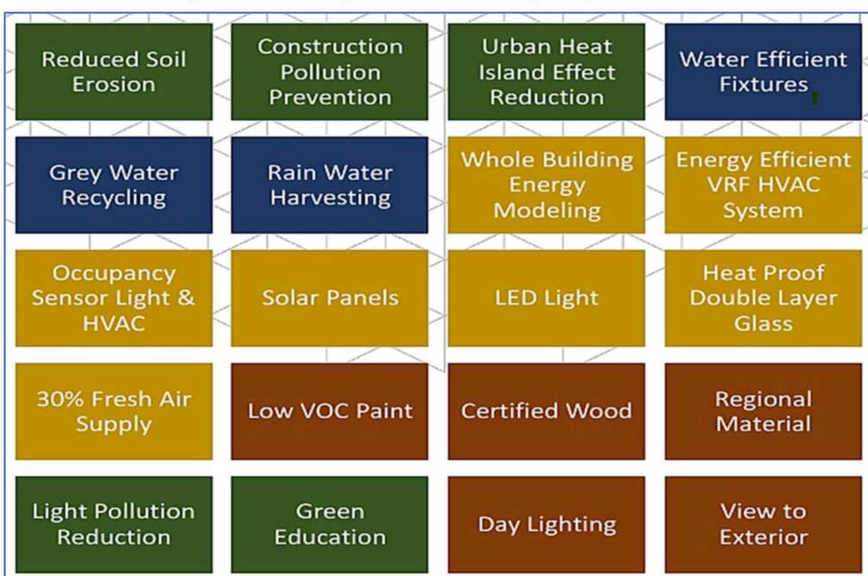
At present, the various facilities layouts of the building at different floors are listed as shown in the following table:

TABLE 5.2.1: FACILITIES LAYOUTS OF THE CITYSCAPE TOWER BUILDING AT DIFFERENT FLOORS

Sl. No.	FLOOR	USE/ FACILITIES
01	Ground Floor (Western side)	A Coffee Shop (Name: North End Cafe)
02	Ground Floor	A Restaurant (Name: Happiness, Café & Restaurant)
03	First Floor	National Bank Ltd.
04	Second Floor	Back office of the restaurants
05	Third Floor	Future Sales office (Unused during survey)
06	Fourth Floor	HR Office (to be used as Gym. Wellness center in future)
07	Fifth Floor	Building Owner's Office
08	Sixth Floor	Store
09	Seventh Floor	Cityscape Global Office
10	Eighth Floor to Tenth Floor	Future Use
11	Eleventh Floor	Corporate Meeting Rooms plus Office
12	Twelfth – Thirteenth floor	Restaurant
13	14^{th} to 16^{th} Floor	Under Construction

PHYSICAL ATTRIBUTES AND ENVIRONMENTAL CONDITIONS OF CASE STUDY BUILDING WITH RESPECT TO ARCHITECTURAL GREEN TECHNOLOGY STATUS:

Some green strategies that the cityscape tower met:



Dia 5.2.5: *Some green features that the cityscape tower met (Ref. 5.2.4)*

Some Green Strategies Scorecard:

1000016210, DHAKA

CITYSCAPE TOWER

LEED BD+C: Core and Shell (v2009)

PLATINUM, AWARDED JAN 2017

SUSTAINABLE SITES		AWARDED: 26 / 28
SSp1	Construction activity pollution prevention	REQUIRED
SSc1	Site selection	1 / 1
SSc2	Development density and community connectivity	5 / 5
SSc3	Brownfield redevelopment	0 / 1
SSc4.1	Alternative transportation - public transportation access	6 / 6
SSc4.2	Alternative transportation - bicycle storage and changing rooms	2 / 2
SSc4.3	Alternative transportation - low-emitting and fuel-efficient vehicles	3 / 3
SSc4.4	Alternative transportation - parking capacity	2 / 2
SSc5.1	Site development - protect or restore habitat	1 / 1
SSc5.2	Site development - maximize open space	1 / 1
SSc6.1	Stormwater design - quantity control	1 / 1
SSc6.2	Stormwater design - quality control	1 / 1
SSc7.1	Heat island effect - nonroof	1 / 1
SSc7.2	Heat island effect - roof	1 / 1
SSc8	Light pollution reduction	0 / 1
SSc9	Tenant design and construction guidelines	1 / 1

WATER EFFICIENCY		AWARDED: 10 / 10
WEp1	Water use reduction	REQUIRED
WEc1	Water efficient landscaping	4 / 4
WEc2	Innovative wastewater technologies	2 / 2
WEc3	Water use reduction	4 / 4

ENERGY & ATMOSPHERE		AWARDED: 21 / 37
EAp1	Fundamental commissioning of building energy systems	REQUIRED
EAp2	Minimum energy performance	REQUIRED
EAp3	Fundamental refrigerant Mgmt	REQUIRED
EAc1	Optimize energy performance	9 / 21
EAc2	On-site renewable energy	4 / 4
EAc3	Enhanced commissioning	2 / 2
EAc4	Enhanced refrigerant Mgmt	0 / 2
EAc5.1	Measurement and verification - base building	3 / 3
EAc5.2	Measurement and verification - tenant submetering	3 / 3
EAc6	Green power	0 / 2

MATERIAL & RESOURCES		AWARDED: 6 / 13
MRp1	Storage and collection of recyclables	REQUIRED
MRc1	Building reuse - maintain existing walls, floors and roof	0 / 5
MRc2	Construction waste Mgmt	2 / 2

MATERIAL & RESOURCES		CONTINUED
MRc3	Materials reuse	0 / 1
MRc4	Recycled content	2 / 2
MRc5	Regional materials	2 / 2
MRc6	Certified wood	0 / 1

INDOOR ENVIRONMENTAL QUALITY		AWARDED: 8 / 12
EQp1	Minimum IAQ performance	REQUIRED
EQp2	Environmental Tobacco Smoke (ETS) control	REQUIRED
EQc1	Outdoor air delivery monitoring	0 / 1
EQc2	Increased ventilation	1 / 1
EQc3	Construction IAQ Mgmt plan - during construction	1 / 1
EQc4.1	Low-emitting materials - adhesives and sealants	0 / 1
EQc4.2	Low-emitting materials - paints and coatings	1 / 1
EQc4.3	Low-emitting materials - flooring systems	1 / 1
EQc4.4	Low-emitting materials - composite wood and agrifiber products	1 / 1
EQc5	Indoor chemical and pollutant source control	0 / 1
EQc6	Controllability of systems - thermal comfort	0 / 1
EQc7	Thermal comfort - design	1 / 1
EQc8.1	Daylight and views - daylight	1 / 1
EQc8.2	Daylight and views - views	1 / 1

INNOVATION		AWARDED: 6 / 6
IDc1	Innovation in design	1 / 1
IDc2	LEED Accredited Professional	1 / 1

REGIONAL PRIORITY CREDITS		AWARDED: 4 / 4
EAc1	Optimize energy performance	0 / 1
EAc3	Enhanced commissioning	0 / 1
EAc5.2	Measurement and verification - tenant submetering	1 / 1
WEc1	Water efficient landscaping	1 / 1
WEc2	Innovative wastewater technologies	1 / 1
WEc3	Water use reduction	1 / 1

TOTAL 81 / 110

40-49 Points	50-59 Points	60-79 Points	80+ Points
CERTIFIED	SILVER	GOLD	PLATINUM

***Dia 5.2.6**: USBGC Scorecard for the Cityscape Tower in Gulshan (Ref. 5.2.5)*

Wooden exterior:

One of its unique architectural features is the use of full wooden cladding, which sets it apart from the typical glass-clad towers commonly seen in the area. This cladding adds to an aesthetic view that emphasizes warmth and relief from the natural materials, contributing to the building's eco-friendly image.
The Spanish brand Prodema manufactures maintenance-free wood coverings. Prodema cladding panels are highly durable, impact-resistant boards with a high-grade natural wood veneer. Prodema panel is ideally suited to the exterior and interior cladding applications.

Pic. 5.2.2: *Picture showing the Cityscape Tower with its wooden cladding at Gulshan, Dhaka (Ref 5.2.6)*

Fitting fixture:
Porcelanosa is renowned for their high-quality products and innovative designs, manufactured with the highest quality production techniques. Porcelanosa tiles are incredibly durable and ideal for high traffic, making them perfect for upscale commercial building and hotels.

Pic. 5.2.3*: Picture showing High quality finish material like tiles*
(Ref. 5.2.6)

Air Conditioning: Cityscape has used Daikin VRF Systems. Currently, Daikin is the most innovative air conditioning company of the world and the provider of advanced, high-quality air conditioning solutions for residential, commercial, and industrial facilities.

Pic. 5.2.4*: Picture showing high quality air-conditioning used for the Cityscape tower (Ref. 5.2.7)*

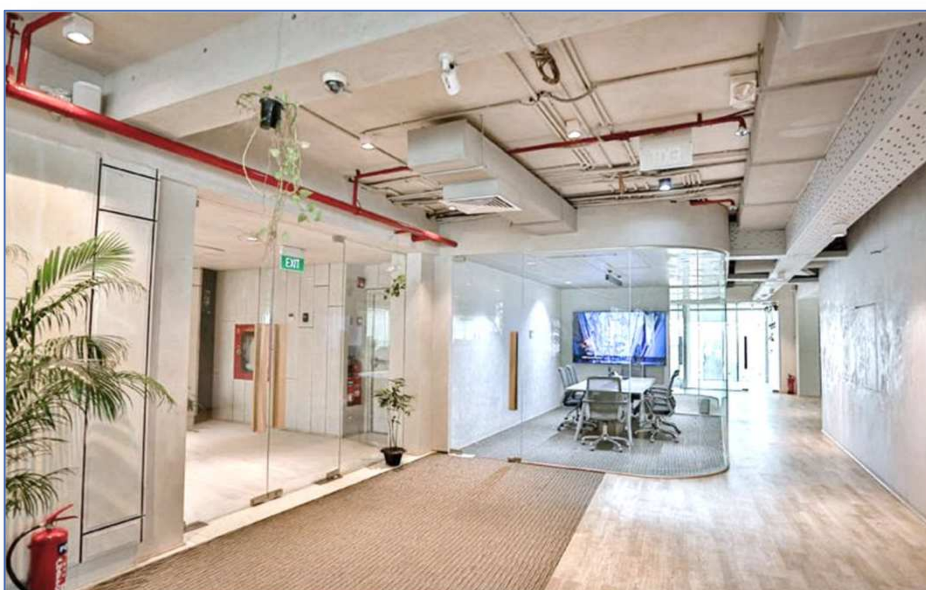
UV GLASS:

Pilkington is a Japanese-owned glass-manufacturing company which is based in Lathom, Lancashire, United Kingdom. The Pilkington Solar Control glass used in the Cityscape Tower reduces solar heat gain and offers high levels of natural light to provide comfortable and pleasant environments.

***Pic. 5.2.5**: Picture showing high quality glazing used for the Cityscape Tower (Ref. 5.2.6)*

***Pic. 5.2.6** : Picture showing High quality glass used in the tower (Ref: Self-sourced, 2024)*

Pic. 5.2.7*: Picture showing the Cityscape Tower at Gulshan, Dhaka (Ref. 5.2.8)*

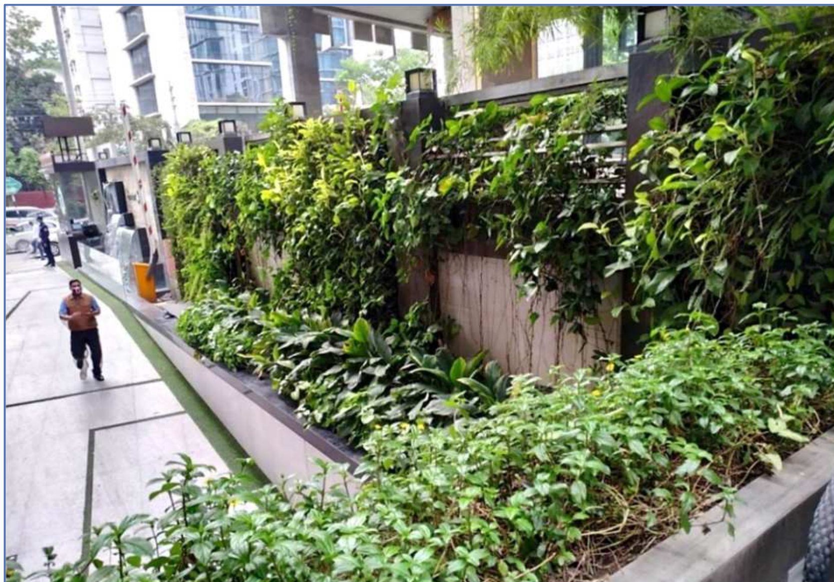


Pic. 5.2.8*: Picture showing office interior in the Cityscape Tower (Ref. 5.2.6)*

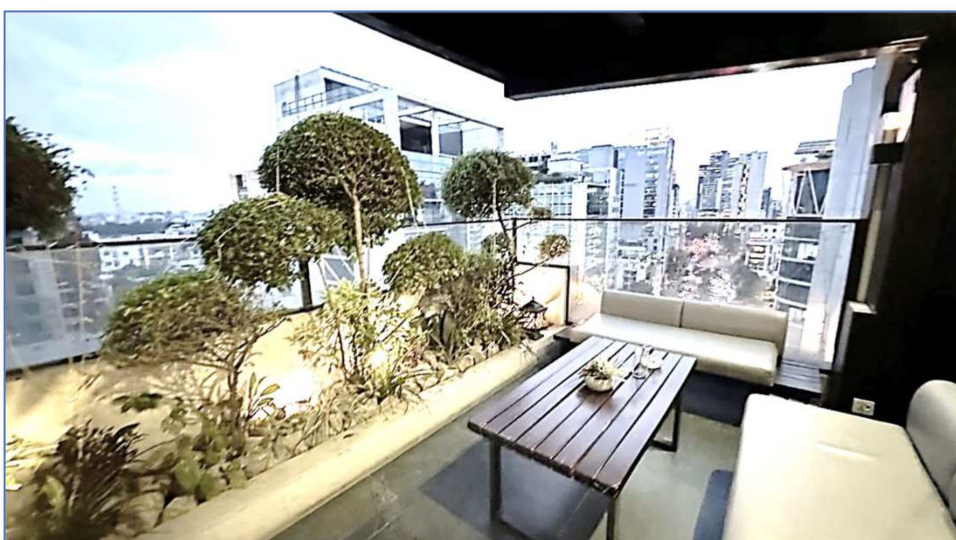
Solar panels:
The first step to securing the energy future of the facility was by making the systems and utilities efficient and reducing the current energy consumption. Bosch rooftop solar panels helped the building with customized Energy Efficiency solutions, thus realize cost savings with pragmatic payback periods.

HVAC Trunking:

Busbar systems are used to safely implement three-phase power distribution systems, often in large environments. For Cityscape Tower, a busbar trunking system from Schneider Electric have been used which is one of the industry-leading manufacturers of such systems. For example, for this tower the Scheiner Electric company products have been used.



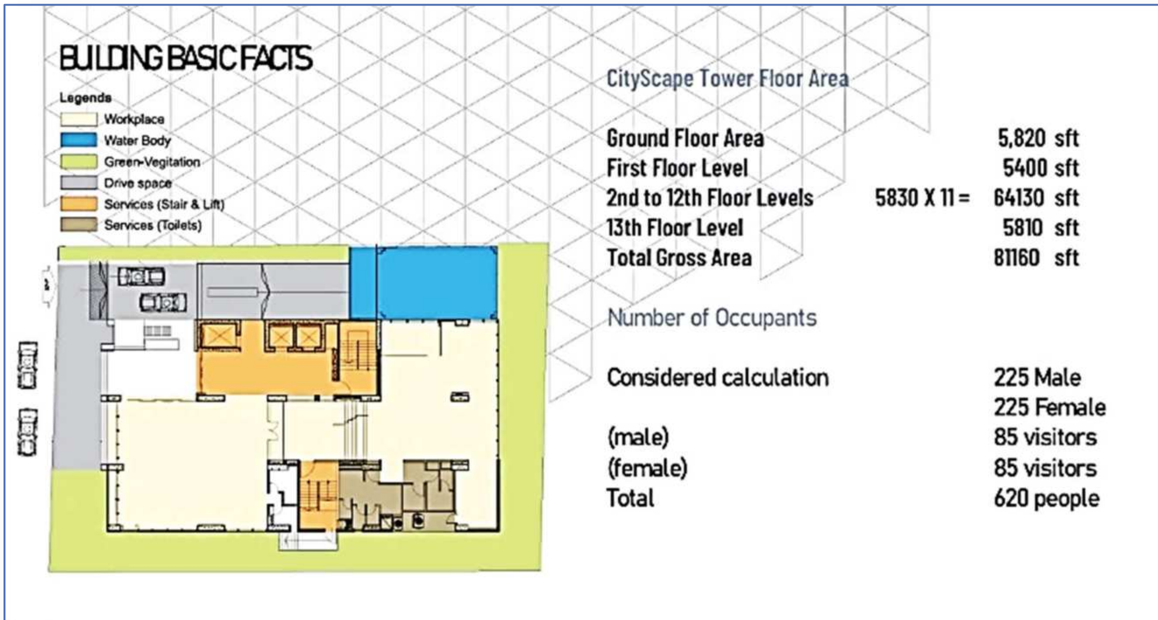
Pic. 5.2.9*: Picture showing the Cityscape Tower exterior garden at Gulshan, Dhaka (Ref. 5.2.6)*



Pic. 5.2.10*: Picture showing Abundance of greeneryeven in some balconies in the Cityscape Tower at Gulshan, Dhaka (Ref: Self-sourced, 2024)*

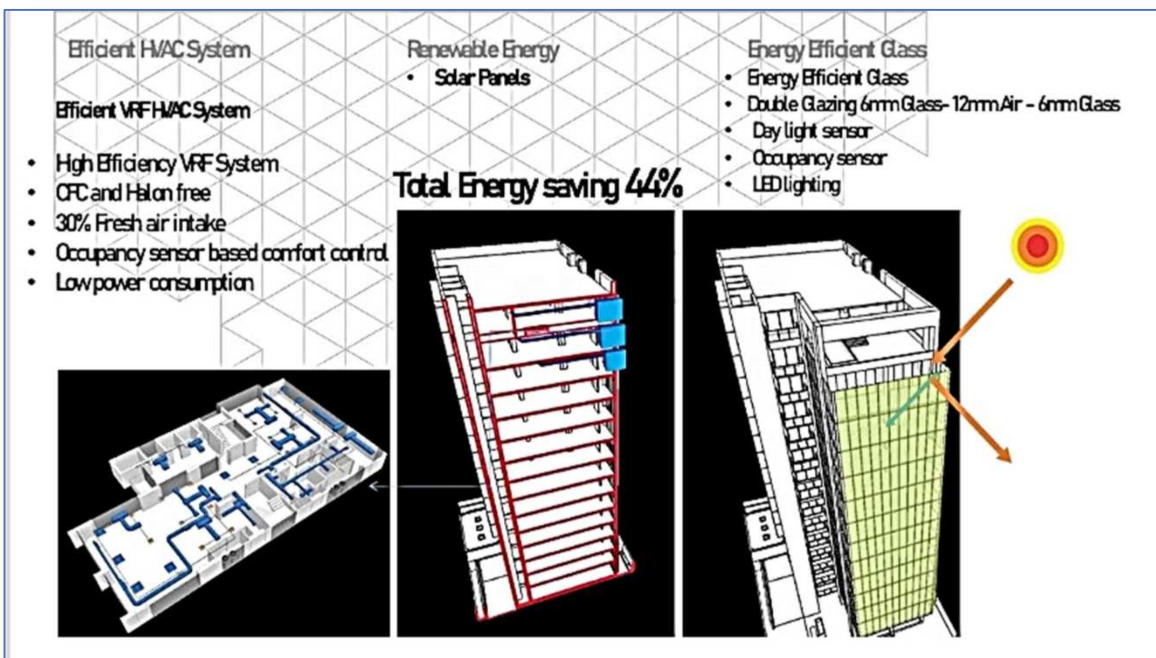
Building Facts: Some building facts related to the sustainability of the building is graphically shown in the following picture.

***Dia 5.2.7**: USBGC Score points for the Cityscape Tower in Gulshan (above and below) (Ref. 5.2.8)*



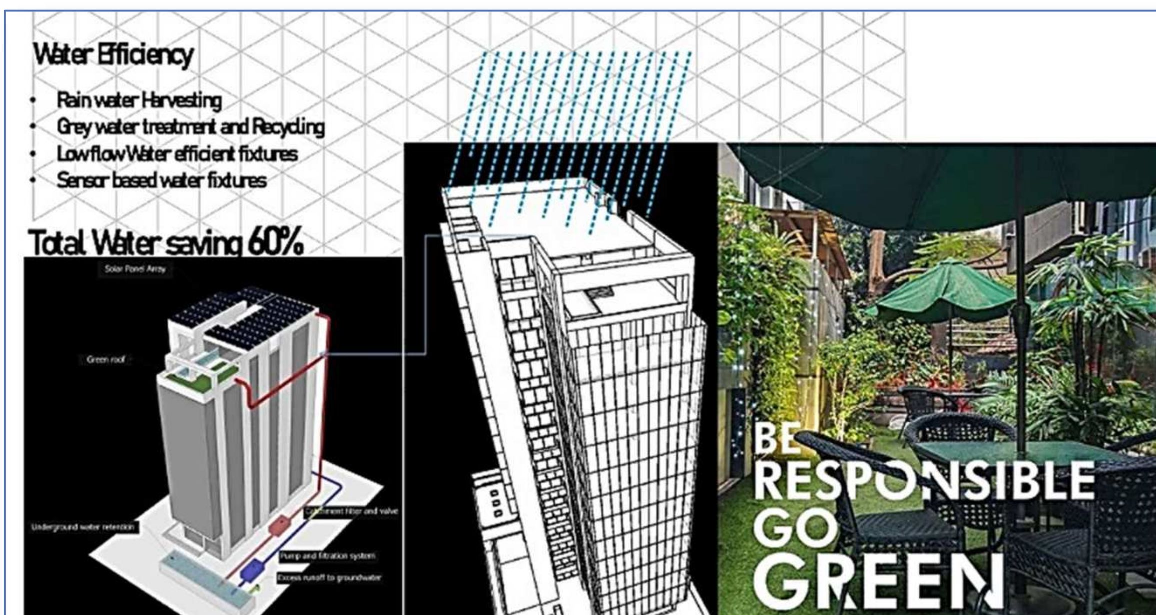
***Dia 5.2.8**: Cityscape Tower Floor Area Details (Ref. 5.2.8)*

OTHER FACTS



***Dia 5.2.9**: Picture shows efficient HVAC system, renewable energy from solar panel and the use of energy efficient glass (Ref. 5.2.8)*

Dia 5.2.10*: Diagram shows building total power consumption is reduced by 44% (Ref. 5.2.8)*



Dia 5.2.11*: Water Efficiency of the Cityscape Tower (Ref. 5.2.8)*

Total water saving for the Cityscape Tower is 60%. The building reuses the water collected from rainfall. It has grey water treatment and recycling, low flow water efficient fixtures and sensor-based water fixtures.

INDOOR ENVIRONMENT QUALITY

***Dia 5.2.12**: Picture shows how indoor environment quality is use of efficient HVAC system and How rating tools work (Ref. 5.2.8)*

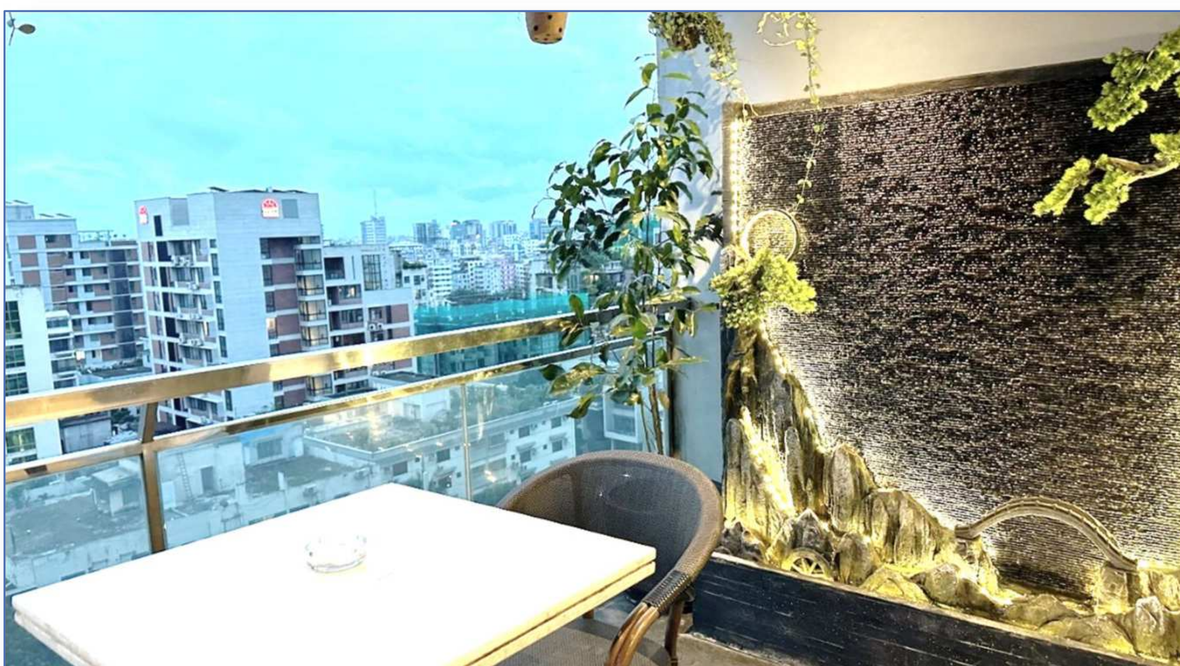
CURRENT DAY SCENARIO

The Cityscape tower has been built over 10 years ago. Yet it performs equally well due to the sincere engagement and accountability of the building owners and the building management team. The performance of the building is more or less the same as the maintenance is properly done. The following pictures are taken from a recent time. The greenery and the technology are commendable and unique as compared to buildings in Dhaka.

Pic. 5.2.11*: The Cityscape Tower Entrance (Ref: Self-sourced, 2024)*

Pic. 5.2.12*: The Cityscape Tower Entrance (Ref: Self-sourced, 2024)*

***Pic. 5.2.13**: The Cityscape Tower Entrance*
Shows how high-quality finish materials are and greenery are still maintained
(Ref: Self-sourced, 2024)



***Pic. 5.2.14**: Use of greenery in a Restaurant terrace (Ref: Self-sourced, 2024)*

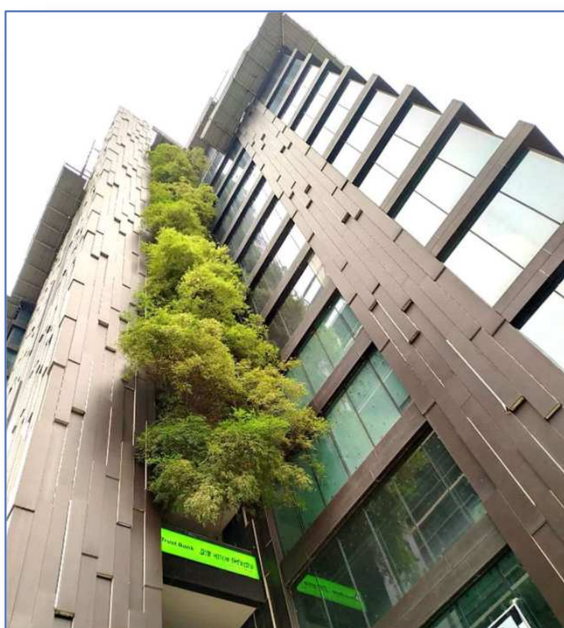
Pic. 5.2.15*: Use of greenery inside a Restaurant (Ref: Self-sourced, 2024)*

Pic. 5.2.16*: Picture greenery is used both in interior as well as exterior*
Restaurant at the 13 th floor (Ref: Self-sourced, 2024)

Pic. 5.2.17*: Picture of a restaurant at the ground floor of the building*
(Ref: Self-sourced, 2024)

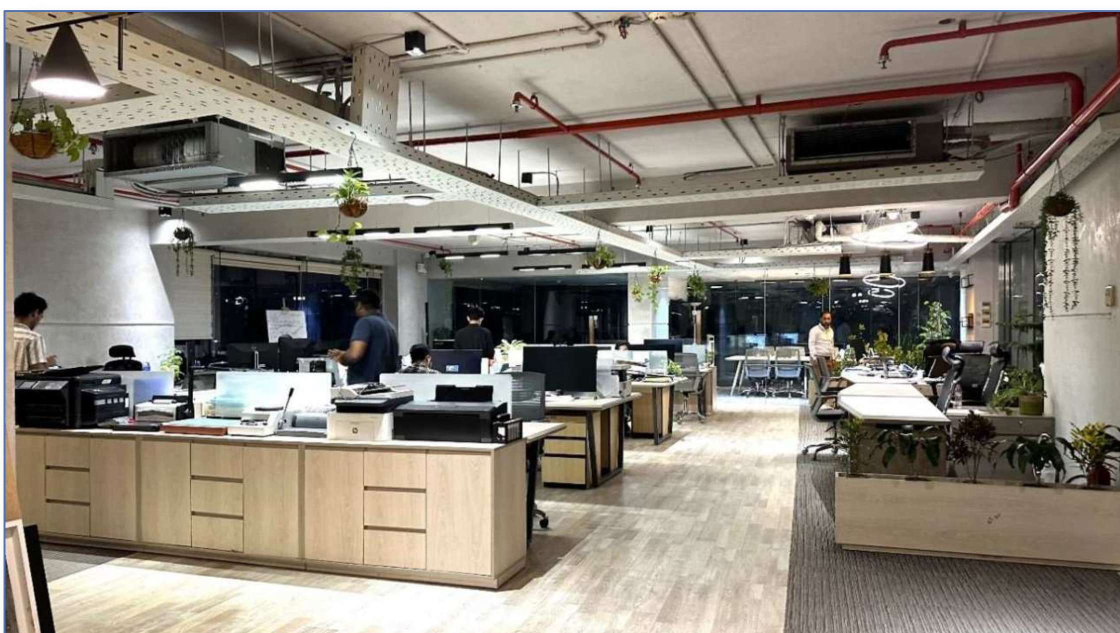
Pic. 5.2.18a*: Restaurant at the 13th floor (Ref: Self-sourced, 2024)*

Pic. 5.2.18b*: Customers at leisure inside the Café called Happiness at the Ground Floor*
(Ref: Self-sourced, 2024)

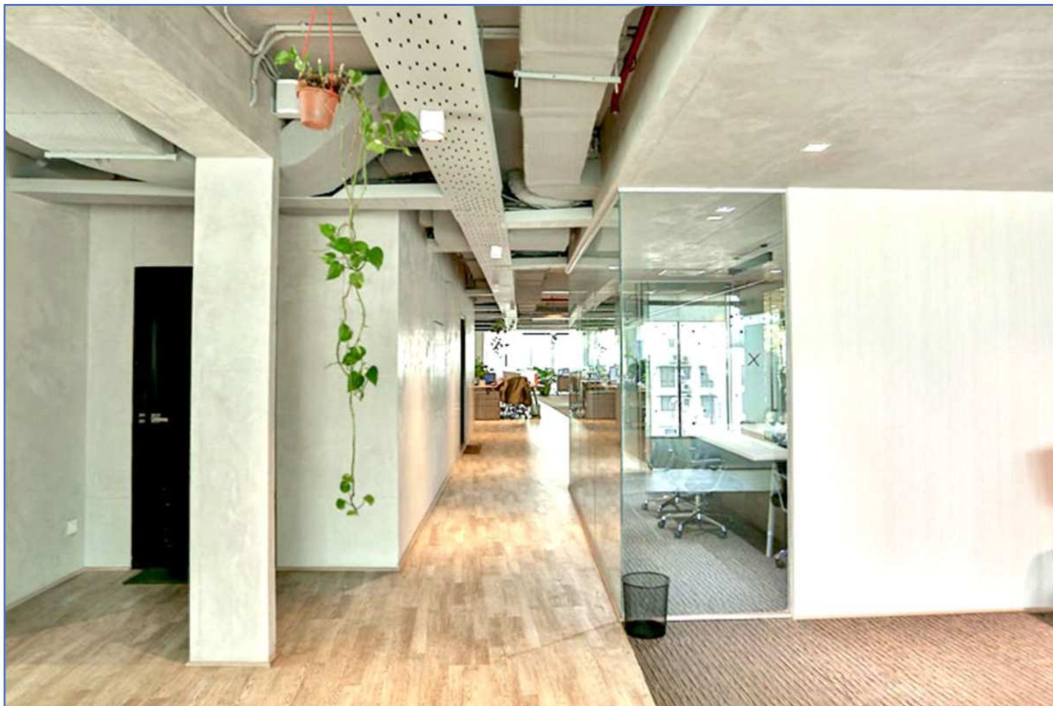


Pic. 5.2.19*: Vertical Greenery development in the Cityscape Tower (Ref. 5.2.6)*

Pic. 5.2.20*: picture of office space 2 (Ref. 5.2.6)*



Pic. 5.2.21*: picture of office space 3*
(Ref: Self-sourced, 2024)



Pic. 5.2.22*: picture of office space 3 (Ref 5.2.6)*

Pic. 5.2.23*: picture of the roof garden of the tower (Ref. 5.2.6)*

Table 5.2.2: List of Respondents from the Cityscape Tower

	NAME	DESIGNATION	AGE
1.	MD. ALI RONNY	IT OFFICER	30
2.	MD. RIAZ	IT OFFIECER	36
3.	MD. RAHAT	ADMIN OFFICER	42
4.	IMMANUEL	MANAGER	40
5.	ISHTIAK ALI KHAN	CUSTOMER CARE	45
6.	BENIAMIN	LIBRARIAN	70
7.	MD. MUKUL	OFFICER, SALES	50
8.	MAIMUNA KHAN	ER. EXECUTIVE	43
9.	SHEEMA	WAITRESS	44
10.	ARAFAT	WAITER	50
11.	SUMAIYA	WATRESS	55
12.	SUNNY	DIPLOMA ENGINEER	39
13.	RAQIBUL HAKIM	IT OFFIECER	75
14.	HASNU AKTER	FINANCE OFFICER	52
15.	AKRAM HOSSAIN	MANAGER	30
16.	MUSTAFA AKAND	CUSTOMER CARE	24
17.	FARZANA RASHID	ENGINEER	22
18.	SULTANA	ADMIN OFFICER	59
19.	AUSHIM MODAK	IT OFFIECER	56
20.	PEYARA BEGUM	WAITER	25
21.	JASIA ZAMAN	SECRETARY	30
22.	MASUMA PARVEEN	ENGINEER	60
23.	FARJANA	JR. EXECUTICE	60
24.	TOWHIDUL HOQ	PEON	70
25.	JALAL MIAH	GUARD	68
26.	AKRAMUDDIN	CLEANER	58
27.	NAZMUL HAQ	BUSINESS PERSON	76
28.	RUHUL	DRIVER	50
29.	MASUM	DRIVER	66
30.	RATNA BEGUM	OFFICE ASSISSTANT	57

5.3 CASE STUDY 03

DESCRIPTION OF THE CASE STUDY
EVE DRESS SHIRT LTD.

BUILDING INFORMATION

NAME OF BUILDING: EVE DRESS SHIRT LTD.
TYPE OF BUILDING: COMMERCIAL BUILDING

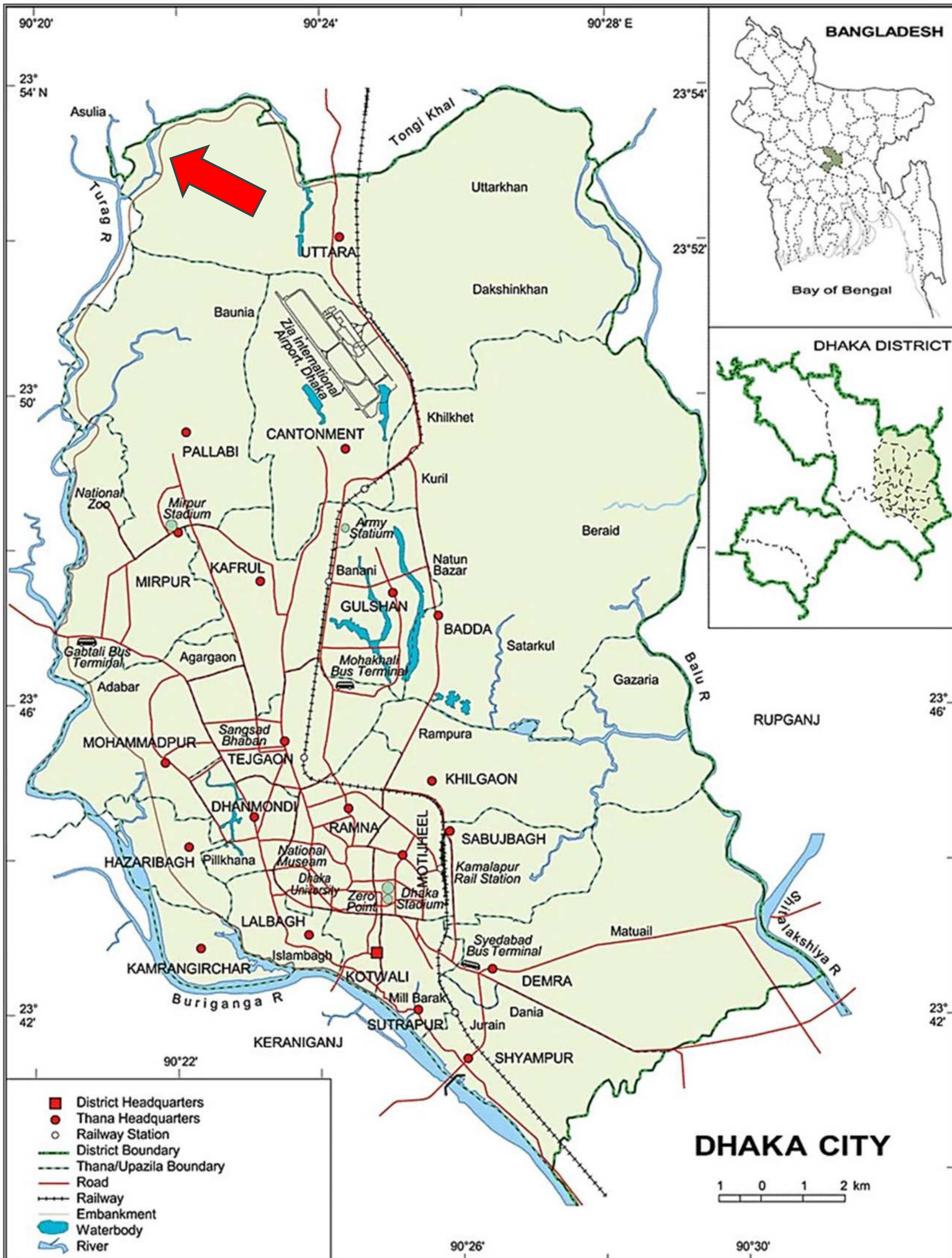
ADDRESS:
The location of the garments factory is at 219 Anwar Jung Road, Ashulia, Dhaka-1341, Bangladesh. Word No. 05, Block A.

LOCATION OF SITE IN THE CONTEXT OF DHAKA CITY:

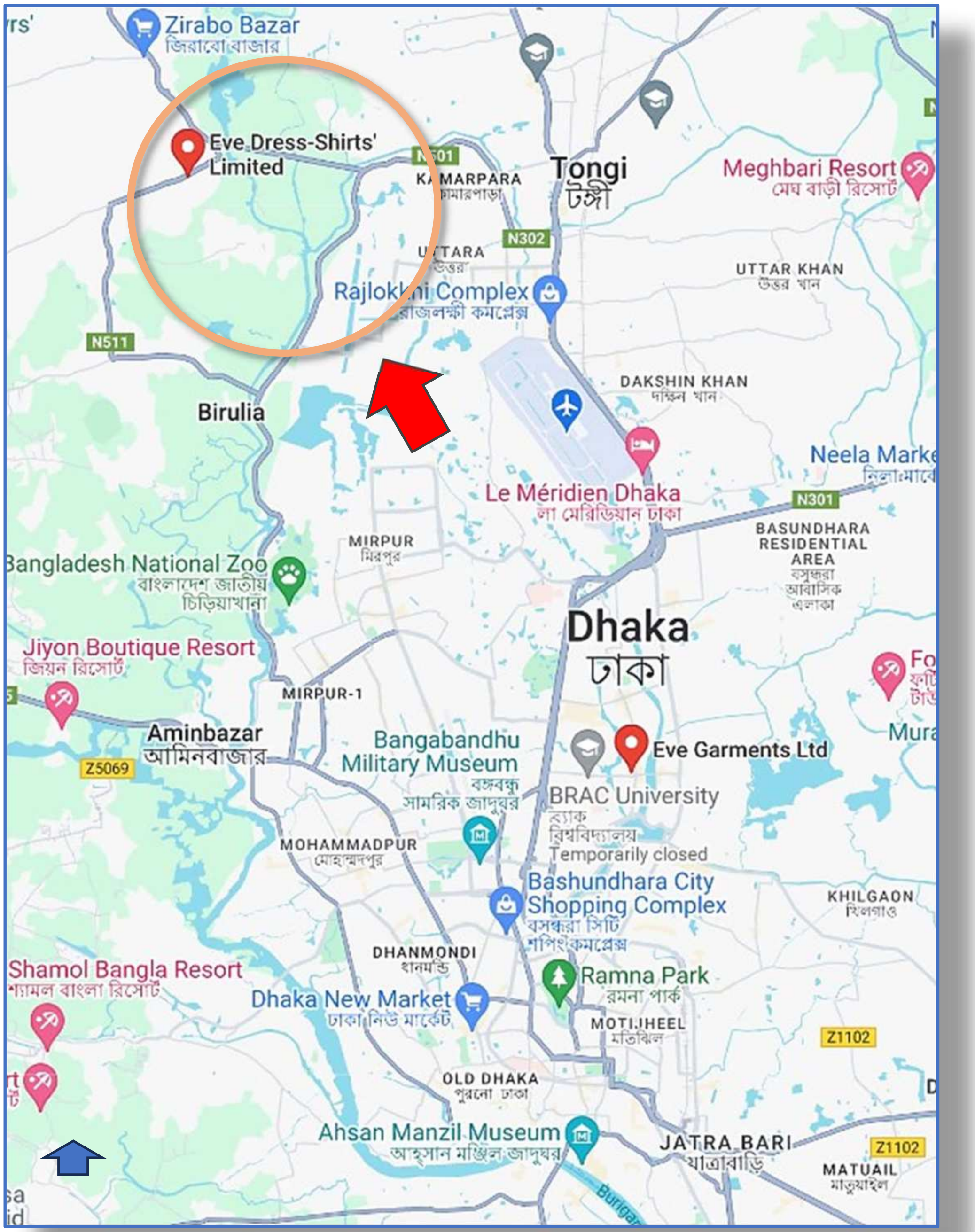
Eve Dress Shirts Limited is located in the northern part of Greater Dhaka, in Ashulia, which is known as a prominent industrial zone. This area hosts a variety of factories, particularly in the garment and textile industries, benefiting from its proximity to Dhaka while providing ample space for manufacturing operations.

BACKGROUND:
Eve Dress Shirts Limited is part of the Eve Group, a well-established woven garment manufacturer in Bangladesh that began operations in 1984. Over the years, it has grown into a major woven garment manufacturer in Bangladesh. The factory's specialization includes the production of dress shirts, casual shirts, blouses, uniforms, and other woven garments. They serve a diverse range of clients, from retailers to workwear companies across the globe.

***Pic. 5.3.1**: Picture showing the location area of the "Eve Dress Shirt Ltd" in the Map of Dhaka City (Ref 5.3.1)*



***Dia. 5.3.1**: Picture showing location area of the Cityscape Tower, "Gulshan Residential Area", in the Map of Dhaka City (Ref. 5.3.2)*



***Dia. 5.3.2**: Diagram showing closeup location area of the "Eve Dress Shirt Ltd" in Dhaka (Ref: 5.3.2)*

PHYSICAL ATTRIBUTES AND ENVIRONMENTAL CONDITIONS OF CASE STUDY BUILDING AND ARCHITECTURAL GREEN TECHNOLOGY STATUS:

The building is a seven-story structure constructed with a steel column and beam framework. The walls are made of clay bricks. The building façade is plastered and painted in a shade of light beige and light brown. The glass to building bricks ration is around 40% to 60%. There is an under construction building to the north of the building. There is a commercial building to the West. There are some open places to the East and South within its boundary. The factory building partly fulfills the requirement of a green building. The owners are positive and committed to have a fully sustainable building structure in the future.

***Dia. 5.3.3**: Bird Eye View of "Eve Dress Shirt Ltd" (Ref **5.3.2**)*

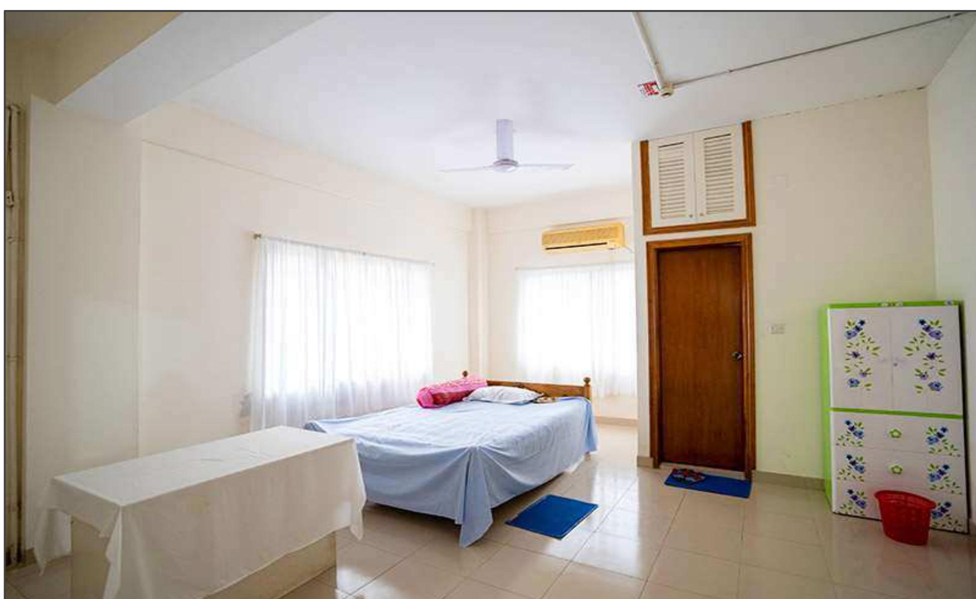
***Pic. 5.3.2**: Outdoors at Eve Dress Shirt Ltd. ((Ref: Self-sourced, 2024)*

***Pic. 5.3.3**: Office area at Eve Dress Shirt Ltd. ((Ref: Self-sourced, 2024)*

***Pic. 5.3.4**: Garment Workers at work at Eve Dress Shirt Ltd (Ref: Self-sourced, 2024)*

***Pic. 5.3.5**: Garment Workers at work (Sewing Line) at Eve Dress Shirt Ltd.; (Ref: 5.3.3)*

Facilities Allocation in this building are as such that the all the garments floor are distributed from the ground floor to the 6th floor. The Office room for staff are at the 7th floor. There are additional rooms like day care room and doctor's checkup room for the garment's workers.



***Pic 5.3.6:** Doctor's Room (Ref: 5.3.6)*

Pic 5.3.7*: Worker's children's play area (Ref 5.3.4)*

Pic 5.3.8*: Fire retardant Door to workers floor (Ref 5.3.4)*

This building has some hanging greenery which meets a criterion of green buildings.

Pic 5.3.9*: *Building exterior façade is plaster and painted. (Ref:5.3.9)

The office staff area is lit by natural sunlight however the garments workers floor has to be lit up by electrical lights during the day time. The building gains heat from sunlight during the day time and the room interiors stay hot. In the Office area it is difficult to work without turning on the AC.

Pic 5.3.10: Use of AC to combat the heat gained from the roof *(Ref: 5.3.9)*

In the context of effluent discharge, it is observed that all effluent from the Eve Shirts Factory is directed to a single discharge point, which is common among the operational practices of various facilities in the region. This practice raises concerns about potential environmental contamination, particularly since the effluent is often treated only once before disposal.

During the rainy season, the factory lacks adequate water collection facilities, which the owners attribute to space constraints. This absence of a rainwater harvesting system can exacerbate water management issues, particularly in a country like Bangladesh, where monsoon rains can lead to significant runoff and waterlogging.

Furthermore, the factory has not implemented any heat-retardant measures, such as specialized paints or insulation, to mitigate heat accumulation in the roof slab. Given Bangladesh's tropical climate, it is imperative that appropriate measures be adopted to reduce thermal gain, thereby enhancing the overall comfort and energy efficiency of the facility.

Proximity to a brickfield, although not directly visible from the factory, raises additional environmental concerns, particularly regarding air quality and dust pollution. Micro-dust particles pose health risks to workers, making the use of masks essential during operations. It is crucial for management to enforce strict adherence to this safety measure to protect employee health.

Regarding water usage, it has been noted that workers frequently lack awareness about the importance of conserving water. The owners recognize the need for comprehensive training programs to educate staff on responsible water use and other sustainable practices.

While the factory installed solar panels on its roof a few years ago, these have fallen into disuse and lack proper maintenance following a breakdown. The owners express that the stress of meeting production deadlines hampers their ability to prioritize sustainable technologies. However, they believe that government mandates requiring the use of green technologies would compel them to adopt and maintain such systems effectively.

The architectural orientation of the building, with its longer side facing north, contributes to issues of heat gain and glare, further emphasizing the need for energy-efficient design strategies.

Overall, there appears to be a limited understanding among the staff regarding the benefits of green building design technologies. This gap in knowledge could hinder the factory's ability to implement sustainable practices effectively.

To enhance workplace safety and preparedness, the factory has established designated meeting points for emergencies such as fire outbreaks or earthquakes. However, ongoing training and awareness programs would make their efforts more successful to ensure that all employees are well-informed about these safety measures.

In summary, the Eve Shirts Factory exhibits several areas in need of improvement regarding environmental management, worker safety, and the implementation of sustainable practices. Addressing these issues could significantly enhance both operational efficiency and worker well-being since users want it to be more efficient in future as well.

Pic 5.3.11: *Workers gathering place during emergency (Ref: Self-sourced, 2024)*

Pic 5.3.12: *Entry staircase of the building*
(Ref: Self-sourced, 2024)

A survey was conducted on thirty participants from various operational levels within the factory in order to assess the user's awareness of green building design technologies and gauge their interest in living in an environment shaped by sustainable building practices. The respondents' list from the factory is provided in the following table.

TABLE 5.3.1: LIST OF RESPONDENTS FROM EVE DRESS AND SHIRTS GARMENTS FACTORY

	NAME	**DESIGNATION**	AGE
1.	MD. TUSHAR	MANAGING DIRECTOR	57
2.	MASUD	PRODUCTION MANAGER	38
3.	MD. TARIQUL ISLAM	PRODUCTION MANAGER	42
4.	Mr. RUBEL	PRODUCTION MANAGER	32
5.	MOSA ALAM	FLOOR IN CHARGE	38
6.	MD. SAGOR AHMED	FLOOR IN CHARGE	36
7.	MD. FURKAN HOSSIN	FLOOR IN CHARGE	43
8.	ALAMIN	LINE CHIEF (SEWING LINE)	36
9.	MOKLAS	LINE CHIEF (SEWING LINE)	37
10.	LITON MIAH	LINE CHIEF (SEWING LINE)	35
11.	ABDUL SALAM	Supervisor (Sewing Line)	42
12.	IBRAHIM	Supervisor (Sewing Line)	32
13.	SHAFIQUL ISLAM	Supervisor (Sewing Line)	45
14.	KANCHON	Supervisor (Sewing Line)	32
15.	AL AMIN	Supervisor (Ironing)	42
16.	AZEDA KHATUN	Supervisor (Ironing)	29
17.	FATEMA AKTER	Jr. Sewing Machine Operator	37
18.	REZAUL KARIM	Jr. Sewing Machine Operator	36
19.	JASMIN	Jr. Sewing Machine Operator	27
20.	MAHFUJA KHATUN	Jr. Sewing Machine Operator	33
21.	NAHAR	Jr. Sewing Machine Operator	42
22.	TANJINA AKTER	Jr. Sewing Machine Operator	24
23.	PAPRI JAHAN TANIA	Jr. Sewing Machine Operator	26
24.	ARJUN CHANDRA	Jr. Sewing Machine Operator	24
25.	RAYHAN	Jr. Sewing Machine Operator	23
26.	YASMIN	Jr. Sewing Machine Operator	34
27.	RIBA KHATUN	Jr. Sewing Machine Operator	26
28.	MOHOSINA	Jr. Sewing Machine Operator	34
29.	RAKIB	Jr. Sewing Machine Operator	27
30.	RAHMAN	Jr. Sewing Machine Operator	23

5.4 CASE STUDY 04: MNR SWEATER LTD.
DESCRIPTION OF THE CASE STUDY

BUILDING INFORMATION

NAME OF BUILDING: MNR SWEATER LTD.
TYPE OF BUILDING: COMMERCIAL CUM OFFICE BUILDING

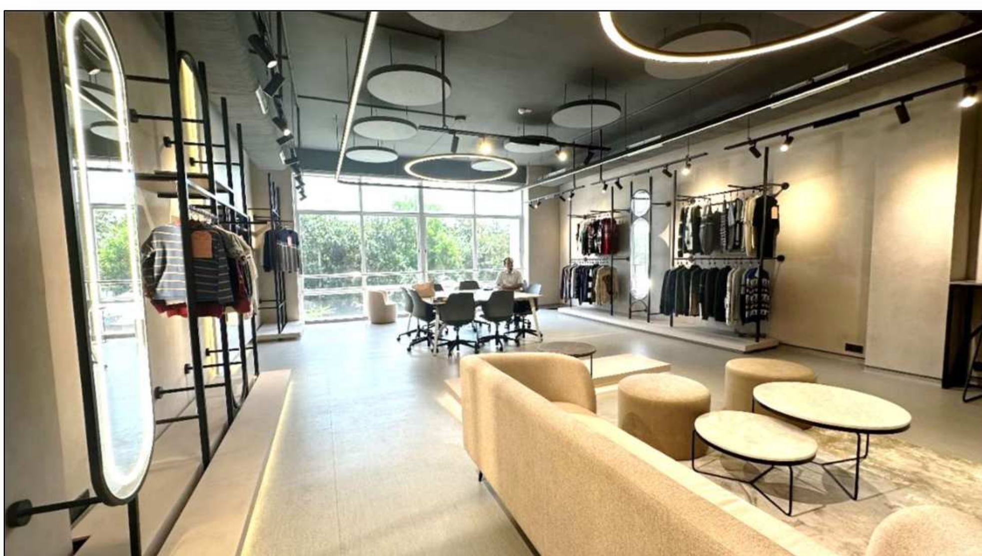
LOCATION OF SITE: MNR is a well-known sweater manufacturer based in Sreepur, Gazipur, greater Dhaka, Bangladesh. This region is famous for its thriving garment industry, including the production of sweaters for global brands.

ADDRESS: Baraider Chala, Sreepur, Gazipur.;Sreepur PS; Gazipur, Greater Dhaka, Bangladesh.
TYPE OF FACILITIES IN THE BUILDING: Garments Factory
SPACE: 55,000 sq-ft per floor

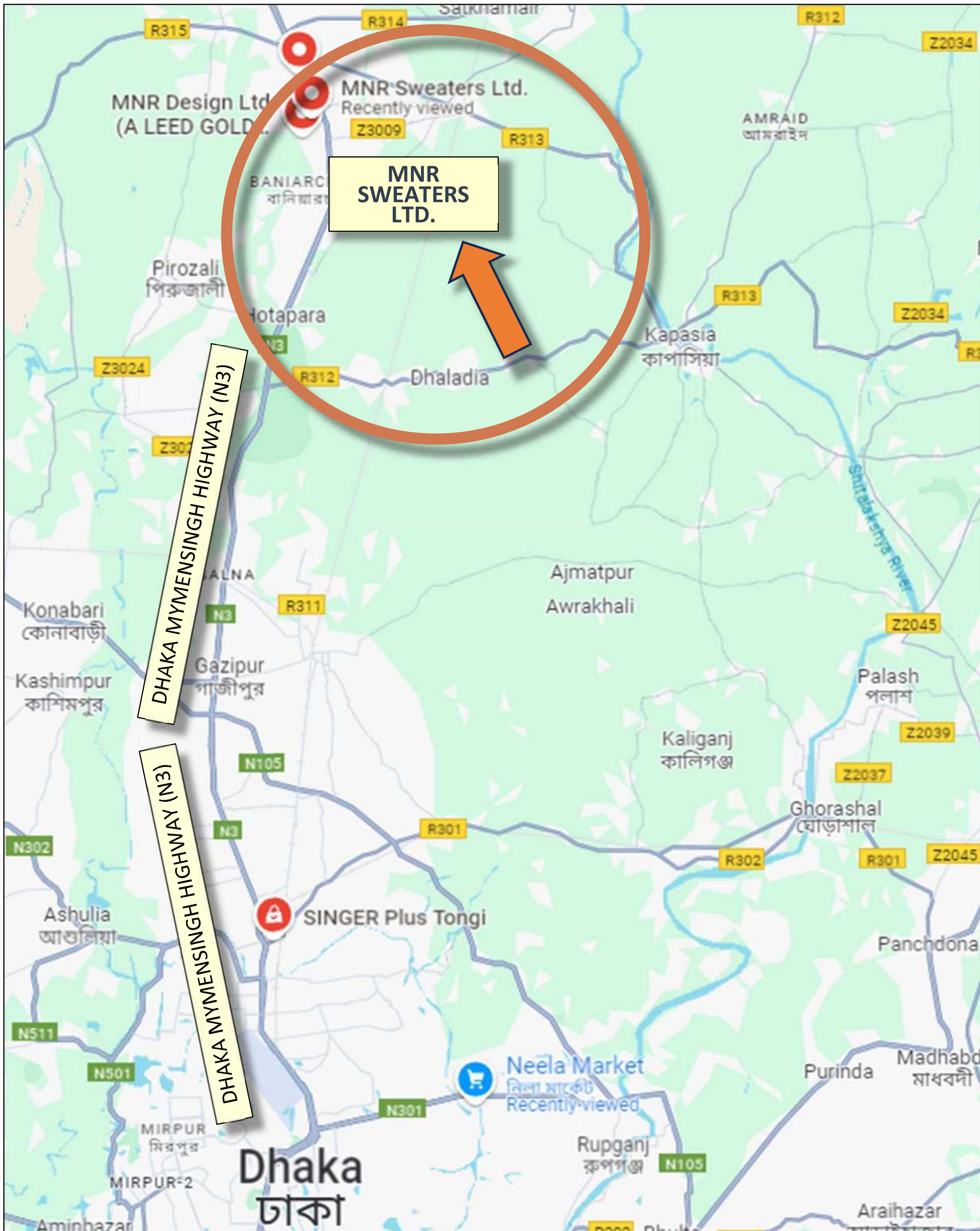
***Pic. 5.4.1:** Picture showing the MNR Sweater Ltd. at Mawna 1, Dhaka; Ref: (self-sourced)*

***Pic. 5.4.2:** Picture showing the MNR Sweater Ltd. at Mawna 2, Dhaka; Ref: (self-sourced)*

Pic. 5.4.3: *Entrance to Office Annex, MNR Sweater Ltd.; Ref: (self sourced)*



Pic. 5.4.4: *Office Annex, Sample room, MNR Sweater Ltd.; Ref: (ss)*



Dia. 5.4.1: *Picture showing location area of the MNR Sweater Ltd. at Sreepur, Gazipur, in the Map of Dhaka (Ref. 5.4.1)*

Pic. 5.4.5*: Bird Eye View showing Location of MNR Sweaters Ltd (Ref. 5.4.1*

BACKGROUND:

MNR Sweaters Ltd. is a garment manufacturing company located in Sreepur, Gazipur, Dhaka, Bangladesh. The company is part of the larger garment and textile industry, which is a major contributor to Bangladesh's economy. This industry is known for producing a significant percentage of the world's clothing, with a focus on ready-made garments (RMG), including sweaters, t-shirts, jackets, and other knitwear products.

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COMPANY OPERATIONS

MNR Sweaters Ltd., like many other factories in the region, is involved in large-scale production of sweaters for export markets. Bangladesh is a leading exporter of sweaters, particularly to the European Union, the United States, and other global markets. MNR Sweaters Ltd. works with international brands (for example s 'Oliver'), and retailers, providing them with high-quality garments at competitive prices. There are more than 2000 workers working in this factory daily.

INDUSTRY OVERVIEW

The MNR Sweaters Ltd. operate within a framework of strict quality control measures, meeting international standards for production. The industry as a whole has faced challenges, including concerns over working conditions and labor rights, and some political instability once in a while, but it remains a crucial part of Bangladesh's economy, providing employment to thousands.

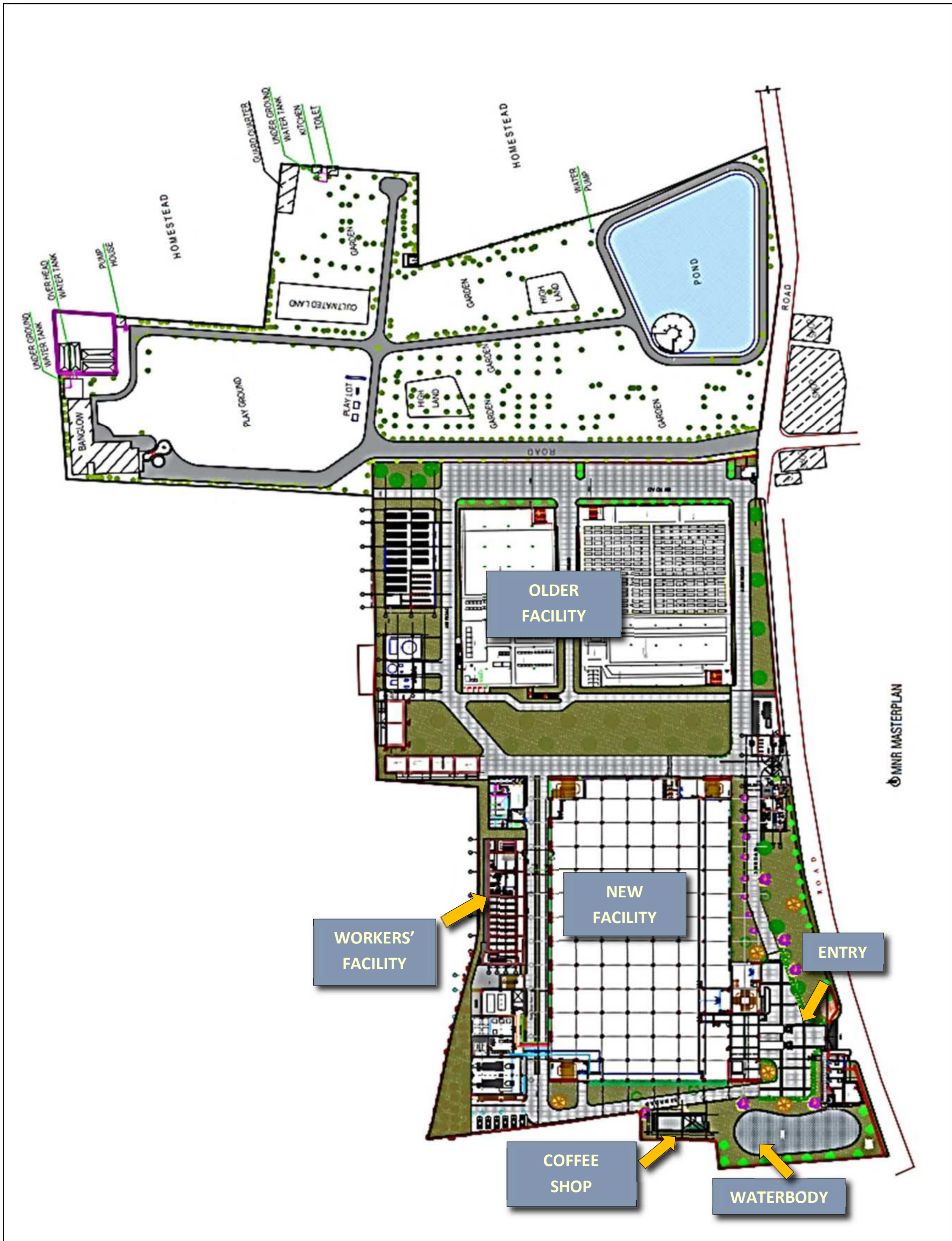
MNR has demonstrated an exemplary commitment to sustainability by being a contender for achieving LEED (Leadership in Energy and Environmental Design) certification. This reflects their focus on environmentally responsible building and operational practices, helping to minimize environmental impact.

The certification aligns with their focus on sustainability initiatives, including the 3Rs (Reduce, Reuse, Recycle), and their investments in advanced facilities, such as water purification systems for waste reuse. The modern facility in Sreepur spans approximately 22,000 square meters and incorporates various advanced environmental and production technologies, such as the use of Jacquard machines, designed to meet international standards for production and environmental efficiency.

BUILDING FACTS:

The building is a six-story structure with a flat reinforced concrete (RCC) roof. It features a column-beam framework constructed using 10-hole hollow bricks and fair-faced concrete. The front of the building faces south, while the facility building of the complex is located to the north. A lush green lawn adorned with imported trees lies at the east and the south side of the complex.
Two other factories belonging which belongs to the same owner lie beyond the complex boundary. A water body and a coffee house (which is used occasionally for special guests) lie within the boundary towards the west. The worker housings are situated outside the boundary, around the three sides of the complex. The entry road lies adjacent to the south of the complex (Dia. 5.4.2).
The factory building is in the process of receiving the LEED Certificate.
The Feasibility checklist for MNR Sweaters Ltd, Bangladesh is given in the chart (Table 5.4.2) at the end of this chapter. The certification process is in progress.

Approximately 50 percent of the total land area of the factory is left as open space.It has a 55,000 sqft (5,109 sqm) of a floor area, 100 No.s car parking and 100 No.s bicycle parking.
A substantial number of workers live nearby and the they come on foot or by riding bicycles or sometimes the comparatively seniors commute by motorcycles.



Dia. 5.4.2: *Masterplan of the MNR Sweater Ltd. at Baraider Chala, Sreepur, Greater Dhaka*
(Source: Collected from Factory Personnel Data)

Pic. 5.4.6 & 5.4.7: *Pic of automatic fabric knitting jacquard machine in the factory (Ref:ss)*

Pic 5.4.8*: Picture shows facility building and green lawn layout in the site*

Pic 5.4.9: *A lot of workers live nearby and the workers come on foot or by cycle. (Ref:ss)*

DISTRIBUTION OF FACILITIES IN THE BUILDING:

The following Table shows the floor wise layout of the factory and the different support facility buildings in the complex.

TABLE 5.4.1: - FOOR WISE LAYOUT OF THE FACTORY AND THE DIFFERENT SUPPORT FACILITY BUILDINGS IN THE COMPLEX.

MNR Sweaters Ltd

Baraider Chala, Sreepur, Gazipur

BUILDING DESCRIPTION

SL	Name	Floor	Floor Description
Building-1	Factory Building	Ground Floor	Winding, Yarn Inspection room, Accessory Issuing Center, Raw material warehouse, Electrical DB room, Toilet zone.
		1st Floor	Finished Goods Area, Inspection Room, Sample Room, Staff Dining, Office area, DB Room, Toilet, QC Room,
		2nd Floor	P2P linking, Finishing, Packing, Moisture Control Room, Distribution Room, Needle Room, Spot Removing Room, Maintenance Room , Washing Section, Chemical Room, Executive Toilet, Male Toilet, Female Toilet, DB Room, Office Room.
		3rd Floor	P2P linking, Finishing, Packing, Moisture Control Room, Distribution Room, Needle Room, Spot Removing Room, Maintenance Room , Washing Section, Chemical Room, Executive Toilet, Male Toilet, Female Toilet, DB Room, Office Rooms.
		4th Floor	Knitting Area, Knitting Distribution, Yarn Distribution, Programmer Room, Needle Room, Maintenance Room, DB Room. Executive Toilet, Male Toilet, Female Toilet, Shoot Area, Office Rooms.
		5th Floor	Finished Good Area, Executive Toilet, Male Toilet, Female Toilet, Shoot Area.
		Roof Top	Lift machine room, Stair Case etc.
Building-2	Facility Building	Ground Floor	Child Care, Medical & Worker Locker area.
		1st Floor	Worker Dinning, Hand Wash & Drinking Water Zoon.
		2nd Floor	Worker Dinning, Hand Wash & Drinking Water Zoon.
		3rd Floor	Training Room & Office Area.
		Roof Top	Stair room
Building-3	Utility Building	Basement	Fire Pump Room
		Ground Floor	Generator Room, Sub-Station & Control Panel Room, UPS Room & Boiler Room.
		1st Floor	Maintenance Room, Chiller Room, Compressor Room & EGB Boiler Room.
		Roof Top	Stair room
Build- 4	Guard House-1	Ground Floor	Security Room, Fire Control Room, BMS Room, RMS Room, Drivers Room & Toilet.
Build- 5	Administative Building	Ground Floor	Security Room & Office Room.
Build- 6	Guard House-2	Ground Floor	Worker Entry Area
Build-7	Wastagr Building	Ground Floor	Wastage store.
Build-8	Gazebo Building	Ground Floor	Coffee area
Build-9	ETP	Ground Floor	Effluent Treatment Plant (ETP).

(Source: Collected from Factory Personnel Data)

PHYSICAL ATTRIBUTES AND ENVIRONMENTAL CONDITIONS OF CASE STUDY BUILDING WITH RESPECT TO ARCHITECTURAL GREEN TECHNOLOGY STATUS

SOME GREEN FEATURES:

Use of Solar Panel: In this complex solar panels are installed to regenerate electricity that is used in the facility.

Pic 5.4.10: *Solar panel are installed on the roof of the facility building to regenerate electricity (Ref:ss)*

Waste water Management: The facility effectively manages its wastewater drainage system through the implementation of Effluent Treatment Plants (ETPs) and Sewage Treatment Plants (STPs) on-site. Wastewater is treated, with 30% of it being recycled for reuse.

Pic 5.4.11: *The waste water treatment plant at site treating waste water to reusable water (Ref:ss)*

The STP is linked to an outfall located in a safe and compliant area via a dedicated collection system. Additionally, the facility operates two separate water systems: one specifically for drinking water and another for domestic use, ensuring proper water management and safety standards are upheld.

Heat Reduction: In the construction of this building, 10-hole bricks are predominantly used due to their effectiveness in reducing heat transfer, making them an ideal choice for structures in hot climates. These bricks contribute significantly to energy efficiency by helping maintain a cooler indoor environment. The holes in the bricks enhance insulation by trapping air, which acts as a natural barrier to heat conduction. Below are the specific ways in which these bricks contribute to reducing the building's overall heat gain:

1. **Thermal Insulation**: The air trapped within the holes acts as a thermal barrier, slowing down the transfer of heat from the outside to the inside of a building. This can make interiors cooler in hot climates and reduce the need for additional cooling systems.

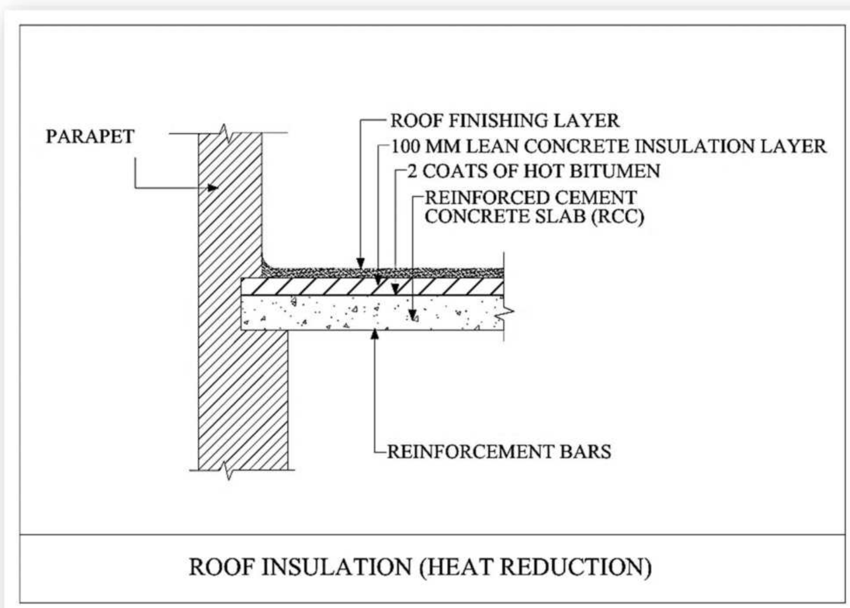
2. **Material Efficiency**: 10-hole bricks use less material compared to solid bricks, making them lighter. This reduction in mass also contributes to lower heat absorption during the day, as less heat is stored in the brick itself.

3. **Improved Ventilation**: The design of 10-hole bricks can allow for better air circulation within walls, which aids in dissipating heat.

Pic 5.4.12: *Facing red bricks used in the building facades (Ref:ss)*

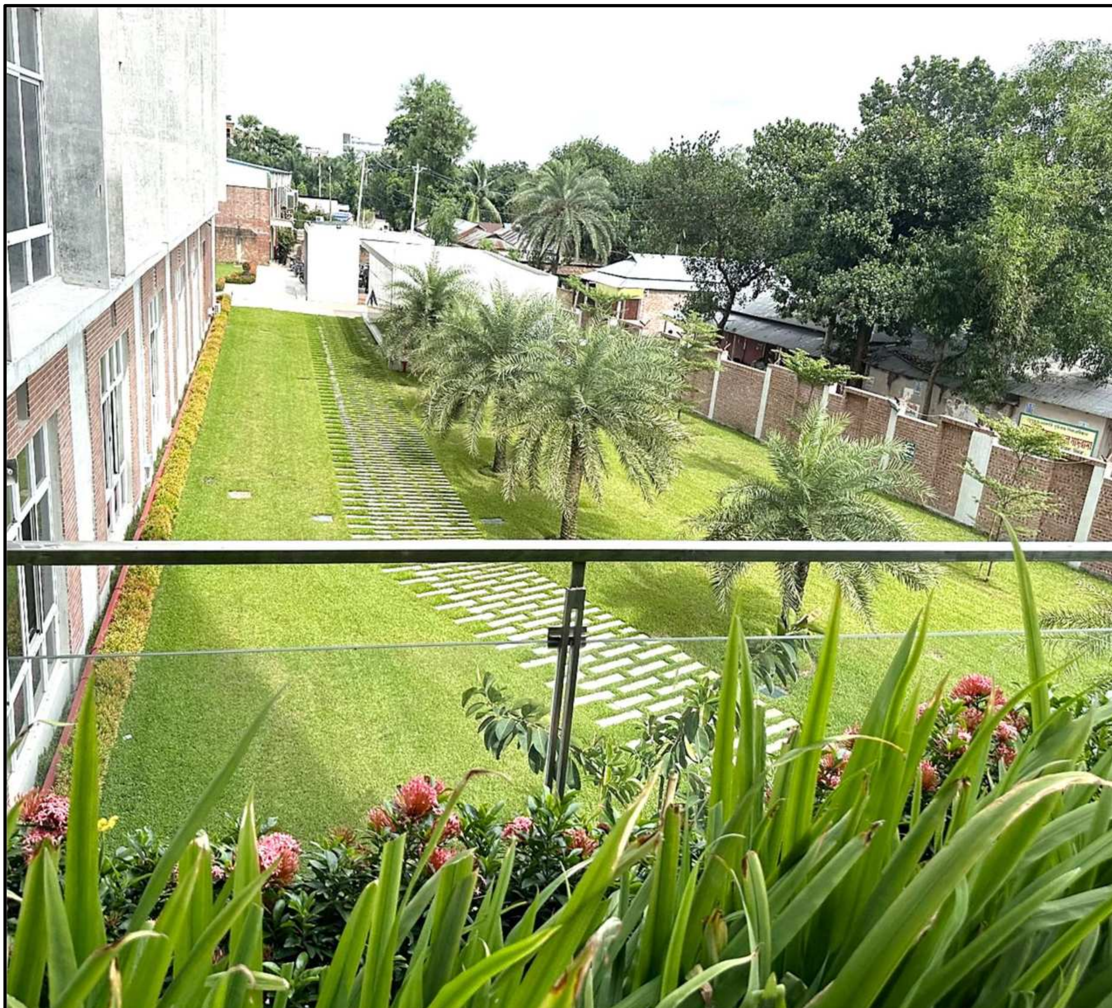
Pic 5.4.13: *10-hole bricks used to build the walls of the building samples at site (Ref:ss)*

Aside from that, a 100 mm patent stone layer is laid during construction over the RCC roof so as to reduce heat from the roof to the interior of the building.



Dia. 5.4.3: *Concept of laying patent stone as insulation on top of roof slab during construction of the building (Ref:ss)*

Open space in the compound: As per green building requirements At least 25% of the required outdoor open space must be vegetated space planted with two or more types of vegetation.
In this case study, nearly 50 percent of the facility is left as open area. A substantial part of the open area is covered with green grasses and light-colored paving blocks which were manufactured at site.



Pic 5.4.14: *Front garden of the building facility (Ref:ss)*

The aesthetically beautiful landscape help create a beautiful atmosphere for the facility.
The building has a few verandahs which are adorned with green grass beds and green plantations even with exclusive plants like bonsais to make the environment pleasant. Grass beds have been incorporated in the MD's floor as well as the staff floor verandah to give it a feel of being close to the earth **(**Pic 5.4.15 & 5.4.16). Light colored floor finishing materials are also used complementing the appearance of the greenery in these verandahs.

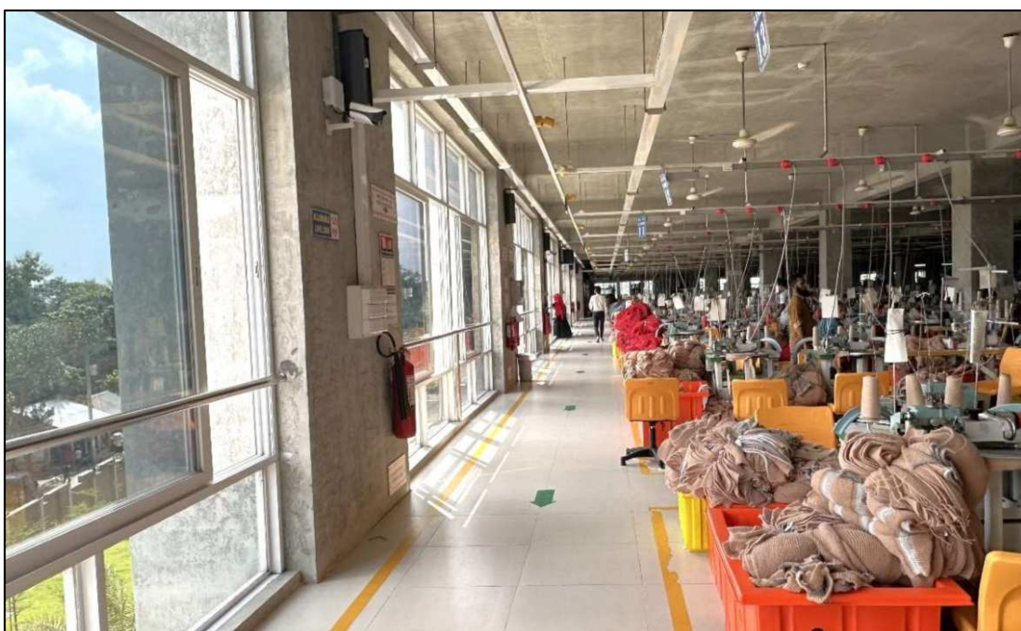
Pic 5.4.15: *Staff verandah at 1st floor with green grass and plantation bed (Ref:ss)*

Pic 5.4.16*: MD's verandah with green grass and plantation bed at an upper floor (Ref:ss)*

Louvers are installed along the west-facing side of the building on nearly every floor, as well as on the roof, to effectively reduce heat gain from direct sunlight. Additionally, all external glazing is tinted, further contributing to maintaining cooler interior temperatures ***(****Pic 5.4.17).*

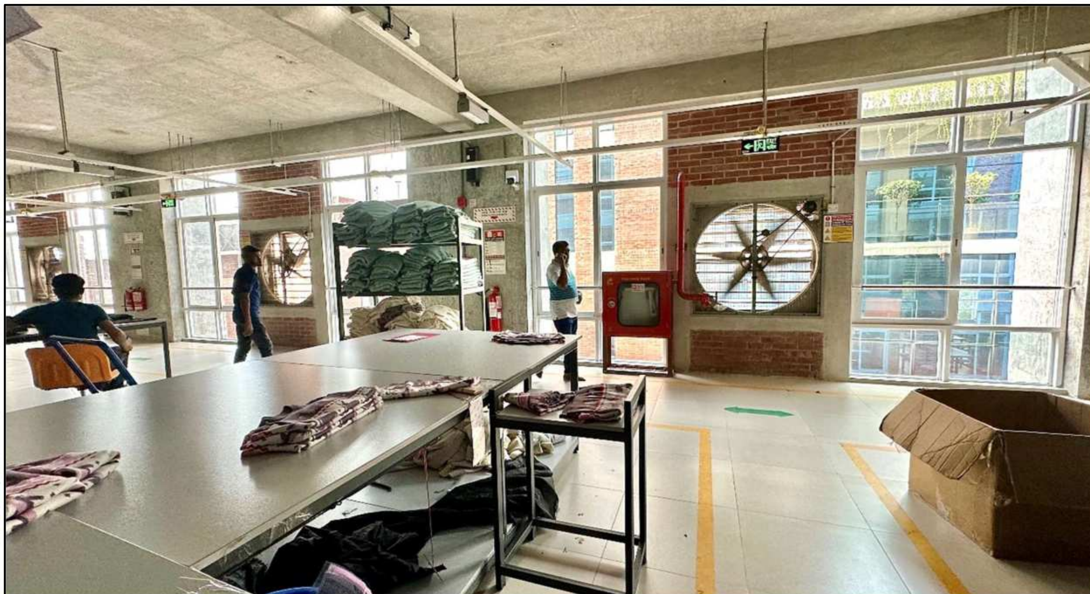
Pic 5.4.17*: Louvers used along the west side (Ref:ss)*

The interior of the building is very well ventilated and has optimum sun light reaches the interior. The longer side of the building faces south so overall it has less surface exposed to sun **(**Pic 5.4.18).

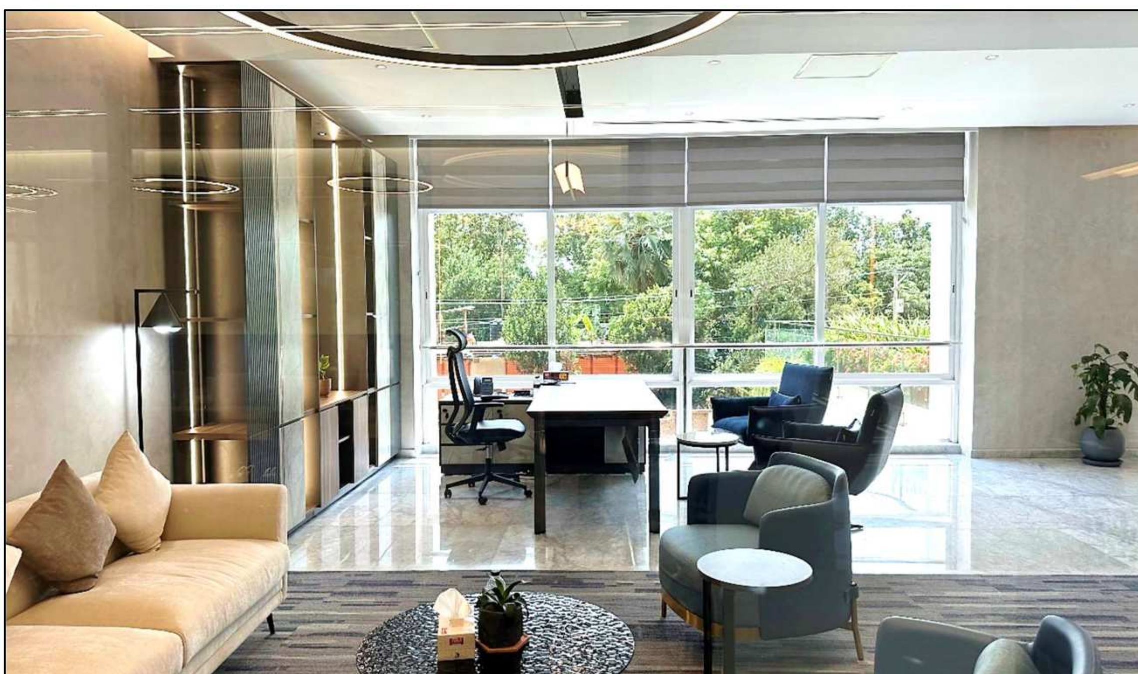


Pic 5.4.18: *Wel lit interior with a good view of the exterior in the working area (Ref:ss)*

To keep the northern side cool exhaust fans have been installed in the northern walls. The heat generated from the ironing is sucked by the exhaust fan and creates a cool working environment **(**Pic 5.4.19).

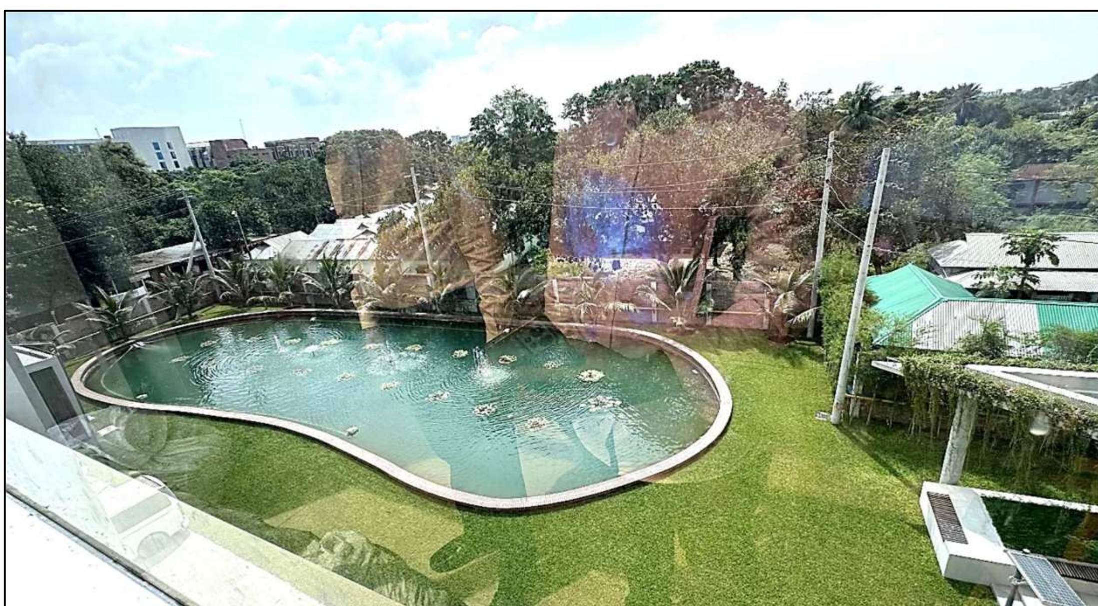


Pic 5.4.19: *Exhaust fan installed in the working areas to keep the area cool (Ref:ss)*



Pic 5.4.20*: Optimum lighting in the office areas (Self sourced) (Ref:ss)*

Pic 5.4.21: *Nice atmosphere boosts mood and in turn productivity of the workers (Ref:ss)*



Pic 5.4.22*: Rainwater reservoir collects rainwater and the water is treated for reuse. (Ref:ss*

Rainwater harvesting: A rainwater harvesting system is considered in the design of the facility. Rainwater is collected in a pond and that is stored there for future use. The pond water is already undergoing the process of purification. Just the connections for reuse to the facilities fixture details are in progress.

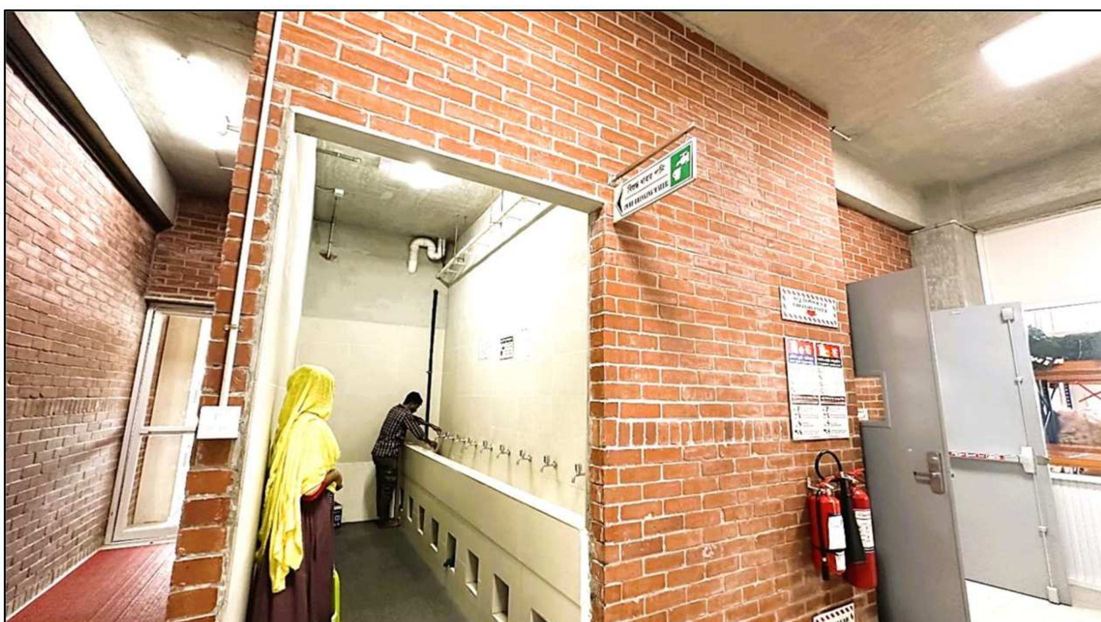
Facilities: The factory workers are very disciplined as they get regular trainings. The owner himself is actively involved to motivate the workers.

The workers have facilities like dining, common room, lockers, fresh water, child care and toilets for the disabled workers. The environment for work is pleasant and there are efficient medical facilities available for the workers. this keeps the workers mentally and physically healthy which is conducive to better productivity which in turn motivates them to help maintain a green building in a passive way.

***Pic 5.4.23**: Locker facility at the factory (Ref:ss)*

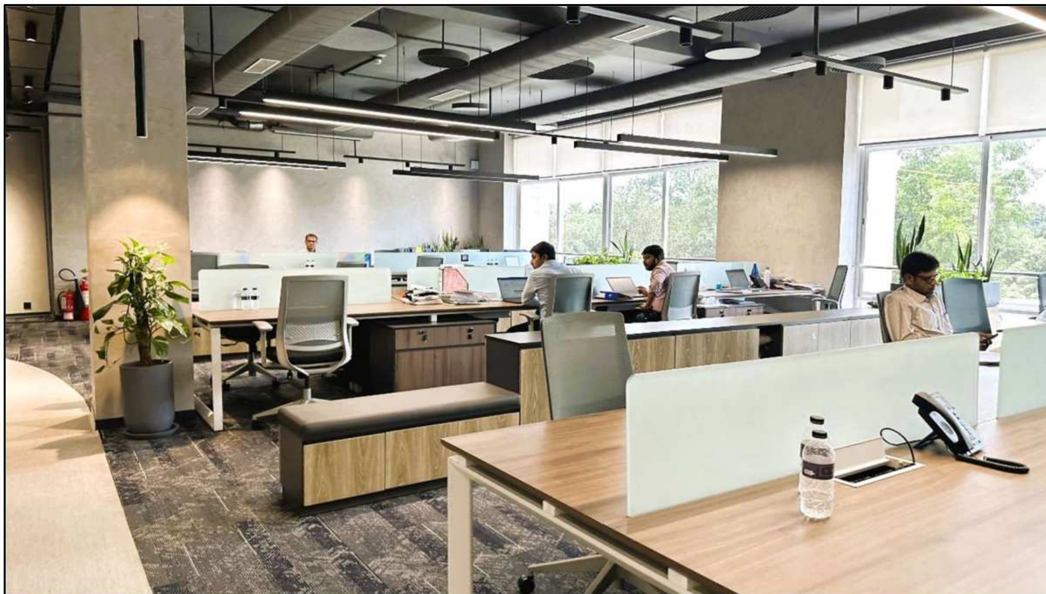
***Pic 5.4.24:** toilets for the disabled workers (Ref:ss)*

Pic 5.4.25: *Child care facility for the Workers' children (Ref:ss)*



Pic 5.4.26*: Drinking water taps in the main building adjacent to the working areas (Ref:ss)*

The factory saves energy in different ways: Foer example for all rooms LED lights are used.



***Pic 5.4.27:** Electricity consumption is reduced as all lightings are LED lights.*
(LED light in Office staff working area) (Ref:ss)

***Pic 4.5.28**: Electricity consumption is reduced as all lightings are LED lights installed in the factory area (Ref:ss)*

Furthermore, the generator exhaust gas is converted into power and then it is reused for the chiller. This reduces gas emission to the environment.

The Feasibility checklist for MNR Sweaters Ltd, Bangladesh is given in the following table:

TABLE 5.4.2: Feasibility checklist for MNR Sweaters Ltd, Bangladesh. Work is in progress.

LEED v4 for BD+C: New Construction

Feasibility Checklist

Project Name - MNR Sweaters Ltd, Bangladesh

Y	Credit		Department	Document/ Data Required	Status	Remarks
7	**LT**	**Location & Transportati on**				
1	*Credit*	Sensitive Land Protection	Client	Local Governing Body Environment Clearance Certificate in English Language	Pending	-
5	*Credit*	Access to Quality Transit	Client & LEED Consultant (D2O)	Pictures of nearby auto- rickshaw or rickshaw stand within 400 m walking distance AND / OR If in-house transport facility is available then need at least 3-year contract copy mentioning number of vehicles and trips per day is required	Pending	Existing informal transit stop is about 800 m from project location Therefore, points have not been assumed. Suggested to provide in-house transport service to target this credit

						incase informal transit is not within 400 m
1	*Credit*	Electric Vehicles	Architect	A. Details of EVSE once designed Must be Level-2 parking (208 – 240 volts) Internet addressable and be capable of participating in a demand-response program or time of use pricing to encourage off-peak charging.	Pending	At least two electric vehicle supply equipment must be provided to achieve this credit Provide signage for Electric Vehicles parking
5	**SS**	**Sustainable Sites**				
Y	*Prereq.*	Construction Activity Pollution Prevention	Civil Contractor	A. Photographs of ESC measures implemented at the site during construction activity.	Receive d	
1	*Credit*	Site Assessment	Client	Site survey report, soil test and water test	Pending	Contour survey report needed
1	*Credit*	Open Space	Architect	Pictures of pedestrian accessible vegetated areas	Pending	

2	*Credit*	Heat Island Reduction	Architect & Landscape Consultant	A. Details of used strategies > High SRI paint on Roof - Specification > Open Grid Grass Pavers - Specification > Shaded Parking covered with High SRI paint/ Energy Generation Systems - Parking Calculations and Specification details of roof system	Pending	-
1	*Credit*	Light Pollution Reduction	Lighting Consultant	A. Details and Specification sheets of all exterior lighting fixtures within project boundary. B. Site Plan showing locations of proposed exterior lighting fixtures. C. BUG Rating simulation results using exterior lighting fixtures IES files.	Pending	
3	**WE**	**Water Efficiency**				
Y	*Prereq.*	Outdoor Water Use Reduction	MEP Consultant	Drip irrigation system specifications drawings or other irrigation if available.	Pending	-
Y	*Prereq.*	Indoor Water Use Reduction	MEP	A. Data sheets/ Make & Model of proposed water fixtures along with the fixtures proposed in kitchen	Pending	-

				area B. Specification of auxiliary requirement for HVAC Cooling Tower (if applicable) such as make up water meters, conductivity controllers, overflow alarms and efficient drift eliminators. C. Provide STP capacity, location and schematic diagram		
2	*Credit*	Cooling Tower Water Use	MEP Consultant	A. For cooling towers and evaporative condensers, conduct a one-time potable water analysis, measuring Ca (as CaCO3),Total alkalinity, SiO2, Cl- and Conductivity and calculate cooling tower cycles on the basis of test results. B. Schematic diagram if using recycled water in Cooling tower	Pending	-
1	*Credit*	Water Metering	MEP Consultant	A. Specification details of water sub meters to be provided for sewage treatment plant, indoor plumbing systems and cooling tower	Pending	-

8	**EA**	**Energy and Atmosphere**				
Y	*Prereq.*	Fundamental Commissioning and Verification	MEP Consultant	A. Design Basis Report for Electrical Systems B. Design Basis Report for Plumbing Systems C. Design Basis Report for HVAC Systems	Received	
Y	*Prereq.*	Minimum Energy Performance	LEED Consultant (D2O)	A. All Floor Architectural Plans B. All Floor HVAC Plans C. Elevation Plans D. Specification and Construction details of Exterior Wall, Roof and Glass used/ proposed in the project. E. Lighting Layouts for interior and exterior lighting	Partly Received	
4	*Credit*	Enhanced Commissioning	Controls Engineer	A. Specification details of proposed BMS System B. Input output point summary details of proposed BMS System	Pending	Additional details needed
1	*Credit*	Advanced Energy Metering	MEP Consultant & Controls Engineer	A. List of all energy meters and sub meter proposed in the project B. Diagram showing location of energy meters	Pending	Space cooling, Equipment loads, Interior & Exterior Lighting etc are required to be metered

3	*Credit*	Renewable Energy	MEP Consultant	A. Details of Renewable Energy Source Used at the Site (Type, Location, Capacity) (If Applicable) B. PO copy and PPA copy once procured	Pending	Roof top of factory building has ample solar potential to get 3 points under this category. Roof top has over 300 kW Solar PV potential which can contribute to energy savings . 10% of total energy consumption of the entire building can be generated through a 150kW Solar PV system and we can target 3 points here.
5	**MR**	**Material and Resources**				
Y	*Prereq.*	Storage and Collection of Recyclables	Architect/Client	Provide designated spaces for collection and storage of recyclable materials for the entire building with photos	Pending	
1	*Credit*	Environmental Product Declarations	Client	List of all civil and interior materials BoQ. Please share manufacturer data and product name with application of these materials in building	Pending	-

2	*Credit*	Sourcing of Raw Materials	Client	Manufacturer letter or other document showing preconsumer and postconsumer recycling content of steel and any other recycled products used in building	Pending	
2	*Credit*	Construction and Demolition Waste Management	Civil Contractor	A. Details of total non hazardous waste generated and diverted during construction and demolition activities. B. Hauler/ Recycler receipt copies for all construction and demolition waste with declaration letters for recycled waste	Pending	Sample letter shared over mail
11	**IEQ**	**Indoor Environmental Quality**				
Y	*Prereq.*	Minimum Indoor Air Quality Performance	MEP Consultant	Outdoor air flow monitoring system details	Pending	
Y	*Prereq.*	Environmental Tobacco Smoke Control	Client	No smoking signage in building with photographs, No smoking Policy	Pending	
2	*Credit*	Enhanced Indoor Air Quality Strategies	Architect	Details, and Photographs of the compliance strategy used. (Entry way mats, CO_2 monitoring systems, MERV 13 filters)	Pending	

2	*Credit*	Indoor Air Quality Assessment	MEP Consultant	IAQ testing report (For Formaldehyde, Particulates, Ozone, TVOCs, Carbon monoxide)	Pending	
1	*Credit*	Thermal Comfort	MEP Consultant	List of spaces by type, quantity, and thermal comfort controls provided at the project.	Pending	
2	*Credit*	Interior Lighting	Lighting Consultant	List of spaces by type, quantity, and lighting comfort controls provided at the project. Specification sheets for lighting fixtures	Pending	
2	*Credit*	Daylight	LEED consultant (D2O)	Provide final glass U-value, SHGC , VLT selected . D2O team will do the daylight simulation for the project.	Pending	Daylight simulation will be carried out once specifications of glass such as U-value, VLT and SHGC are provided. For best results it is recommend to have U-value below 1.2 Btu/hft2 F and VLT of at least 50-60%

1	Credit	Quality Views	Architect	Renderings, or photos indicating outdoor views and blinds/screens	Pending	
1	Credit	Acoustic Performance	Architect	Acoustic test report for project interior spaces as per LEED guidelines	Pending	Needs third party consultant
6	**IN**	**Innovation**				
5	*Credit*	Innovation	LEED Consultant (D2O)			Exemplary in Rainwater Harvesting , Heat Island Effect reduction Innovation in O+M Starter kit, Sustainable wastewater managemen t and Pilot credit for promoting social equity in the community
1	*Credit*	LEED Accredited Professional	LEED Consultant (D2O)	-		Available

TABLE 5.4.3: LIST OF RESPONDENTS FROM MNR GARMENTS FACTOR

	NAME	DESIGNATION	AGE
1.	MD. MOSTAFA	MANAGING DIRECTOR, MNR	58
2.	AHMED	GENERAL MANAGER	57
6.	OBAYDUR RAHMAN	MANAGER, ADMIN, HR & COM	42
7.	MD. ABU TUHIN	ASSTT. MANAGER, ADMIN	37
3.	NAHID KAMAL	ENGINEER	28
4.	MD. KABIR	SUPPLIER (GM)	62
8.	MD. AL IMRAN	OFFICER (HR)	35
9.	MAHAMUDA AKTER MUNNI	SR. WELFARE OFFICER	36
10.	ARMAN RAFI	OFFICER (HR)	37
11.	MD. JEWEL MIAH	AUTO KNITTING IN CHARGE	35
12.	MD. MUSTOFA KAMAL	LINKING IN CHARGE	45
13.	MD. BELAL HOSSAIN	AUTO KNITTING SUPERVISOR	37
14.	MD. FAZLUL HAQUE	LINKING SUPERVISOR	38
15.	HANNAN CHOWDHURY	PACKING SUPERVISOR	33
16.	MD. ANICHUR RAHMAN SHEIKH	IRON SUPERVISOR	45
17.	MD. SAFIUL	FINISHING SUPERVISOR	42
18.	TASLIMA AKTER	JR. MENDING OPERATOR	33
19.	MRS. AMINA KHATUN	JR. MENDING OPERATOR	31
20.	MRS. MINARA AKTER	JR. MENDING OPERATOR	27
21.	MD. AMIR HAMZA	JR. KNITTING QI	37
22.	MD. SHAHIN MIAH	JR. KNITTING QI	44
	NARGIS ARA	JR. KNITTING QI	38
23.	MD. KHAIRUL ISLAM	JR. MENDING OPERATOR	29
24.	SHOHAG MIAH	JR. KNITTING QI	35
25.	SHAHIN ALOM	JR. KNITTING QI	38
26.	ASIYA AKTER	JR. LINKING OPERATOR	22
27.	ANOWAR HOSSAIN	JR. LINKING OPERATOR	26
28.	RABIA AKTER	JR. TRIMMING QUALITY INSPECTOR	33
29.	KHALILUR RAHMAN	JR. AUTO LINKING OPERATOR	28
30.	MRS. SANIA	JR. AUTO LINKING OPERATOR	25

5.5 CASE STUDY 05
RESIDENTIAL HOMES (HOUSEHOLD)

In this section, a survey was conducted to fifteen households or residential buildings in Dhaka to assess the residents' awareness and demand for the element indicative of green building design technologies. Additionally, the survey aimed to observe their interest in living within an environmental set up, shaped by sustainable building practices.

The survey was conducted in fifteen households with two respondents selected from each of the households. The total number of respondents were thirty. The southern part of Dhaka is known for its higher population density, and most case studies were chosen from around that area.

The questionnaire was designed based on specific green building indicators, with values assigned to responses. Positive values were attributed to affirmative answers, while negative values were attributed to negative responses. In instances where respondents were either unable to provide an answer or were uncertain, a value of zero (null) was recorded.

After collating the responses, the answers to the survey questions were weighted and analyzed. The questionnaire was structured such that responses in the 'Yes' column indicated a favorable inclination towards the benefits of green buildings, while responses in the 'No' column reflected a reluctance or opposition to green technology. Those who responded with 'Not sure' suggested either a lack of understanding regarding the advantages of green design or an absence of a firm opinion on the topic.

If the weighted responses skewed more towards positive values, it was interpreted as an indication that respondents were inclined towards the benefits of green building designs. Conversely, if the weighted responses leaned more towards negative values, it suggested that the respondents were less supportive of green building designs. A predominantly positive response would suggest that the adoption of green technology in shaping future building designs is more feasible and sustainable.

The list of the households surveyed is given in the table below:

TABLE 5.5.1: THE LIST OF THE HOUSEHOLDS SURVEYED UNDER THE STUDY

01. Sahara Begum Bhaban	09. Teacher’s quarter,Muktijoddha Ziaur Rahman Hall, DU
02. Lovely Vila	10. Azimpur Govt. Officer's Quarter
03. NCB Tower	11. 33/2, Azimpur Road,Lalbag,Dhaka
04. Kunjobithi Apartment	12. 76, Lake Circus,Kalabagan
05. Baisara	13. Khandokar Palace
06. Matri Kunjo	14. Mozaffar Mansion
07. Earth Oasis	15. Khondokar's home
08. Zobeda Vila	

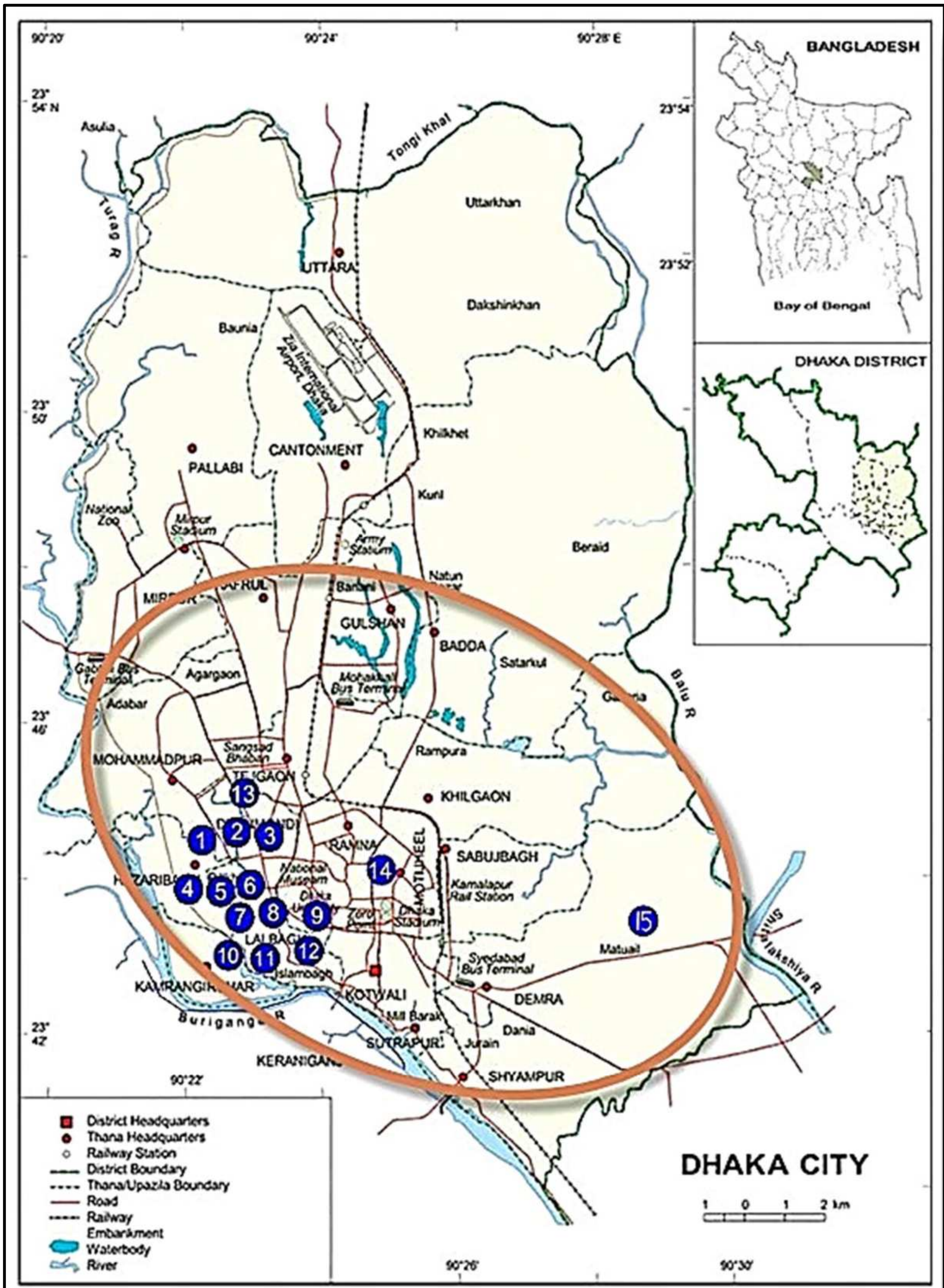
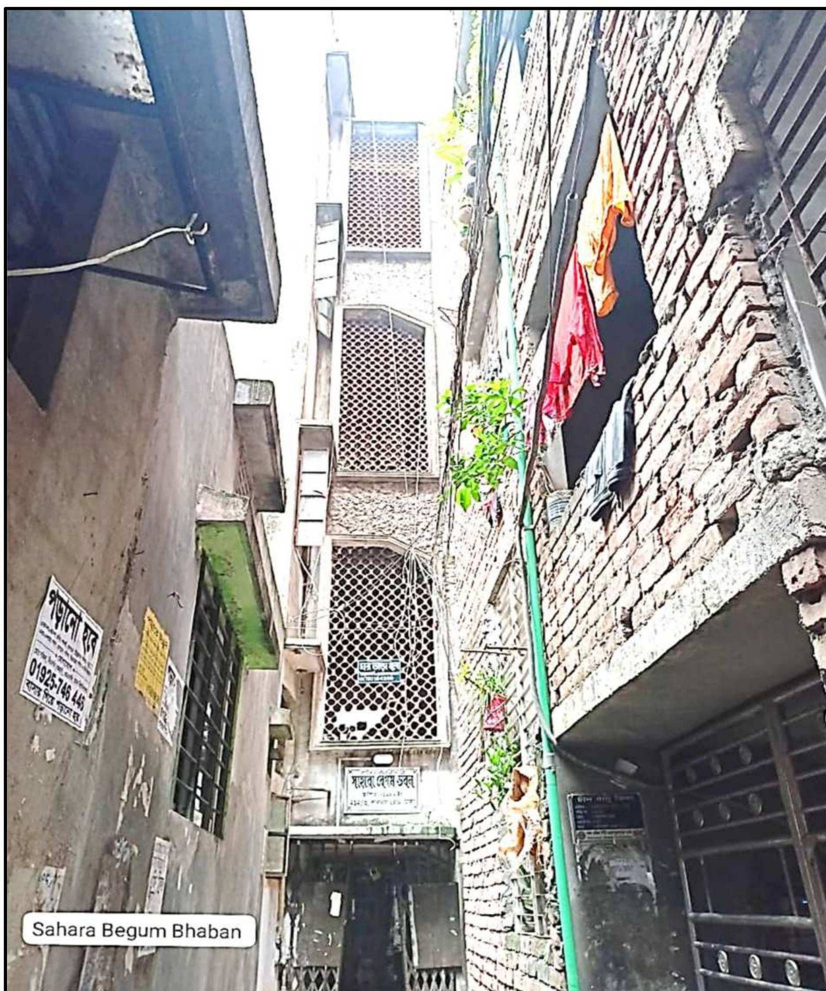


Diagram 5.5.1: Location of the Case Studies of the Households on the Dhaka City Ma

THE DETAILS OF THE CASE STUDIES ARE GIVEN BELOW:
(Picture of the case studies are given along with their detail information).

CASE STUDY: 01

NAME OF RESIDENCE: **SAHARA BEGUM BHABAN**
ADDRESS: 212/B, Lalbag Road, Pilkhana, Dhaka-1212,
Near Medical Staff Quarter
NAME OF RESPONDANT: Md. Abdul Malek
AGE: 75 Y; OCCUPATION: Retired Person
NAME OF RESPONDANT 2: Md. Raqibul
AGE: 35 Y; **OCCUPATION**: Pharmacist



Pic 5.5.1: *Picture showing the CASE STUDY: 01*
Name of Residence: SAHARA BEGUM BHABAN

CASE STUDY: 02

NAME OF RESIDENCE: LOVELY VILLA
ADDRESS: 35/1, Lalit Mohan Das Lane, Lalbag, Dhaka
NAME OF RESPONDANT 1: Md. Pappu**; AGE**: 65; OCCUPATION: Business
NAME OF RESPONDANT 2: Shahana; **AGE**: 18 Y; **OCCUPATION**: College Student
NO. OF OCCUPANTS IN THE BUILDING: 80 persons (16 Families)

Pic 5.5.2 (above) Pic 5.5.3 (below): *Pictures showing the CASE STUDY: 02 Building & Solar panels on roof* ***(****Name of Residence: LOVELY VILLA****)***

CASE STUDY: 03

Pic 5.5.4: *Picture showing the CASE STUDY: 03*
Name of Residence: N C B TOWER

NAME OF RESIDENCE: **NCB TOWER**

ADDRESS: 1, Lalbag Road, Dhaka

NAME OF RESPONDANT 1: Molly Begum

AGE: 50 Y; OCCUPATION: House wife

NAME OF RESPONDANT 2: Md. Sarwar Uddin

AGE: 38 Y; **OCCUPATION**: Shop Owner

NO. OF OCCUPANTS IN THE BUILDING: 140 persons (28 Families)

CASE STUDY: 04

NAME OF RESIDENCE: **KUNJOBITHI APARTMENT**

ADDRESS: 63, Pilkhana Road, Azimpur, Dhaka

Pic 5.5.5: *Picture showing the CASE STUDY: 04*
Name of Residence: KUNJOBITHI APARTMENT

NAME OF RESPONDANT 1: Mirja Monir

AGE: 44 Y; OCCUPATION: Manager

NAME OF RESPONDANT 2: Md. Fakhrul

AGE: 25 Y; **OCCUPATION**: Cleaner

NO. OF OCCUPANTS IN THE BUILDING: 395 persons (80 Families)

(20 respondents verbally participated but 2 were recorded in writing)

CASE STUDY: 05

NAME OF RESIDENCE: **BAISARA**

ADDRESS: 59/2, Pilkhana Road, Azimpur, Dhaka

Pic 5.5.6: *Picture showing the CASE STUDY: 05*
Name of Residence: BAISARA

NAME OF RESPONDANT 1: Md. Robin

AGE: 60 Y; **OCCUPATION**: Retired

NAME OF RESPONDANT 2: Nasrin Keya

AGE: 21 Y; **OCCUPATION**: Student

NO. OF OCCUPANTS IN THE BUILDING: 14 persons (3 Families)

CASE STUDY: 06

NAME OF RESIDENCE: **MATRI KUNJO**

ADDRESS: 44/1, Pilkhana, Dhaka.

Pic 5.5.7: *Picture showing the CASE STUDY: 06*
Name of Residence: MATRI KUNJO (left)
Pic 5.5.8: *MATRI KUNJO Entry Gate (right)*

NAME OF RESPONDANT 1: Abdul Karim Bhuyan

AGE: 70 Y; **OCCUPATION**: Librarian (Ex.)

NAME OF RESPONDANT 2: Amena Begum

AGE: 65 Y; **OCCUPATION**: Housewife

NO. OF OCCUPANTS IN THE BUILDING: 22 persons (4 Families)

CASE STUDY: 07

NAME OF RESIDENCE: EARTH OASIS

ADDRESS: 43/A, Pilkhana Road, Azimpur, Dhaka

Pic 5.5.9: *Picture showing the CASE STUDY: 07
Name of Residence: EARTH OASIS*

NAME OF RESPONDANT 1: Ms. Farzana Alam Choudhury

AGE: 45 Y; **OCCUPATION**: Housewife

NAME OF RESPONDANT 2: Md. Ashraful

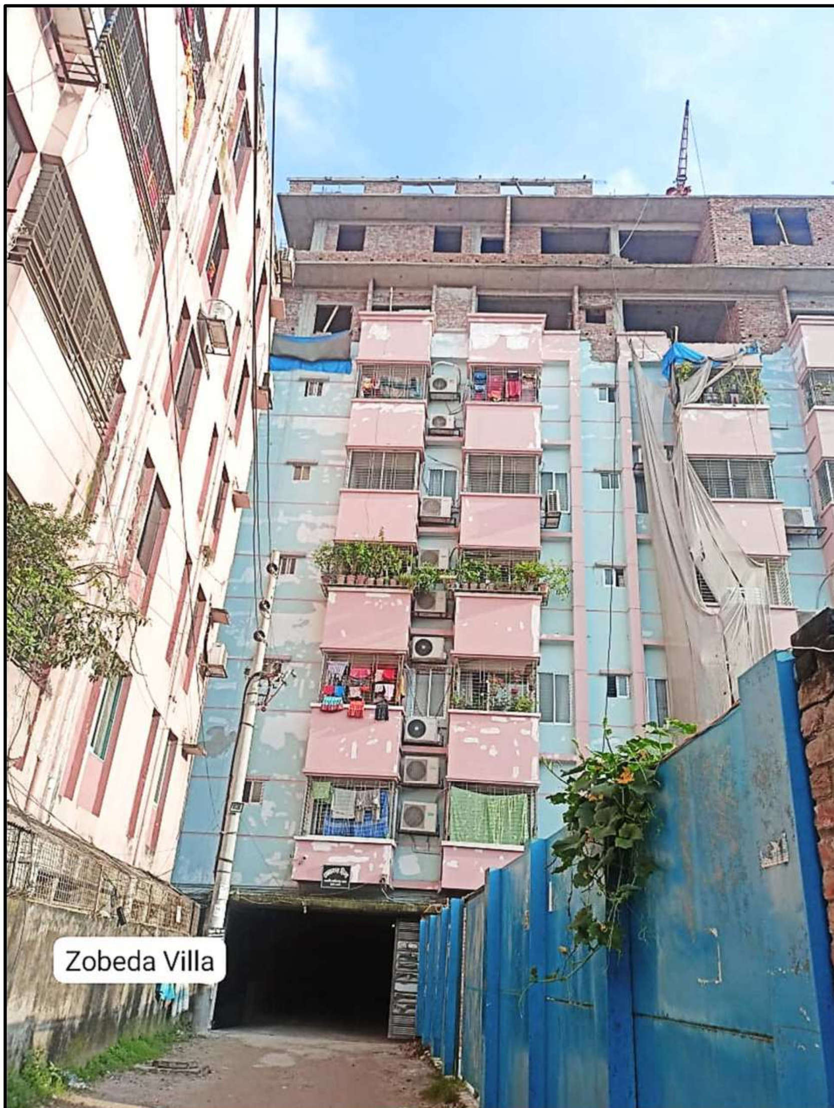
AGE: 55 Y; **OCCUPATION**: Businessman

NO. OF OCCUPANTS IN THE BUILDING: 90 persons (18 Families)

CASE STUDY: 08

NAME OF RESIDENCE: ZOBEDA VILLA

ADDRESS: 33/C, Azimpur Road, Dhaka-1205



Pic 5.5.10: *Picture showing the CASE STUDY: 08*
Name of Residence: ZOBEDA VILLA

NAME OF RESPONDANT 1: Akram Hossain

AGE: 30 Y; **OCCUPATION**: Teacher

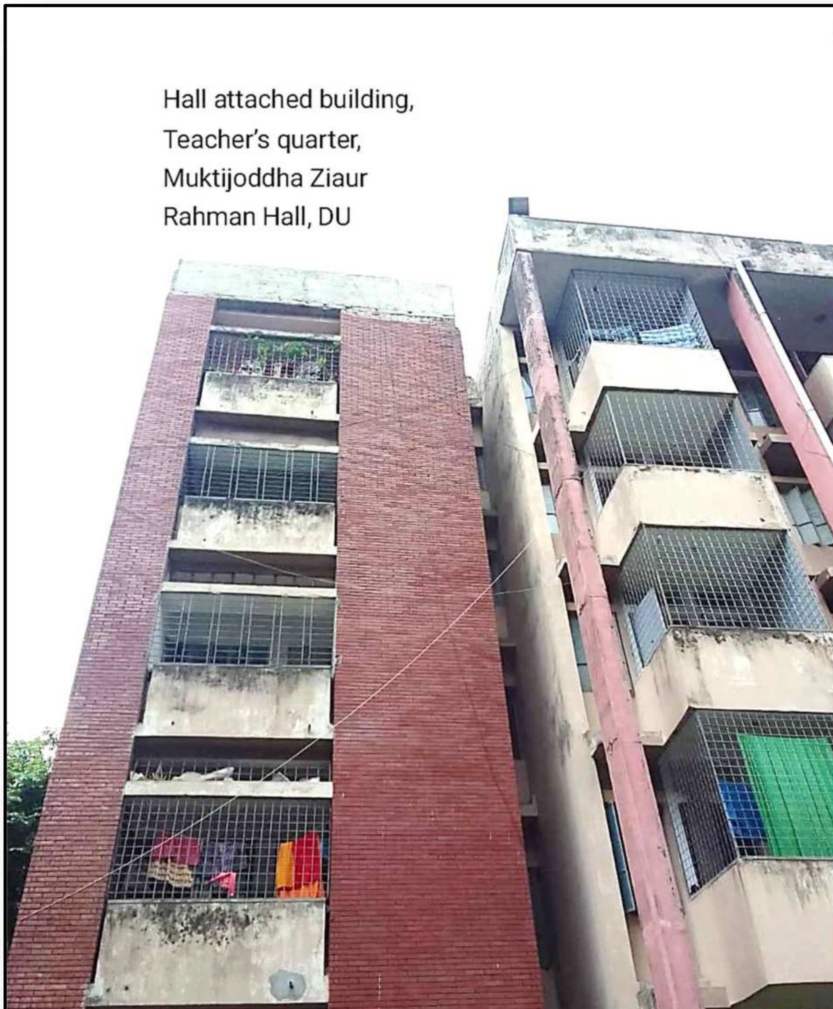
NAME OF RESPONDANT 2: Bellal Hossain

AGE: 28 Y; **OCCUPATION**: Accountant

NO. OF OCCUPANTS IN THE BUILDING: 120 persons (22 Families)

CASE STUDY: 09

NAME OF RESIDENCE: **TEACHER'S QUARTER** (HALL ATTACHED BUILDING)
ADDRESS: Muktijoddha Ziaur Rahman Hall, University odf Dhaka.



Pic 5.5.11: *Picture showing the CASE STUDY: 09*
TEACHER'S QUARTER

NAME OF RESPONDANT 1: K. M. Aftabul Islam Tonmoy; **AGE**: 30 Y;

OCCUPATION: Lecturer, Dept. of Pali and Buddhist Studies, University of Asia Pacific

NAME OF RESPONDANT 2: Md. Kamruzzaman

AGE: 26 Y; **OCCUPATION**: IT Officer

NO. OF OCCUPANTS IN THE BUILDING: 40 persons (8 Families)

CASE STUDY: 10

NAME OF RESIDENCE: **AZIMPUR GOVT. OFFICER'S QUARTER**

ADDRESS: Azimpur Govt. Officer's Quarter, Bldg. No. 04, Azimpur, Dhaka

Pic 5.5.12: *Picture showing the CASE STUDY: 10*
Name of Residence:: AZIMPUR GOVT. OFFICER'S QUARTER

NAME OF RESPONDANT 1: Amanullah Bhuiyan

AGE: 75 Y; OCCUPATION: Retired Person, Ex. Personnel, Border Guard Bangladesh (BGB)

NAME OF RESPONDANT 2: Mojina Begum

AGE: 32 Y; **OCCUPATION**: Home Tutor

NO. OF OCCUPANTS IN THE BUILDING: 296 persons (60 Families)

CASE STUDY: 11

NAME OF RESIDENCE: Building with no name
ADDRESS: 33/2, Azimpur Main Road, Lalbag, Dhaka

Pic 5.5.13: *Picture showing the CASE STUDY: 11*
(Building with no name)

NAME OF RESPONDANT 1: M.A. Wahab
AGE: 51 Y; **OCCUPATION**: Lawyer
NAME OF RESPONDANT 2: Shumon
AGE: 22 Y; **OCCUPATION**: University Student
NO. OF OCCUPANTS IN THE BUILDING: 53 persons (10 Families)

CASE STUDY: 12

NAME OF RESIDENCE: Building with no name

ADDRESS: 76, Lake Circus, Kalabagan, Dhaka

Pic 5.5.14: *Picture showing the CASE STUDY: 12, at 76, Lake Circus, Kalabagan. (Building with no name)*

NAME OF RESPONDANT 1: Anima

AGE: 51 Y; **OCCUPATION**: Housewife

NAME OF RESPONDANT 2: Ritika

AGE: 18 Y; **OCCUPATION**: College Student

NO. OF OCCUPANTS IN THE BUILDING: 19 persons (4 Families)

CASE STUDY: 13

NAME OF RESIDENCE: KHANDOKAR PALACE
ADDRESS: 42/1, North Road, Dhanmondi, Dhaka.

Pic 5.5.15: *Picture showing the CASE STUDY: 13*
Name of Residence: (KHANDOKAR PALACE)

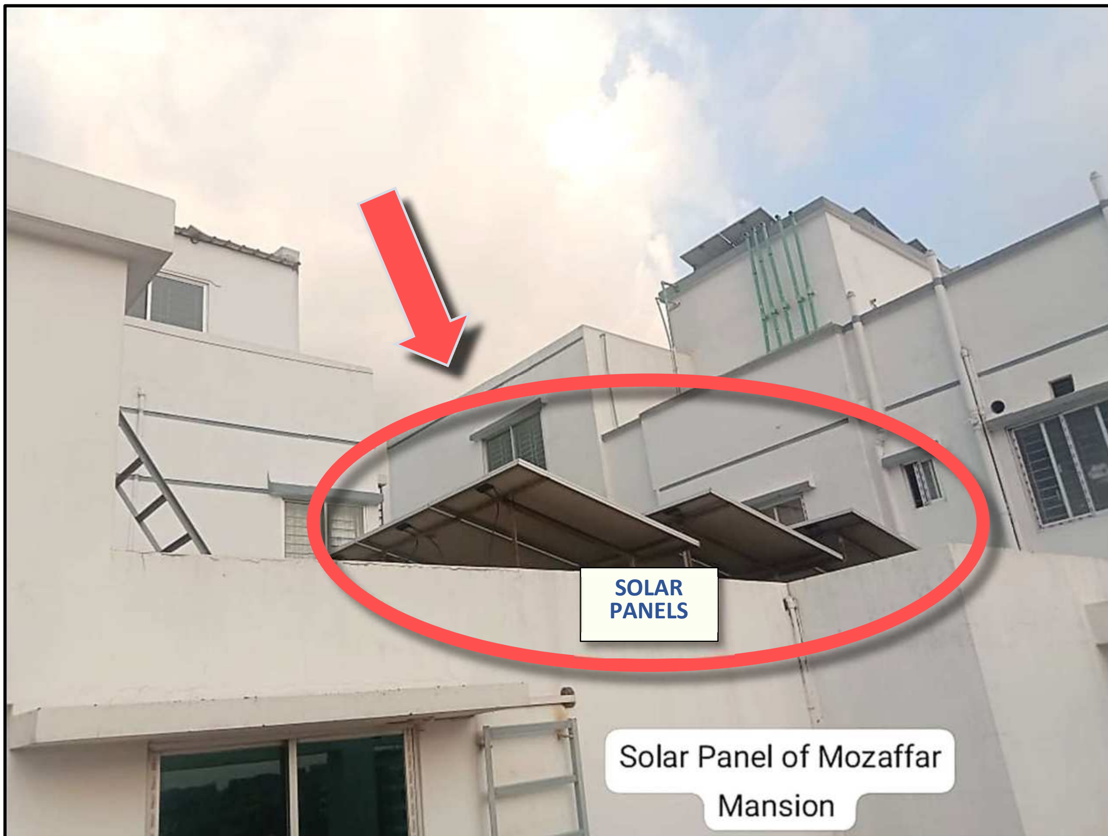
NAME OF RESPONDANT 1: Tanbir Khandokar
AGE: 28 Y; **OCCUPATION**: Lecturer, Dept. of Law, University of Asia Pacific
NAME OF RESPONDANT 2: Masuma Parvin
AGE: 25 Y; **OCCUPATION**: School Teacher
NO. OF OCCUPANTS IN THE BUILDING: 48 persons (10 Families)

CASE STUDY: 14

NAME OF RESIDENCE: MOZAFFAR MANSION

ADDRESS: 6/13, Modhubag, Dhaka

Pic 5.5.16: *Picture showing the CASE STUDY from exterior: 14*
Name of Residence: MOZAFFAR MANSION



Pic 5.5.17: *Picture showing the CASE STUDY: 14*
Name of Residence: MOZAFFAR MANSION

NAME OF RESPONDANT 1: Kulsum Haque

AGE: 39 Y; **OCCUPATION**: Teacher

NAME OF RESPONDANT 2: Jamila

AGE: 16 Y; **OCCUPATION**: School Student

NO. OF OCCUPANTS IN THE BUILDING: 71 persons (14 Families)

CASE STUDY: 15

NAME OF RESIDENCE: KHONDOKAR'S HOME
ADDRESS: Matuail, Dhaka

Pic 5.5.18: *Picture showing the CASE STUDY: 15*
Name of Residence: KHONDOKAR'S HOME

NAME OF RESPONDANT 1: Khondokar Shahjahan
AGE: 45 Y; **OCCUPATION**: Private service holder
NAME OF RESPONDANT 2: Jasmina Tonu
AGE: 35 Y; **OCCUPATION**: Housewife
NO. OF OCCUPANTS IN THE BUILDING: 24 persons (5 Families)

TABLE 5.5.2: THE LIST OF RESPONDENTS FROM THE HOUSEHOLDS SURVEYED

	NAME	DESIGNATION	AGE
1.	K M AFTABUL ISLAM	LECTURER, DHAKA UNIVERSITY	30
2.	KHONDOKAR	PRIVATE SERVICE	42
3.	TANBIR KHANDKER	LECTURER, UNIVERSITY OF ASIA	28
4.	ABDUL MALEK	RETIRED PERSON	75
5.	FARZANA ALAM	HOUSEWIFE	45
6.	ABDUL KARIM BHUYAN	EX. LIBRARIAN	70
7.	MD. ROBIN	RETIRED OFFICER	50
8.	MD. FURKAN HOSSIN	FLOOR IN CHARGE	43
9.	MIRJA MONIR	MANAGER	44
10.	MOLLY	BUSINESS PERSON	50
11.	MD. PAPPU	BUSINESS PERSON	55
12.	KULSUM HAQUE	TEACHER	39
13.	AMANULLAH BHUIYAN	RETIRED PERSON (BGB)	75
14.	M A WAHAB	LAWYER	52
15.	AKRAM HOSSAIN	MANAGER	30
16.	ISHMAM AHMED	STUDENT	24
17.	TAHMIN AHMED	STUDENT	22
18.	RUKHSANA KHAN	PHYSICIAN	59
19.	NASRIN PAVIN	PHYSICIAN	56
20.	ELHAAM PARVEEN	STUDENT	25
21.	NAZRANA KHALED	CONSULTANT	30
22.	MUSTAFA HASAN	CHIEF COORDINATOR, BAY	60
23.	KHALED MOHSIN	PHYSICIAN	60
24.	SARWAR ALAM	BUSINESS PERSON	70
25.	SHIRIN MAHMUD	EX. VICE PRINCIPAL, SHAHEEN	68
26.	TAMZEED AHMED	PHYSICIAN	58
27.	MAHMUD HOQ	BUSINESS PERSON	76
28.	FAISAL ISLAM	CHEMICAL ENGINEER	50
29.	TANI ALAM	BA, DHAKA UNIVERSITY	66
30.	NAHEED ZAIDI	BUSINESS	57

ANNEX 5.1

SCANNED IMAGES OF A TYPICAL QUESTIONNAIRE UNDER THE STUDY

QUESTIONNAIRE SET NO. 1

TABLE1: SURVEY ON PEOPLE'S ANSWERS BASED ON GREEN BUILDING INDICATORS AND CURRENT STATUS OF BUILDINGS

CASE STUDY 01	**LOCATION:** 35/1, Lalit Mohan Das Lane, Lalbag, Dhaka
NAME OF BUILDING: Lovely villa	**NAME OF RESPONDENT:** MD. Pappu Age: 65
	OCCUPATION: Business
	TYPE OF FACILITIES IN THE BUILDING (RESIDECE / OFFICES/ FACTORIES/ COMMERCIAL/ OTHER): Residence
	NO OF OCCUPANTS IN THE BUILDING (TOTAL NUMBER & NO. OF FAMILIES): 16 Families

1

Sl.	INDICATORS		ACQUIRED NUMBER: Yes = 2	Not Sure =0	No = -2	Not applicable (N/A)	TOTAL NUMBER (Column R)	COMMENTS
01.	LOCATION AND TRANSPORTATION	i) Was the building constructed on an unused vacant land?			No		-2	
		ii) Is the building renovated or restored?			No		-2	
		iii) Is there any hospital nearby?	Yes				2	
		iv) Is there any market nearby?	Yes				2	

2

		INDICATORS	Yes = 2	Not Sure =0	No = -2	Not applicable (N/A)	TOTAL NUMBER (Column R)	COMMENTS
	LOCATION AND TRANSPORTATION	v) Is there any mosque nearby?	Yes				2	
		vi) Is there any bus stop nearby?	Yes				2	
		vii) Is there any area dedicated for bicycle parking for the building?			No		-2	
		viii) Would it be convenient for the users if the above facilities were nearby?	Yes				2	

3

		INDICATORS	Yes = 2	Not Sure =0	No = -2	Not applicable (N/A)	TOTAL NUMBER (Column R)	COMMENTS
02.	**SUSTAINABLE SITES**	i) **In case of renovations or restorations** are any part of the building restored?			No		-2	
		ii) Is there any **open space** in the site?			No		-2	There were a field many times ago.
		Heat Island reduction:						
		iii) Is there any special paint used on the roof surface to reflect the heat from sunlight/ or was any treatment other than that done? (e.g. *Jolchhad* (waterproofing by means of patent stone)			No		-2	

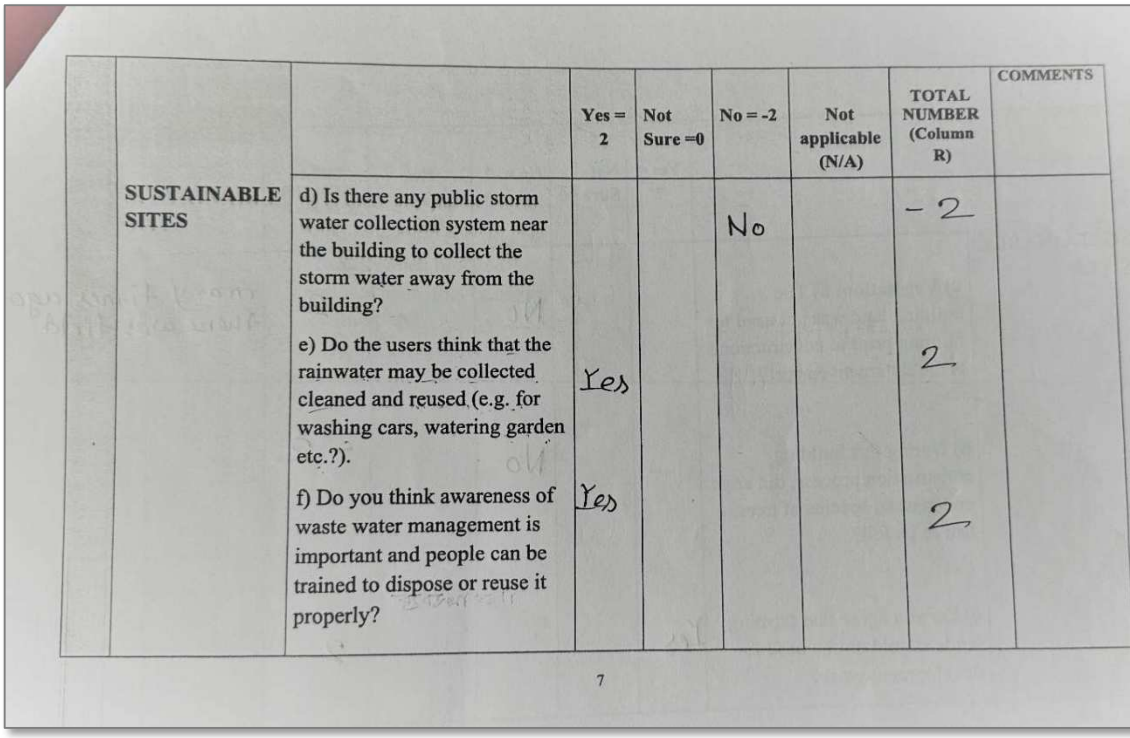
4

			Yes = 2	Not Sure =0	No = -2	Not applicable (N/A)	TOTAL NUMBER (Column R)	COMMENTS
	SUSTAINABLE SITES	iv) Is the majority of the open area green?	Yes				2	
		v) In case if there are some paved areas, are the paving tiles light in color such as light gray or light red? [illegible]			No		-2	
		vi) Wouldn't it be convenient if the answers to the above were, yes?	Yes				2	

5

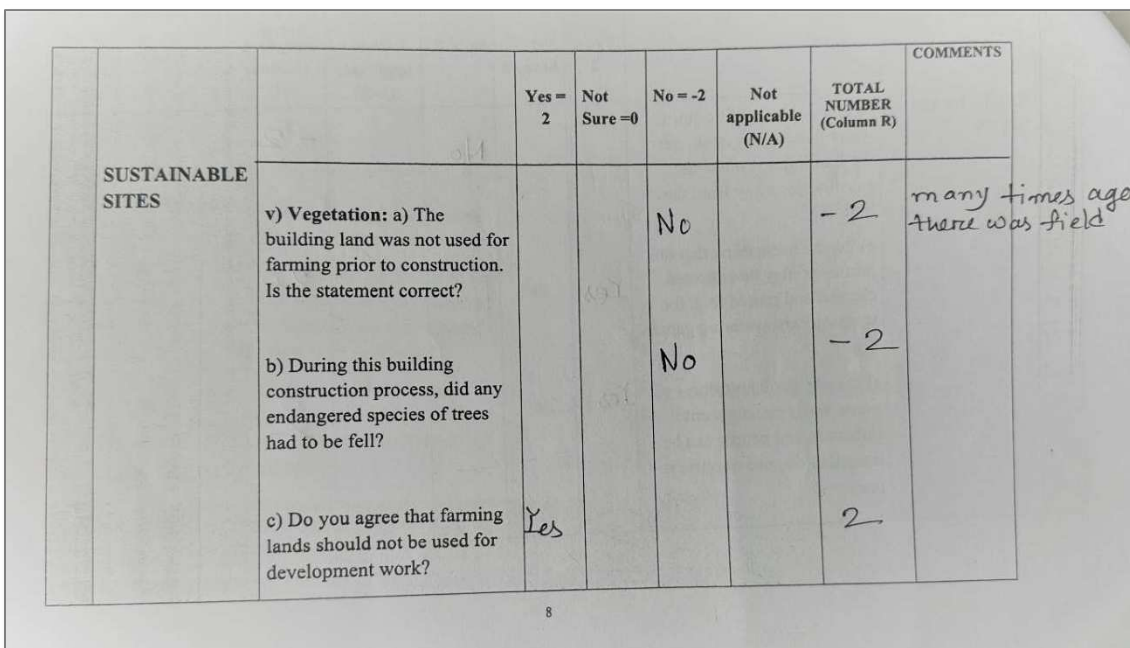
			Yes = 2	Not Sure =0	No = -2	Not applicable (N/A)	TOTAL NUMBER (Column R)	COMMENTS
	SUSTAINABLE SITES	vii) **Hydrology and Storm Water Management:**						
		a) Is the site located in an area where there is less chance of flooding (is the site situated away from wetlands)?	Yes				2	
		b) Does the building have drainage pipe on the roof for rain water to run down to the ground?	Yes				2	
		c) Are all the drains and pipes maintained properly from time to time?	~~Yes~~		No		-2	

6



			Yes = 2	Not Sure =0	No = -2	Not applicable (N/A)	TOTAL NUMBER (Column R)	COMMENTS
	SUSTAINABLE SITES	d) Is there any public storm water collection system near the building to collect the storm water away from the building?			No		-2	
		e) Do the users think that the rainwater may be collected cleaned and reused (e.g. for washing cars, watering garden etc.?).	Yes				2	
		f) Do you think awareness of waste water management is important and people can be trained to dispose or reuse it properly?	Yes				2	

7



			Yes = 2	Not Sure =0	No = -2	Not applicable (N/A)	TOTAL NUMBER (Column R)	COMMENTS
	SUSTAINABLE SITES	**v) Vegetation:** a) The building land was not used for farming prior to construction. Is the statement correct?			No		-2	many times ago there was field
		b) During this building construction process, did any endangered species of trees had to be fell?			No		-2	
		c) Do you agree that farming lands should not be used for development work?	Yes				2	

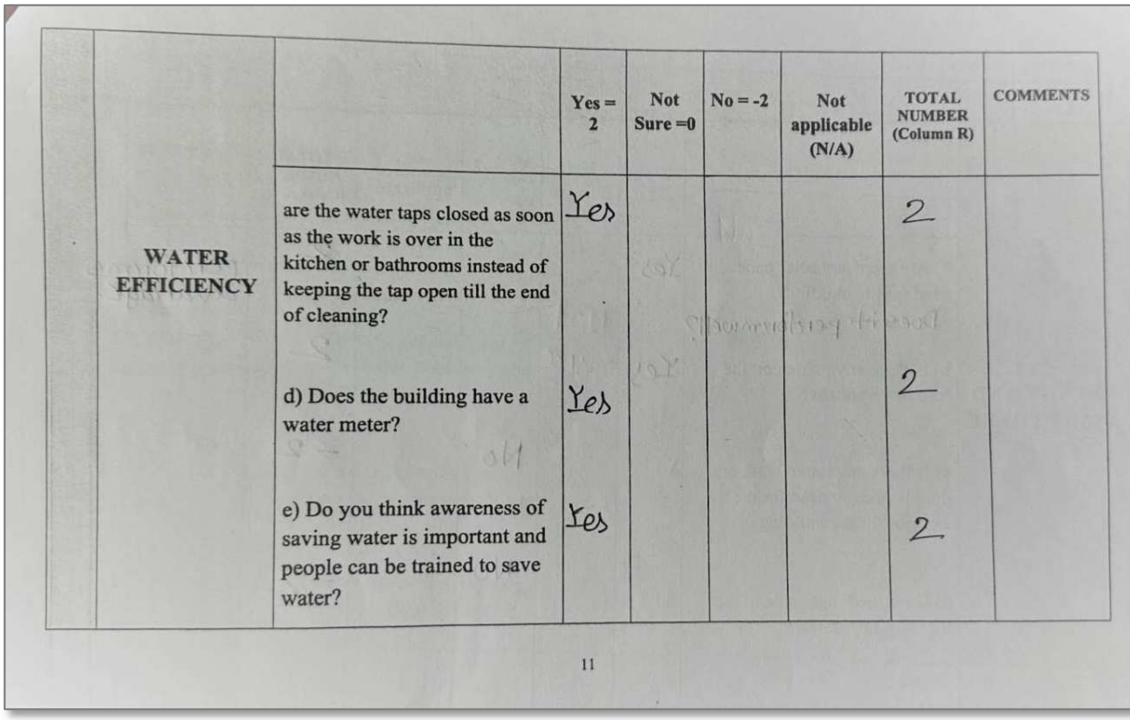
8

			Yes = 2	Not Sure =0	No = -2	Not applicable (N/A)	TOTAL NUMBER (Column R)	COMMENTS
	SUSTAINABLE SITES	**vi) Human health effects:** Is there are any factories or sources which produce polluted air within or nearby the building?			No		-2	

9

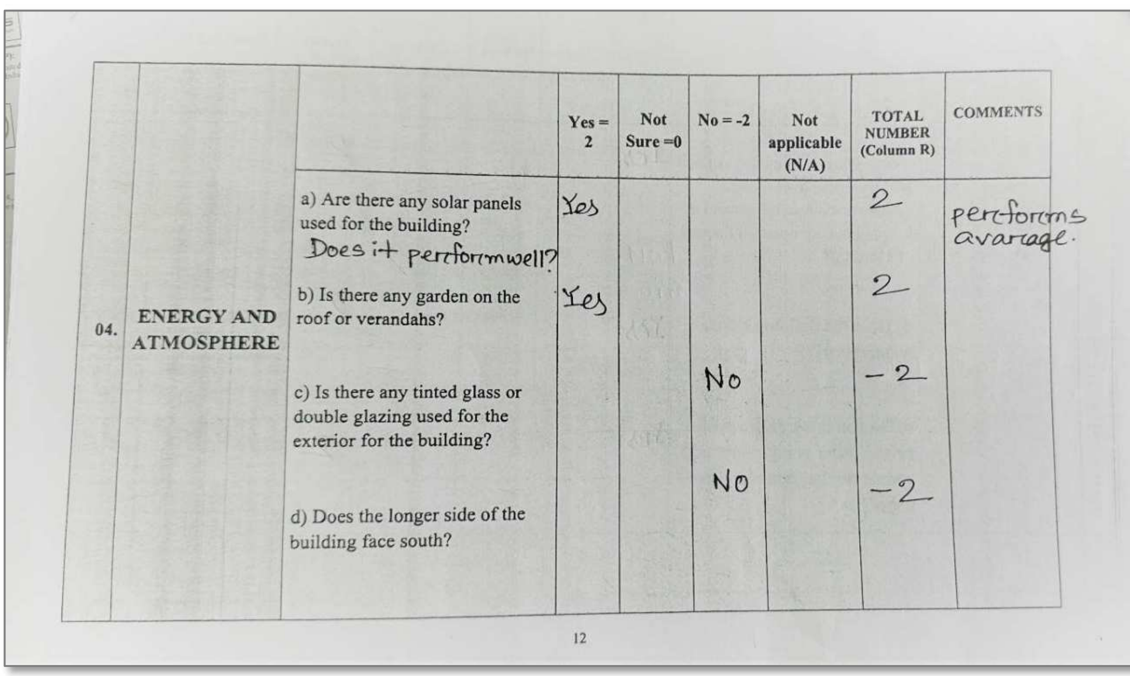
		Usage of Water:	Yes = 2	Not Sure =0	No = -2	Not applicable (N/A)	TOTAL NUMBER (Column R)	COMMENTS
03.	WATER EFFICIENCY	a) Do the users of the building use as minimum water as possible, outdoors? For example, use water in buckets to wash the motorbikes or cars instead of using water pipes?		Not Sure			0	
		b) While watering the garden or for cleaning purposes, are the water taps turned off as soon as the work is over?	Ies				2	
		c) Do the users of the building use as minimum water as possible, indoors? For example,						

10



		Yes = 2	Not Sure =0	No = -2	Not applicable (N/A)	TOTAL NUMBER (Column R)	COMMENTS
WATER EFFICIENCY	are the water taps closed as soon as the work is over in the kitchen or bathrooms instead of keeping the tap open till the end of cleaning?	Yes				2	
	d) Does the building have a water meter?	Yes				2	
	e) Do you think awareness of saving water is important and people can be trained to save water?	Yes				2	

11



			Yes = 2	Not Sure =0	No = -2	Not applicable (N/A)	TOTAL NUMBER (Column R)	COMMENTS
04.	ENERGY AND ATMOSPHERE	a) Are there any solar panels used for the building? Does it performwell?	Yes				2	performs avarage.
		b) Is there any garden on the roof or verandahs?	Yes				2	
		c) Is there any tinted glass or double glazing used for the exterior for the building?			No		-2	
		d) Does the longer side of the building face south?			No		-2	

12

			Yes = 2	Not Sure =0	No = -2	Not applicable (N/A)	TOTAL NUMBER (Column R)	COMMENTS
	ENERGY AND ATMOSPHERE	e) Do the users use LED or energy lights, sensors or any energy efficient appliances in the building?	Yes				2	
		f) Do people get sufficient seasonal wind in summer and sunshine in winter?			No		-2	
		g) Do the users agree that making use of energy efficient items are beneficial for the environment and may also reduce pressure on utility (e.g. electricity) bills as well?	Yes				2	

13

			Yes = 2	Not Sure =0	No = -2	Not applicable (N/A)	TOTAL NUMBER (Column R)	COMMENTS
05.	INDOOR ENVIRONMENTAL QUALITY	Does the performance of the building meet the expectation regarding thermal and ventilation comfort for the user:		Not Sure			0	
		a) is the ventilation sufficient for the building?	Yes				2	But not same on every floor
		b) Is the heat from sunlight optimum?			No		-2	
		c) Are the room interiors comfortable?	Yes				2	

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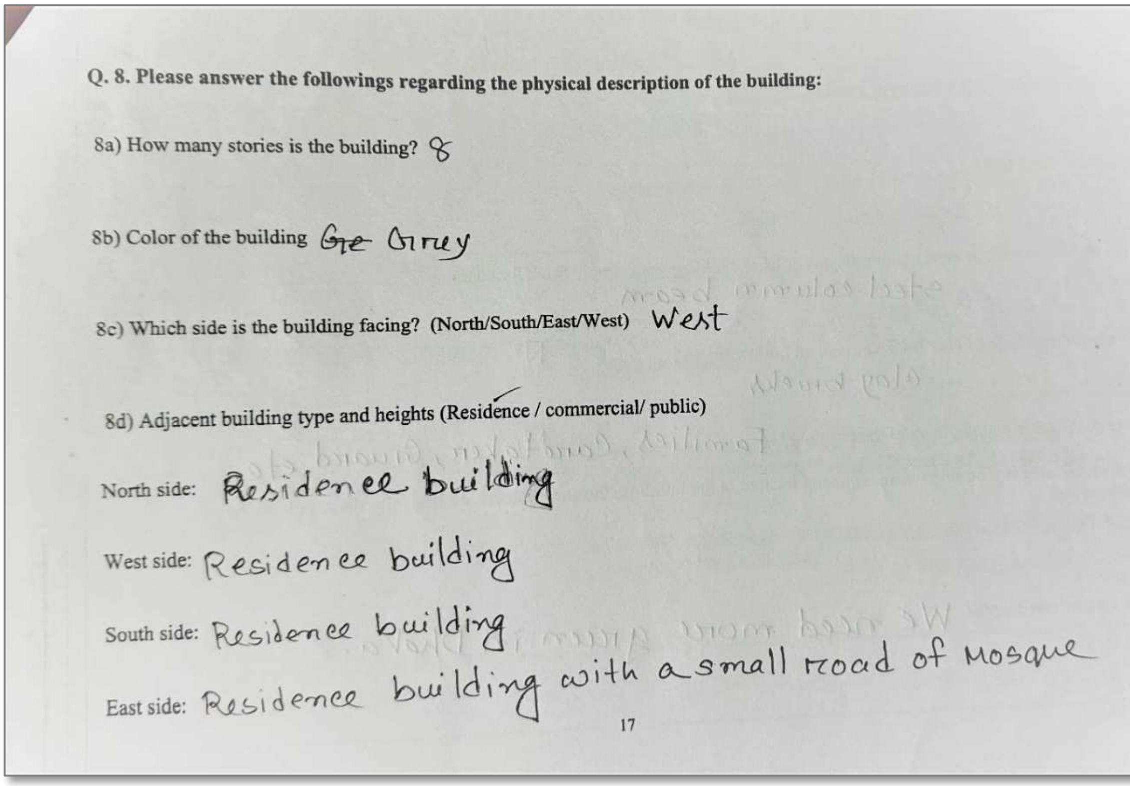
			Yes = 2	Not Sure =0	No = -2	Not applicable (N/A)	TOTAL NUMBER (Column R)	COMMENTS
	INDOOR ENVIRONMENTAL QUALITY	d) Is the lighting sufficient from electrical bulbs at night?	Yes				2	we use tubelight for this
		e) If the expected environmental condition within the interior of the rooms is ensured, without any mechanical intervention, would you accept it?	Yes				2	

15

06.	Innovations	a) Is any vertical green gardening (hydroponics) used in the building?			No		- 2	
	TOTAL		48	0	- 34		14	

16



Q. 8. Please answer the followings regarding the physical description of the building:

8a) How many stories is the building? 8

8b) Color of the building ~~Gre~~ Grey

8c) Which side is the building facing? (North/South/East/West) West

8d) Adjacent building type and heights (Residence / commercial/ public)

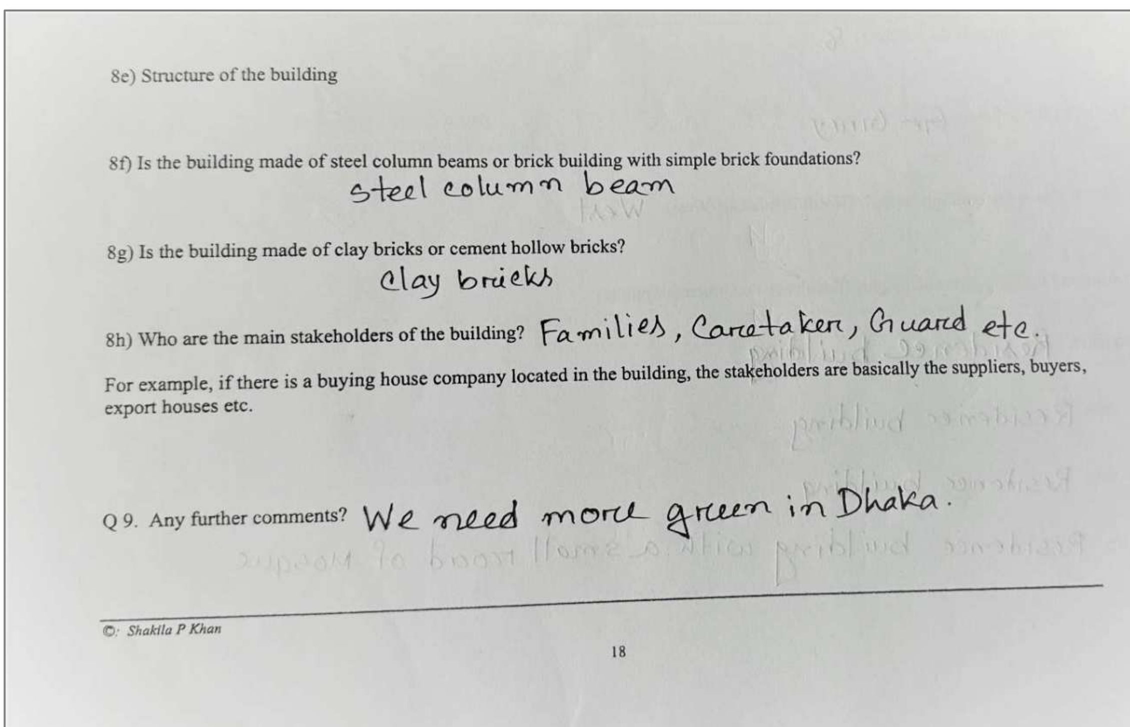
North side: Residence building

West side: Residence building

South side: Residence building

East side: Residence building with a small road of Mosque

17



8e) Structure of the building

8f) Is the building made of steel column beams or brick building with simple brick foundations?
steel column beam

8g) Is the building made of clay bricks or cement hollow bricks?
clay bricks

8h) Who are the main stakeholders of the building? Families, Caretaker, Guard etc.

For example, if there is a buying house company located in the building, the stakeholders are basically the suppliers, buyers, export houses etc.

Q 9. Any further comments? We need more green in Dhaka.

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CHAPTER 06

CASE BY CASE ANALYSIS OF BUILDINGS UNDER STUDY

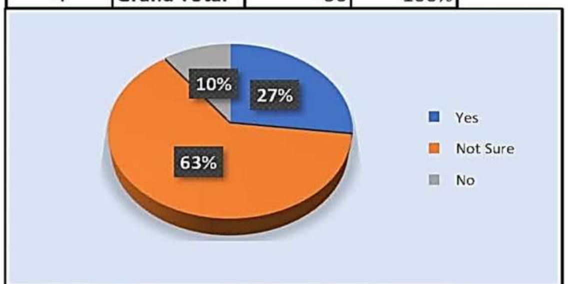
CHAPTER 6. CASE BY CASE ANALYSIS OF BUILDINGS UNDER SURVEY

6.1 DEL VISTA TOWER

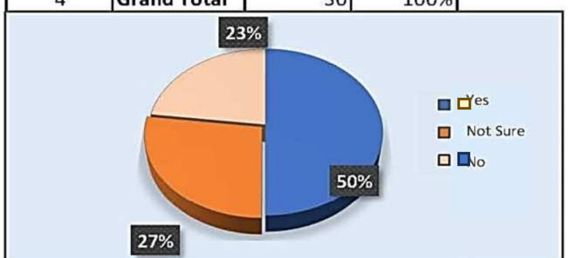
Pic 6.1*: The Del Vista Commercial Tower at Gulshan Dhaka (Ref:ss)*

LOCATION AND TRANSPORTATION

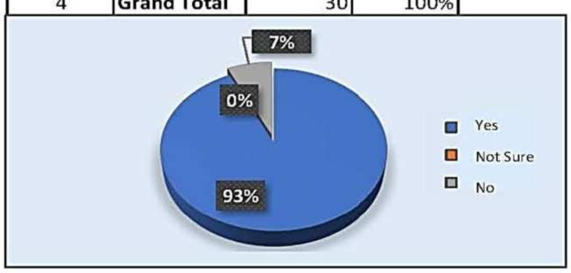
i) Was the building constructed on an unused vacant land?			
1	Yes	8	27.00%
2	Not sure	19	63%
3	No	3	10.00%
4	Grand Total	30	100%



ii) Is the building renovated or restored?			
1	Yes	7	50%
2	Not sure	8	27%
3	No	15	23%
4	Grand Total	30	100%

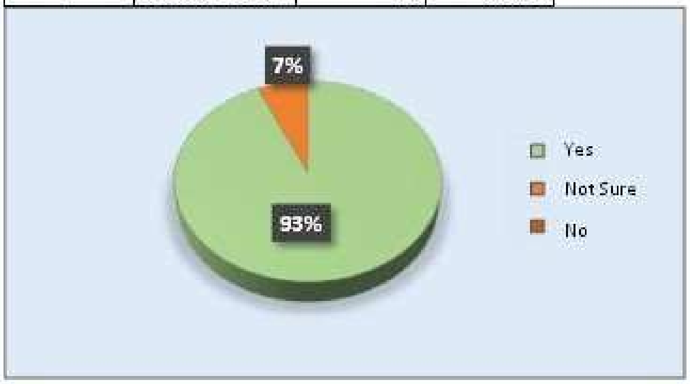


iii) Is there any hospital nearby?			
1	Yes	28	93%
2	Not sure	0	0%
3	No	2	7%
4	Grand Total	30	100%

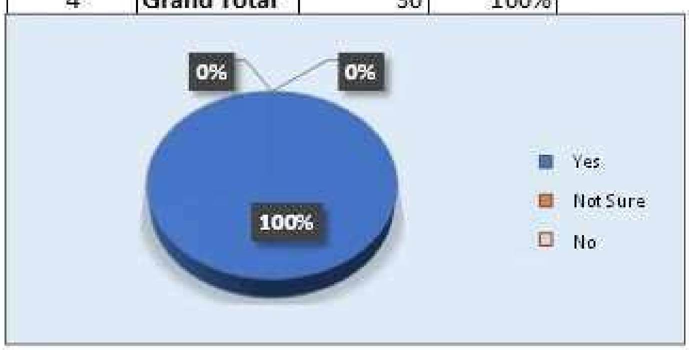


Dia 6.1*: Pie diagram(i-iii): Case Study: Del Vista Tower Building*

iv. Is there any market nearby?			
1	Yes	28	93.00%
2	Not sure	2	7%
3	No	0	0.00%
4	Grand Total	30	100%

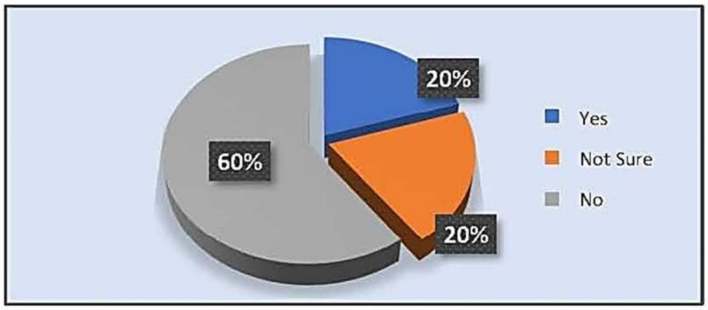


v) Is there any mosque nearby?			
1	Yes	30	100%
2	Not sure	0	0%
3	No	0	0%
4	Grand Total	30	100%

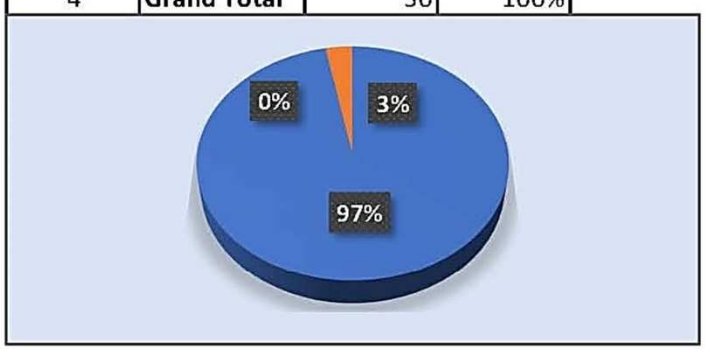


Dia 6.2*: Pie diagram(iv-v): Case Study: Del Vista Tower Building*

vi. Is there any area dedicated for bicycle parking for the building?			
1	Yes	6	20.00%
2	Not sure	6	20%
3	No	18	60.00%
4	Grand Total	30	100%

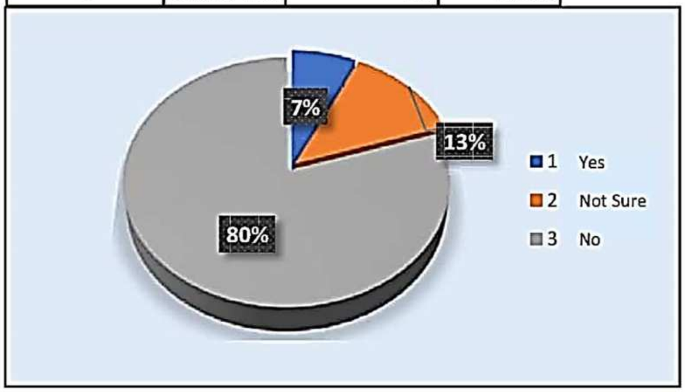


vii) Would it be convenient for the users if the above facilities were nearby?			
1	Yes	29	97%
2	Not sure	1	3%
3	No	0	0%
4	Grand Total	30	100%

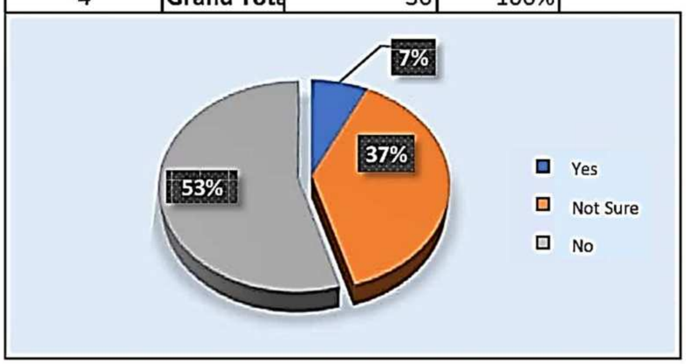


***Dia 6.3**: Pie diagram(vi-vii): Case Study: Del Vista Tower Building*

i) Is there any open space in the site?			
1	Yes	2	7%
2	Not sure	4	13%
3	No	24	80%
4	Grand Tota	30	100%

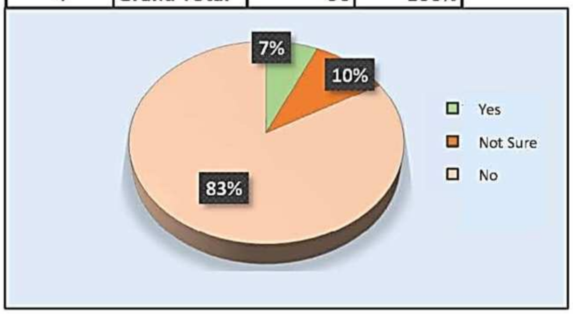


Heat Island Reduction:			
i) Is there any special paint used on the roof or insulation done for heat reduction?			
1	Yes	3	7%
2	Not sure	11	37%
3	No	16	53%
4	Grand Tota	30	100%

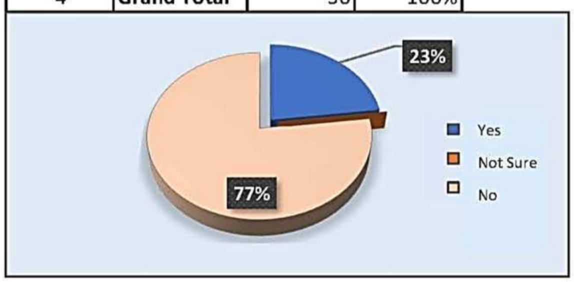


***Dia 6.4**: Pie diagram(i) & HIR(i): Case Study: Del Vista Tower Building*

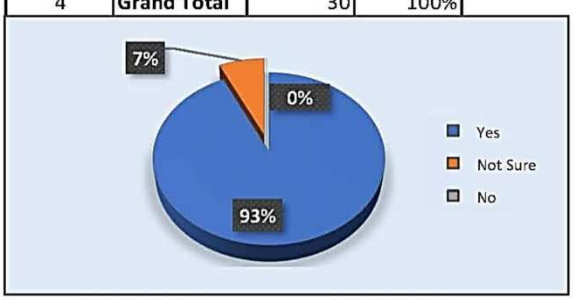
ii. Is the majority of the open area green?			
1	Yes	2	7.00%
2	Not sure	3	10%
3	No	25	83.00%
4	Grand Total	30	100%



iii) In case if there are some paved areas, are the paving tiles light in color such as light gray orlight red?			
1	Yes	7	23%
2	Not sure	0	0%
3	No	23	77%
4	Grand Total	30	100%



iv) Wouldn't it be convenient if the answers to the above were, yes?			
1	Yes	28	93%
2	Not sure	2	7%
3	No	0	0%
4	Grand Total	30	100%

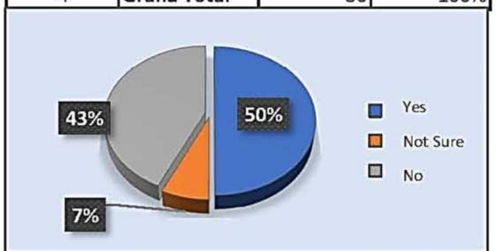


***Dia 6.5**: Pie diagram(ii-iv): Case Study: Del Vista Tower Building*

Hydrology and Storm Water Management:

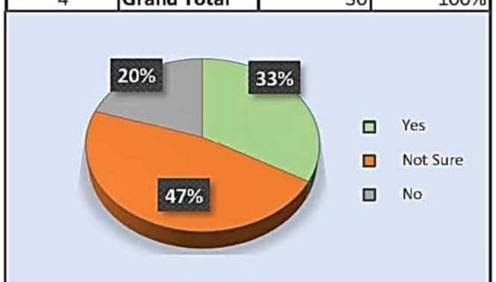
i) Is the site located in an area where there is less chance of flooding (site away from wetland)?

1	**Yes**	15	50.00%
2	**Not sure**	2	7%
3	**No**	13	43.00%
4	**Grand Total**	30	100%



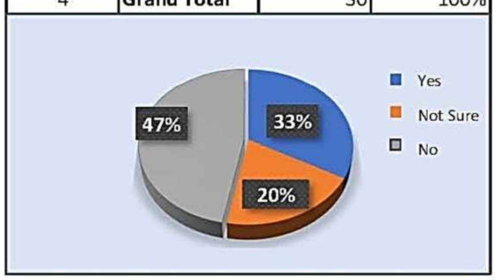
ii) Does the building have roof drainage pipes?

1	**Yes**	10	33%
2	**Not sure**	14	47%
3	**No**	6	20%
4	**Grand Total**	30	100%



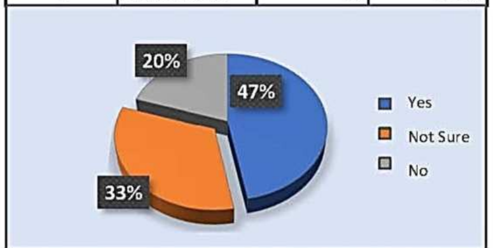
iii) Are all the drainage pipes and drains cleaned and maintained from time to time?

1	**Yes**	10	33%
2	**Not sure**	6	20%
3	**No**	14	47%
4	**Grand Total**	30	100%

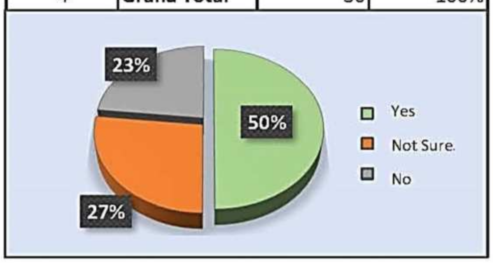


***Dia 6.6**: Pie diagram(i-iii): Case Study: Del Vista Tower Building*

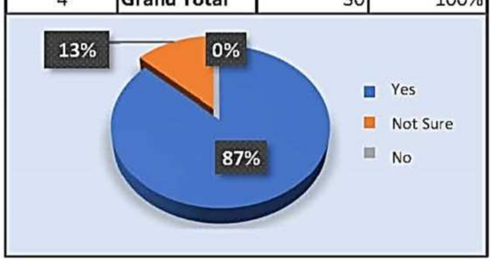
iv) Is there any public storm water collection system near the building to collect the storm water away from the building?			
1	Yes	14	47.00%
2	Not sure	10	33%
3	No	6	20.00%
4	Grand Total	30	100%



v) Do the users think that the rainwater may be collected treated and reused (e.g. for washing cars, watering garden etc.?).			
1	Yes	15	50%
2	Not sure	8	27%
3	No	7	23%
4	Grand Total	30	100%



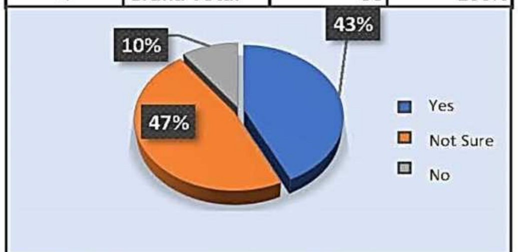
vi) Do you think awareness of waste water management is important and people can be trained to dispose or reuse it properly?			
1	Yes	26	87%
2	Not sure	4	13%
3	No	0	0%
4	Grand Total	30	100%



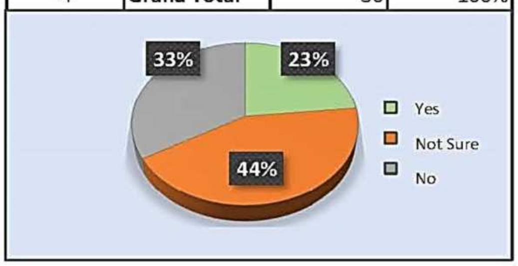
***Dia 6.7**: Pie diagram(iv-vi): Case Study: Del Vista Tower Building*

Vegetation

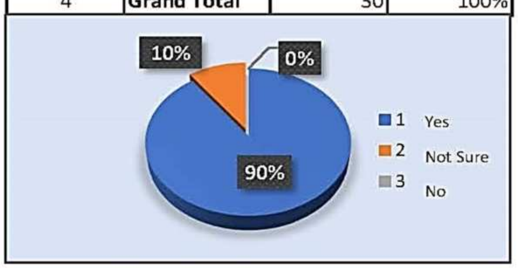
i) The building land was not used for farming prior to construction. Is the statement correct?			
1	**Yes**	13	43.00%
2	**Not sure**	14	47%
3	**No**	3	10.00%
4	**Grand Total**	30	100%



ii) During this building construction process,no endangered species of trees had to be fell,correct?			
1	**Yes**	7	23%
2	**Not sure**	13	44%
3	**No**	10	33%
4	**Grand Total**	30	100%



iii) Do you agree that the farming lands should not be used for development work?			
1	**Yes**	27	90%
2	**Not sure**	3	10%
3	**No**	0	0%
4	**Grand Total**	30	100%

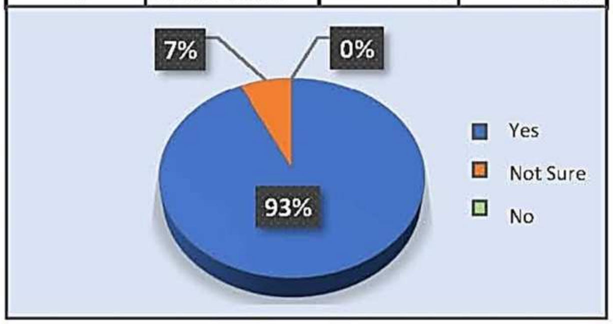


***Dia 6.8**: Pie diagram(i-iii) Vegetation; Case Study: Del Vista Tower Building*

Human Health Effects:

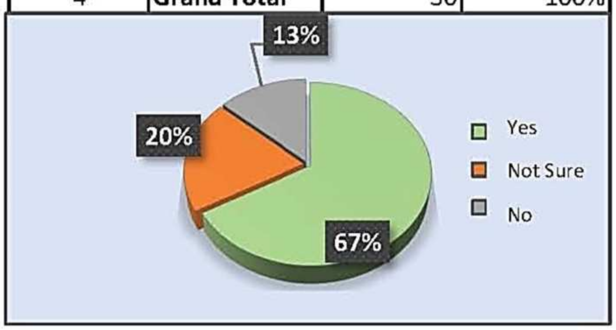
i) There are no factories nearby that produce pollution in the area, correct?

1	**Yes**	28	93.00%
2	**Not sure**	2	7%
3	**No**	0	0.00%
4	**Grand Total**	30	100%



ii) The building does not produce any toxic gas store any hazardous item, is the staement correct?

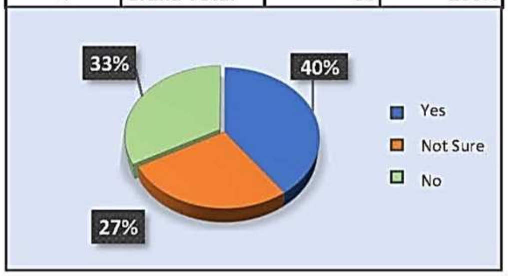
1	**Yes**	20	67%
2	**Not sure**	6	20%
3	**No**	4	13%
4	**Grand Total**	30	100%



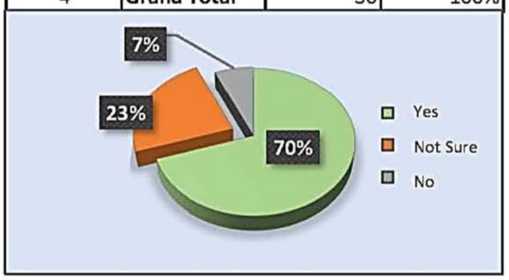
Dia 6.9*: Pie diagram(i-ii) Human Health Effects; Case Study: Del Vista Tower Building*

WATER EFFICIENCY

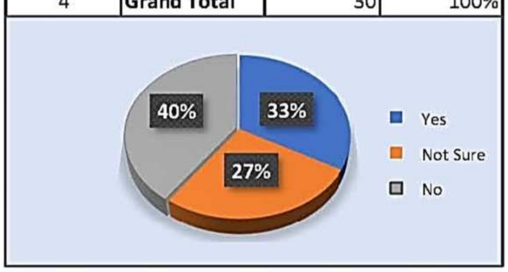
i) While doing water related work are the water taps turned off immediately after the work is over indoors?			
1	Yes	12	40.00%
2	Not sure	8	27%
3	No	10	33.00%
4	Grand Total	30	100%



ii) Does the building have a water meter?			
1	Yes	21	70%
2	Not sure	7	23%
3	No	2	7%
4	Grand Total	30	100%

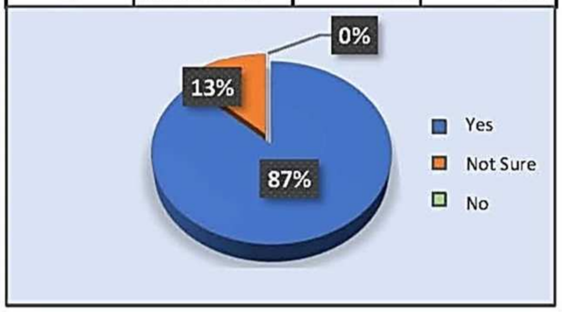


iii) Are users cautious about using water outdoors?			
1	Yes	10	33%
2	Not sure	8	27%
3	No	12	40%
4	Grand Total	30	100%



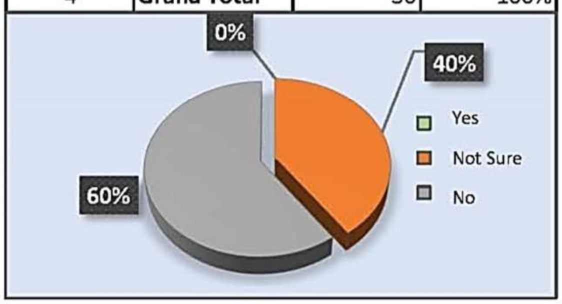
***Dia 6.10**: Pie diagram (i-iii) Water Efficiency; Case Study: Del Vista Tower Building*

iv) Do you think awareness regarding the use of water is important and people perform better if they are trained in this matter?			
1	**Yes**	26	87.00%
2	**Not sure**	4	13%
3	**No**	0	0.00%
4	**Grand Total**	30	100%



ENERGY AND ATMOSPHERE

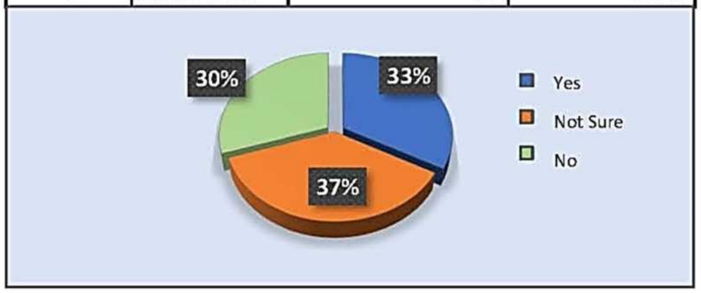
i) Are there any solar panels in the building?			
1	**Yes**	0	0%
2	**Not sure**	12	40%
3	**No**	18	60%
4	**Grand Total**	30	100%



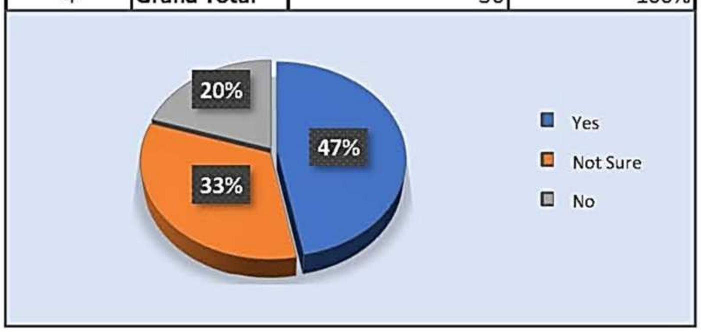
ii) Does the solar panel work properly? Ans: N/A			
1	**Yes**	0	0%
2	**Not sure**	0	0%
3	**No**	0	0%
4	**Grand Total**	0	0%

Dia 6.11*: Pie diagram (iv) Water Awareness & EA(i-ii)Energy and Atmosphere ; Case Study: Del Vista Tower Building*

iii) Is there any garden on the roof or verandah of the building?			
1	Yes	10	33.00%
2	Not sure	11	37%
3	No	9	30.00%
4	Grand Total	30	100%



iv) Has any tinted glass or double glazing been used at the exterior walls of the building?			
1	Yes	14	47%
2	Not sure	10	33%
3	No	6	20%
4	Grand Total	30	100%



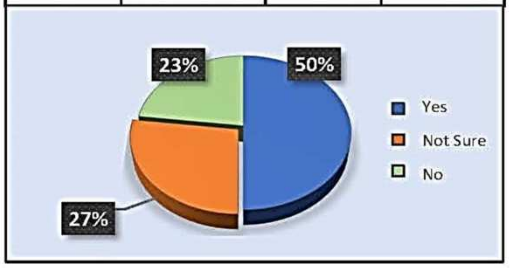
v) Does the longer side of the building face south?			
1	Yes	30 (but blocked)*	0%
2	Not sure	0	0%
3	No	0	0%
4	Grand Total	0	100%

* The building is blocked by another adjacent highrise building.

***Dia 6.12**: Pie diagram (iii-v); Case Study: Del Vista Tower Building*

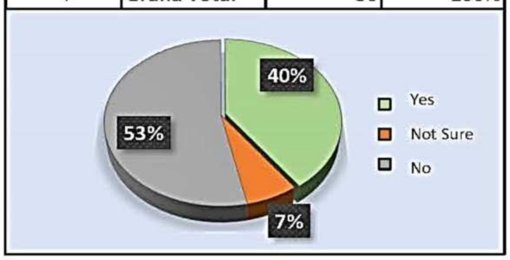
vi) Do the inhabitants use LED lights, sensor light of any other energy efficient applianced in the building?

1	**Yes**	15	50.00%
2	**Not sure**	8	27%
3	**No**	7	23.00%
4	**Grand Total**	30	100%



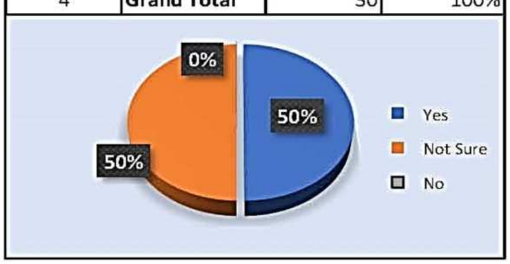
vii) Does the inhabitant get sufficient wind in summer and sunshine in winter?

1	**Yes**	12	40%
2	**Not sure**	2	7%
3	**No**	16	53%
4	**Grand Total**	30	100%



viii) Do the inhabitants agree that making use of energy efficient items reduce carbon footprint and reduce pressure even on utility bills?

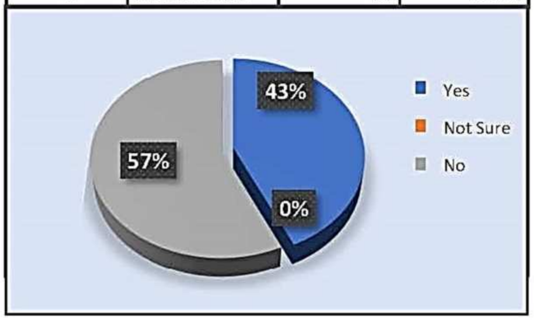
1	**Yes**	15	50%
2	**Not sure**	15	50%
3	**No**	0	0%
4	**Grand Total**	30	100%



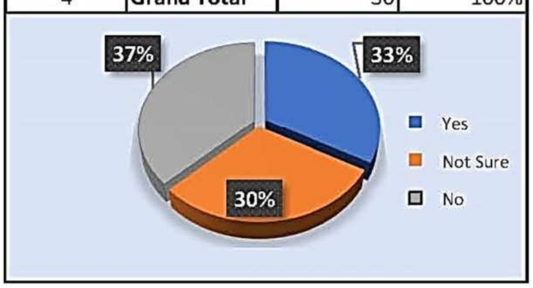
***Dia 6.13**: Pie diagram(vi-viii); Case Study: Del Vista Tower Building*

INDOOR ENVIRONMENT

i) Indoor Environment: Does the inhabitant get sufficient sunshine?			
1	Yes	13	43%
2	Not sure	0	0%
3	No	17	57%
4	Grand Total	30	100%



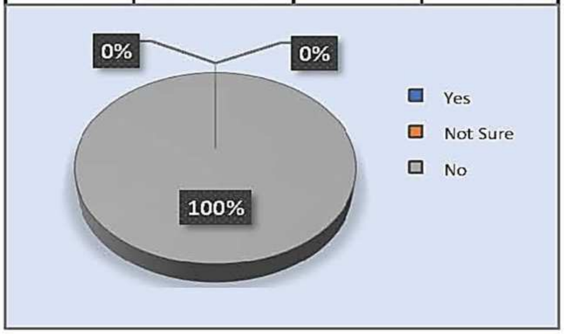
ii) Are the room interior comfortable regarding natural ventilation?			
1	Yes	10	33%
2	Not sure	9	30%
3	No	11	37%
4	Grand Total	30	100%



Dia 6.14*: Pie diagram(i-ii) Indoor Environment; Case Study: Del Vista Tower Building*

INNOVATION:

i) Does any vertical green planting system (hydroponics) exist in the building?			
1	Yes	0	0%
2	Not sure	6	0%
3	No	24	100%
4	Grand Total	30	100%



***Dia 6.15**: Pie diagram (i)Innovation : Case Study: Del Vista Tower Building*

Del Vista Tower in Gulshan, while a notable architectural project, is yet to be identified as a green building. This may be due to several factors. To qualify as a green building, a structure must meet specific sustainability standards set by organizations like LEED or BREEAM. This includes criteria related to energy efficiency, water conservation, and the use of sustainable materials. Del Vista Tower does not yet comply with these benchmarks remarkably.

Green buildings typically utilize energy-efficient systems, such as high-performance HVAC, LED lighting, and smart building technologies. Del Vista Tower does not yet comply with these benchmarks remarkably.

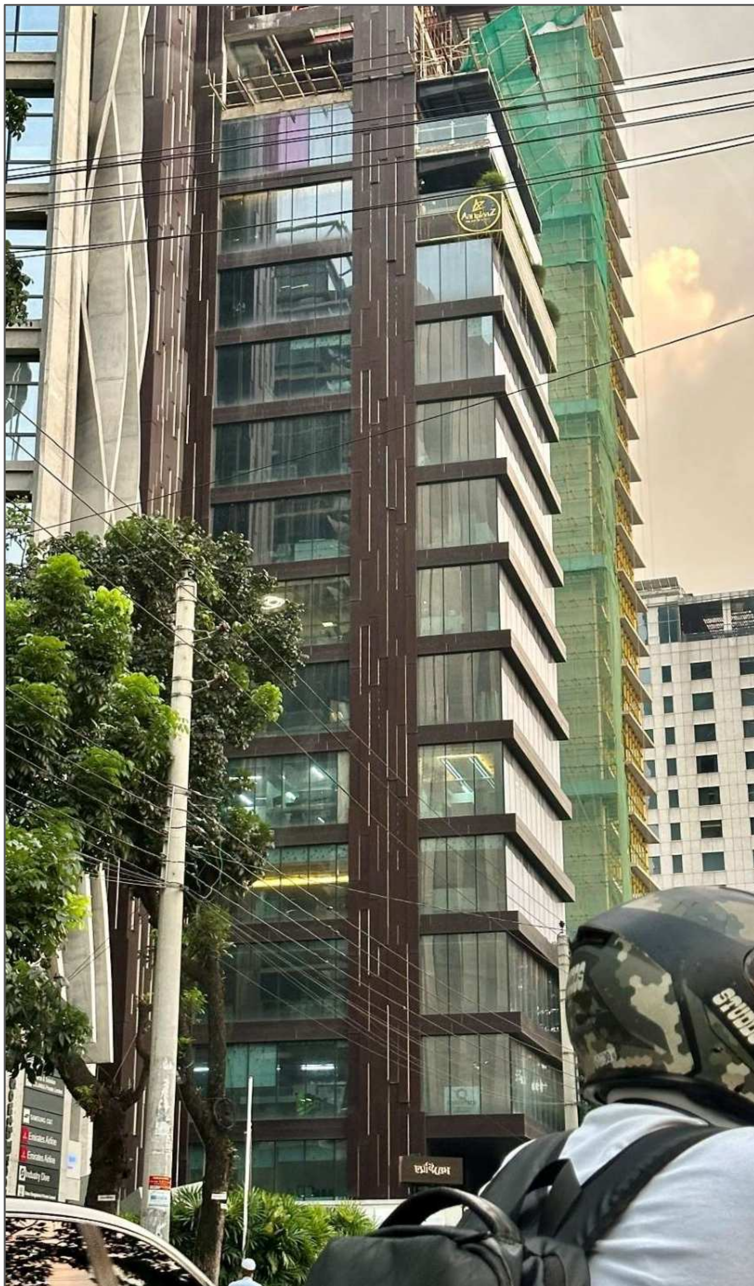
Effective water management systems, including rainwater harvesting and greywater recycling, are essential for green buildings. Del Vista Lacks in it.

Green buildings often prioritize indoor air quality, natural lighting, and ventilation. Del Vista Tower does not incorporate these elements substantially and thus does not meet the necessary standards.

Other than these, considerations such as openness of site and minimizing the ecological impact are crucial for green buildings. The use of recycled or sustainably sourced materials plays a significant role in green building certification. Del Vista Tower does not incorporate these elements significantly and thus does not completely meet the necessary standards.

To enhance its chances of becoming a green building, Del Vista Tower needs to consider implementing these sustainable practices and pursuing formal certification to showcase its commitment to environmental responsibility.

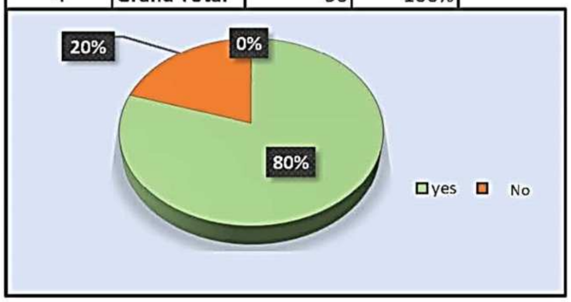
6.2 CITYSCAPE TOWER BUILDING



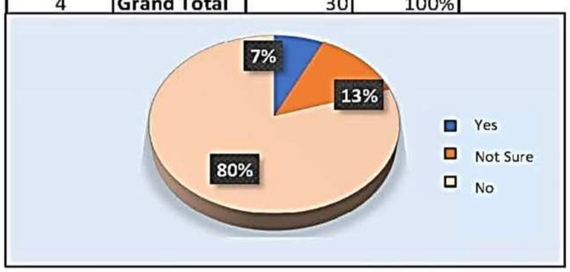
***Pic 6.2**: The Cityscape Commercial Tower at Gulshan Dhaka (Self-sourced)*

LOCATION AND TRANSPORTATION

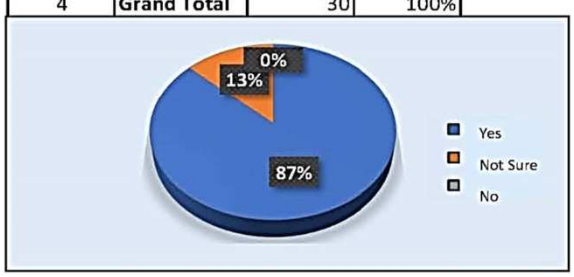
i) Was the building constructed on an unused vacant land?			
1	Yes	24	80.00%
2	Not sure	6	20%
3	No	0	0.00%
4	Grand Total	30	100%



ii) Is the building renovated or restored?			
1	Yes	2	7%
2	Not sure	4	13%
3	No	24	80%
4	Grand Total	30	100%

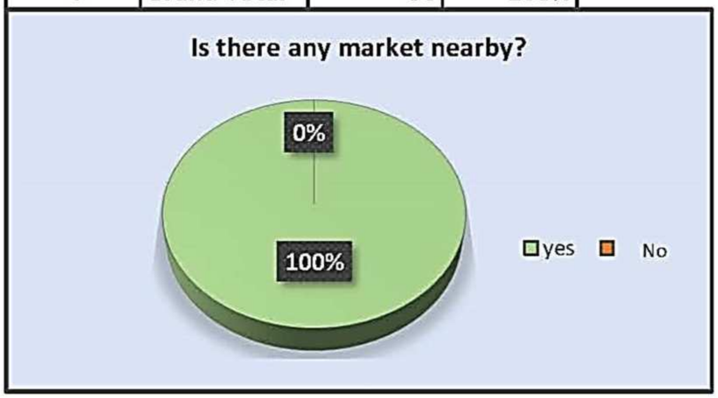


iii) Is there any hospital nearby?			
1	Yes	26	87%
2	Not sure	4	13%
3	No	0	0%
4	Grand Total	30	100%

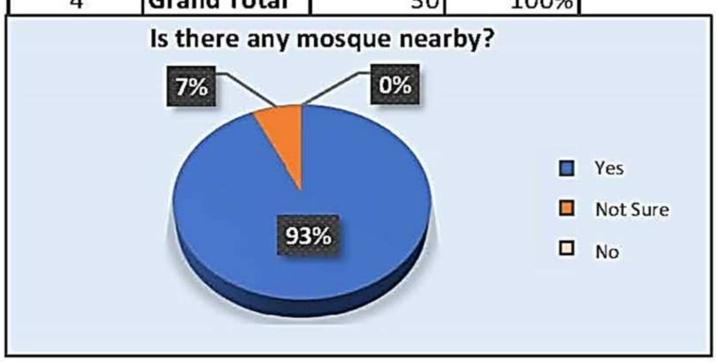


***Dia 6.16**: Pie diagram (i-iii) Location and Transportation; Case Study: Del Vista Tower Building*

iv. Is there any market nearby?			
1	**Yes**	30	100.00%
2	**Not sure**	0	0%
3	**No**	0	0.00%
4	**Grand Total**	30	100%

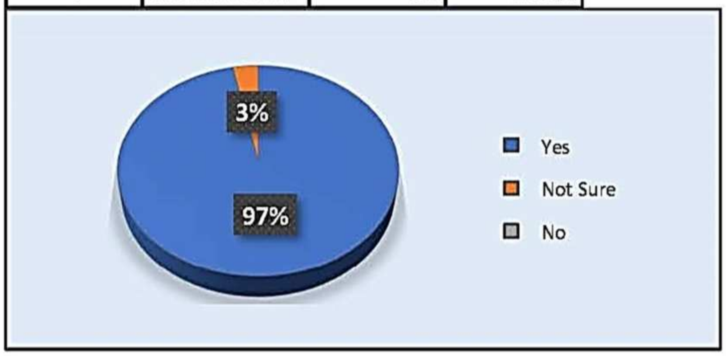


v) Is there any mosque nearby?			
1	**Yes**	28	93%
2	**Not sure**	2	7%
3	**No**	0	0%
4	**Grand Total**	30	100%

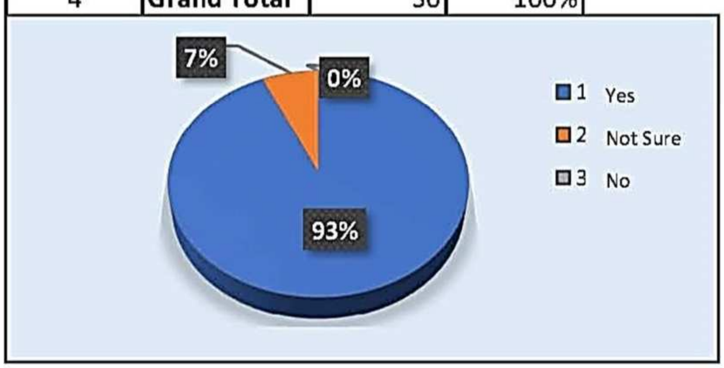


Dia 6.17*: Pie diagram(iv-v); Case Study: Del Vista Tower Building*

vi. Is there any area dedicated for bicycle parking for the building?			
1	Yes	29	97.00%
2	Not sure	0	0%
3	No	1	3.00%
4	Grand Total	30	100%

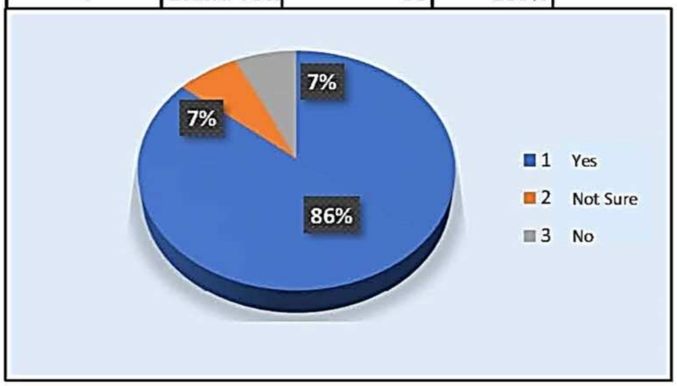


vii) Would it be convenient for the users if the above facilities were nearby?			
1	Yes	28	87%
2	Not sure	2	13%
3	No	0	0%
4	Grand Total	30	100%

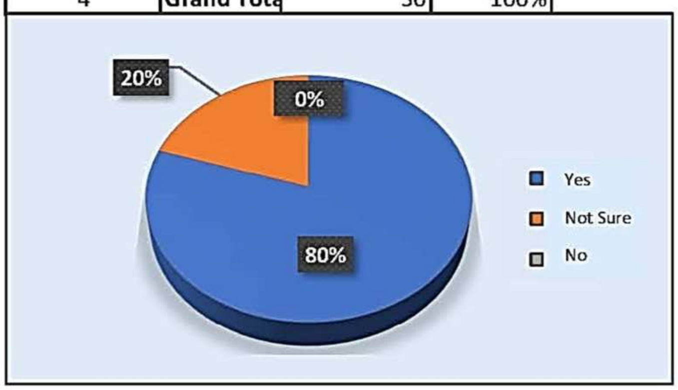


***Dia 6.18**: Pie diagram(vi-vii); Case Study: Del Vista Tower Building*

i) Is there any open space in the site?			
1	Yes	26	86%
2	Not sure	2	7%
3	No	2	7%
4	Grand Tota	30	100%

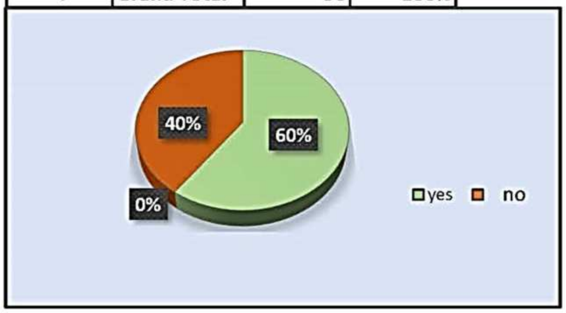


Heat Island Reduction:			
i) Is there any special paint used on the roof or insulation done for heat reduction?			
1	Yes	24	80%
2	Not sure	6	20%
3	No	0	0%
4	Grand Tota	30	100%

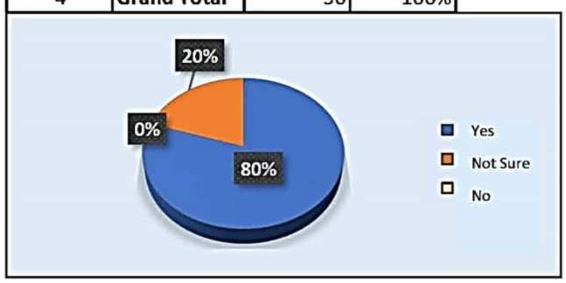


Dia 6.19: *Pie diagram(i) Open Space & HIR(i): Case Study: Del Vista Tower Building*

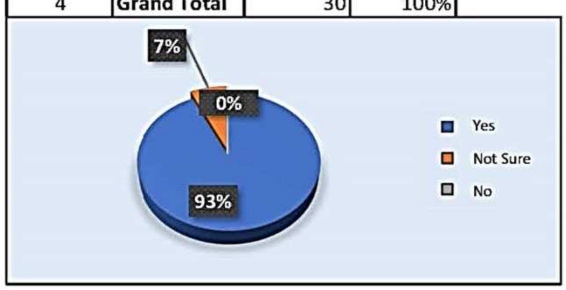
ii. Is the majority of the open area green?			
1	Yes	18	60.00%
2	Not sure	0	0%
3	No	12	40.00%
4	Grand Total	30	100%



iii) In case if there are some paved areas, are the paving tiles light in color such as light gray orlight red?			
1	Yes	24	80%
2	Not sure	6	20%
3	No	0	0%
4	Grand Total	30	100%



iv) Wouldn't it be convenient if the answers to the above were, yes?			
1	Yes	28	93%
2	Not sure	2	7%
3	No	0	0%
4	Grand Total	30	100%

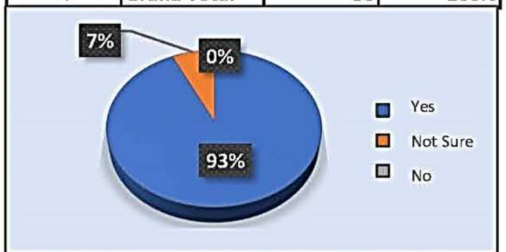


Dia 6.20*: Pie diagram(ii-iv); Case Study: Del Vista Tower Building*

Hydrology and Storm Water Management:

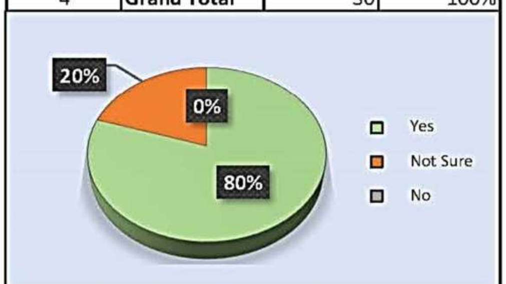
i) Is the site located in an area where there is less chance of flooding (site away from wetland).

1	**Yes**	28	93.00%
2	**Not sure**	2	7%
3	**No**	0	0.00%
4	**Grand Total**	30	100%



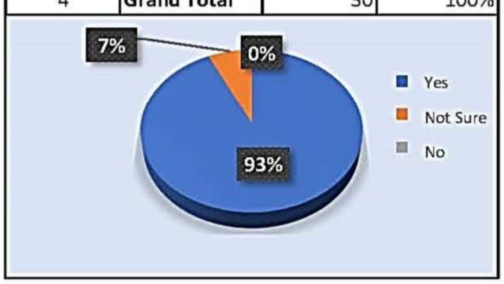
ii) Does the building have roof drainage pipes?

1	**Yes**	24	80%
2	**Not sure**	6	20%
3	**No**	0	20%
4	**Grand Total**	30	100%



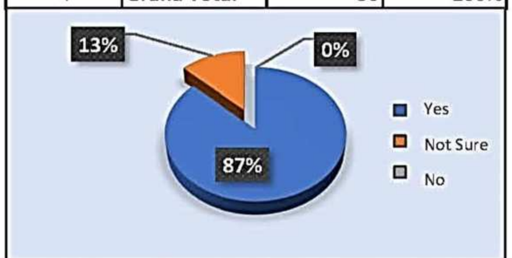
iii) Are all the drainage pipes and drains cleaned and maintained from time to time?

1	**Yes**	28	93%
2	**Not sure**	2	7%
3	**No**	0	0%
4	**Grand Total**	30	100%

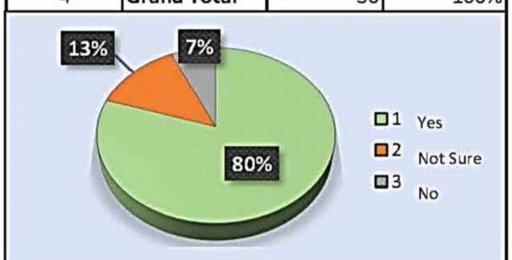


***Dia 6.21**: Pie diagram(i-iii) Hydrology & Storm Water Management; Case Study: Del Vista Tower Building*

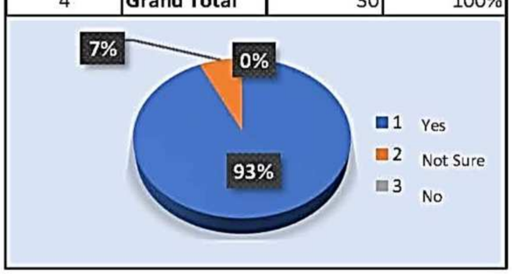
iv) Is there any public storm water collection system near the building to collect the storm water away from the building?			
1	**Yes**	26	87.00%
2	**Not sure**	4	13%
3	**No**	0	0.00%
4	**Grand Total**	30	100%



v) Do the users think that the rainwater may be collected treated and reused (e.g. for washing cars, watering garden etc.?).			
1	**Yes**	24	80%
2	**Not sure**	4	13%
3	**No**	2	7%
4	**Grand Total**	30	100%



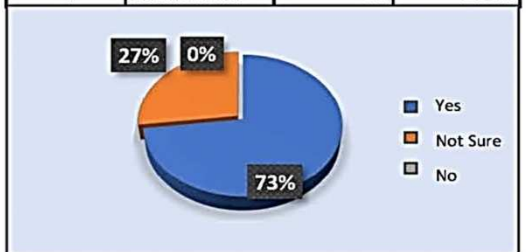
vi) Do you think awareness of waste water management is important and people can be trained to dispose or reuse it properly?			
1	**Yes**	28	93%
2	**Not sure**	2	7%
3	**No**	0	0%
4	**Grand Total**	30	100%



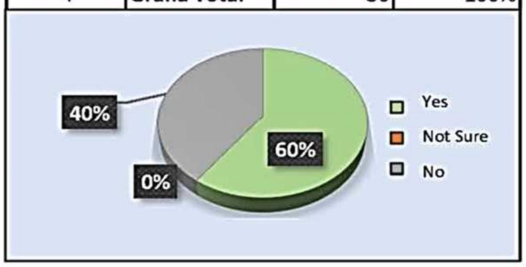
***Dia 6.22**: Pie diagram(iv-vi)) Hydrology & Storm Water Management; Study: Del Vista Tower Building*

Vegetation

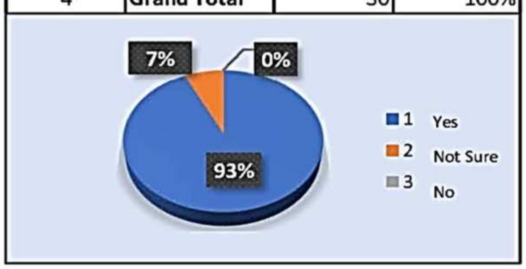
i) The building land was not used for farming prior to construction. Is the statement correct?			
1	Yes	22	73.00%
2	Not sure	8	27%
3	No	0	0.00%
4	Grand Total	30	100%



ii) During this building construction process, no endangered species of trees had to be fell?			
1	Yes	18	20%
2	Not sure	0	20%
3	No	12	60%
4	Grand Total	30	100%



iii) Do you agree that the farming lands should not be used for development work?			
1	Yes	28	93%
2	Not sure	2	7%
3	No	0	0%
4	Grand Total	30	100%

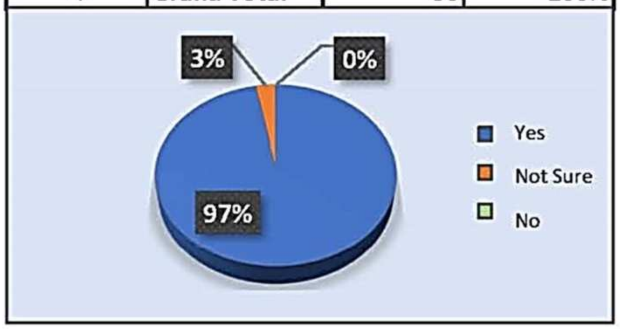


Dia 6.23: *Pie diagram(i-iii) Vegetation; Study: Del Vista Tower Building*

Human Health Effects:

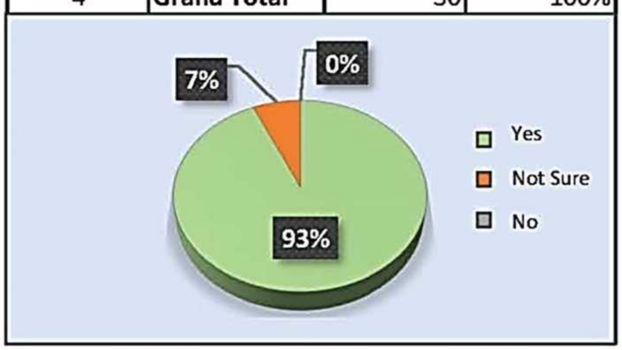
i) There are no factories nearby that produce pollution in the area, correct? to construction. Is the statement correct?

1	Yes	29	97.00%
2	Not sure	1	3%
3	No	0	0.00%
4	Grand Total	30	100%



ii) The building does not produce any toxic gas or store any hazardous item, is the staement correct?

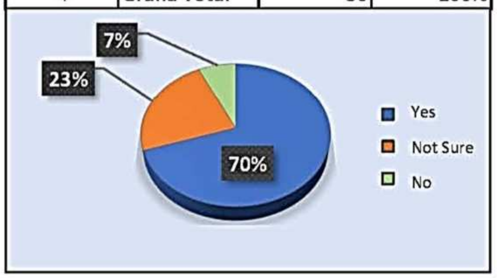
1	Yes	28	93%
2	Not sure	2	7%
3	No	0	0%
4	Grand Total	30	100%



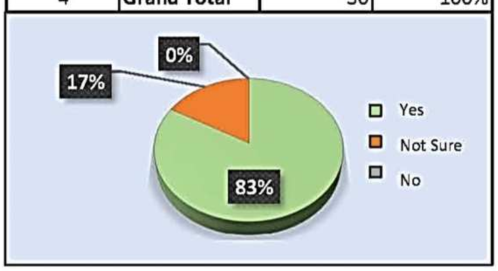
***Dia 6.24**: Pie diagram(i-ii) Human Health Effects: Study: Del Vista Tower Building*

WATER EFFICIENCY

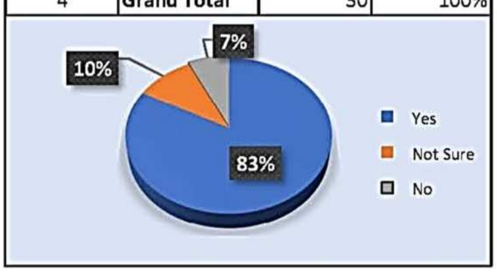
i) While doing water related work are the water taps turned off immediately after the work is over indoors?			
1	Yes	21	70.00%
2	Not sure	7	23%
3	No	2	7.00%
4	Grand Total	30	100%



ii) Does the building have a water meter?			
1	Yes	25	83%
2	Not sure	5	17%
3	No	0	0%
4	Grand Total	30	100%

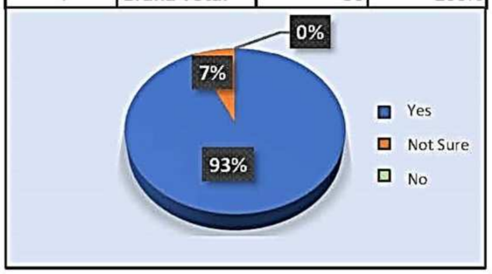


iii) Are users cautious about using water outdoors?			
1	Yes	25	83%
2	Not sure	3	10%
3	No	2	7%
4	Grand Total	30	100%



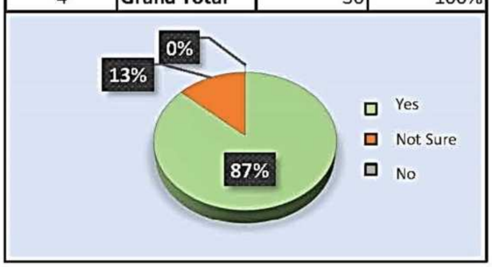
***Dia 6.25**: Pie diagram(i-iii) Water Efficiency; Study: Del Vista Tower Building*

iv) Do you think awareness regarding the use of water is important and people perform better if they are trained in this matter?			
1	Yes	28	93.00%
2	Not sure	2	7%
3	No	0	0.00%
4	Grand Total	30	100%

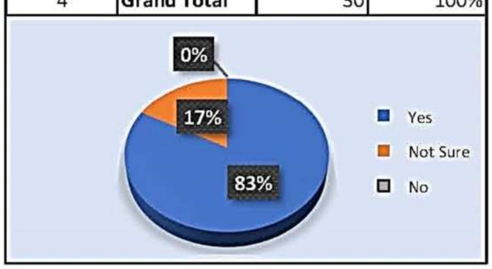


ENERGY AND ATMOSPHERE

i) Are there any solar panels in the building?			
1	Yes	26	87%
2	Not sure	4	13%
3	No	0	0%
4	Grand Total	30	100%

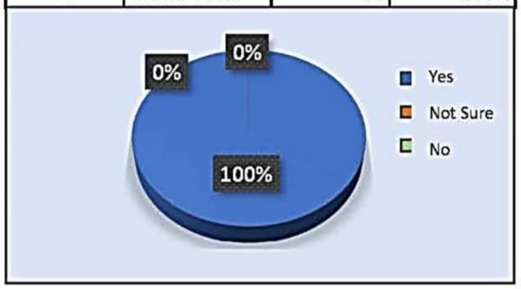


ii) Does the solar panel work properly?			
1	Yes	25	83%
2	Not sure	5	17%
3	No	0	0%
4	Grand Total	30	100%

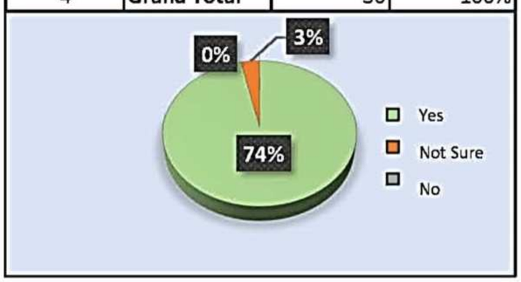


***Dia 6.26**: Pie diagram(iv) & (i)Energy & Atmosphere; Study: Del Vista Tower Building*

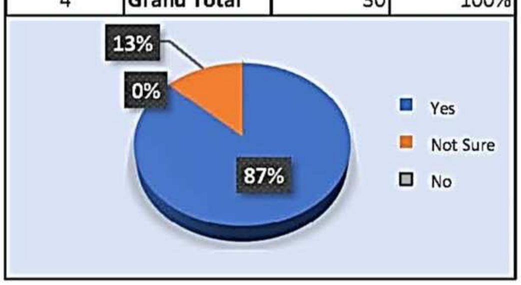
iii) Is there any garden on the roof or verandah of the building?			
1	Yes	30	100.00%
2	Not sure	0	0%
3	No	0	0.00%
4	Grand Total	30	100%



iv) Has any tinted glass or double glazing been used at the exterior walls of the building?			
1	Yes	29	97%
2	Not sure	1	3%
3	No	0	0%
4	Grand Total	30	100%

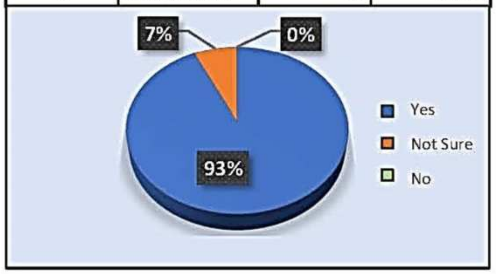


v) Does the longer side of the building face south?			
1	Yes	26	87%
2	Not sure	4	13%
3	No	0	0%
4	Grand Total	30	100%

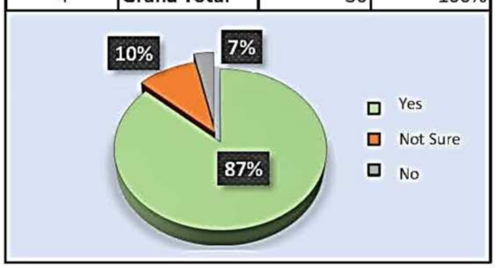


***Dia 6.27**: Pie diagram(iii-vi): Study: Del Vista Tower Building*

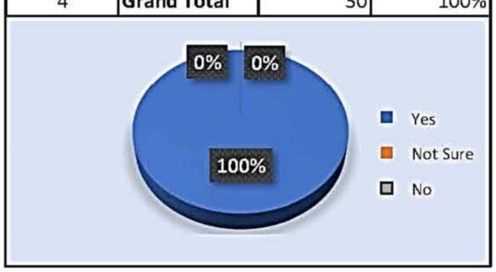
v) Do the inhabitants use LED lights, sensor light of any other energy efficient applianced in the building?			
1	Yes	28	93.00%
2	Not sure	2	7%
3	No	0	0.00%
4	Grand Total	30	100%



vi) Does the inhabitant get sufficient wind in summer and sunshine in winter?			
1	Yes	26	87%
2	Not sure	3	10%
3	No	1	7%
4	Grand Total	30	100%



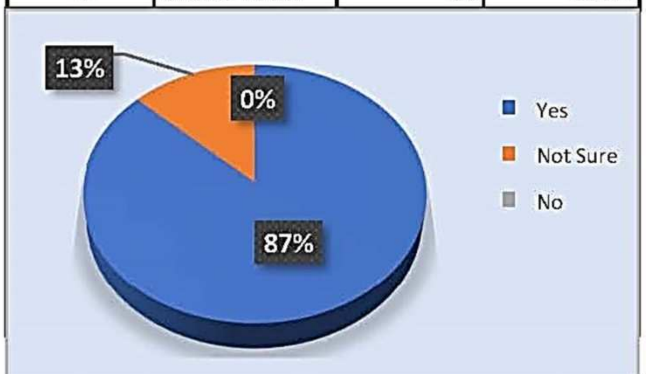
vii) Do the inhabitants agree that making use of energy efficient items reduce carbon footprint and reduce pressure even on utility bills?			
1	Yes	30	100%
2	Not sure	0	0%
3	No	0	0%
4	Grand Total	30	100%



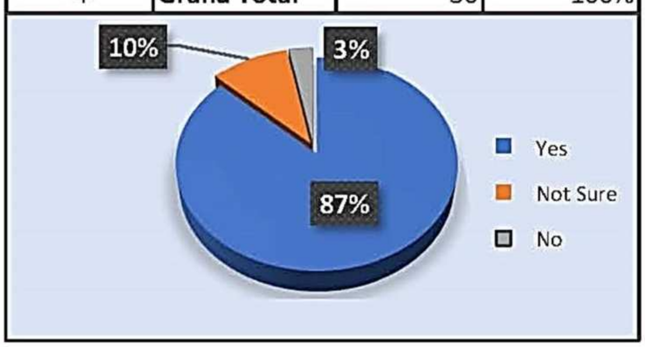
***Dia 6.28**: Pie diagram(v-vii); Study: Del Vista Tower Building*

INDOOR ENVIRONMENT

i) Indoor Environment: Does the inhabitant get sufficient sunshine?			
1	**Yes**	26	87%
2	**Not sure**	4	13%
3	**No**	0	0%
4	**Grand Total**	30	100%



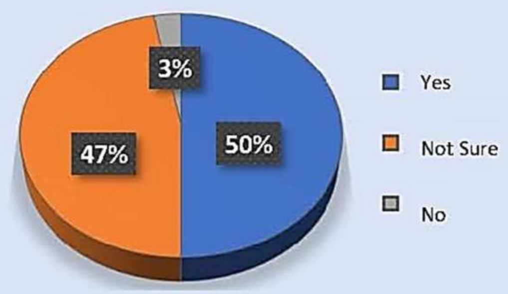
ii) Are the room interior comfortable regarding natural ventilation?			
1	**Yes**	26	87%
2	**Not sure**	3	10%
3	**No**	1	3%
4	**Grand Total**	30	100%



***Dia 6.29**: Pie diagram(i-ii) Indoor Environment; Study: Del Vista Tower Building*

INNOVATION:

i) Does any vertical green planting system (hydroponics) exist in the building?			
1	**Yes**	15	50%
2	**Not sure**	14	47%
3	**No**	1	3%
4	**Grand Total**	30	100%



***Dia 6.30**: Pie diagram(i)Innovation; Study: Del Vista Tower Building*

Cityscape Tower in Gulshan exemplifies a successful green building, integrating sustainable design principles that enhance environmental performance. The building incorporates energy-efficient technologies, such as high-performance HVAC systems and LED lighting, which significantly reduce energy consumption. Additionally, it features water conservation strategies, including rainwater harvesting and low-flow fixtures, contributing to efficient resource management.

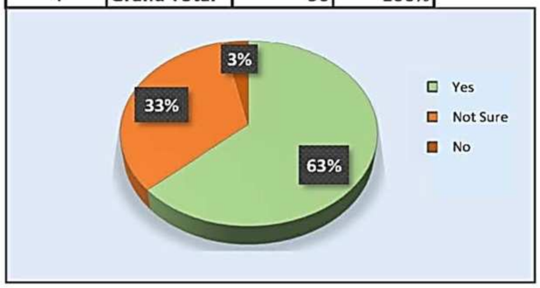
The design prioritizes indoor environmental quality by maximizing natural light and ensuring effective ventilation, thus promoting occupant health and well-being. Furthermore, the use of sustainable materials minimizes the ecological footprint of the construction process. Overall, Cityscape Tower not only meets but exceeds many contemporary sustainability standards, serving as a model for future developments in urban settings.

6.3 EVE DRESS AND SHIRTS GARMENTS BUILDING

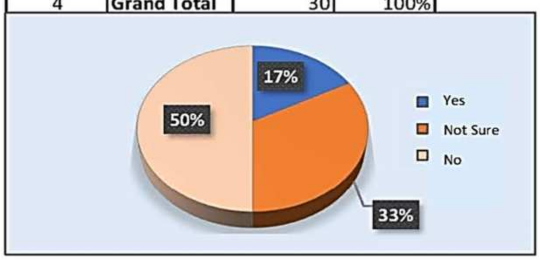
***Pic 6.3**: The Eve Dress & Shirts Garments Factory (Ref 6.1)*

LOCATION AND TRANSPORTATION

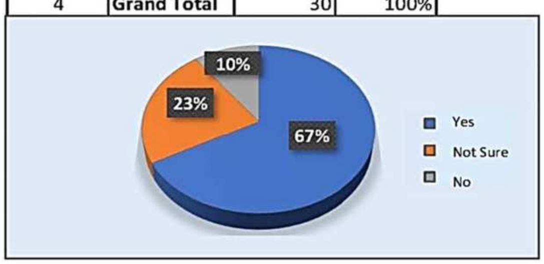
i) Was the building constructed on an unused vacant land?			
1	Yes	19	63.00%
2	Not sure	10	33%
3	No	1	3.00%
4	Grand Total	30	100%



ii) Is the building renovated or restored?			
1	Yes	5	17%
2	Not sure	10	33%
3	No	15	50%
4	Grand Total	30	100%

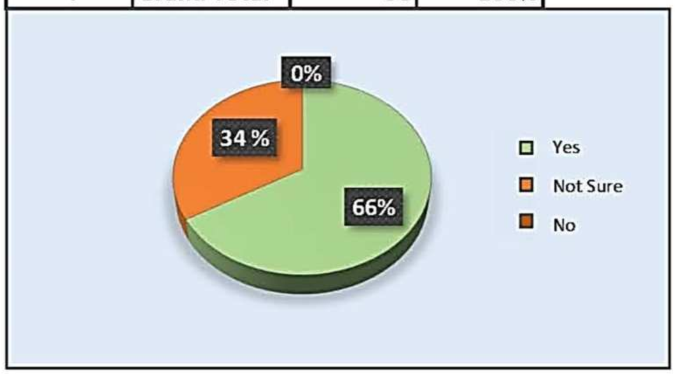


iii) Is there any hospital nearby?			
1	Yes	20	67%
2	Not sure	7	23%
3	No	3	10%
4	Grand Total	30	100%

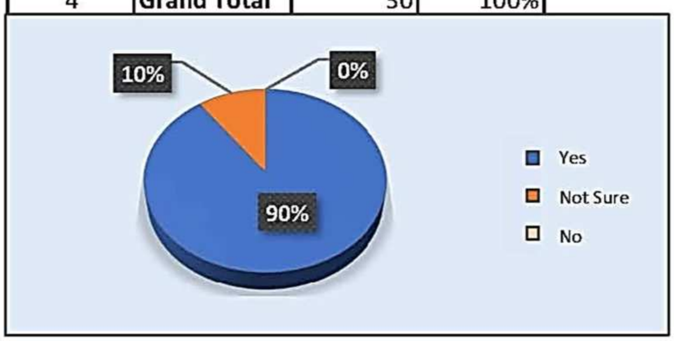


***Dia 6.31**: Pie diagram(i=iii) Location and Transportation; Study: Eve Dress and Shirts Garments Factory*

iv. Is there any market nearby?			
1	Yes	20	66.00%
2	Not sure	10	34%
3	No	0	23.00%
4	Grand Total	30	100%

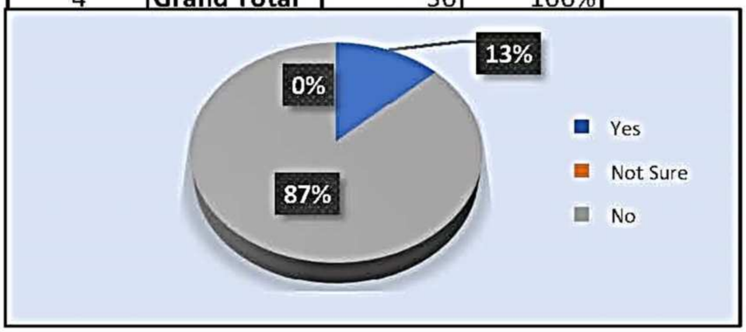


v) Is there any mosque nearby?			
1	Yes	27	90%
2	Not sure	3	10%
3	No	0	0%
4	Grand Total	30	100%

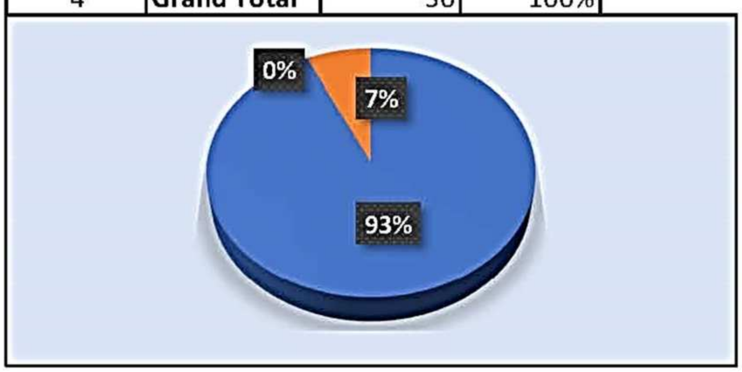


***Dia 6.32**: Pie diagram(iv-v); Study: Eve Dress and Shirts Garments Factory*

vii. Is there any area dedicated for bicycle parking for the building?			
1	Yes	4	13.00%
2	Not sure	0	0%
3	No	26	87.00%
4	Grand Total	30	100%



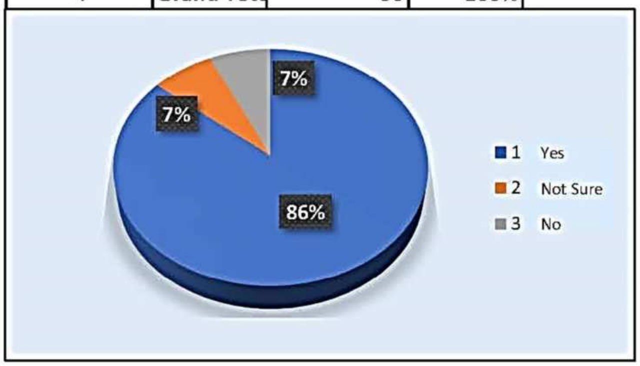
viii) Would it be convenient for the users if the above facilities were nearby?			
1	Yes	28	93%
2	Not sure	2	7%
3	No	0	0%
4	Grand Total	30	100%



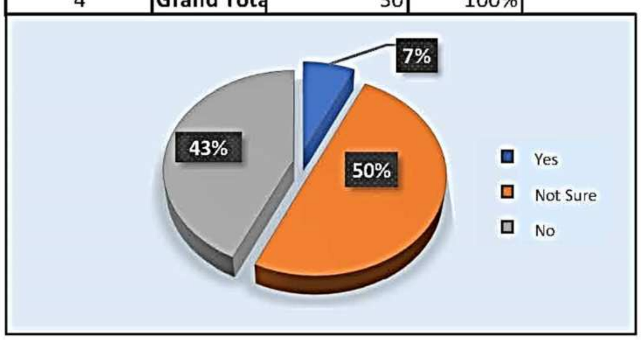
***Dia 6.33**: Pie diagram(vii-viii); Study: Eve Dress and Shirts Garments Factory*

SUSTAINABLE SITES

i) Is there any open space in the site?			
1	Yes	26	86%
2	Not sure	2	7%
3	No	2	7%
4	Grand Tota	30	100%

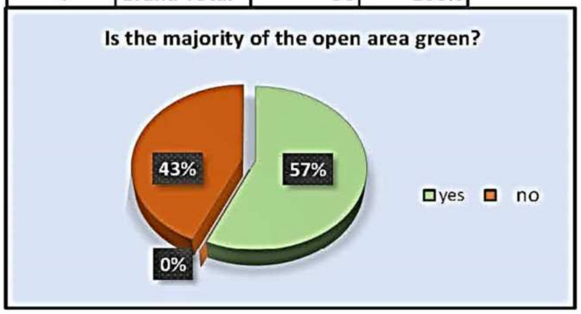


Heat Island Reduction: i) Is there any special paint used on the roof or insulation done for heat reduction?			
1	Yes	2	7%
2	Not sure	15	50%
3	No	13	43%
4	Grand Tota	30	100%

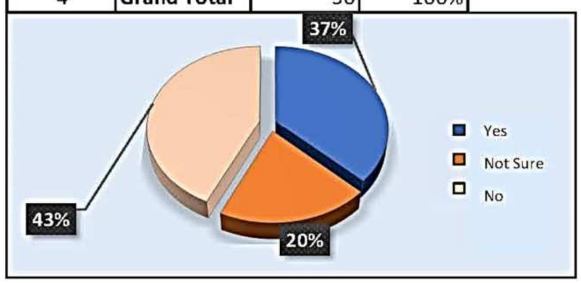


Dia 6.34: *Pie diagram(i) Sustainable Sites & (i) HIR; Study: Eve Dress and Shirts Garments Factory*

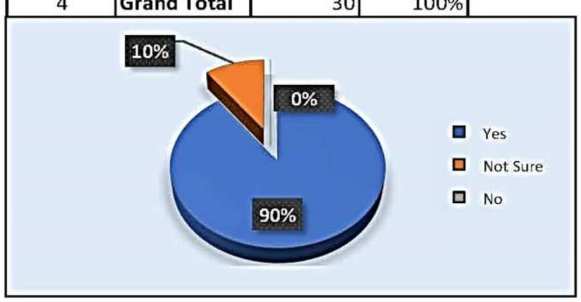
ii. Is the majority of the open area green?			
1	**Yes**	17	57.00%
2	**Not sure**	0	0%
3	**No**	13	43.00%
4	**Grand Total**	30	100%



iii) In case if there are some paved areas, are the paving tiles light in color such as light gray orlight red?			
1	**Yes**	11	37%
2	**Not sure**	6	20%
3	**No**	13	43%
4	**Grand Total**	30	100%



iv) Wouldn't it be convenient if the answers to the above were, yes?			
1	**Yes**	27	90%
2	**Not sure**	3	10%
3	**No**	0	0%
4	**Grand Total**	30	100%

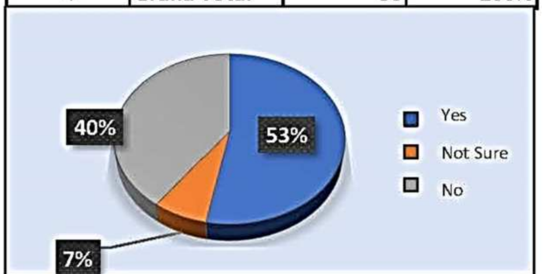


Dia 6.35: *Pie diagram (ii-iv) HIR: Study: Eve Dress and Shirts Garments Factory*

Hydrology and Storm Water Management:

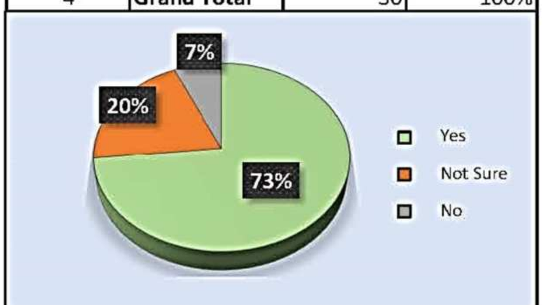
i) Is the site located in an area where there is less chance of flooding (site away from wetland).

1	Yes	16	53.00%
2	Not sure	2	7%
3	No	12	40.00%
4	Grand Total	30	100%



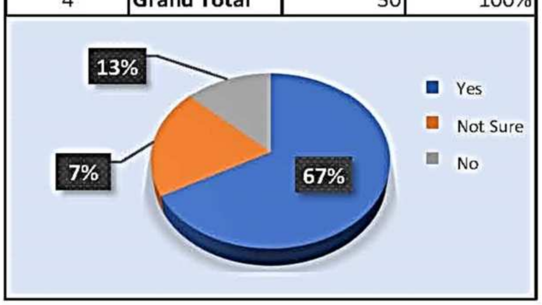
ii) Does the building have roof drainage pipes?

1	Yes	22	73%
2	Not sure	6	20%
3	No	2	7%
4	Grand Total	30	100%



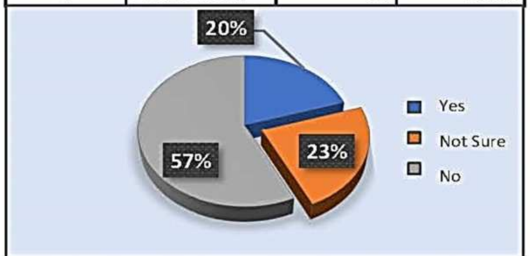
iii) Are all the drainage pipes and drains cleaned and maintained from time to time?

1	Yes	20	67%
2	Not sure	6	20%
3	No	4	13%
4	Grand Total	30	100%

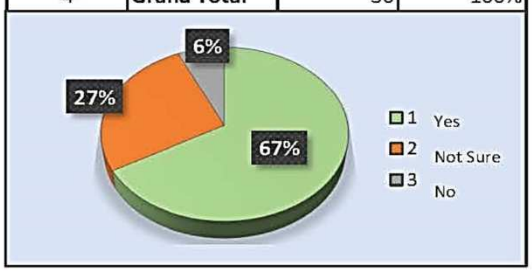


Dia 6.36*: Pie diagram (i-iii) Hydrology and Storm Water Management; Study: Eve Dress and Shirts Garments Factory*

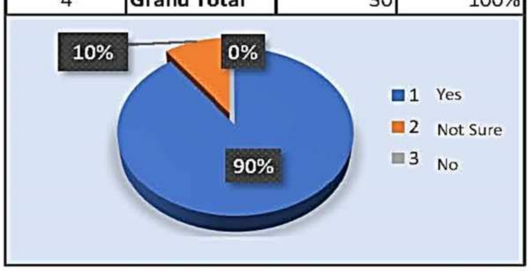
iv) Is there any public storm water collection system near the building to collect the storm water away from the building?			
1	**Yes**	6	20.00%
2	**Not sure**	7	23%
3	**No**	17	57.00%
4	**Grand Total**	30	100%



v) Do the users think that the rainwater may be collected treated and reused (e.g. for washing cars, watering garden etc.?).			
1	**Yes**	20	66%
2	**Not sure**	8	27%
3	**No**	2	7%
4	**Grand Total**	30	100%



vi) Do you think awareness of waste water management is important and people can be trained to dispose or reuse it properly?			
1	**Yes**	27	90%
2	**Not sure**	3	10%
3	**No**	0	0%
4	**Grand Total**	30	100%

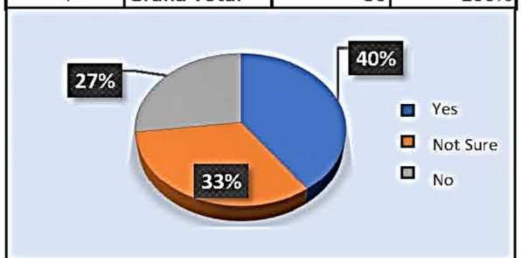


***Dia 6.37**: Pie diagram(iv-vi)) Hydrology and Storm Water Management; Study: Eve Dress and Shirts Garments Factory*

Vegetation

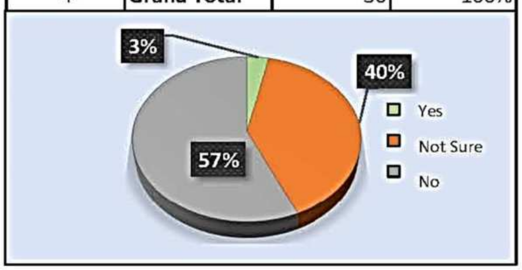
i) The building land was not used for farming prior to construction. Is the statement correct?

1	Yes	12	40.00%
2	Not sure	10	33%
3	No	8	27.00%
4	Grand Total	30	100%



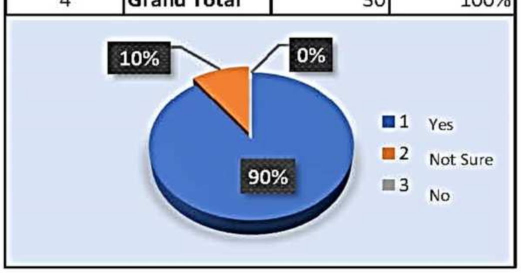
ii) During this building construction process, no endangered species of trees had to be fell?

1	Yes	1	0%
2	Not sure	12	40%
3	No	17	60%
4	Grand Total	30	100%



iii) Do you agree that the farming lands should not be used for development work?

1	Yes	27	90%
2	Not sure	3	10%
3	No	0	0%
4	Grand Total	30	100%

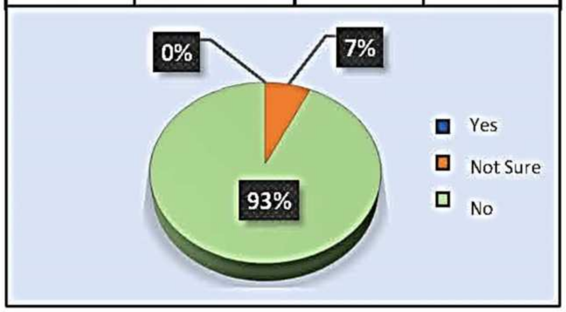


***Dia 6.38**: Pie diagram(i-iii) Vegetation; Study: Del Vista Tower Building*

Human Health Effects:

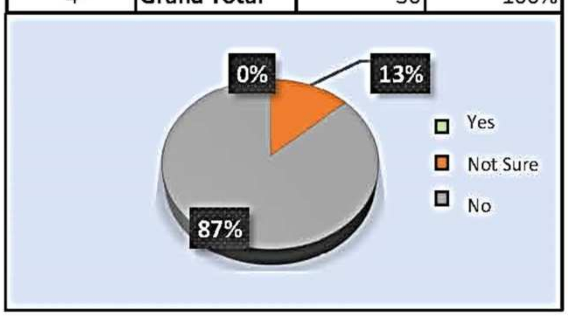
i) There are no factories nearby that produce pollution in the area, correct? to construction. Is the statement correct?

1	**Yes**	0	0.00%
2	**Not sure**	2	7%
3	**No**	28	93.00%
4	**Grand Total**	30	100%



ii) The building does not produce any toxic gas or store any hazardous item, does it?

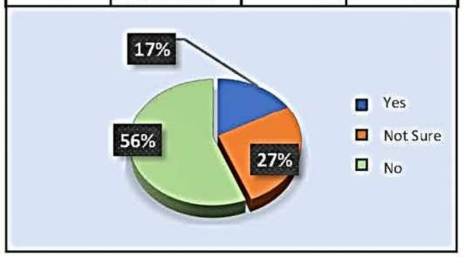
1	**Yes**	0	0%
2	**Not sure**	4	13%
3	**No**	26	87%
4	**Grand Total**	30	100%



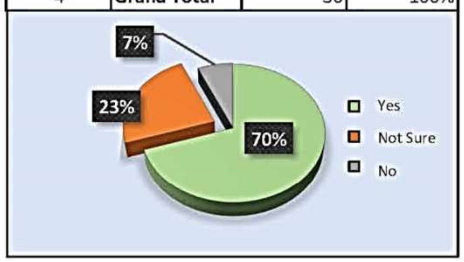
Dia 6.39*: Pie diagram(i-ii) Human Health Effect; Study: Eve Dress and Shirts Garments Factory*

WATER EFFICIENCY

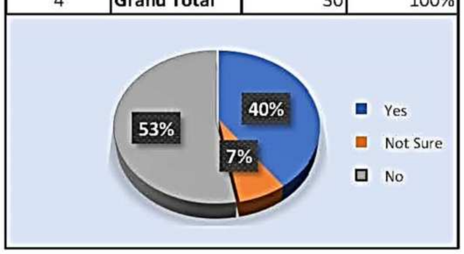
i) While doing water related work are the water taps turned off immediately after the work is over indoors?			
1	**Yes**	5	17.00%
2	**Not sure**	8	27%
3	**No**	17	56.00%
4	**Grand Total**	30	100%



ii) Does the building have a water meter?			
1	**Yes**	21	70%
2	**Not sure**	7	23%
3	**No**	2	7%
4	**Grand Total**	30	100%

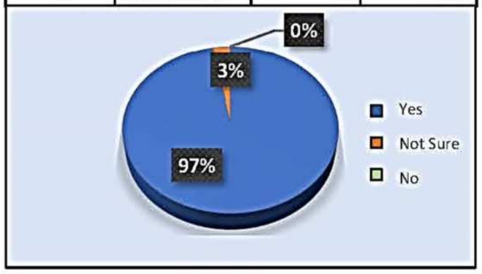


iii) Water efficiency: Are users cautious about using water outdoors?			
1	**Yes**	12	40%
2	**Not sure**	2	7%
3	**No**	16	53%
4	**Grand Total**	30	100%



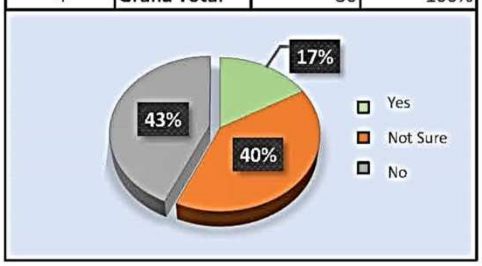
***Dia 6.40**: Pie diagram(i-iii) Water Efficiency; Study: Eve Dress and Shirts Garments Factory*

iv) Do you think awareness regarding the use of water is important and people perform better if they are trained in this matter?			
1	Yes	29	97.00%
2	Not sure	1	3%
3	No	0	0.00%
4	Grand Total	30	100%

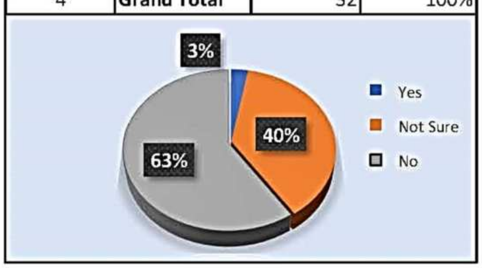


ENERGY AND ATMOSPHERE

i) Are there any solar panels in the building?			
1	Yes	5	33%
2	Not sure	12	40%
3	No	13	43%
4	Grand Total	30	100%



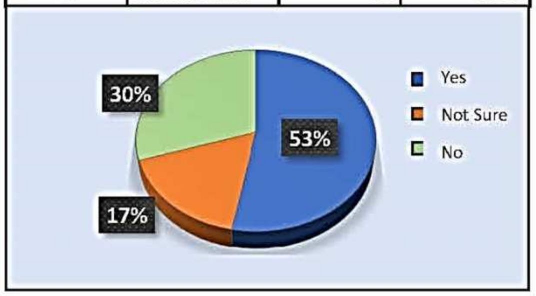
ii) Does the solar panel work properly?			
1	Yes	1	3%
2	Not sure	12	40%
3	No	19	63%
4	Grand Total	32	100%



Dia 6.41*: Pie diagram (iv) Water Efficiency & (i-ii) Energy and Atmosphere: Study: Eve Dress and Shirts Garments Factory*

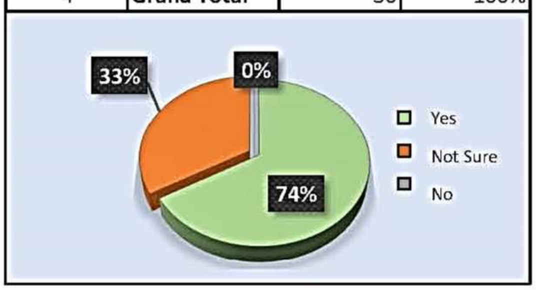
iii) Is there any garden on the roof or verandah of the building?

1	**Yes**	16	53.00%
2	**Not sure**	5	17%
3	**No**	9	30.00%
4	**Grand Total**	30	100%



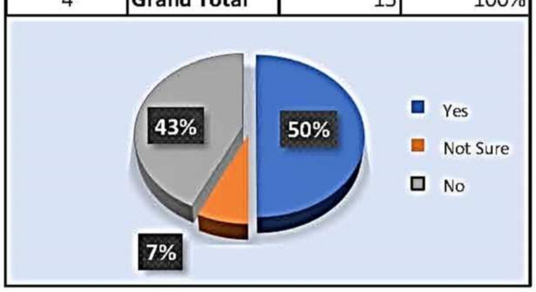
iv) Has any tinted glass or double glazing been used at the exterior walls of the building?

1	**Yes**	20	87%
2	**Not sure**	10	13%
3	**No**	0	0%
4	**Grand Total**	30	100%



v) Does the longer side of the building face south?

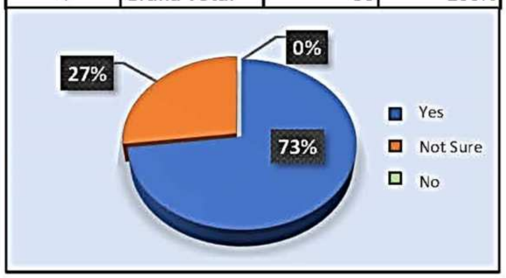
1	**Yes**	(partly) 15	50%
2	**Not sure**	2	7%
3	**No**	13	43%
4	**Grand Total**	15	100%



***Dia 6.42**: Pie diagram(iii-v); Study: Eve Dress and Shirts Garments Factory*

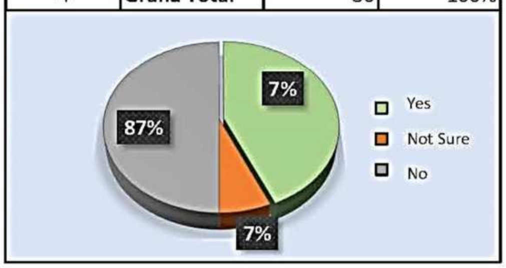
v) Do the inhabitants use LED lights, sensor light of any other energy efficient applianced in the building?

1	Yes	22	73.00%
2	Not sure	8	27%
3	No	0	0.00%
4	Grand Total	30	100%



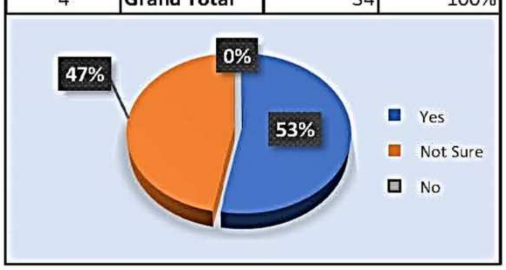
vi) Does the inhabitant get sufficient wind in summer and sunshine in winter?

1	Yes	13	87%
2	Not sure	2	10%
3	No	15	7%
4	Grand Total	30	100%



vii) Do the inhabitants agree that making use of energy efficient items reduce carbon footprint and reduce pressure even on utility bills?

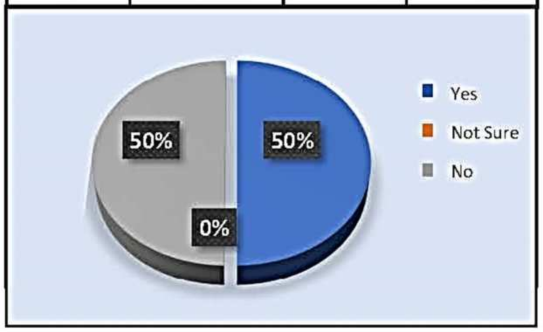
1	Yes	18	60%
2	Not sure	16	53%
3	No	0	0%
4	Grand Total	34	100%



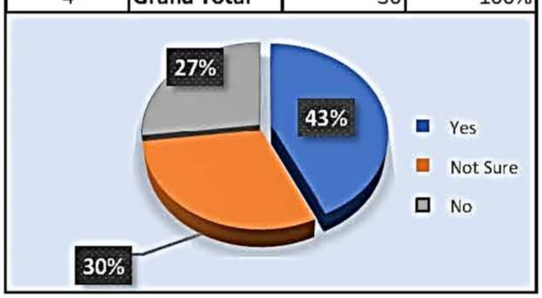
***Dia 6.43**: Pie diagram-(v-vii); Study: Eve Dress and Shirts Garments Factory*

INDOOR ENVIRONMENT

i) Indoor Environment: Does the inhabitant get sufficient sunshine?			
1	**Yes**	15	50%
2	**Not sure**	0	0%
3	**No**	15	50%
4	**Grand Total**	30	100%



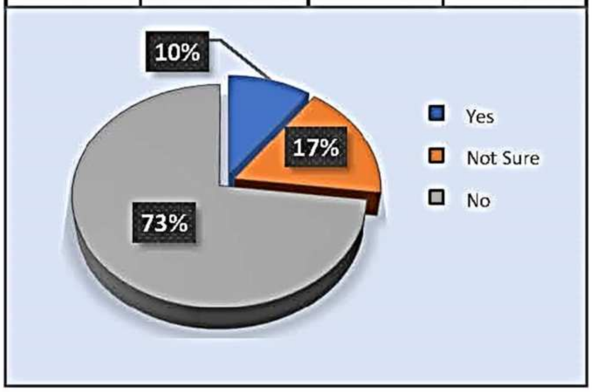
ii) Are the room interior comfortable regarding natural ventilation?			
1	**Yes**	13	43%
2	**Not sure**	9	30%
3	**No**	8	27%
4	**Grand Total**	30	100%



Dia 6.44*: Pie diagram (i-ii) Indoor Environment; Study: Eve Dress and Shirts Garments Factory*

INNOVATION:

i) Does any vertical green planting system (hydroponics) exist in the building?			
1	Yes	3	10%
2	Not sure	5	17%
3	No	22	73%
4	Grand Total	30	100%



***Dia 6.45**: Pie diagram(i)Innovation; Study: Eve Dress and Shirts Garments Factory*

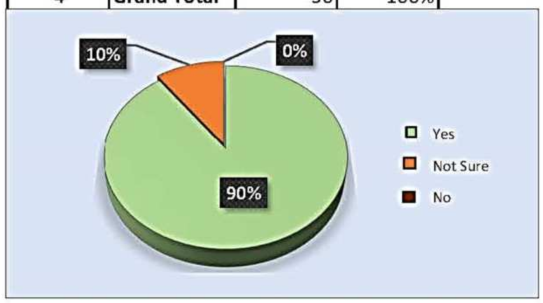
The Eve Dress and Shirts Garments factory has earned a reputation for maintaining good standards of quality and compliance, as evidenced by its certifications from ISO, WRAP, and SEDEX. Transparency is emphasized, with audit reports available to clients. Eve Group emphasizes the significance of ethical practices and sustainability, aligning its operations with established industry standards to promote worker safety and environmental responsibility. Nonetheless, it currently falls short of the comprehensive standards necessary to be classified as a "green building." Nevertheless, the organization is actively progressing toward its objective of achieving full sustainability in its practices.

6.4 MNR SWEATERS GARMENTS BUILDING

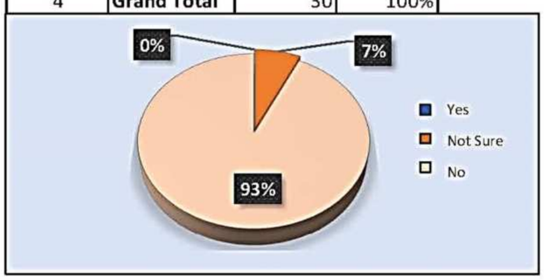
Pic 6.4*: The MNR Sweaters Garments Factory (Self-sourced)*

LOCATION AND TRANSPORTATION

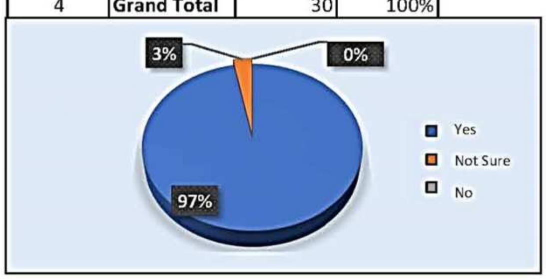
i) Was the building constructed on an unused vacant land?			
1	Yes	27	90.00%
2	Not sure	3	10%
3	No	0	0.00%
4	Grand Total	30	100%



ii) Is the building renovated or restored?			
1	Yes	0	0%
2	Not sure	2	7%
3	No	28	93%
4	Grand Total	30	100%

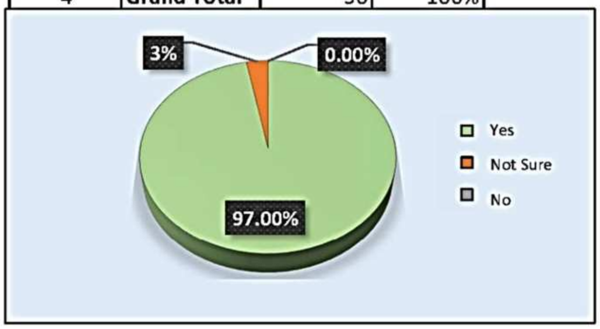


iii) Is there any hospital nearby?			
1	Yes	29	97%
2	Not sure	1	3%
3	No	0	0%
4	Grand Total	30	100%

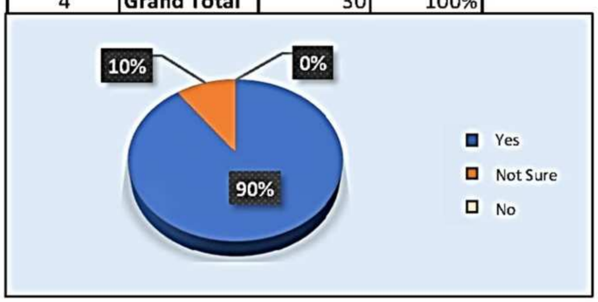


Dia 6.46: *Pie diagram(i-iii) Location and Transportation; Study: MNR Sweaters Garments Factory*

iv. Is there any market nearby?			
1	Yes	29	97.00%
2	Not sure	1	3%
3	No	0	0.00%
4	Grand Total	30	100%

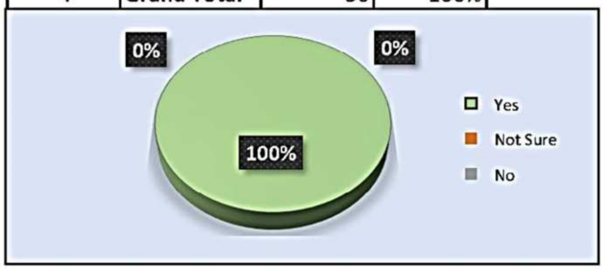


v) Is there any mosque nearby?			
1	Yes	27	90%
2	Not sure	3	10%
3	No	0	0%
4	Grand Total	30	100%

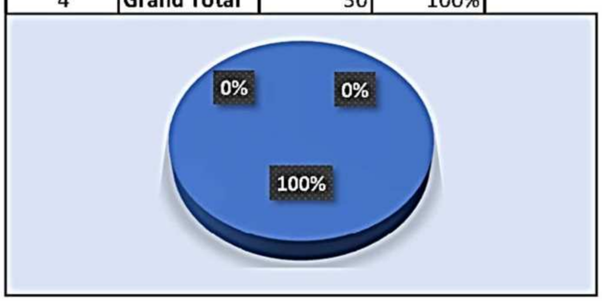


***Dia 6.4**7: Pie diagram(i); Study: MNR Sweaters Garments Factory*

vii. Is there any area dedicated for bicycle parking for the building?			
1	Yes	30	100.00%
2	Not sure	0	0%
3	No	0	0.00%
4	Grand Total	30	100%



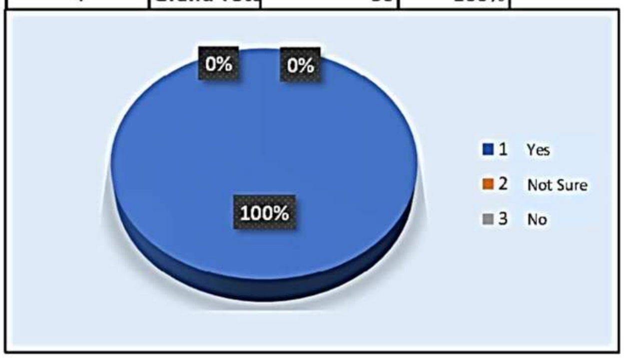
viii) Would it be convenient for the users if the above facilities were nearby?			
1	Yes	30	100%
2	Not sure	0	0%
3	No	0	0%
4	Grand Total	30	100%



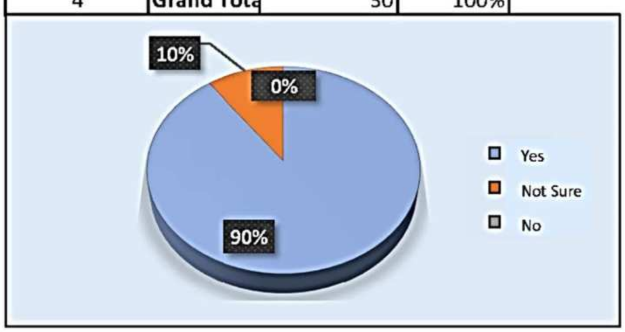
***Dia 6.48**: Pie diagram(vii-viii); Study: MNR Sweaters Garments Factory*

SUSTAINABLE SITES

i) Is there any open space in the site?			
1	Yes	30	100%
2	Not sure	0	0%
3	No	0	0%
4	Grand Tota	30	100%

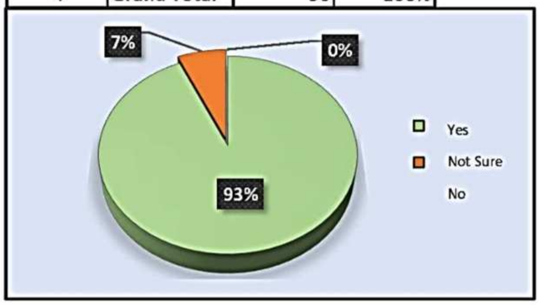


Heat Island Reduction: i) Is there any special paint used on the roof or insulation done for heat reduction?			
1	Yes	27	90%
2	Not sure	3	10%
3	No	0	0%
4	Grand Tota	30	100%

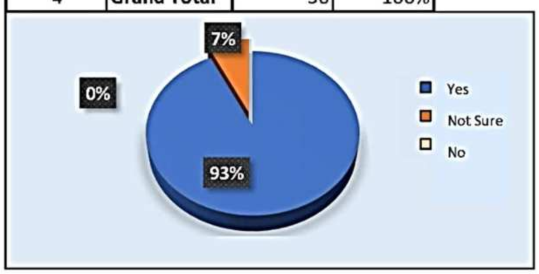


***Dia 6.49**: Pie diagram(i)Sustainable Sites& (i) Heat Island Reduction; Study: MNR Sweaters Garments*

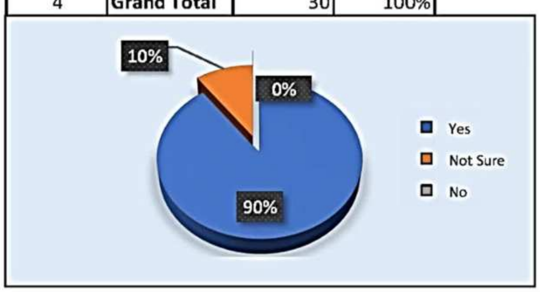
ii. Is the majority of the open area green?			
1	Yes	28	93.00%
2	Not sure	2	7%
3	No	0	43.00%
4	Grand Total	30	100%



iii) In case if there are some paved areas, are the paving tiles light in color such as light gray orlight red?			
1	Yes	28	93%
2	Not sure	2	7%
3	No	0	0%
4	Grand Total	30	100%



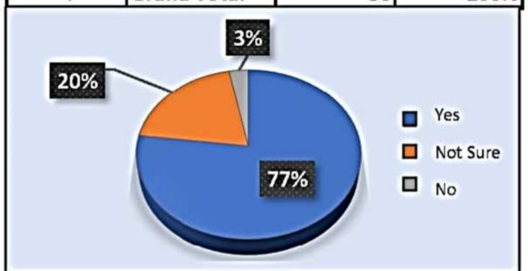
iv) Wouldn't it be convenient if the answers to the above were, yes?			
1	Yes	27	90%
2	Not sure	3	10%
3	No	0	0%
4	Grand Total	30	100%



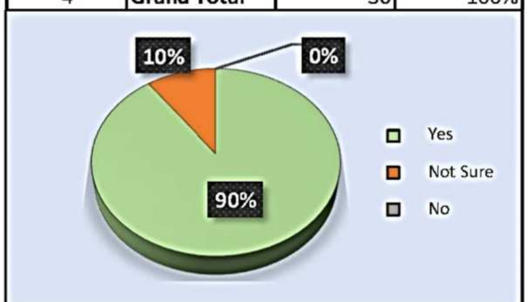
Dia 6.50*: Pie diagram(ii-iv)) Heat Island Reduction; Study: MNR Sweaters Garments*

Hydrology and Storm Water Management:

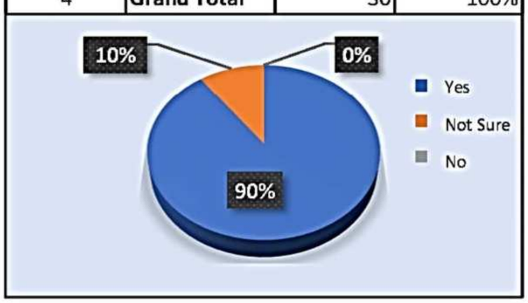
i) Is the site located in an area where there is less chance of flooding (site away from wetland).			
1	Yes	23	77.00%
2	Not sure	6	20%
3	No	1	3.00%
4	Grand Total	30	100%



ii) Does the building have roof drainage pipes?			
1	Yes	27	90%
2	Not sure	3	10%
3	No	0	0%
4	Grand Total	30	100%



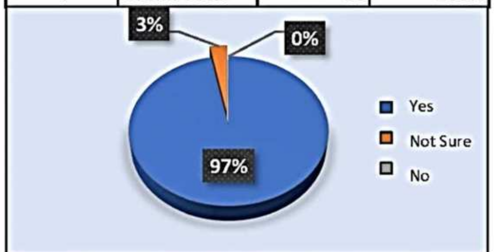
iii) Are all the drainage pipes and drains cleaned and maintained from time to time?			
1	Yes	27	90%
2	Not sure	3	10%
3	No	0	0%
4	Grand Total	30	100%



***Dia 6.51**: Pie diagram(i-iii) Hydrology and Storm Water Management; Study: MNR Sweaters Garments*

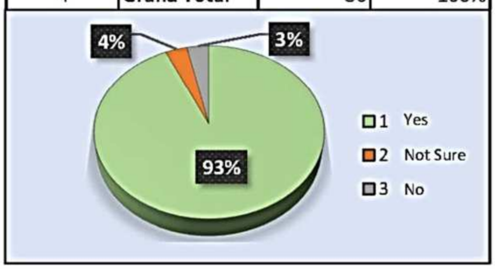
iv) Is there any public storm water collection system near the building to collect the storm water away from the building?

1	Yes	29	97.00%
2	Not sure	1	3%
3	No	0	0.00%
4	Grand Total	30	100%



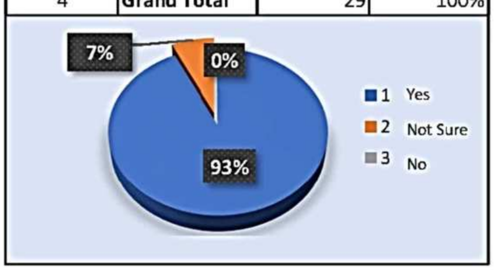
v) Do the users think that the rainwater may be collected treated and reused (e.g. for washing cars, watering garden etc.?).

1	Yes	28	66%
2	Not sure	1	27%
3	No	1	7%
4	Grand Total	30	100%



vi) Do you think awareness of waste water management is important and people can be trained to dispose or reuse it properly?

1	Yes	28	93%
2	Not sure	1	7%
3	No	0	0%
4	Grand Total	29	100%

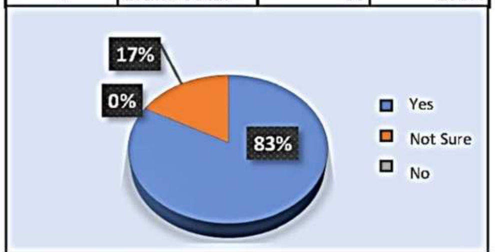


***Dia 6.52**: Pie diagram(iv-vi)) Hydrology and Storm Water Management; Study: MNR Sweaters Garments*

Vegetation

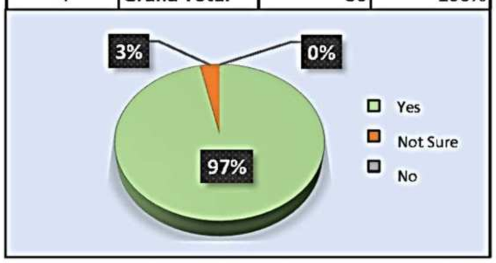
i) The building land was not used for farming prior to construction. Is the statement correct?

1	Yes	25	83.00%
2	Not sure	5	17%
3	No	0	0.00%
4	Grand Total	30	100%



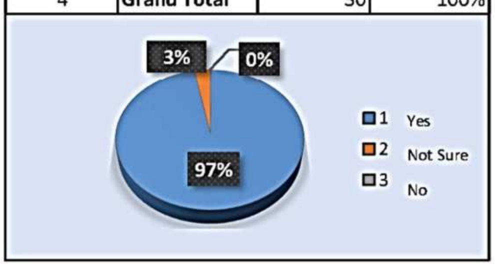
ii) During this building construction process, no endangered species of trees had to be fell?

1	Yes	29	97%
2	Not sure	1	3%
3	No	0	0%
4	Grand Total	30	100%



iii) Do you agree that the farming lands should not be used for development work?

1	Yes	27	97%
2	Not sure	3	3%
3	No	0	0%
4	Grand Total	30	100%

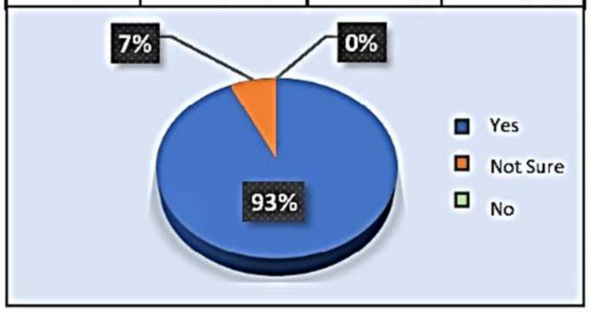


***Dia 6.53**: Pie diagram(i-iii) Vegetation; Study: MNR Sweaters Garments*

Human Health Effects:

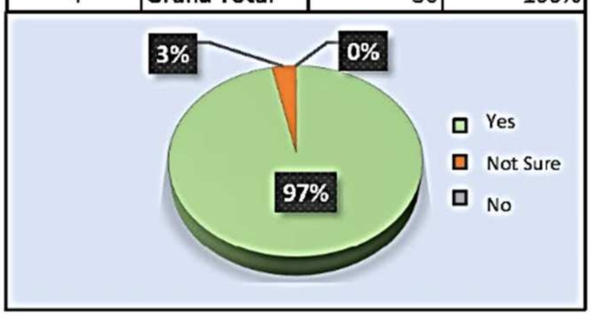
i) There are no factories nearby that produce pollution in the area, correct? to construction. Is the statement correct?

1	Yes	28	93.00%
2	Not sure	2	7%
3	No	0	0.00%
4	Grand Total	30	100%



ii) The building does not produce any toxic gas or store any hazardous item,Is the statement correct?

1	Yes	29	97%
2	Not sure	1	3%
3	No	0	0%
4	Grand Total	30	100%

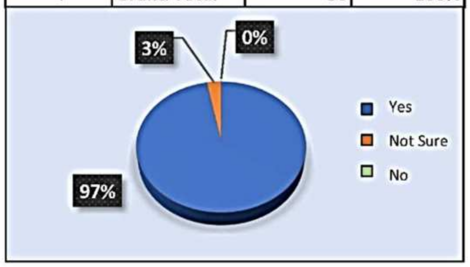


Dia 6.54*: Pie diagram(i-ii) Human Health Effects; Study: MNR Sweaters Garments*

WATER EFFICIENCY

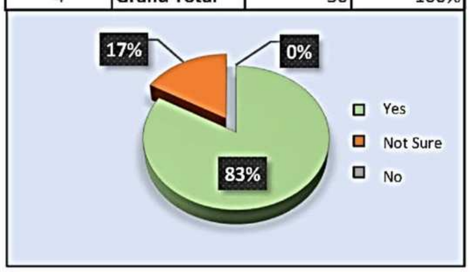
i) While doing water related work are the water taps turned off immediately after the work is over indoors?

1	Yes	29	97.00%
2	Not sure	1	3%
3	No	0	0.00%
4	Grand Total	30	100%



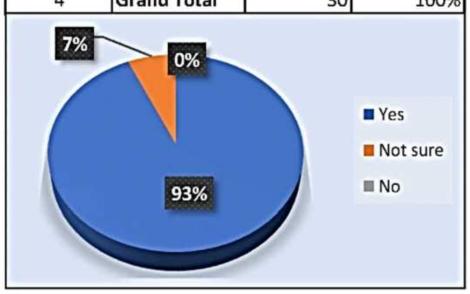
ii) Does the building have a water meter?

1	Yes	25	83%
2	Not sure	5	17%
3	No	0	0%
4	Grand Total	30	100%



iii) Water efficiency:
Are users cautious about using water outdoors?

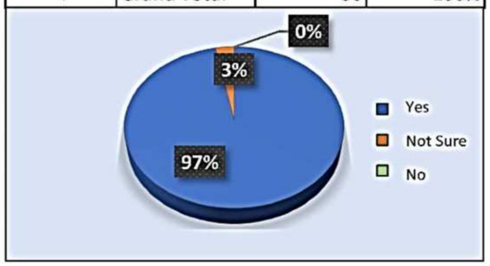
1	Yes	28	93%
2	Not sure	2	7%
3	No	0	0%
4	Grand Total	30	100%



Dia 6.55*: Pie diagram(i-iii) Water Efficiency; Study: MNR Sweaters Garments*

iv) Do you think awareness regarding the use of water is important and people perform better if they are trained in this matter?

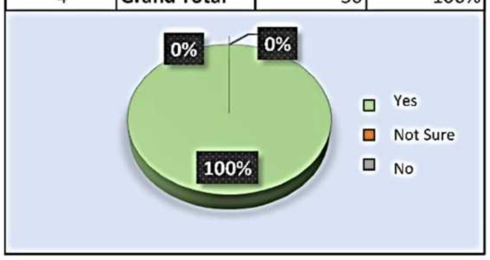
1	Yes	29	97.00%
2	Not sure	1	3%
3	No	0	0.00%
4	Grand Total	30	100%



ENERGY AND ATMOSPHERE

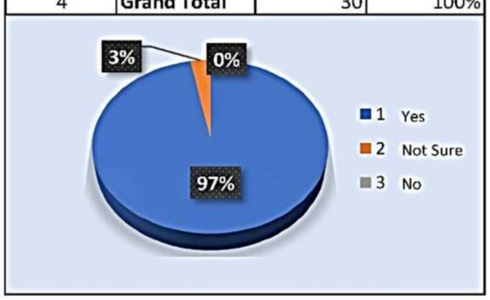
i) Are there any solar panels in the building?

1	Yes	30	33%
2	Not sure	0	40%
3	No	0	27%
4	Grand Total	30	100%



ii) Does the solar panel work properly?

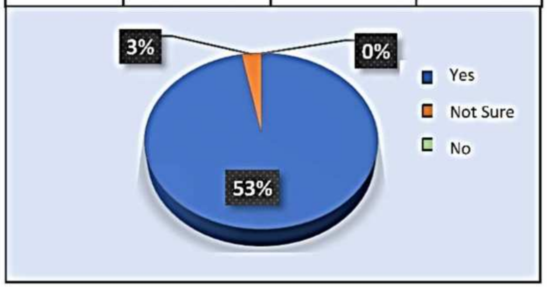
1	Yes	29	97%
2	Not sure	1	3%
3	No	0	0%
4	Grand Total	30	100%



***Dia 6.56**: Pie diagram(iv) Water Efficiency & Energy and Atmosphere (i-ii); Study: MNR Sweaters Garments*

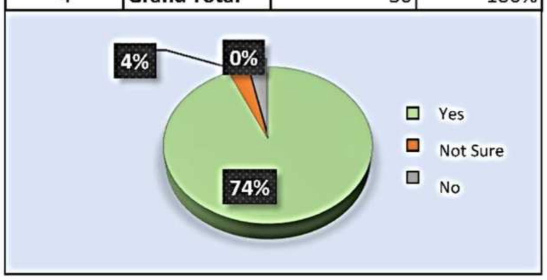
iii) Is there any garden on the roof or verandah of the building?

1	**Yes**	(Verandah) 29	97.00%
2	**Not sure**	1	3%
3	**No**	0	0.00%
4	**Grand Total**	30	100%



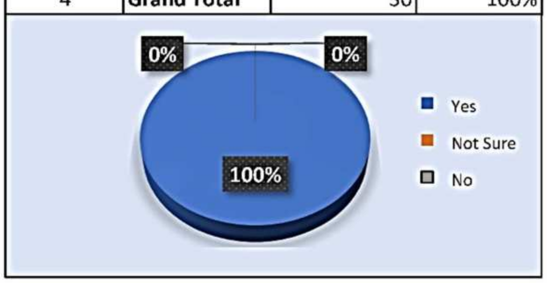
iv) Has any tinted glass or double glazing been used at the exterior walls of the building?

1	**Yes**	28	93%
2	**Not sure**	1	4%
3	**No**	1	3%
4	**Grand Total**	30	100%



v) Does the longer side of the building face south?

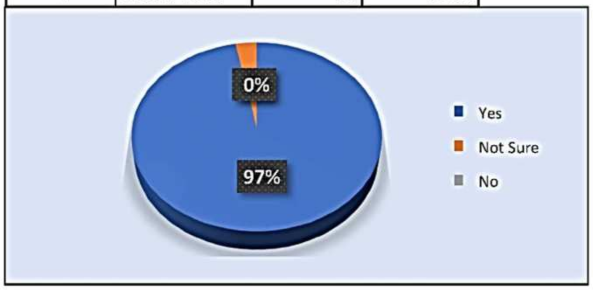
1	**Yes**	30	100%
2	**Not sure**	0	0%
3	**No**	0	0%
4	**Grand Total**	30	100%



***Dia 6.57**: Pie diagram(iii-v); Study: MNR Sweaters Garments*

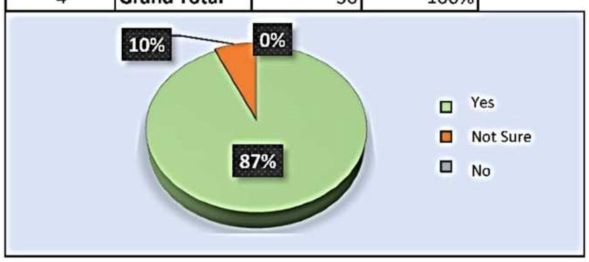
v) Do the inhabitants use LED lights, sensor light of any other energy efficient applianced in the building?

1	Yes	29	97.00%
2	Not sure	1	3%
3	No	0	0.00%
4	Grand Total	30	100%



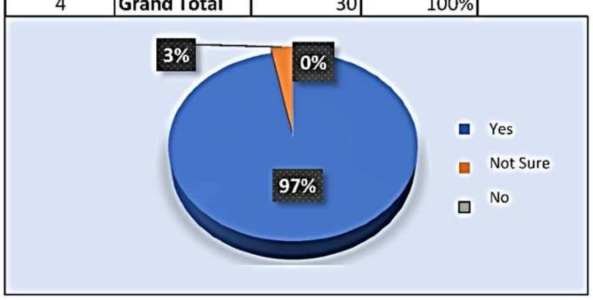
vi) Does the inhabitant get sufficient wind in summer and sunshine in winter?

1	Yes	28	87%
2	Not sure	2	10%
3	No	0	0%
4	Grand Total	30	100%



vii) Do the inhabitants agree that making use of energy efficient items reduce carbon footprint and reduce pressure even on utility bills?

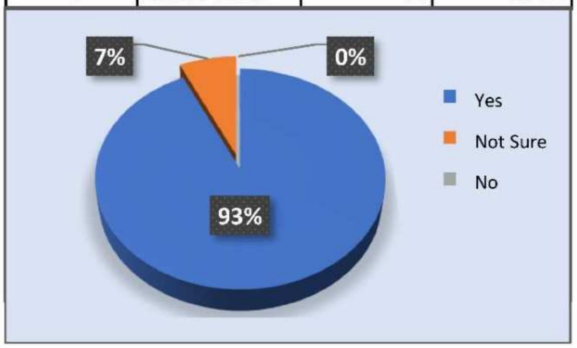
1	Yes	29	97%
2	Not sure	1	3%
3	No	0	0%
4	Grand Total	30	100%



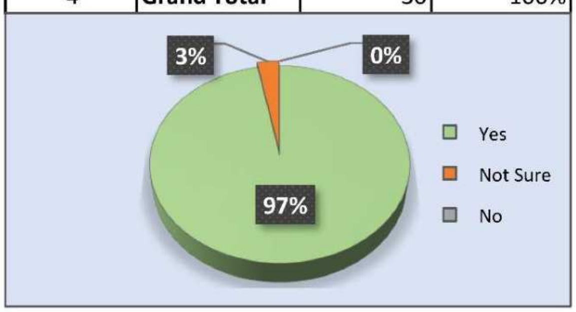
***Dia 6.58**: Pie diagram(v-vii); Study: MNR Sweaters Garment*

INDOOR ENVIRONMENT

i) Indoor Environment: Does the inhabitant get sufficient sunshine?			
1	Yes	28	93%
2	Not sure	2	7%
3	No	0	0%
4	Grand Total	30	100%



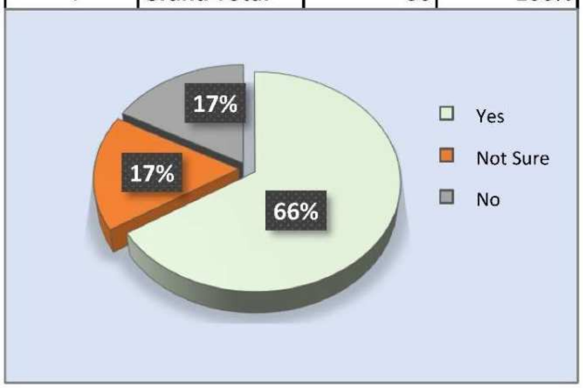
ii) Are the room interior comfortable regarding natural ventilation?			
1	Yes	29	97%
2	Not sure	1	3%
3	No	0	0%
4	Grand Total	30	100%



***Dia 6.59**: Pie diagram(i-ii) Indoor Environment; Study: MNR Sweaters Garments*

INNOVATION:

i) Does any vertical green planting system (hydroponics) exist in the building?			
1	**Yes**	20	66%
2	**Not sure**	5	17%
3	**No**	5	17%
4	**Grand Total**	30	100%



***Dia 6.60**: Pie diagram(i) Innovation; Study: MNR Sweaters Garments*

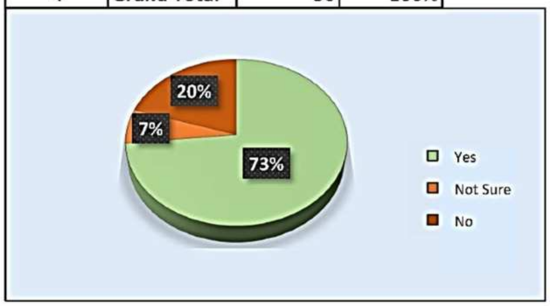
The MNR Sweaters Garments Factory is a notable example of a green building, embodying sustainable practices in industrial construction and operation. Key features include energy-efficient systems, such as advanced HVAC technology and LED lighting, which collectively reduce energy consumption and operational costs. The factory also implements renewable energy sources, such as solar panels, further minimizing its carbon footprint.

Water management strategies are integral to its design, incorporating rainwater harvesting and wastewater recycling systems that promote efficient resource use. Additionally, the factory prioritizes indoor environmental quality by ensuring adequate ventilation and the use of low-VOC (volatile organic compounds) materials, thereby safeguarding worker health.
The factory's landscaping incorporates native and plants from the neighboring countries, enhancing biodiversity and reducing the need for irrigation. By aligning with sustainability certifications, MNR Sweaters demonstrates a commitment to environmental stewardship and social responsibility, setting a precedent for future industrial developments in the Dhaka region.

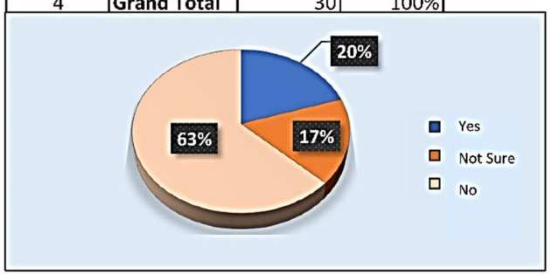
6.5 HOUSE HOLDS

***Pic 6.5**: Pictures of a few Houses in Dhaka under the study (Self-sourced)*

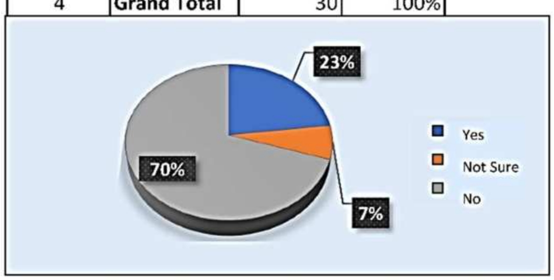
i.Was the building constructedon an unused vacant land?			
1	Yes	22	73.00%
2	Not sure	2	7%
3	No	6	20.00%
4	Grand Total	30	100%



ii) Is the building renovated or restored?			
1	Yes	6	20%
2	Not sure	5	17%
3	No	19	63%
4	Grand Total	30	100%

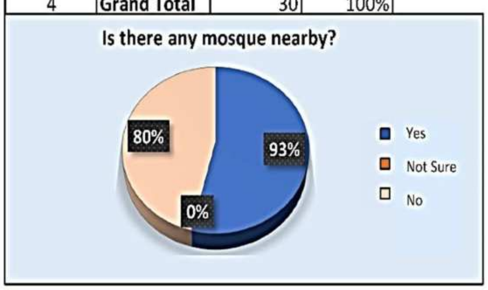


iii) Is there any hospital nearby?			
1	Yes	7	23%
2	Not sure	2	7%
3	No	21	70%
4	Grand Total	30	100%

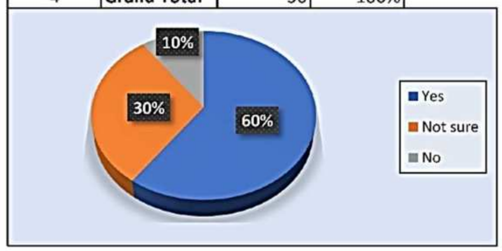


Dia 6.61: *Pie diagram(i-iii); Study: Housings, Dhaka*

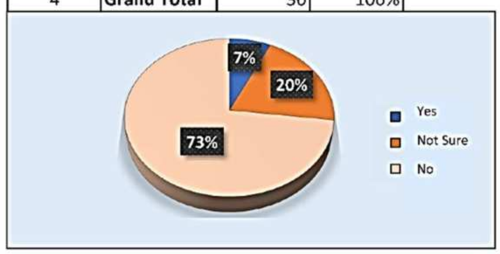
v) Is there any mosque nearby?			
1	**Yes**	28	93%
2	**Not sure**	0	0%
3	**No**	2	80%
4	**Grand Total**	30	100%



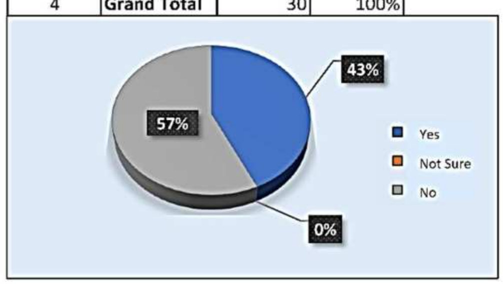
i. Was the building constructed on an unused vacant land?			
1	**Yes**	18	60.00%
2	**Not sure**	9	30%
3	**No**	3	10.00%
4	**Grand Total**	30	100%



ii) Is the building renovated or restored?			
1	**Yes**	2	7%
2	**Not sure**	6	20%
3	**No**	22	73%
4	**Grand Total**	30	100%

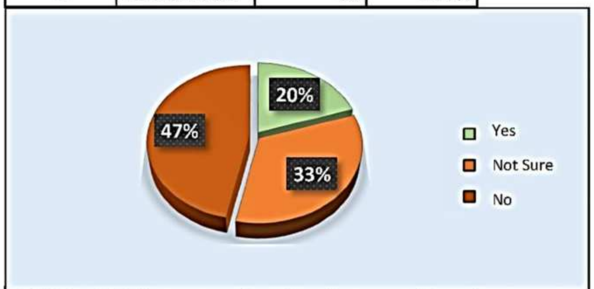


Is there any hospital nearby?			
1	**Yes**	13	43%
2	**Not sure**	0	0%
3	**No**	17	57%
4	**Grand Total**	30	100%

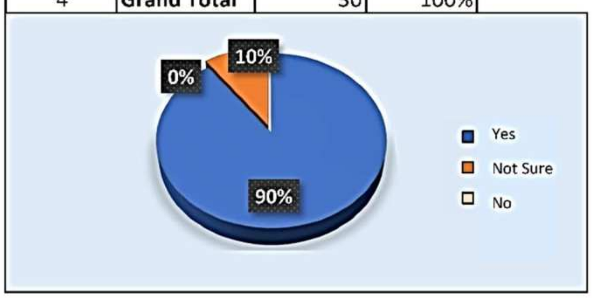


***Dia 6.62**: Pie diagram(v) & **Dia 6.63**: Pie diagram(i-iii): Study: Housings, Dhaka*

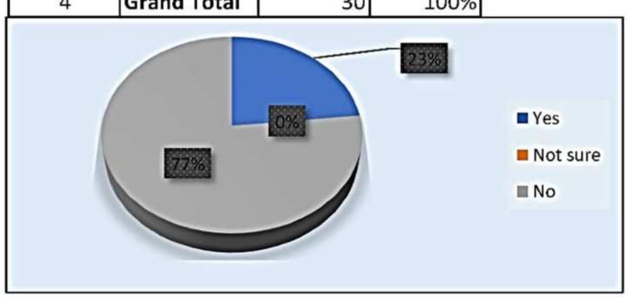
vii. Is there any area dedicated for bicycle parking for the building?			
1	**Yes**	6	20.00%
2	**Not sure**	10	33%
3	**No**	14	47.00%
4	**Grand Total**	30	100%



viii) Would it be convenient for the users if the above facilities were nearby?			
1	**Yes**	27	90%
2	**Not sure**	3	10%
3	**No**	0	0%
4	**Grand Total**	30	100%

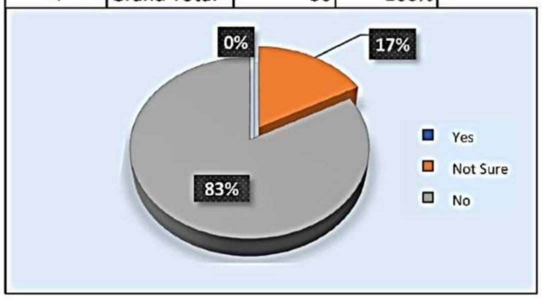


viii) Is there any open space in site?			
1	**Yes**	7	23%
2	**Not sure**	0	10%
3	**No**	23	77%
4	**Grand Total**	30	100%

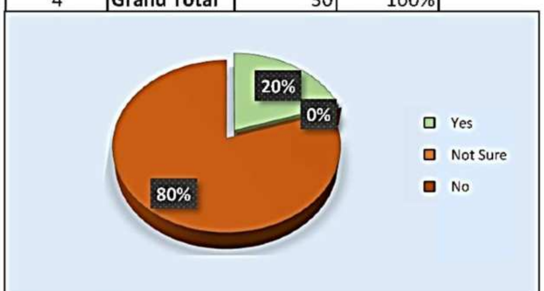


Dia 6.64: *Pie diagram (vii-viii); Study: Housings, Dhaka*

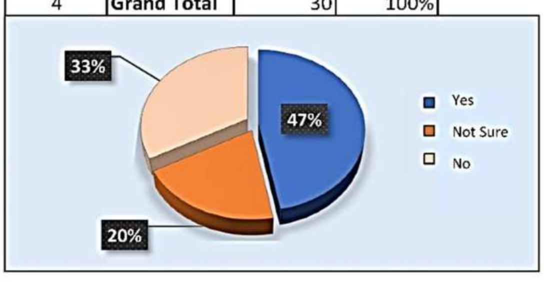
ix) Heat Island Reduction: Is there any special paint used on the roof or insulation done for heat reduction?			
1	Yes	0	0%
2	Not sure	5	17%
3	No	25	83%
4	Grand Total	30	100%



x. Is the majority of the open area green?			
1	Yes	6	20.00%
2	Not sure	0	0%
3	No	24	80.00%
4	Grand Total	30	100%



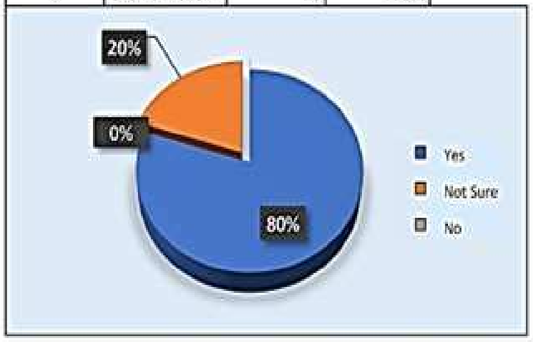
xi) In case if there are some paved areas, are the paving tiles light in color such as light gray orlight red?			
1	Yes	14	47%
2	Not sure	6	20%
3	No	10	33%
4	Grand Total	30	100%



***Dia 6.65**: Pie diagram(ix-xi) Heat Island Reduction: Study; Housings, Dhaka*

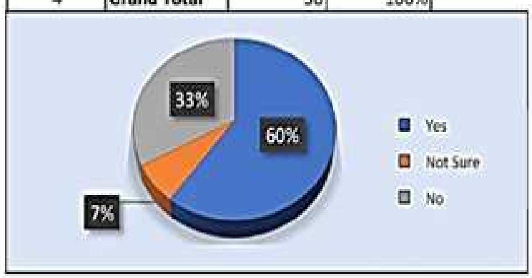
xii) Wouldn't it be convenient if the answers to the above were, yes?

1	Yes	24	80%
2	Not sure	6	20%
3	No	0	0%
4	Grand Total	30	100%



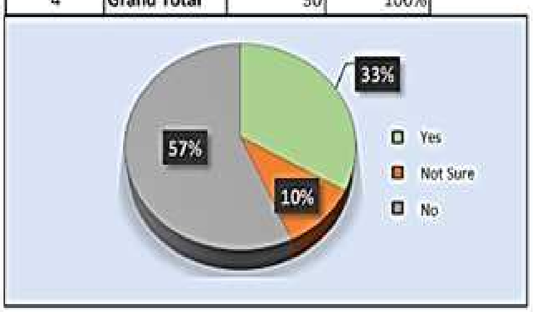
xiii) Hydrology and Storm Water Management: Is the site located in an area where there is less chance of flooding (site away from wetland).

1	Yes	18	60.00%
2	Not sure	2	7%
3	No	10	33.00%
4	Grand Total	30	100%



xiv) Does the building have roof drainage pipes?

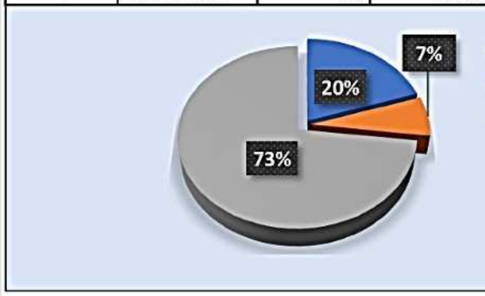
1	Yes	10	33%
2	Not sure	3	10%
3	No	17	57%
4	Grand Total	30	100%



***Dia 6.66**: Pie diagram(xii-xiv; Study: Housings, Dhaka*

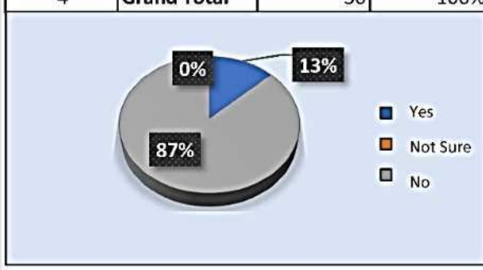
XV) Are all the drainage pipes and drains cleaned and maintained from time to time?

1	Yes	6	20%
2	Not sure	2	7%
3	No	22	73%
4	Grand Total	30	100%



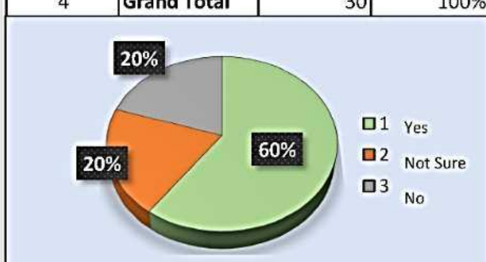
XV1) Is there any public storm water collection system near the building to collect the storm water away from the building?

1	Yes	4	13.00%
2	Not sure	0	0%
3	No	26	87.00%
4	Grand Total	30	100%



XV11) Do the users think that the rainwater may be collected treated and reused (e.g. for washing cars, watering garden etc.?).

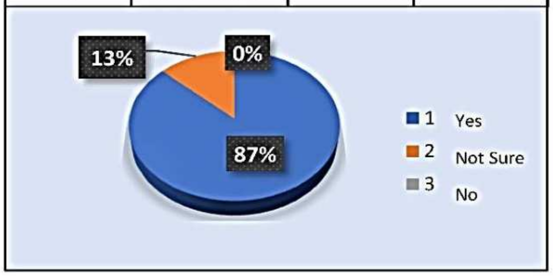
1	Yes	18	60%
2	Not sure	6	20%
3	No	6	20%
4	Grand Total	30	100%



Dia 6.6*7: Pie diagram(xv-xvii); Study: Housings, Dhaka*

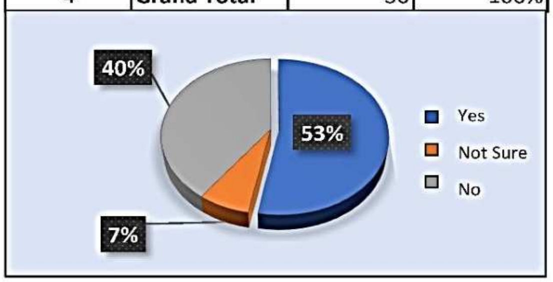
xviii) Do you think awareness of waste water management is important and people can be trained to dispose or reuse it properly?

1	Yes	26	87%
2	Not sure	4	13%
3	No	0	0%
4	Grand Total	30	100%



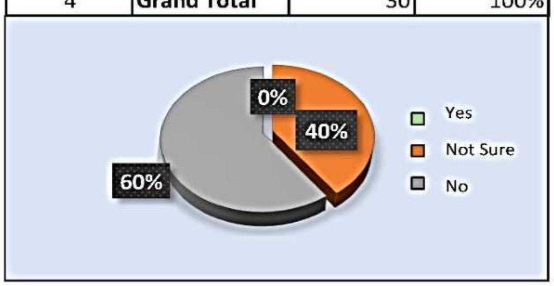
xix) The building land was not used for farming prior to construction. Is the statement correct?

1	Yes	16	53.00%
2	Not sure	2	7%
3	No	12	40.00%
4	Grand Total	30	100%



xx) During this building construction process, no endangered species of trees had to be fell?

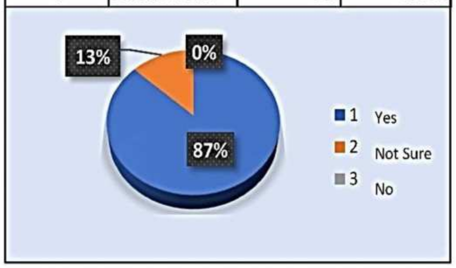
1	Yes	0	0%
2	Not sure	12	40%
3	No	18	60%
4	Grand Total	30	100%



***Dia 6.68**: Pie diagram(xviii-xx): Study: Housings, Dhak*

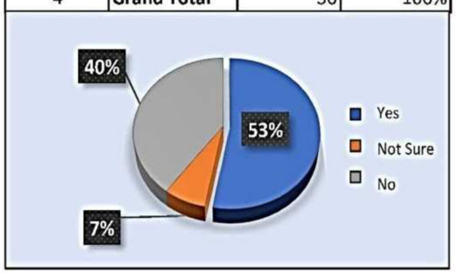
xxi)

18) Do you think awareness of waste water management is important and people can be trained to dispose or reuse it properly?			
1	Yes	26	87%
2	Not sure	4	13%
3	No	0	0%
4	Grand Total	30	100%



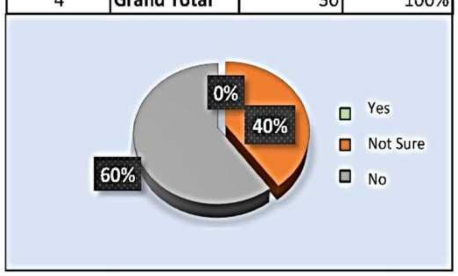
xxii)

19)The building land was not used for farming prior to construction. Is the statement correct?			
1	Yes	16	53.00%
2	Not sure	2	7%
3	No	12	40.00%
4	Grand Total	30	100%



xxiii)

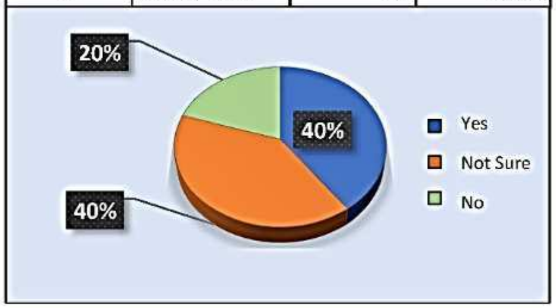
20) During this building construction process, no endangered species of trees had to be fell?			
1	Yes	0	0%
2	Not sure	12	40%
3	No	18	60%
4	Grand Total	30	100%



***Dia 6.69**: Pie diagram(xxi-xxiii): Study: Housings, Dhaka*

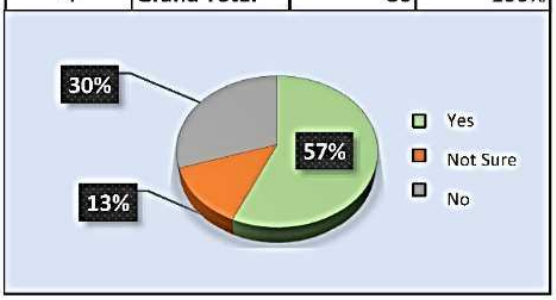
XXV)Are water taps turned off immediately after the work is over indoors?

1	Yes	12	40.00%
2	Not sure	12	40%
3	No	6	20.00%
4	Grand Total	30	100%



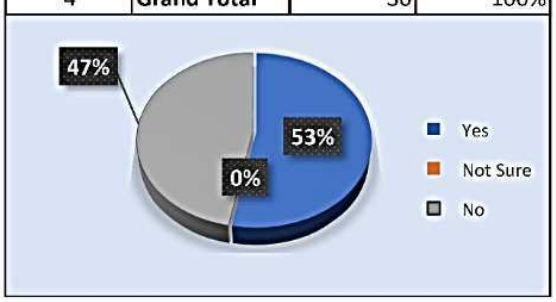
XXV1)Does the building have a water meter?

1	Yes	17	57%
2	Not sure	4	13%
3	No	9	30%
4	Grand Total	30	100%



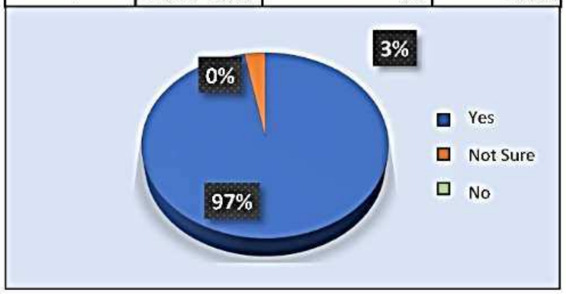
XXVII)Water efficiency:
Are users cautious about using water outdoors?

1	Yes	16	53%
2	Not sure	0	0%
3	No	14	47%
4	Grand Total	30	100%

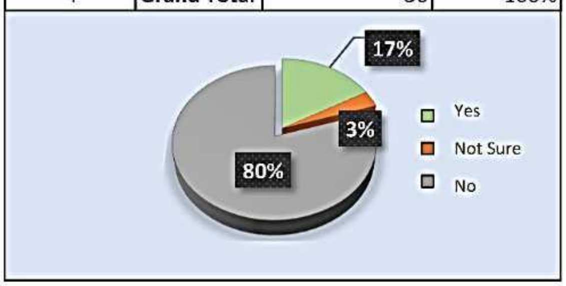


***Dia 6.70**: Pie diagram(xxv-xxvii): Study: Housings, Dhaka*

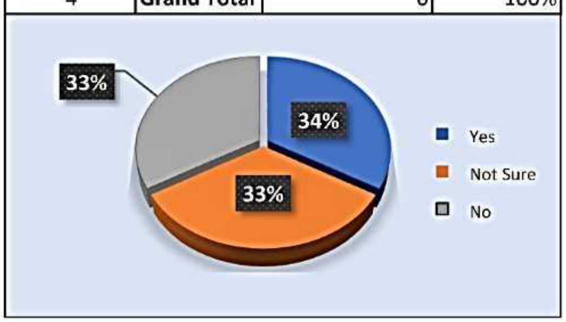
xxviii) Do you think awareness regading the use of water is important and people perform better if they are trained in this matter?			
1	Yes	29	97.00%
2	Not sure	1	3%
3	No	0	0.00%
4	Grand Total	30	100%



xxix) Are there any solar panels in the building?			
1	Yes	5	20%
2	Not sure	1	7%
3	No	24	73%
4	Grand Total	30	100%

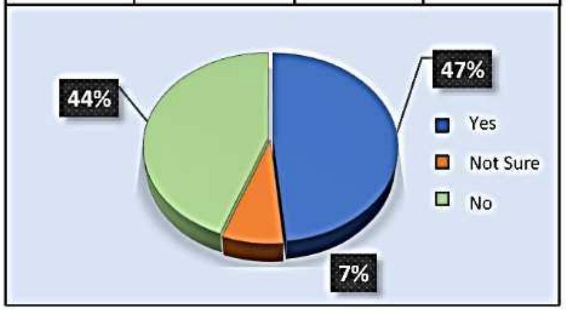


xxx) Does the solar panel work properly?			
1	Yes	4	33%
2	Not sure	2	33%
3	No	(not present) 24	33%
4	Grand Total	6	100%

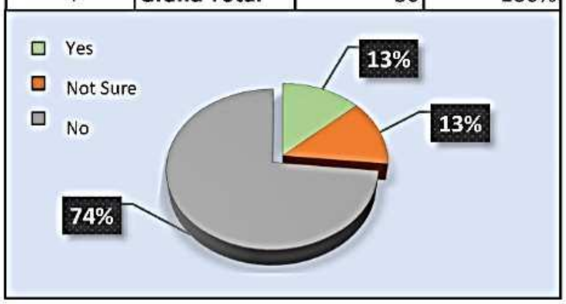


Dia 6.71*: Pie diagram(xxviii-xxx): Study: Housings, Dhaka*

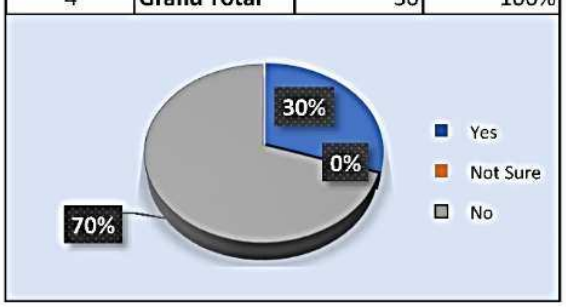
xxxi)Is there any garden on the roof or verandah of the building?			
1	Yes	14	47.00%
2	Not sure	3	7%
3	No	13	43.00%
4	Grand Total	30	100%



xxxii)Has tinted glass or double glazing been used at the exterior walls of the building?			
1	Yes	4	13%
2	Not sure	4	13%
3	No	22	74%
4	Grand Total	30	100%

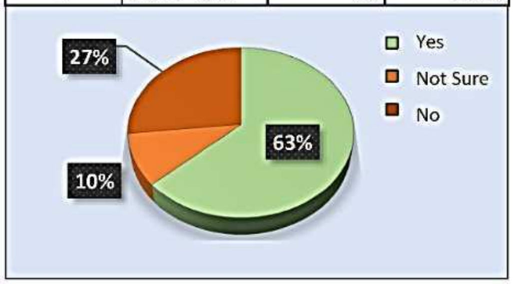


xxxiii Does the longer side of the building face south?			
1	Yes	9	30%
2	Not sure	0	0%
3	No	21	70%
4	Grand Total	30	100%

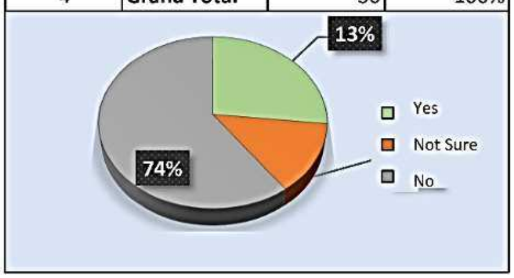


Dia 6.72: *Pie diagram(xxxi-xxxiii): Study: Housings, Dhaka*

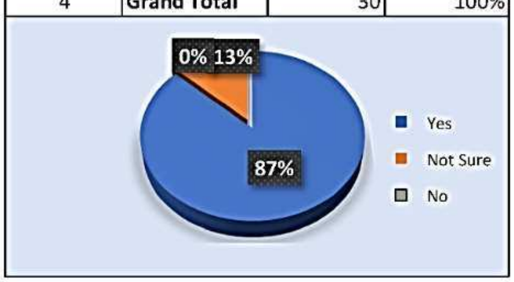
xxxiv) Energy saving: Do the inhabitants use LED lights, sensor light of any other energy efficient appliances in the building?			
1	Yes	19	63.00%
2	Not sure	3	10%
3	No	8	27.00%
4	Grand Total	30	100%



xxxv) Does the inhabitant get sufficient wind in summer and sunshine in winter?			
1	Yes	8	33%
2	Not sure	4	13%
3	No	18	74%
4	Grand Total	30	100%



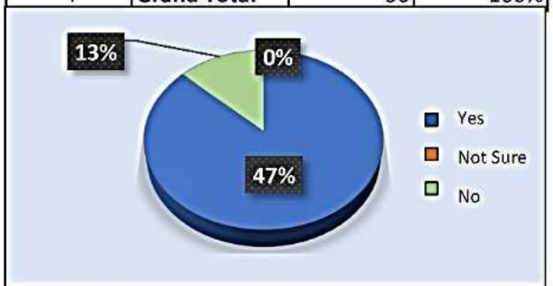
xxxvi) Do the inhabitants agree that making use of energy efficient items reduce carbon footprint and reduce pressure even on utility bills?			
1	Yes	26	87%
2	Not sure	4	13%
3	No	0	0%
4	Grand Total	30	100%



***Dia 6.73**: Pie diagram(xxxiv-xxxvi): Study: Housings, Dhaka*

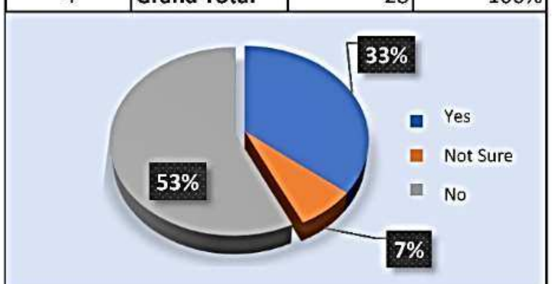
xxxvii) **Energy saving: Do the inhabitants use LED lights, sensor light of any other energy efficient applianced in the building?**

1	Yes	26	87.00%
2	Not sure	0	0%
3	No	4	13.00%
4	Grand Total	30	100%



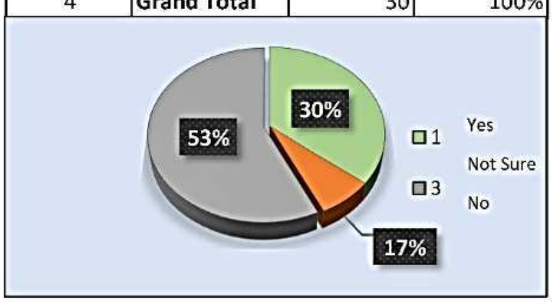
xxxviii) **Indoor Environment: Does the inhabitant get sufficient sunshine?**

1	Yes	10	33%
2	Not sure	2	7%
3	No	16	53%
4	Grand Total	28	100%

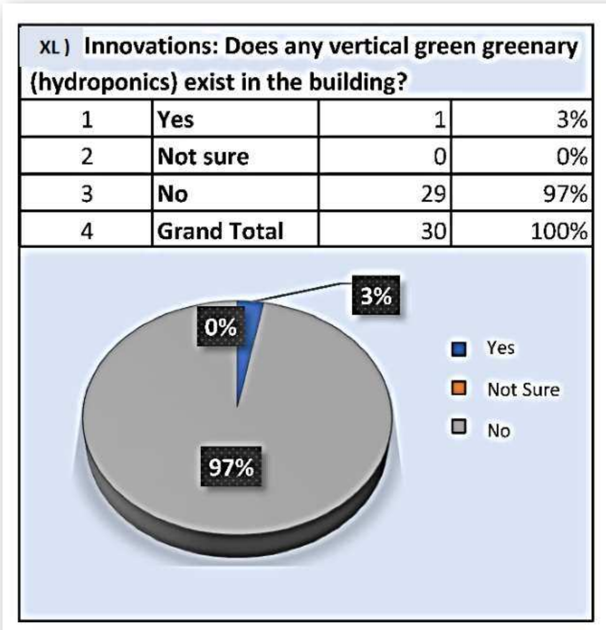


xxxix) **Are the room interior comfortable regarding natural ventilation?**

1	Yes	9	30%
2	Not sure	5	17%
3	No	16	53%
4	Grand Total	30	100%



***Dia 6.74**: Pie diagram(xxxvii-xxxix): Study: Housings, Dhaka*



XL) Innovations: Does any vertical green greenary (hydroponics) exist in the building?			
1	Yes	1	3%
2	Not sure	0	0%
3	No	29	97%
4	Grand Total	30	100%

***Dia 6.75**: Pie diagram(xl): Study: Housings, Dhaka*

The residential buildings under the survey represents the that many of these residential buildings in Dhaka, have so long been overlooking the concept of incorporating green technology in their designs. While some include gardens and green spaces, the integration of eco-friendly practices in these buildings or green-certified buildings are still quite limited. This gap may incentivize the opportunity for incorporating green technology in the buildings of Dhaka. For instance, incorporating sustainable features like energy-efficient systems, rainwater harvesting, and proper insulation could significantly enhance the quality of life for residents as well as benefit the environment. Promoting awareness and incentivizing developers to adopt green building practices could lead to a more sustainable urban landscape in Dhaka.

TABLE 6.1: COMPARATIVE ANALYSIS OF THE CASE STUDIES UNDER SURVEY

INDICATORS BASED ON GREEN BUILDING CRITEREA	CITY-SCAPE TOWER		DEL VISTA TOWER		MNR SWEATERS G.FACTORY		EVE SWEATERS G.FACTORY		HOUSEHOLDS	
YES (Y) =2; NOT SURE (NS) =0; NO=0; P=NO OF RESPONDENTS	Formula: (A) = Y*P+NS*P+N*P		Formula: (B) = Y*P+NS*P+N*P		Formula (C) = Y*P+NS*P+N*P		Formula: (D) = Y*P+NS*P+N*P		Formula: (E) = Y*P+NS*P+N*P	
LOCATION AND TRANSPORTATION	Calculation	Total	Calculation	Total	Calculation		Calculation		Calculation	
i) Was the building constructed on an unused vacant land?	2*24+0*6+0	48	2*8+0*19+3	10	2*28+0*2+0	56	2*19+0*10+(-2)*1	36	2*22+0*2+(-2)*6	32
ii) Is the building renovated or restored?	2*2+0*6+(-2)*12	-44	2*7+0*8+15*(-2)	-16	0+0*2+(-2)*28	_56	2*5+0*10+(-2)*15	-20	2*6+0*5+(-2)*19	-26
iii) Is there any hospital nearby?	2*26+0*4+0	52	2*28+0+2(-2)	52	2*29+0*1+0	58	2*20+0*7+(-2)*3	34	2*7+0*2+(-2)*21	-28
iv) Is there any market nearby?	2*30+0+0	60	2*28+0*2+0	56	2*29+0*1+0	58	2*20+0*10+0	40	2*16+0+(-2)*14	4
v) Is there any mosque nearby?	2*28+0*2+0	56	2*30+0*2+0	60	2*27+0*3+0	54	2*27+0*3+0	54	2*28+0+(-2)*2	52
vi)Is there any area dedicated for bicycle parking for the building?	2*29+0+1*+(-2)*1	56	2*6+0*6+18*(-2)	-24	2*30+0+0	60	2*4+0*3+(-2)*26	-44	2*6+0*10+(-2)*14	-16
vii) Would it be convenient for the users if the above facilities were nearby?	2*28+0*2+0	56	2*29+0*1+0	58	2*30+0+0	60	2*28+0*2+0	56	2*27+0*3+0	54
SUSTAINABLE SITES										
i) Is there any open space in the site?	2*26+0*6+(-2)*2	48	2*2+0*4+2*(-24)	-44	2*30+0+0	60	2*26+0*2+(-2)*2	48	2*7+0+(-2)*23	_32
Heat Island Reduction:	–		–		–		–		–	
i) Is there any special paint used on the roof or insulation done for heat reduction?	2*24+0*6+0	48	2*3+0*11+16*(-2)	-26	2*27+0*3+0	54	2*2+0*15+(-2)*13	-22	0+0*5+(-2)*25	-50
ii) Is the majority of the open area green?	2*18+0+(-2)*12	12	2*2+0*3+25*(-2)	-46	2*28+0*2+0	56	2*17+0+(-2)*13	8	2*6+0+(-2)*24	-36
iii) In case if there are some paved areas, are the paving tiles light in color such as light gray or light red?	2*24+0*6+0	48	2*7+0+23*(-2)	-32	2*28+0*2+0	56	2*11+0*6+(-2)*13	-22	2*14+0*6+(-2)*10	8
iv)Wouldn’t it be convenient if the answers to the above were, yes?	2*28+0*2+0	56	2*28+0*2+0	56	2*27+0*3+0	54	2*27+0*3+0	54	2*24+0*6+0	48

Hydrology and Storm Water Management:	–		–		–		–		–	
i) Is the site located in an area where there is less chance of flooding (site away from wetland)?	2*28+0*2+0	56	2*15+0*2+(-2)*13	4	2*23+0*6+(-2)*1	44	2*16+0*2+(-2)*12	8	2*18+0*2+(-2)*10	16
ii) Does the building have roof drainage pipes?	2*24+0*6+0	48	2*10+0*14+(-2)*6	8	2*27+0*3+0	54	2*22+0*6+(-2)*2	40	2*10+0*3+(-2)*17	-34
iii) Are all the drainage pipes and drains cleaned and maintained from time to time?	2*28+0*2+0	56	2*10+0*6+(-2)*14	-8	2*27+0*3+0	54	2*20+0*6+(-2)*4	32	2*6+0*2+(-2)*22	-32
iv) Is there any public storm water collection system near the building to collect the storm water away from the building?	2*26+0*4+0	52	2*14+0*10+(-2)*6	16	2*29+0*1+0	58	2*6+0*7+(-2)*17	-22	2*4+0+(-2)*26	-44
v) Do the users think that the rainwater may becollected treated and reused (e.g. for washing cars, watering garden etc.?).	2*24+0*4+(-2)*2	48	2*15+0*8+(-2)*7	16	2*28+0*1+(-2)*1	54	2*20+0*8+(-2)*2	36	2*18+0*6+(-2)*6	-24
vi) Do you think awareness of waste water management is important and people can be trained to dispose or reuse it properly?	2*28+0*2+0	56	2*26+0*4+0	52	2*28+0*1+0	56	2*27+0*3+0	54	2*26+0*4+0	52
Vegetation	–		–		–		–		–	
i) The building land was not used for farming prior to construction. Is the statement correct?	22*2+0*8+0	44	13*2+0*14+(-2)*3	20	2*25+0*5+0	50	2*12+0*10+(-2)*8	8	2*16+0*2+(-2)*12	8
ii) During this building construction process,no endangered species of trees had to be fell,correct?	2*18+0+(-2)*12	12	2*7+0*13+(-2)*10	-6	2*29+0*1+0	58	2*1+0*12+(-2)*17	-32	0+0*12+(-2)*18	-36
iii) Do you agree that the farming lands should not be used for development work?	2*28+0*2+0	56	2*27+0*3+0	54	2*27+0*3+0	54	2*27+0*3+0	54	2*18+0*6+(-2)*6	-24
Human Health Effects:		–	–		–		–		–	
i) There are no factories nearby that produce pollution in the area, correct?	2*29+0*1+0	58	2*28+0*2+0	54	2*28+0*2+0	56	0+0*2+(-2)*28	-56	2*16+0+(-2)*14	4
ii) The building does not produce any toxic gas or store any hazardous item, is the statement correct?	2*28+0*2+0	56	2*20+0*6+(-2)*4	32	2*29+0*1+0	58	0+0*4+(-2)*26	-52	0+0*7+(-2)*23	-46

WATER EFFICIENCY										
i) While doing water related work are the water taps turned off immediately after the work is over indoors?	2*21+0*7+(-2)*2	38	2*12+0*8+(-2)*10	4	2*29+0*1+0	58	2*5+0*8+(-2)*17	-24	2*12+0*12+(-2)*6	12
ii) Does the building have a water meter?	2*25+0*5+0	50	2*21+0*7+(-2)*2	38	2*25+0*5+0	50	2*21+0*7+(-2)*2	38	2*17+0*4+(-2)*9	16
iii) Are users cautious about using water outdoors?	2*25+0*3+(-2)*2	46	2*10+0*8+(-2)*12	4	2*28+0*2+0	56	2*12+0*2+(-2)*16	-8	2*16+0+(-2)*14	4
iv) Do you think awareness regarding the use of water is important and people perform better if they are trained in this matter?	2*28+0*2+0	56	2*26+0*4+0	52	2*29+0*1+0	58	2*29+0*1+0	58	2*29+0*1+0	58
ENERGY AND ATMOSPHERE										
i) Are there any solar panels in the building?	2*26+0*4+0	52	2*0+0*12+(-2)*18	-36	2*30+0+0	60	2*5+0*12+(-2)*13	-16	2*5+0*1+(-2)*24	-43
ii) Does the solar panel work properly?	2*25+0*5+0	50	0+0+0 (no panel)	0	2*29+0*1+0	58	2*1+0*12+(-2)*19	-36	2*4+0*2+(-2)*24	40
iii) Is there any garden on the roof or verandah of the building?	2*30+0+0	60	2*10+11*10+ (-2)*9	2	2*29+0*1+0	58	2*16+0*5+(-2)*9	14	2*14+0*3+(-2)*13	2
iv) Has any tinted glass or double glazing been used at the exterior walls of the building?	2*29+0*1+0	58	2*14+0*10+(-2)*6	16	2*28+0*1+(-2)*1	58	2*20+0*10+0	40	2*4+0*4+(-2)*22	-36
v) Does the longer side of the building face south?	2*26+0*4+0	52	0+0+0 (blocked by highrise)	0	2*30+0+0	60	2*15+0*2+(-2)*13	4	2*9+0+(-2)*21	-24
vi) Do the inhabitants use LED lighsensor light or any other energy efficient applianced in the building?	2*28+0*2+0	50	2*15+0*8+(-2)*7	16	2*29+0*1+0	58	2*22+0*8+0	44	2*19+0*3+(-2)*8	22
vii) Does the inhabitant get sufficient wind in summer and sunshine in winter?	2*26+0*3+(-2)*1	50	2*12+0*2+(-2)*16	-12	2*28+0*2+0	56	2*13+0*2+(-2)*15	-4	2*8+0*4+(-2)*18	-20
viii) Do the inhabitants agree that making use of energy efficient items reduce carbon footprint and reduce pressure even on utility bills?	2*30+0+0	60	2*15+0*15+0	30	2*29+0*1+0	58	2*18+0*16+0	36	2*26+0+(-2)*4	46
INDOOR ENVIRONMENT										
i) Indoor Environment: Does the inhabitant get sufficient sunshine?	2*26+0*4+0	52	2*13+0+(-2)*17	-8	2*28+0*2+0	56	2*15+0+(-2)*15	0	2*10+0*2+(-2)*16	-12

ii) Are the room interior comfortable regarding natural ventilation?	2*26+0*3+(-2)*1	50	2*10+0*9+(-2)*11	-2	2*29+0*1+0	58	2*13+0*9+(-2)*8	10	2*9+0*5+(-2)*16	-14
INNOVATION:										
i) Does any vertical green planting system	2*15+0*14+(-2)*1	28	0+0*6+(-2)*24	-48	2*20+0*5+(-2)*5	30	2*3+0*5+(-2)*22	-38	2*1+0+(-2)*29	-56
T O T A L S	**(A) =**	**1790**	**(B) =**	**402**	**(C) =**	**1998**	**(D) =**	**410**	**(E) =**	**-155**

6.6 CALCULATIONS

Calculation 1:

For the purpose of this analysis, an average value was derived from the two green buildings included in the study, namely the Cityscape Tower and the MNR Sweaters Garments Factory.

Also, the results from the housing survey were carefully examined. While only a very limited number of green households have been identified due to various constraints in Dhaka, the study was accounted for this limitation. It was assumed that the population residing in similar green households' settings have a comparable experience with the green buildings mentioned above. Therefore, the average result was referred to as the Virtual Green Household (F) which was derived from the following equation:

$$(A + C) / 2 = (F)$$

A = The average value (Cityscape Tower)
C = The average value (MNR Sweaters Garments Factory)

Calculation 2:

Comparative Analysis of Green and Non-Green Buildings

Step 1)

The total results from the survey of the **two green buildings** (Cityscape Tower and MNR Sweaters Garments Factory) will be combined, along with the value from the results from the housing survey

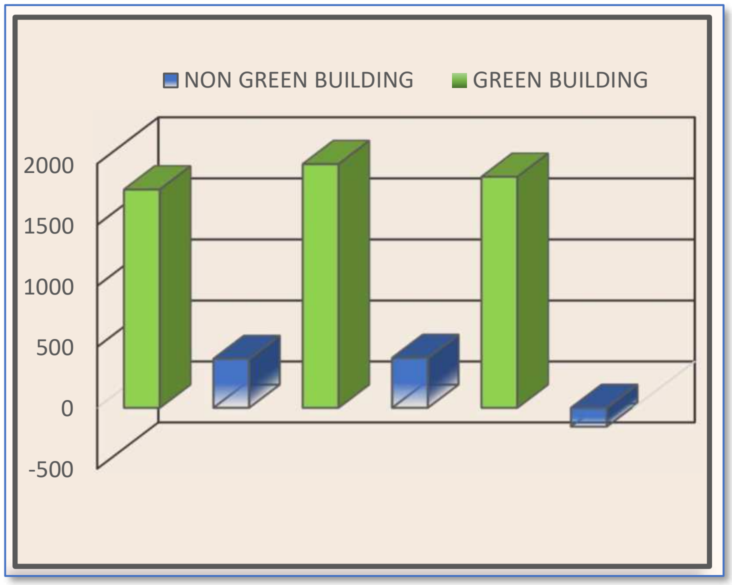
(A+C+F) ……………………………………(i)

Step 2)

The total results from the survey of the two **non-green buildings**, the EVE Dress and Shirt Garments and the Del Vista Tower and the result of the Households under survey shall be added

(B+D+E) …………………..………..……. (ii)

Given that the indicators utilized in the questionnaire are designed to support green building criteria, a positive value will indicate a trend toward greater acceptance of green technology among Dhaka's inhabitants. Conversely, a negative value would indicate a reluctance to adopt such technologies, potentially leading to challenges in the sustainability and feasibility of green buildings.



Dia. 6.76: Questionnaire Survey Graph for Comparative Analysis of Green and Non-Green Buildings

A (1790) + C (1998) + F (1894) = (5682) ……..……………………(i)

B (402) + D (410) – E (155) = 657 ……………………..………….(ii)

Result V = (ii) – (i) = 5682 – 657 = **5025 (An affirmative value)**

The sum total of the values from the green buildings [as calculated in (i)] exceeds that of the non-green buildings [as calculated in (ii)]. The subtraction of the two (V) results in an affirmative value which indicate a positive trend toward acceptance of buildings shaped by green technology among Dhaka's inhabitants (Dia. 6.76).

CONCLUSION

Upon the completion of the calculations, the resultant value emerged as positive, suggesting a notable trend toward the acceptance of buildings designed with green technology among the residents of Dhaka. This observation not only reflects a shift in public sentiment but also highlights the increasing recognition of the importance of sustainable practices in the realm of architecture.

The implications of this finding are significant, as they underscore the potential for sustainable architectural practices to become more prevalent in Dhaka's urban landscape. The growing acceptance of green technology in building design can lead to a variety of benefits, including enhanced energy efficiency, reduced environmental impact, and improved public health outcomes.

In addition to that, this trend may encourage the policymakers, architects, and urban planners to prioritize sustainable initiatives in future developments, thereby fostering a more environmentally responsible urban environment in Dhaka. As Dhaka continues to confront challenges related to rapid urbanization and climate change, the integration of green technology in building practices emerges as a critical component in shaping a resilient and sustainable future for the city.

CHAPTER 07

CONCLUSION AND RECOMMENDATIONS

Abbreviations
BCCRF: Bangladesh Climate Change Resilience Fund
BCCTF: Bangladesh Climate Change Trust Fund

CHAPTER 07

CONCLUSION AND RECOMMENDATIONS

Existing green technology in Dhaka, though still in its early stages compared to global standards, has been gradually gaining traction. These technologies aim to reduce energy consumption, improve resource efficiency, and mitigate environmental impact. To promote green building in Dhaka, some initiatives are vital. These initiatives help reduce Dhaka's environmental footprint while ensuring better living and working conditions.

Some of the key green technologies and practices being implemented in Dhaka include:

1. Energy-Efficient Building Design

- Solar Panels: In Dhaka, the adoption of photovoltaic (PV) solar panels is steadily increasing, particularly in high-rise buildings and commercial properties. These systems are being implemented as a sustainable solution to reduce dependence on the national power grid, which often struggles to meet the city's growing electricity demands. By harnessing renewable solar energy, these panels provide an environmentally friendly and cost-effective alternative for powering buildings. They are particularly beneficial in a city like Dhaka, which experiences frequent power shortages and rising energy costs. Moreover, government incentives and growing awareness of the environmental and economic benefits of solar energy are encouraging more property developers and businesses to integrate PV systems into their designs. As this trend continues, solar panels are expected to play a significant role in promoting energy sustainability and reducing the city's carbon footprint.

- Green Roofs: In Dhaka, the concept of green roofs and rooftop gardens is gaining traction, particularly among commercial buildings and high-end residential properties. These eco-friendly initiatives involve transforming rooftops into green spaces, which provide multiple environmental and functional benefits. Green roofs help cool buildings by reducing heat absorption, lowering indoor temperatures, and decreasing the need for air conditioning, which in turn conserves energy. They also contribute to mitigating the urban heat island effect—a common issue in densely built areas like Dhaka—by cooling the surrounding air and reducing ambient temperatures.

  Additionally, rooftop gardens improve air quality by filtering pollutants and increasing oxygen levels while offering aesthetic appeal and recreational opportunities for residents. These spaces can also assist in rainwater management by absorbing rainfall, reducing water runoff, and easing the burden on the city's drainage systems. As awareness of sustainable urban living grows, the adoption of green roofs is likely to expand, contributing to a healthier and more environmentally friendly urban landscape in Dhaka.

- Natural Ventilation and Daylighting: Designs that maximize natural ventilation and use of daylight are increasingly being incorporated to minimize the reliance on air conditioning and artificial lighting.

2. Water Management Systems

- Rainwater Harvesting: The rainy season in Bangladesh typically spans from June to October, providing a substantial period for rainwater collection. With abundant rainfall during this time, there is significant potential for harnessing rainwater as an alternative water resource. While rainwater harvesting systems remain relatively uncommon, a growing number of buildings are beginning to adopt this sustainable practice. These systems collect and store rainwater, which can then be used for various non-potable purposes such as gardening, toilet flushing, and cleaning. By reducing dependency on traditional water supplies, rainwater harvesting helps address water scarcity challenges in densely populated urban areas. As awareness of environmental sustainability and water conservation grows, it is expected that the adoption of rainwater harvesting systems will increase in the future, contributing to a more sustainable urban water management approach.
- Water-Efficient Fixtures: In Dhaka, Bangladesh, where rapid urbanization and population growth have led to increasing water demand, water-saving technologies are gradually being introduced in modern buildings to promote efficiency and conservation. These include low-flow faucets equipped with aerators, which reduce water flow without compromising functionality, and sensor-operated faucets that minimize wastage by only activating when needed. Additionally, dual-flush toilets, which offer options for using less water per flush, are becoming more common. Modern water-efficient appliances, such as washing machines designed to use minimal water while maintaining performance, are also being adopted. These initiatives reflect a growing awareness of the need for sustainable water management, especially in a city like Dhaka, where water scarcity and supply challenges are pressing issues. Over time, these technologies are expected to play a critical role in reducing water consumption and supporting sustainable urban living.

3. Waste Management Systems

Recycling initiatives in Bangladesh, while still in their early stages, are beginning to take shape in certain areas, particularly in Dhaka. A small but growing number of buildings and housing developments have started implementing waste segregation and recycling programs to manage urban waste more sustainably. These programs encourage residents to separate organic waste from recyclable materials, such as plastics, paper, and metal, at the source, making it easier to process and repurpose waste effectively.

Notable examples include efforts in the Gulshan Residential Area under Dhaka North City Corporation and Dhanmondi under Dhaka South City Corporation, where services for waste segregation and collection have been introduced. These initiatives aim to reduce the volume of waste sent to landfills, promote recycling, and create awareness about responsible waste management. While challenges such as public awareness and infrastructure development remain, these pilot programs represent a positive step toward a more sustainable waste management system in Bangladesh's urban areas.

In Dhaka, organic waste composting is gradually gaining attention as a sustainable waste management practice, particularly in residential and institutional settings. This initiative involves converting biodegradable waste, such as kitchen scraps and garden clippings, into nutrient-rich compost, which is then used as a natural fertilizer for rooftop gardens or community green spaces.

Some forward-thinking residential complexes and institutions have started integrating composting systems to manage organic waste locally. These systems not only reduce the volume of waste sent to landfills but also support urban gardening efforts, providing a cost-effective and eco-friendly way to nourish plants. Rooftop gardens in Dhaka, which are becoming increasingly popular, particularly benefit from this practice, as compost improves soil quality and promotes plant health.

While the adoption of composting remains limited, awareness campaigns and pilot projects are encouraging more communities to embrace this sustainable approach. Over time, composting has the potential to significantly contribute to waste reduction and urban greening efforts in Dhaka.

4. Energy-Efficient Appliances and Systems

- LED Lighting: In Dhaka, the use of energy-efficient lighting systems, particularly LED lights, has been steadily increasing in both commercial and residential spaces. LEDs consume significantly less electricity compared to traditional lighting options, offering a cost-effective and environmentally friendly solution for illuminating buildings. Their longer lifespan and reduced maintenance needs make them a practical choice for energy-conscious users.

  In addition to the growing popularity of LED lighting, modern buildings are beginning to incorporate advanced technologies such as motion-sensor lighting systems. These systems ensure lights are only activated when needed, further reducing energy consumption and operational costs. A notable example of this innovation is the new Hazrat Shahjalal International Airport Terminal 3, which integrates motion-sensor lighting as part of its sustainable design.

The adoption of these energy-efficient lighting solutions reflects a broader trend toward sustainability in building practices across Bangladesh. As energy costs rise and awareness of environmental impacts grows, such technologies are expected to become standard features in both new constructions and retrofitted properties.

- Energy-Efficient HVAC Systems: In Dhaka, energy-efficient heating, ventilation, and air conditioning (HVAC) systems are increasingly being incorporated into the design of advanced buildings, reflecting a shift toward sustainable construction practices. These modern HVAC systems are engineered to optimize energy use while maintaining comfortable indoor environments, making them particularly valuable in a city where high temperatures and humidity are common.

  A prime example of this trend is the Shanta Pinnacle Commercial Building, located in Dhaka's industrial area. This building has adopted state-of-the-art energy-efficient HVAC technology, enabling it to reduce energy consumption significantly compared to conventional systems. These systems often include features such as variable refrigerant flow (VRF) technology, smart sensors, and advanced climate control mechanisms, which adjust heating and cooling outputs based on occupancy and environmental conditions.

  As energy efficiency becomes a key consideration in urban development, more buildings in Dhaka are expected to adopt similar HVAC technologies. This transition not only helps reduce operational costs for property owners and tenants but also contributes to mitigating the environmental impact of urban energy use.

5. Sustainable Construction Materials

- Locally Sourced and Recycled Materials: In Dhaka, the use of locally sourced and recycled building materials is gradually being adopted as part of sustainable construction practices. Locally sourced materials help reduce the carbon footprint associated with transportation and support the local economy, while recycled materials minimize waste and promote resource efficiency.

  Some developers are experimenting with innovative materials like recycled steel and eco-friendly concrete, which incorporate waste products into their composition. An example of this is the use of hollow concrete blocks by Building Technology and Ideas (BTI). These blocks are not only more sustainable but also provide better insulation, contributing to energy efficiency in buildings.

  Although these practices remain limited in scope, they represent a growing awareness of the environmental impacts of traditional construction methods. As sustainable architecture gains momentum and more stakeholders prioritize eco-friendly solutions, the use of locally sourced and recycled materials is expected to increase, paving the way for greener urban development in Dhaka.

6. Certification and Standards

In Dhaka, global green building certifications such as LEED (Leadership in Energy and Environmental Design) and EDGE (Excellence in Design for Greater Efficiencies) are beginning to make their mark, reflecting a shift towards more sustainable architectural practices.

LEED Certification:

LEED certification, a globally recognized standard for evaluating a building's environmental impact, is gradually gaining recognition in Dhaka. This certification assesses various factors such as energy efficiency, water conservation, indoor air quality, and sustainable material usage. A few prominent buildings, including corporate offices and institutional headquarters, have achieved LEED certification, signifying their commitment to sustainability and resource efficiency. These buildings serve as benchmarks for greener architectural standards in the city, encouraging others to adopt similar practices.

EDGE Certification:

EDGE certification, developed by the International Finance Corporation (IFC), focuses on promoting resource-efficient buildings by targeting reduced energy, water, and material usage. Some buildings in Dhaka have pursued EDGE certification, especially in the commercial and residential sectors, as it offers a cost-effective pathway to sustainability. By optimizing resource use, EDGE-certified buildings contribute to lower operational costs and reduced environmental impacts, making them an attractive option for developers and property owners.

As awareness of sustainable development grows and environmental concerns intensify, these certifications are expected to play a more prominent role in shaping Dhaka’s urban landscape, fostering greener and more efficient building practices.

7. Smart Building Technology

Building Management Systems (BMS) are becoming increasingly integral to modern commercial buildings in Dhaka. These systems automate the control of various building functions, including lighting, temperature regulation, and security management. By integrating sensors and intelligent algorithms, BMS optimize resource usage, reduce energy consumption, and improve overall operational efficiency. For example, light sensors have been incorporated in the design of the Terminal 3 buildings at certain points, in the Hazrat Shahjalal Airport Building Complex. These advancements not only enhance the comfort and security of occupants but also contribute to the building's environmental sustainability by minimizing waste and reducing the carbon footprint.

As Dhaka continues to urbanize, the adoption of such smart technologies will be crucial for creating energy-efficient and sustainable infrastructure.

8. Public Green Spaces and Parks

In recent years, there has been a gradual yet significant improvement in the development of public green spaces, parks, and green belts around Dhaka. These initiatives are contributing to the city's environmental resilience by providing areas for ecological balance, reducing urban heat islands, and improving air quality. Public parks and green spaces also offer recreational opportunities for residents, promoting physical and mental well-being. As the city continues to grow, expanding and maintaining these green spaces will be essential for fostering a healthier, more sustainable urban environment in Dhaka. Besides, Training and Awareness plays a pivotal role. Builders, architects, and construction professionals should be trained and educated about sustainable building practices to drive the green building movement

9. Government Initiatives

Green Building Code: The Bangladesh government has started to promote green building practices by updating building codes and introducing the Bangladesh Green Building Guidelines, which encourage the use of sustainable materials, energy-efficient designs, and eco-friendly construction practices.

There are several barriers to the widespread adoption of green technologies. These include the high initial costs of implementation, lack of awareness among key stakeholders, insufficient regulatory frameworks, and limited access to appropriate materials and expertise. Additionally, the economic structure of the construction industry in Dhaka, with its focus on short-term profits, often discourages investment in long-term sustainable solutions. There should be increased government incentives, subsidies, or stricter regulations, the adoption of green technologies remains limited to high-end projects, making it inaccessible to the broader population.

Moreover, public and private sector collaboration is essential for scaling up green design technologies. Policy interventions, such as tax incentives, low-interest loans for green projects, and public awareness campaigns, could encourage developers to integrate green technologies in both new and retrofit buildings. Educational programs aimed at architects, engineers, and urban planners could also help bridge the knowledge gap and facilitate the integration of these technologies into mainstream architectural practices.

Green building awards in Dhaka highlight the growing focus on sustainability and eco-friendly construction practices. Bangladesh has become a global leader in green factory certifications, particularly in the garment sector, with 215 green factories certified by the U.S. Green Building Council (USGBC). The country is recognized for its advancements in sustainable building practices, including the use of eco-friendly materials such as fly ash bricks and concrete blocks, which help reduce environmental degradation.

Recently, at an event celebrating "National Occupational Health and Safety Day 2024," 29 companies across various industries, including textiles, leather, cement, and electronics, were honored for their green initiatives. This recognition underscores the efforts to protect both worker health and the environment in Bangladesh *(Ref 7.1-7.2)*.

These awards also reflect the increasing adoption of LEED-certified buildings in Bangladesh, which focus on energy efficiency, water conservation, and indoor air quality. Many industrial buildings in Dhaka are leading this movement, and rooftop gardening is also gaining popularity as a way to make the city greener.

While these technologies and practices are becoming more common, their adoption is still limited to select sectors (industries, commercial buildings and the like) and remains largely inaccessible for the broader population (e.g. residences) due to high costs, lack of awareness, and limited regulatory enforcement. Nevertheless, the growing interest in green technology signals a positive trend for Dhaka's future sustainability efforts.

This exploratory study on the buildings with green architectural design technology in Dhaka has provided valuable insights into both the opportunities and challenges associated with implementing sustainable practices in urban development. As Dhaka continues to grow as a megacity, the importance of integrating green design technologies has to be considered seriously. As Dhaka continues to grow rapidly, integrating green design technologies has become increasingly critical to ensure sustainable urban development. The city faces numerous environmental challenges, such as air and water pollution, heat island effects, and poor waste management, all of which are exacerbated by high population density and unregulated construction.

From the analysis, the study reveals that green architectural designs in Dhaka have the potential to significantly reduce energy consumption, that is improve energy efficiency, reduce environmental impact, improve air quality, improve public health in turn and enhance urban living conditions and contribute to a more sustainable urban environment. This is particularly crucial given the city's high population density and rapid urbanization, which have exacerbated environmental degradation and increased pressure on natural resources.

The findings of this study have significant implications, highlighting the potential for sustainable architectural practices to gain greater prominence in Dhaka's evolving urban landscape. As green technology becomes more widely accepted in building design, it can bring a range of benefits, mentioned above. However, the feasibility of widespread adoption faces several constraints that need to be addressed.

This shift toward sustainability may also influence policymakers, architects, and urban planners to prioritize green initiatives in upcoming projects, helping to cultivate a more environmentally conscious urban environment. As Dhaka grapples with the challenges posed by rapid urbanization and climate change, integrating green technologies into building practices emerges as a crucial strategy for shaping a resilient and sustainable future for the city.

In conclusion, while green architectural design technology presents significant potential for transforming Dhaka into a more sustainable urban environment, its successful implementation is contingent upon overcoming key challenges, including financial constraints, regulatory barriers, and limited public awareness. To enhance the feasibility of these technologies, future research should prioritize comprehensive cost-benefit analyses, expand the collection of case studies showcasing successful applications, and support the development of policies that incentivize the adoption of green technologies. Addressing these critical areas will enable Dhaka to progress toward becoming a leading example of sustainable urban development in South East Asia.

References

Ref.1.1a:https://bbs.portal.gov.bd/sites/default/files/files/bbs.portal.gov.bd/page/b343a8b4_956b_45ca_872f_4cf9b2f1a6e0/2024-01-31-15-51-b53c55dd692233ae401ba013060b9cbb.pdf (Pg. 43)

Ref.1.1b:https://sid.portal.gov.bd/sites/default/files/files/sid.portal.gov.bd/publications/01ad1ffe_cfef_4811_af97_594b6c64d7c3/PHC_Preliminary_Report_(English)_August_2022.pdf (Page vii)

Ref. 1.2: *Naznin Islam[1] Shah Md.Azimul Ehsan[2] Bushra Khanam[3] ,Factors of population movement towards Dhaka: An Empirical Study* https://journal.bcsadminacademy.gov.bd/index.php/bjam/article/view/31

Ref. 1.3: *Bangladesh Construction Market, 23-31, Growth Market reports* https://growthmarketreports.com/report/construction-market-bangladesh-industry-analysis

Ref. 1.4: *Dr. Abdullah Al Faruque Professor & Dean, Faculty of Law, University of Chittagong, From Basic Need to Basic Right: Right to Food in Context, A study prepared for National Human Rights Commission of Bangladesh June 2014*

Ref. 1.5: *Green Buildings, IFC (International Finance Corporation, World Bank Group, 2023* https://www.google.com/search?q=%E2%80%9COver+half+of+the+world%E2%80%99s+population+lives+in+urban+areas+and+that+number+is+expected+to+increase+to+68+percent+by+2050.+The+resulting+demand+for+more+and+more+space+is+expected+to+double+the+floor+area+of+buildings+by+2060%2C+with+most+of+the+growth+in+residential+construction%2C+particularly+in+middle-income+countries.%E2%80%9D&rlz=1C1CHBF_enBD1033BD1033&oq=%E2%80%9COver+half+of+the+world%E2%80%99s+population+lives+in+urban+areas+and+that+number+is+expected+to+increase+to+68+percent+by+2050.+The+resulting+demand+for+more+and+more+space+is+expected+to+double+the+floor+area+of+buildings+by+2060%2C+with+most+of+the+growth+in+residential+construction%2C+particularly+in+middle-income+countries.%E2%80%9D+&gs_lcrp=EgZjaHJvbWUyBggAEEUYOdIBCTIwNDFqMGoxNagCCLACAQ&sourceid=chrome&ie=UTF-8

Ref. 1.6: *Towards the Middle-Income Status in Bangladesh, July 3, 2023, EIAS* https://eias.org/policy-briefs/towards-the-middle-income-status-in-bangladesh/

Ref. 3.1: *Aim for Zero - Zero Energy and Zero Energy Ready Homes, Energy Saver, Efficient Design, Types of Homes, Energy Saver.* https://www.energy.gov/energysaver/aim-zero-zero-energy-and-zero-energy-ready-homes

Ref. 3.2: *Vini M. Shah, P. Chaudhari, Dilip H. Thakor, Rudra Patel, M. I. Balya, V.M. Patel, V. Patel. (19th September, 2019). The Concept of Zero Energy Buildings (ZEB) – A Literature Study, Engineering, Environmental Science.* *The Concept of Zero Energy Buildings (ZEB)- A Literature Study by Vini M. Shah, P. Chaudhari, +4 authors V. Patel, Published 19 September 2019, Engineering, Environmental Science*

Ref. 3.3: *Ochuko Felix Orikpete, Samuel Ikemba, Daniel Raphael Ejike Ewim. Integration of Renewable Energy Technologies in Smart Building Design for Enhanced Energy Efficiency and Self-Sufficiency.* file:///C:/Users/USER/Downloads/Paper111.pdf

Ref. 3.4: *LG Electronics, Inc. (27 Aug, 2023, 21:00 ET). LG HOME APPLIANCES SHOWCASE TOP-RATED ENERGY EFFICIENCY FOR A SUSTAINABLE LIFE AT IFA 2023,* https://www.prnewswire.com/news-releases/lg-home-appliances-showcase-top-rated-energy-efficiency-for-a-sustainable-life-at-ifa-2023-301910697.html

Ref. 3.5: *Smart Glass manufacturers & suppliers, Made in China, Connecting Buyers with Chinese Suppliers.https://www.made-in-china.com/products-search/hot-china-products/Smart_Glass_Film.html*

Ref. 3.6: *Long Zheng and Shah Kwok Wei. (January 2019). Chapter 16. Electrochromic Smart Windows for Green Building Applications: Fabrication and Applications. National University of Singapore*
https://www.researchgate.net/publication/330156303_Chapter_16_Electrochromic_Smart_Windows_for_Green_Building_Applications_Fabrication_and_Applications

Ref. 3.7: *Solar Home System, Hamko Group*
http://www.hamko.com.bd/show_product.php?product_category=solar_home_system#

Ref. 3.8: *Peter Fabris (December 6, 2022), Contributing Editor. Google spinoff uses pay-as-you-go business model to spur growth in geothermal systems,*
Building Design+Construction's Daily 5
https://www.bdcnetwork.com/home/news/55165275/google-spinoff-uses-pay-as-you-go-business-model-to-spur-growth-in-geothermal-systems

Ref. 3.9*: https://westernhvac.com/three-reasons-to-consider-a-geothermal-heat-pump/*

Ref. 3.10*: Non-combustible insulation*
Non-combustible Insulation | ROCKWOOL UK

Ref. 3.11*: Andrea Valentino, guest author, Modern construction taps natural materials https://www.lgt.com/hk-tc/insights/modern-construction-taps-natural-materials-156794*

Ref. 3.12: *Paul Finch. DECEMBER 2006. Awards. Handmade School, Rudrapur, Bangladesh by Anna Heringer*
. Handmade School, Rudrapur, Bangladesh by Anna Heringer - The Architectural Review

Ref. 3.13: *Global Street Design Guide. Green Infrastructure and Stormwater Management.*
https://globaldesigningcities.org/publication/global-street-design-guide/utilities-and-infrastructure/green-infrastructure-stormwater-management/

Ref. 3.14:
https://www.ashrae.org/file%20library/technical%20resources/standards%20and%20guidelines/standards%20 addenda/189_1_2017_j_20200302.pdfRef. 3.15: Green Insulation: Material for Commercial Buildings
https://s3da-design.com/green-insulation-material-for-commercial-buildings/

Ref. 3.15: *How BREEAM works*
A guide to BREEAM sustainable building certification and third-party accreditation.
https://bregroup.com/products/breeam/how-breeam-works/#:~:text=A%20BREEAM%20assessment%20uses%20recognised,criteria%20from%20energy%20to%20ecology.

Ref. 3.16: *Nora Knox. (Apr 02, 2015) What is WELL.*
https://www.usgbc.org/articles/what-well

Ref. 3.17: *Paul Walsh, The LEED Rating System explained.*
CIM, August 20,2024.
https://www.cim.io/blog/the-leed-rating-system-explained#:~:text=The%20LEED%20rating%20system%20is,its%20LEED%20rating%20will%20be.

Ref. 3.18: *Green Mark Certification Scheme, Building and Construction Authority, A Singapore Government Agency website*
https://www1.bca.gov.sg/buildsg/sustainability/green-mark-certification-scheme

Ref. 3.19: *Green Globe Certification, Green Building Initiative*

Ref 3.20**:** *Green Buidings are a Priority of IFC, EDGE*
https://edgebuildings.com/about/ifc-green-buildings/

Ref. 3.21: *What Is the HERS Rating System and Why Is It Important? BPC Green Builders, Crafting Sustainable and Healthy Homes*
https://www.bpcgreenbuilders.com/blog/what-is-the-hers-rating-system-and-why-is-it-important/

Ref 4.1: *Basiago, Andrew D (1995). Methods of defining 'sustainability', Sustainable Development, Volume 3, Issue 3, p. 109-119, Abstract, Wiley Online Library.*
https://onlinelibrary.wiley.com/doi/10.1002/sd.3460030302

Ref 4.2: *Daniel Thomas Mollenkamp (December 13, 2023), Reviewed by, Jefreda R. Brown Fact-Checked by Timothy Li. What is Sustainability? How Sustainabilities Work, Benefits, and Example, Sustainable Investing, Investing, Investopedia.*
https://www.investopedia.com/terms/s/sustainability.asp

Ref 4.3: *Justice Mensah (September 08, 2019), Sandra Ricart (Reviewing Editor). Sustainable development: Meaning, history, principles, pillars, and implications for human action: Literature review. Abstract, Cogent Social Sciences, Volume 5, 2019-Issue 1, Taylor & Francis Online*
https://www.tandfonline.com/doi/full/10.1080/23311886.2019.1653531

Ref 4.4: *UN World Commission on Environment and Development, ed., Report of the World Commission on Environment and Development: Our Common Future*
https://www.environmentandsociety.org/mml/un-world-commission-environment-and-development-ed-report-world-commission-environment-and

Ref 4.5: *Michelle E Jarvie, Fact checked by The Editor of Encyclopedia Britannica, Brundtland Report Also known as (Our Common Future), publication by World Commission on Environment and Development, Britannica.*
Brundtland Report | Sustainable Development & Global Environmental Issues | Britannica

Ref 4.6: *Adriaan Perrels (January, 2005), Economic Sustainability, ISBN 952-19-2817-3 (pdf) ISSN 1235-44494.6 Perrels_2005_econ_sustainability_inNygrenJalkanen_eds.pdf*

Ref 4.7: *Nicholas Patterson (Jan 16, 2024) What is Environmental Sustainability? Goals with Examples.*

Ref 4.8: *5 Effective Ways to Achieve Sustainable Development, aeiforiaarchitects.com*
5 Ways to Achieve Sustainable Development (aeiforiaarchitects.com)

Ref 4.8a: *What is Environmental Sustainability (May 19, 2020), By Sphera's Editorial Team*
https://sphera.com/glossary/what-is-environmental-sustainability/

Ref 4.9: *U.S. Carbon Dioxide Emissions, 1990-2022, Overview of Greenhouse Gases (2022), Greenhouse Gas Emissions, EPA (Overview of Greenhouse Gases | US EPA)*

Ref 4.10: *https://cfpub.epa.gov/ghgdata/inventoryexplorer/*

Ref 4.11: *Renewable energy jobs hit 12.7 million globally (22 September, 2022), Geneva ILO news, Renewable Energy and Jobs.*
https://www.ilo.org/resource/news/renewable-energy-jobs-hit-127-million-globally
Renewables are the key to green, secure, affordable energy (worldbank.org)

Ref 4.12: *Nilu, Scott Randall, Bjarne Sivertsen, Sk. Salahuddin Ahammad, Nathaniel Dela Cruz, VoThanh Dam, Emissions Inventory for Dhaka and Chittagong of Pollutants PM10, PM2.5, NOX,SOX, and CO,Bangladesh Air Pollution Studies (BAPS) (2015), ISBN: 978-425-2719-6*
https://doe.portal.gov.bd/sites/default/files/files/doe.portal.gov.bd/page/cdbe516f_1756_426f_af6b_3ae9f35a78a4/2020-06-10-16-30-6a8801bba5009c814b7d5cbeebebd3aa.pdf

Ref 4.13*:* *Top 5 Benefits of Green Building*
Galia Shtang, Head of Sustainability at Environmental Sustainable Development (ESD) Israel August 17, 2022
Environmental Advantages & Benefits of Building Green | Inogen

Ref 4.14**:** *Unravelling the History of Green Building in Bangladesh*

Ref 4.15: *Green Building (01 January, 2021 first online), Springer Link*
https://link.springer.com/referenceworkentry/10.1007/978-3-319-95873-6_20#:~:text=Several%20definitions%20of%20a%20green,and%20operation%20of%20%20building.

Ref 4.16: *Rachel Carson (May 16, 2022), What Silent Spring Teaches Us*
Rachel Carson: What Silent Spring Teaches Us | by Reecha | Medium

Ref 4.17: *Olivia Bolt (November 17, 23), 6 Advantages and Disadvantages of Green Building, Energy Theory.com*

Ref 4.18: *Transforming our World: The 2030 Agenda for Sustainable Development, United Nations Sustainable Development, Department of Economic and Social Affairs.*
https://sdgs.un.org/2030agenda

Ref 4.19: *5 Ways to Achieve Sustainable Development, Aeiforia*
Ref 4.20: *What is Energy Transition? | S&P Global*m, *Market Insights*
Ref 4.21: *Will Kenton ((Updated April 6, 2024), Reviewed by, Chip Stapleton & Fact Checked by Vikki Velasquez. What Is Green Tech? How It Works, Types, Adoption, and Examples. https://www.investopedia.com/terms/g/green_tech.asp*
Ref 4.22: *AAETI, Rainwater Harvesting, Rainwater Harvesting (cseindia.org)*
Ref 4.23: *Nationwide Climate Vulnerability Assessment in Bangladesh***,** *Final Draft, November, 2018*
Ref 4.23: *Sustainable and Resource Efficient Singapore, Report 2021-2022, Integrated Sustainability, National Environment Agency*
Ref 4.24: *Duachas, The Role of technology in Sustainable Design. Revolutionizing Architecture: The Impact of Green Technologies*
Ref 4.25: Green Building Technology, Trends *https://www.rubenius.in/post/green-building-technology*
Ref 4.26: *Benefits of Green Building, Press Room, www.usgbc.org https://www.usgbc.org/press/benefits-of-green-building*
Ref 4.27: *Rubenius Team (2002-2005) Green Building Technology https://www.rubenius.in/post/green-building-technology 6 Advantages and Disadvantages of Green Building - Energy Theory*
Ref 4.28: *University of California, Sacramento https://betterbuildingssolutioncenter.energy.gov/partners/california-state-university-sacramento#:~:text=California%20State%20University%2C%20Sacramento%2C%20founded,PORTFOLIO%2DWIDE%20LEADERSHIP%20COMMITMENTS*
Ref 4.29: *University of California, Merced California LEED Certified State Buildings*
Ref 4.30: Bosco Verticale in Milan, Italy *https://www.pedestal-eternoivica.com/en/posts/bosco-verticale-in-milan*
Ref 4.31*: Vertical Forest, Milan, Stefano Boeri Architetti https://www.stefanoboeriarchitetti.net/en/project/vertical-forest/*
Ref 4.32*: TAIPEI 101 Tower | U.S. Green Building Council(usgbc.org)*
Ref 4.33*: 20 Highest Rated Green Buildings in the World, RTF Fresh Perspectives 20 Highest rated Green Buildings in the world - RTF | Rethinking Th e Future (re-thinkingthefuture.com)*
Ref 4.34: *Setting the Olympic Values in Motion Creating an immersive multimedia experience at the heart of the Olympic House, Olympic Values in Motion at New IOC Headquarters | Studio Banana*
Ref 4.35:*Inside the games,IOC headquarters receives US Green Build ing Council Leadership Award*
Ref 36: *Central Park, Nesuto, Chippendale https://www.nesuto.com/chippendale/central-park*
Ref 4.37: *One Central Park, The Free Encyclopedia One Central Park - Wikipedia*
Ref 4.38: *Bahrain World Trade Center (BWTC) buildings-mena.com/project/manama-bahrain-world-trade-center-bwtc*
Ref 4.39*: Eco-Friendly Buildings: Example of Sustainable Architecture Design Around the World https://ceiarchitecture.com/green-home-and-building/eco-friendly-buildings/*
Ref 4.40: *Suzlon One Earth, Bahrain https://inhabitat.com/landmark-cyber-park-state-of-the-art-green-it-hub-in-india/13275/*
Ref 4.41: *Suzlon One Earth Global Corporate Headquarters. / CCBA Design © A. Ramprasad Naidu Gallery of Suzlon One Earth Global Corporate Headquarters. / CCBA Design - 9*
Ref 4.42: *South Asia, A Brief Introduction to World Regional Geography, Pressbooks South Asia – A Brief Introduction to World Regional Geography*
Ref 4.43: *Shauradip Mazumder, Beautiful Bangladeshi Village, Photos, www.flickr.com*

Beautiful Bangladeshi Village | Shauradip Mazumder | Flickr

Ref 4.44: *Green building in Bangladesh, The Free Encyclopedia*
Green building in Bangladesh - Wikipedia

Ref 4.45: *Md. Nafizur Rahman, Mujtaba Ahsan, (January, 2009) Study on Eco-Housing, Conference Paper (Pg. 5), Publication at www.researchgate.net SeminarPaper_Ecohousing_19Jan2009.pdf*

Ref 4.46: *Greenhouse Gas Emissions in Bangladesh, USAID from the American People*
GHG Emissions Factsheet Bangladesh_4-28-16_edited_rev08-18-2016_Clean.pdf

Ref 4.47: *BUILDING ENERGY EFFICIENCY & ENVIRONMENT RATING (BEEER) for DESIGN AND CONSTRUCTION OF BUILDINGS*
2020-07-14-14-41-4283a662ff28ecad60d91906a6dc72db.pdf (portal.gov.bd)

Ref 4.48: *Bangladesh now has 204 green factories in RMG sector, Dhaka Tribune, December 25, 2024*

Ref 4.49: *Saleh Ahmed Mujaffor1, Bangladesh Climate Change Trust Fund Policy: Challenges and Way Forward, Bangladesh Journal of Administration and Management, Volume 32*

Ref 4.50: *Bangladesh's apparel industry enjoys rejuvenation (March 7, 2022), Financial Express*
https://thefinancialexpress.com.bd/trade/bangladeshs-apparel-industry-enjoys-rejuvenation- 1646620781

Ref 4.51: *Ahsan Manzil, a city of historical edifices*
https://www.shutterstock.com/image-photo/dhaka-ahsan-manzil-tourism-pink-palace-548458840

Ref 4.52 *The Curzon Hall, a British Raj-era building and home of the Faculty of Sciences at the University of Dhaka, located in Shahbagh.*
https://www.atlasobscura.com/places/curzon-hall

Ref 4.53: *A residential building in Old Dhaka, Hidden Heritage - Homes in Dhaka Nasir Khan Saikat*
https://nasirkhn.com/articles/hidden-heritage-homes-in-dhaka

Ref 4.54: *The Parliament House remains one of the best landmarks in Dhaka*
https://www.bproperty.com/blog/5-most-famous-buildings-dhaka/

Ref 4.55: *Bay's Edgewater at Gulshan 2*
https://vymaps.com/BD/Bay-Developments-Ltd--66327/

Ref 4.56: *City Center Dhaka at Motijheel Commercial Area*
List of tallest buildings in Dhaka - Wikipedia

Ref 4.57: *Arial view of building clusters at Dhaka City*
https://c7.alamy.com/comp/MRG1RK/top-view-of-the-dhaka-city-bangladesh-MRG1RK.jpg

Ref 4.58: *Some Residential Buildings in Adabor, Mohammadpur, Dhaka area Dhaka*
https://www.google.com/url?sa=i&url=https%3A%2F%2Fwww.pinterest.com%2Fpin%2F350225308522228465%2F&psig=AOvVaw0NVq2f4hQq4-9GZLPdnip6&ust=1714910399920000&source=images&cd=vfe&opi=89978449&ved=0CBIQjRxqFwoTCMjIuJz584UDFQAAAAAdAAAAABAJ

Ref 4.59: *Mega Mall Bashundhara-City-Shopping-Complex, Daily Sun (April 12, 2021)*
https://www.daily-sun.com/post/546838/Bashundhara-City-Shopping-Complex

Ref 4.60: *Amazing view of Bashundhara City!, (08-31-2019), Samsung, India*
https://r2.community.samsung.com/t5/Galaxy-Gallery/Amazing-view-of-Bashundhara-City/td-p/2251838

Ref 4.61: *Prothom Alo (25 October, 2020), https://en.prothomalo.com/youth/education/east-west-university-waives-student-activity-fees-2*

Ref 4.62: *Cityscape Tower, a LEED Gold Certified Building in Dhaka City*
https://chbbd.com/completed-projects/cityscape-tower/

Ref 4.63: *Aga Khan Academy Dhaka Recognised for Commitment to Building Green | Aga Khan Academies*

Ref 4.64: *Viyellatex group is a rapidly growing multi-dimensional organization in Bangladesh.*

Within a very short period of time.
https://www.viyellatexgroup.com/about/
Ref 4.65: *Exterior View of Plummy Fashion Limited (Ref 4.65)*
Ref 4.66: *Northern Tosrifa Group Official Website*
Website: ntg.com.bd
Ref 4.67: *Top 10 Green Garments Manufacturers With Leed Certification In The World - The InCAP*
Ref 4.67: *Saiham Tower https://www.saiham.com/*

Ref 4.68: *BRAC University Campus, Badda, Dhaka*
https://www.dezeen.com/2020/03/17/woha-brac-university-campus-bangladesh-architecture/
Ref 4.69: *Trust Green City, bd*
RIH-Ann-Project_Update-Trust_Green_City.ashx
Ref 4.70: Trust Green City Project Update
https://links.sgx.com/FileOpen/RIH-Ann-Project_Update-Trust_Green_City.ashx?App=Announcement&FileID=705818
Ref 4.71: *Bangladesh garment exports rebound from coronavirus crisis | Prothom Alo*
Ref 4.72: *Green Field of Karupannya Rangpur Factory / Nakshabid Architects | ArchDaily*
Ref. 5.1.1: Dhaka City Map
https://www.researchgate.net/figure/Location-and-administrative-map-of-Dhaka-city-13_fig1_320292356
Ref.5.1.2:*https://www.google.com/maps/search/parking+lot+of+grand+delvista+tower+gulshan+dhaka/@23.7882519,90.4166667,224m/data=!3m1!1e3?entry=ttu&g_ep=EgoyMDI0MDkwOC4wIKXMDSoASAFQAw%3D%3D*
Ref. 5.2.3: *https://www.pikpng.com/pngvi/hJxwhim_02-certificacio-n-l-leed-certification-clipart/.*
Ref. 5.2.4: *PowerPoint Presentation: sushantuniversity.edu.in/admin-assets/uploaddata/G-City-Scape-Tower-The-first-LEED-Platinum-Building-in-Bangladesh-Associate-Professor-Mujtaba-Ahasan_compressed.pdf*
Ref 5.2.5: *file:///C:/Users/USER/Downloads/Scorecard%20(3).pdf*
Ref 5.2.6: *https://cityscapeintl.com/portfolio/cityscape-tower/*
Ref. 5.2.7: *Picture showing high quality air-conditioning used for the Cityscape tower*
Ref 5.2.8: *https://sushantuniversity.edu.in/admin-assets/uploaddata/G-City-Scape-Tower-The-first-LEED-Platinum-Building-in-Bangladesh-Associate-Professor-**Mujtaba-Ahasan**_compressed.pdf*
Ref 5.3.1: *https://www.mawbiz.com.bd/eve-group*
Ref5.3.2:https*://www.google.com/maps/search/Eve+shirts+Ltd/@23.8245793,90.2533618,11z?entry=ttu&g_ep=EgoyMDI0MDkxMC4wIKXMDSoASAFQAw%3D%3D*
Ref 5.3.3: *https://www.evegroupbd.com/portfolio_category/factory-overview/*
Ref 5.3.4: *https://www.evegroupbd.com/portfolio_category/quarantine-room/*
Ref 5.3.5: *https://www.evegroupbd.com/*
Ref 5.3.6: *https://www.evegroupbd.com/portfolio-items/factory-overview-6/*
Ref 5.3.7: *https://www.evegroupbd.com/, (Office room)*
Ref5.4.1:*https://www.google.com/maps/search/TONGI+TO+MNR+SWEATER/@23.9236625,90.3772442,12.14z?entry=ttu&g_ep=EgoyMDI0MDgyOC4wIKXMDSoASAFQAw%3D%3D*
Ref 6.1: *https://www.evegroupbd.com/wp-content/uploads/assembly-03.jpg*
Ref 7.1 *https://www.thedailystar.net/business/economy/news/green-building-practices-gaining-momentum-309316*
Ref 7.2 *https://rmgbd.net/2024/04/29-companies-honoured-with-green-factory-awards/*